CHAPTER 1 POSITION OF THE NORTHEAST REGION: ECONOMIC GROWTH AND REGIONAL DISPARITY

1.1 Background, Objectives and Methodology

1.1.1 Background[1]

Economic development has been continuing as shown in GDP per capita as much as US$4,081 in 2008, an economic disparity between urban area such as Bangkok and rural area becomes a big issue for Thailand. Especially, the GDP per capita of Northeast region is as low as US$1,040 or only one-fourth of that in national average. The northeast region is considered as "Poorest Region" of the country. Though agriculture is the major industry in the Region, poor soil fertility, water shortage in dry season, less irrigated land resulted in low productivity of agricultural production. It is assumed that, therefore, improvement of water management is the issue to be solved in the region. Department of Water Resources under Ministry of Natural Resources and Environment, Royal Irrigation Department, under Ministry of Agriculture and Cooperatives and other government agencies has planned and implemented water resources development and utilization plan, but issues still remain unsolved. If it is necessary to development of large scale irrigation and water resources to increase productivity, environmental consideration, conservation of natural resources and impact to international rivers shall be taken into consideration. Public participation is also a necessary issue to be addressed. Under such circumstance, Thai government agencies prepare several plans for water resources sector.

1.1.2 Objectives

(1) Objectives and Expected Out-puts

The objectives is "**Consolidating all necessary information/data for fixing a framework of cooperation by the government of Japan in a long term perspective in the agriculture/water resource sector**" and expected four (4) out-puts are as shown below;

1) The latest situation on poverty and income disparity in Thailand be grasped and the position of the Northeast Region be confirmed.

2) Presently prevailing situation on the followings be confirmed and the related issues be consolidated after analysis.

3) Lessons leaned / best practices involved in the similar projects with supports by Japanese ODA and other donors are to be consolidated.

4) Proposal on direction of cooperation framework by Japanese Official Development Assistance (ODA) in medium to long term perspective in the agriculture/water resources management sector in the Northeast Region, which would contribute to rectifying regional disparity.

[1] Extract from TOR given by JICA

(2) Study Area

- Northeast region (19 provinces)
- Poverty profile: whole country

1.1.3 Methodology

(1) Study Period

The study mainly consists of the 1st filed study, domestic works, and the 2nd field survey. The 1st field survey was implemented for grasping of situations and review of existing information by main five experts of the JICA Study Team from March to April in 2010. The Progress Report was formulated during the domestic works and based on comments on the report from JICA personnel, the work schedule of the 2nd field survey was prepared. The 2nd field survey was implemented from early beginning of May to mid-August in 2010. All experts of the JICA Study Team joined in the study since June and they collected data/information and inspected some project sites for three (3) weeks in the field. Based on the collected information, the Team examined issues in water resource and agriculture in Northeast and discussed about future direction in collaboration with the agencies concerned. Those out-puts were compiled as the Final Report describing the long-term cooperation frame for water resource management sector.

Fiscal Year	2009	2010					
Works	March	April	May	June	July	August	Sep.
Domestic works							
1st Field survey							
Domestic works							
2nd Field survey							
Domestic works							
Submission of Reports	▲ IC/R	▲ P/R				▲ DFR	▲ FR

IC/R: Inception Report P/R: Progress Report DFR: Draft Final Report FR: Final Report

Figure 1.1.1 Work Schedule

(2) Methodology

1) Existing secondary data such as economic and agricultural data were collected and made best use for examination of current status. The collected statistic data is saved in data CD.

2) Relevant plan in various sectors and policy documents were collected from the agencies concerned to grasp policy directions of Government of Thailand. These are written in Thai Language and it is difficult to cover all information for the Team. However, main points were grasped and confirmed through interviews to personnel concerned.

3) Collected data/information concerning geography, water resource, natural environment, agriculture, social environment and so on were consolidated into GIS database. Based on the data, thematic maps in various sectors were prepared to grasp the situations with bird-eye.

4) Direction of development and issues were confirmed through the interviews. Those interviewees are not only governmental personnel but also researchers and academics, international organization, and Non-Governmental Organization (NGO) for hearing of various opinions.

5) During the field survey, the JICA Study Team inspected some sites of water resource management projects, irrigation projects, rural development projects and so on.

1.2 Enter into a Middle Income Country and Importance of Agricultural Sector

(1) Economic Growth

Overall trend of the national economic growth in Thailand is shown in the Figure below. The period covers 47 years to the year 2007 from 1961 when the National Economic and Social Development Plan (NESDP) was first launched.

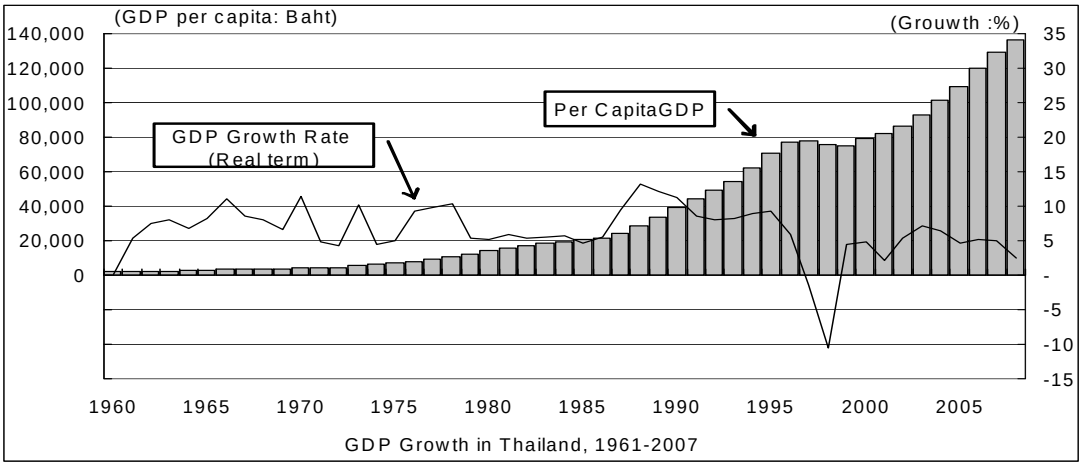


Figure 1.2.1 Per Capita GDP Growth and Real GDP Growth Rate in Thailand, 1961-2007

Through the entire period while the world economy accelerated its pace of globalization, the Thai economy attained good growth in general for quite a long period and moving forward to become a middle income country, except the two years period of 1997-1998 when the country suffered an enormous damage and negative growth due to the currency and economic crisis as originated from Thailand.

It was the manufacturing sector which exerted a pull to the national economy leading a way for Thailand to become a middle income country. Looking at the GDP amounts segregated by sector (see Table 1.2.1), the manufacturing sector who led the growth increased its share in the overall national economy, and reversed its position relatively contrary with the agriculture/fishery sector which decreased the share considerably during the period.

Table 1.2.1 Change of Composition of GDP by Agriculture Manufacturing sector

	1960	1970	1980	1990	2000	Q1/2010
Agriculture	33.4 %	25.9 %	23.2 %	12.5 %	9.0 %	12.1 %
Manufacturing	14.5 %	16.1 %	21.5 %	27.2 %	33.6 %	36.6 %

Source: NESDB

Provided, however, it shall be noted that as compared with the manufacturing sector, the agriculture/fishery sector require much less import of machine and equipment and raw materials, and can enjoy positive surplus in the balance of international payments. This, in addition to the fact that the sector covers a large sum of employment population as much as 34.9% of labor (as of January, 2010), implies that the agriculture/fishery sector still maintains its important and crucial position in the overall national economy.

In 20 years of the recent past, it can be said that the good growth/expansion of the national economy could be made possible by the expansion of export. The export could be expanded owing to the diversification of export items with a good balance between the newly emerged manufactured goods(Computer, automobile and electric alliances) as supported by foreign investment and the ever-continuing steady increase in the indigenous agricultural items. In parallel with the said diversification of export items, Thailand has successfully developed/expanded new export markets as China, India and neighboring ASEAN countries keeping the pace with the movement of the world economy. As the result, it can be said that the market deployment for Thai export is seemed to have a very good balance in global basis view point.

Table 1.2.2 Transition of Export Goods and Value, 1960-2008 (million baht)

	1960	1970	1980	1990	2000	2008	
Agriculture Product	6,628	9,855	69,310	113,270	237,811	590,978	
Rice	2,570	2,516	19,508	27,770	65,557	203,219	1
Para Rubber	2,579	2,232	12,351	23,557	60,712	223,628	1
Tin	537	1,618	11,347	1,880	2,802	8,442	2
Maize	551	1,969	7,299	4,144	396	7,797	3
Tapioca	288	1,223	14,887	23,136	20,281	47,765	1
Cattle fish	100	73	1,301	4,577	11,659	13,471	3
Prawn	3	224	1,961	20,454	60,598	84,403	3
Broiler (Frozen)			656	7,752	15,806	2,253	2
Manufacturing (Old)		312	22,240	221,507	608,737	917,031	
Fish Can			603	15,895	26,808	71,758	3
Canned Pineapple		55	1,432	5,524	7,876	17,052	3
Sugar		94	2,975	17,694	25,751	47,637	1
Textile		13	9,643	92,231	221,971	101,842	1
Furniture			378	11,511	39,148	46,115	2
Footwear			181	20,213	33,479	31,967	2
Gem		150	502	34,858	63,379	274,102	1
Plastic product			370	9,116	11,038	88,587	1
IC			6,156	14,465	179,287	237,971	1
Manufacturing (New)				69,652	663,858	1,453,854	
Computer and Parts				38,671	338,641	605,314	1
Air Condition and parts				1,955	42,225	107,117	1
Refrigerator, Microwave				3,764	23,052	45,306	1
Television, radio				7,272	60,760	103,685	1
Clock, Watch				4,887	11,760	16,435	2
Motor				2,997	67,401	29,181	2
Electrical wire				4,565	18,719	33,589	2
Vehicle and Auto parts				5,541	101,300	513,227	1
Total	8,614	14,772	159,728	589,813	2,773,826	5,853,613	2

(Data Source modified from Watanabe, T (2006) “Readings in Asian Economy”, with additional data on for 2008 from 1:Ministry of Commerce, 2:World Trade Atlas, 3: Agricultural Trade Statistics

(2) Position of the Northeast and situation of the Regional Economy

As can be seen from the graph below, while national economy continued favorable growth as a whole, the Northeast Region ranked at the lowest at all times and the disparities in GRP amount with the other Regions expanded as well.

To this end, what to be remarked are East Region which surpassed Bangkok Metropolitan area in recent years with the rapid expansion of GRP as derived from the ever-developing Eastern Seaboard industrial area since 1990 and Central Region which attained good and steady growth since 1990's. These remarkable accomplishments in both Regions are deemed to be caused by rapid production increase in manufacturing sector as accompanied by the fast expansion of industrial estates in the Regions.

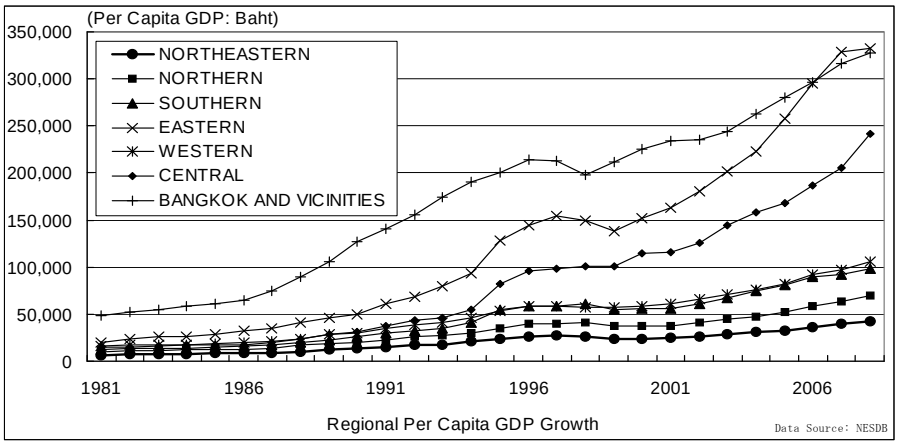


Figure 1.2.2 Regional Per Capita GDP Growth, 1995-2008

For the Northeast, the regional share in the national GDP has been maintained at around 10 %, while it is to be noted that some years in the recent past the regional growth rates were higher than the national average. Such growing sectors which caused higher regional growth were agriculture as supported by higher price level, whole sale-retailing, manufacturing, transportation and education (see Figure 1.1.3). It is considered that the high growth in those sectors with relatively larger GRP amount share caused the higher growth rate as the overall regional rate. This implies that in order to attain higher

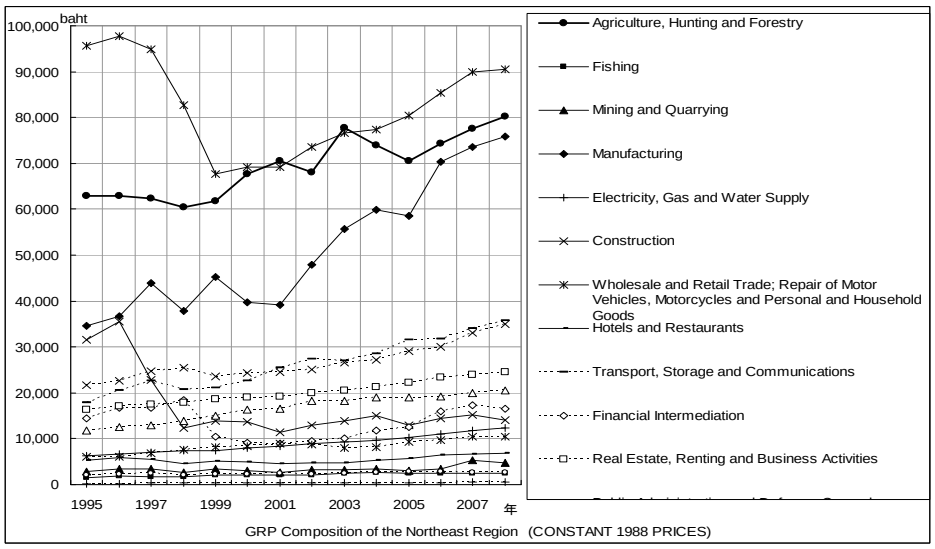


Figure 1.2.3 Regional GDP Growth of the Northeast by Sector, 1995-2008

economic growth rate in the Northeast Region, development of agriculture and manufacturing sectors is inevitably important.

(3) Sector-wise GDP Composition by Region

The following Table and Graph as prepared based on the NESDB data in 2007 show sector-wise GDP composition, GDP per capita and the compositional trend of regional production in Northeast (2001-2007). What are remarkable includes the following points. (Sub-division by 8 Regions)

* The amount of GDP per capita is of clear bipolar.

	i) Bangkok and Vicinity, Central, Eastern	**ii) West, Northeast, North, South,**	**Whole Nation**
GDP (million baht)	5,632,809 (66.3%)	2,860,502 (33.7%)	8,493,311 (100%)
Population ('000)	18,835 (28.5%)	47,206 (71.5%)	66,041 (100%)
Per Capita GDP (Baht)	299,060 (232)	60,596 (47)	128,606 (100)

* Major factor of above bipolar situation is in the difference of ratios shared by either manufacturing or agriculture and also the difference in the production values.

	i) Bangkok and Vicinity, Central, Eastern	**ii) West, Northeast, North, South,**
Agriculture	B 132,234 million (16%)	B675,664 million (84%)
Manufacturing	B 2,552,193 million (84.9%)	B 471,262 million (15.1%)

The reason/cause of the regional disparity is exactly here in this point which implies further that the disparity in per capita GDP is derived from the difference in ratios between agriculture and manufacturing.

This further suggests that regional income disparity can not be rectified satisfactorily even if considerable efforts be exerted to develop agriculture in Northeast Region if not accompanied by the increase of agriculture-related manufacturing sector as agro-industries and food industry in the Region.

Table 1.2.3 GDP at Current Market Prices: by Industrial Origin and Region, 2007

Unit: million Baht

	Bangkok	Vicinity of Bangkok	Central	Eastern	Western	Northeastern	Northern	Southern	Whole Kingdom
Agriculture	3,524	20,434	38,044	70,232	69,222	180,335	176,326	249,781	807,898
Fishing	310	14,541	848	13,845	4,568	3,643	2,914	65,360	106,029
Mining and Quarrying	-	1,503	8,729	193,960	8,871	11,833	31,332	20,442	276,670
Manufacturing	477,895	914,887	392,715	766,696	74,439	145,822	135,574	115,427	3,023,455
Electricity, Gas and Water Supply	40,972	35,991	18,326	75,773	28,727	14,512	14,029	19,788	248,118
Construction	75,036	33,611	8,828	24,429	9,686	37,516	32,884	24,631	246,621
Wholesale and Retail Trade	535,796	71,737	44,344	102,081	52,599	181,856	110,966	93,308	1,192,687
Hotels and Restaurants	258,643	25,556	4,726	34,151	11,707	17,744	19,139	44,926	416,592
Transport and Communication	277,845	135,591	19,466	62,415	17,889	36,627	30,233	42,013	622,079
Financial Intermediation	164,238	26,906	8,461	16,242	9,667	36,134	27,381	22,460	311,489
Real Estate, Renting	78,062	20,110	14,529	15,335	8,872	29,908	25,049	23,532	215,397
Public Administration, Compulsory Social Security	135,478	14,107	20,889	28,708	19,871	62,304	51,035	40,819	373,211
Education	54,702	18,497	17,944	21,778	19,174	107,392	66,454	54,211	360,152
Health and Social Work	37,133	14,525	9,250	11,790	10,141	32,025	28,598	20,389	163,851
Other Community, Social and Personal Services Activities	72,165	11,114	4,114	6,792	4,703	5,282	6,550	9,134	119,854
Private Household with Employed Persons	5,197	691	200	372	237	1,188	936	391	9,212
Gross Domestic Product (GDP)	2,216,997	1,359,801	611,413	1,444,598	350,372	904,119	759,400	846,611	8,493,311
Population	6,842,000	4,535,000	3,008,000	4,450,000	3,623,000	22,522,000	12,037,000	9,024,000	66,041,000
GDP per Capita (Baht)	324,039	299,846	203,245	324,609	96,714	40,144	63,088	93,821	128,606

Source: Gross Regional and Provincial Products 2007 series. Office of the National Economic and Social Development Board. Office of the Prime Minister.

In addition to the above, it may be interesting to look into the rather big differences among the group of ii) regions. In this group too, the Northeast Region stays at the lowest level. In this case the crucial difference is not in the ratios for manufacturing and agriculture. What is evident is only the fact that the South Region shares as high as 62 % in the fishery sector and no any others. While when considering the GDP amounts in agriculture sector in comparison with the total planted area, the low productivity per unit area in Northeast is judged to be extremely disadvantageous.

Table 1.2.4 Comparison of Value of Agricultural Production by 3 Regions

	South	North	Northeast
(1)Total Cultivation land (million rai)	23,340	32,590	63,550
- Paddy Field	2,170	15,970	41,770
- Upland	20	10,910	15,340
- Fruit Tree and Perennial	1,955	375	360
(2) Agriculture Production Value (Mill. Baht)	249,781	176,326	180,335
(2) / (1)	B10,700/rai	B5,400/rai	B2,838/rai

From the above Table, the regional characteristics of crop cultivation can be summarized/tabulated as the followings:

* South: Higher productivity/profitability fruit trees/perennial crop are main sharing as much as 84 % of the total.
* North: Paddy and upland (Soybean/maize) are rather balanced. Unit yield is higher comparable to Central region.
* Northeast: 2/3 is paddy planting. Of the paddy area, 90 % is under rain-fed.Very low unit yield by extensive manner of farm management.

As the result, as shown in the above table, the land productivity in NE Region is quite low, causing least GDP per capita as derived mainly from the rain-fed farming.

In view of the foregoing, it can be concluded that though there remains some hesitation to insist crop changes from rain-fed paddy to some others may be the best countermeasure in tackling the poverty problem in the Region, as there are constrained natural conditions and based on which rural society of each locality of the Northeast Region is existing, however, in order to rectify the regional income disparity by raising up the GDP per capita, either considerable improvement in rain-fed paddy cultivation productivity or large scale crop conversion to other potential crops will be inevitable.

On the other hand, Agro-industry, including sugar, feed, food processing and bio-ethanol, is important sub-sector to Thai economy since it has been leading sector in export. Thai government has policy to make Thailand to be “Kitchen of the World” by fostering agriculture and food industry and promoting export of those goods. Currently Thailand is the second rank in agro-food exporting after China. It is expected to contribute to economic growth based on agriculture by value adding to agriculture.

1.3 Economic Disparity and Poverty Issues in Thailand

(1) Regional Disparity

As shown in above, main reason why the Northeast Region is considered as a poor area is in the fact that the per capita GDP is very low as compared with the others (see Figure2.1.1 and Table 2.1.3). As per the statistics in 2007, the per capita GDP in the Region is mere 40,144 Baht, which is only 1/8 of the level representing Bangkok Metropolitan area and East Region. The very basic factor causing such difference is that the Northeast Region having as many as 21 Million people sharing 1/3 of the national total of 63 Million (Notified data in 2008), but most of them depend their lives upon small-medium enterprises and agriculture which usually suffer from comparatively low productivity.

Aside from per capita GDP which shows productivity, household income also shows regional economic disparity. Results of 2007 household socio-economic survey (NSO) shows that average monthly income in the Northeast is the lowest as little as 12,995bhat per month per household, and followed by the North with 13,568 bhat. Average income of the Northeast is 37% of average income of Bangkok, which is narrower gap of GDP per capita due to including transfer from migrated family member. As for gap in expenditure is still narrower, average expenditure of Northeast is as much as 46% of that of Bangkok. Ratio of expenditure against income is highest in the Northeast as much as 84%. Ration of indebted household is also highest in the Northeast as much as 77%.

. **Table 1.3.1 Household Income, Expenditure and Debt by Regions (2007)**

	Whole Kingdom	Region									
		Greater Bangkok		Central		North		Northeast		South	
Average Monthly Income (Baht)	18,660	35,007	100	18,932	54	13,568	39	12,995	37	19,716	56
Average Monthly Expenditures (Baht)	14,500	23,996	100	15,168	63	10,990	46	10,920	46	15,875	66
Expenditure/ Income	78%	69%		80%		81%		84%		81%	
Number of Indebted Households (Household)	11,506,100	1,278,900	56%	2,090,600	35%	2,351,400	59%	4,397,200	77%	1,388,000	51%
Average Debt per Household (Baht)	116,681	151,168	100	112,342	74	110,702	73	105,006	69	118,525	78

Source: Socio-economic Survey 2007 (NSO), DLA(Number of total household)

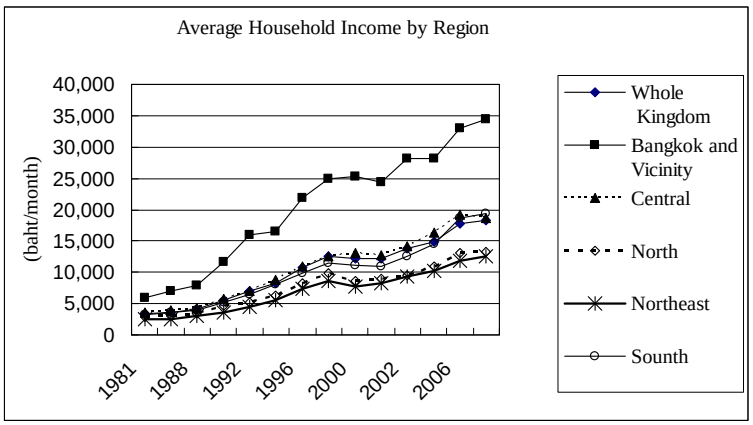
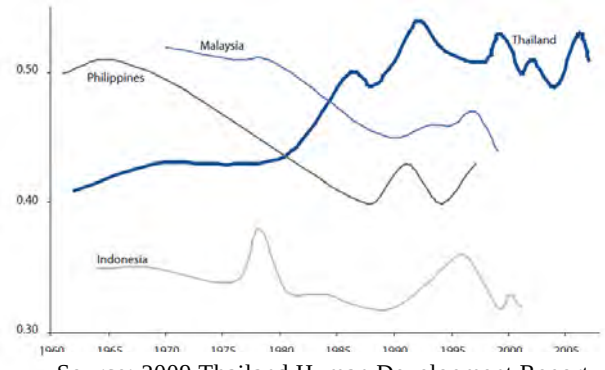


Figure 1.3.1 Changes of Household Income by Region, 1981-2007

(2) Inequality

Thailand has a problem of considerable income inequality comparing with other Asian countries by Gini Coefficient. While other countries improving income equality with economic growth, income inequality in Thailand has trend to get worse with economic growth. Recent data on Gini coefficient in Asian countries are as follows; Thailand 0.425, Malaysia 0.379, Vietnam 0.378, Indonesia 0.394, India 0.368, Philippines 0.44, Singapore 0.425. (See Appendix 1.3.3)



Source: 2009 Thailand Human Development Report

Figure 1.3.2 Gini Coefficient of Thailand and Other Asian Countries

Though recent improvement in Gini coefficient, yet situation has not changed from the richest 20% enjoy half of wealth in Thailand. The richest 10% earns 12-15 times of average income of poorest 10%[2].

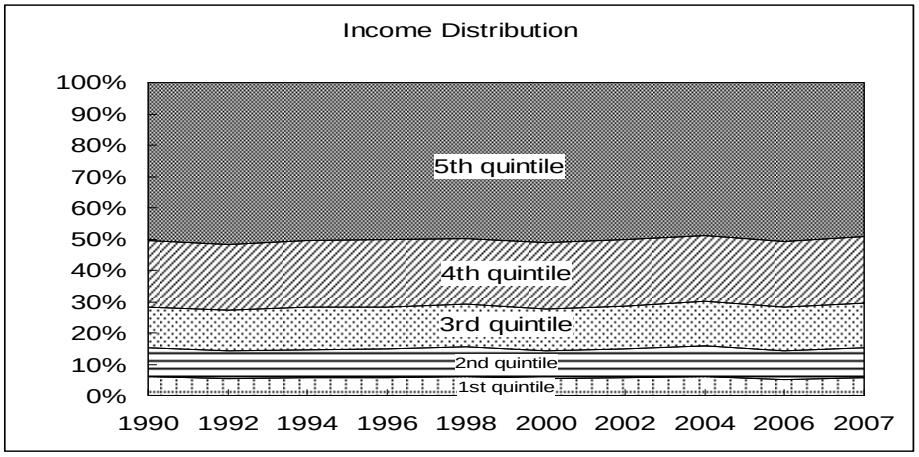


Figure 2.2.3 Income Distribution by Quintile, 1990-2007

(3) Poverty Incidence and Number of the Poor

Population under poverty line was over 40% or more than 22 million people in 1998. It has been decreased to approximately 15% or 8.5 million people by 1996 before Asian financial crisis in 1997. Though once increasing after the crisis by year 2000, Poverty incidence has been halved by 2006. Poverty incidence in 2007 shows only 8.48%.

Looking into regional difference, half of population under poverty line resides in the Northeast. Accordingly poverty incidence is always highest in the Northeast, and that of 1988 was more than 50%. Situation has been rapidly improved after year 2000, and the latest poverty incidence of the Northeast in 2007 is 13% only.

[2] "Thailand Economic Monitor November 2009" World Bank, p47-48 (www.worldbank.or.th)

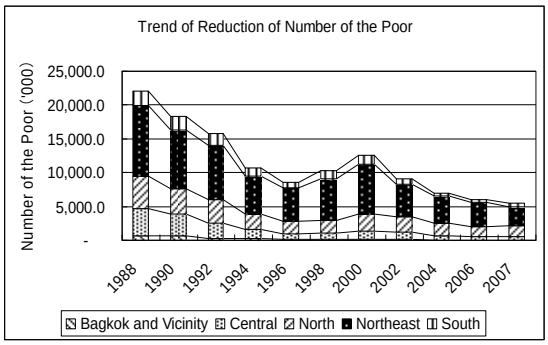


Figure 1.3.4 Trend of Reduction of Poverty

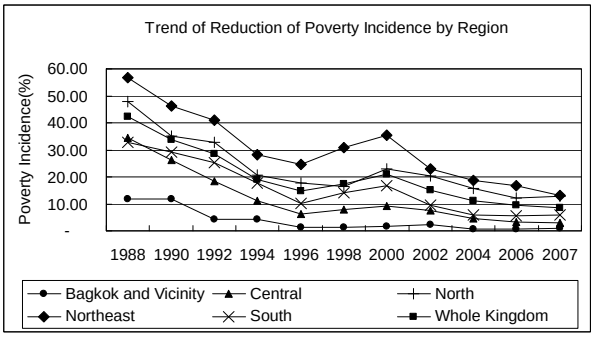


Figure 1.3.5 Trend of Poverty Incidence

(4) Poverty in Rural Area

About 80-90 percent of Poor people live in rural area. Though poverty incidence has been reduced in rural area from 50% in 1988 to 10 % in 2007, still 4.8 million people stay below poverty line in rural area. On the other hand, urban poverty incidence is below 4%, which suggest that target of poverty reduction shall be focused on rural poor in the region.

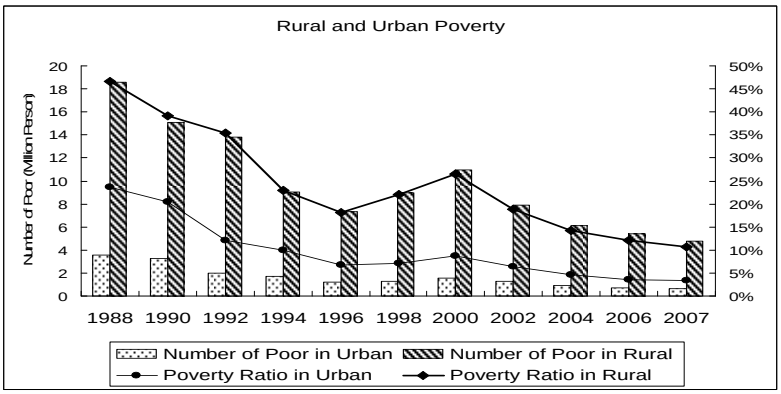


Figure 1.3.6 Rural and Urban Poverty, 1988-2007

Poverty Map based on household economic survey in 2007 (Figure 2.2.7) shows that poverty incidence is high in rural area in the Northeast and the North region. It should be noted that high poverty incidence provinces can be found mostly in the Northeast.

According to Poverty Assessment report (NESDB, 2009) prepared with socio-economic survey data in 2007, poverty is remarkable in farm household (agricultural land holder and agricultural service employee). Especially that is true in the Northeast and the North region. In the Central and South region, poverty incidence of farm household is still low.

Table 1.3.2 Poverty Incidence and Number by Occupation (Whole country 2004-2007)

Occupation	Poverty Incidence (%)			Number of Poor (1,000)		
	2004	2006	2007	2004	2006	2007
Farm Operator						
- Mainly Owning land	18.97	15.69	13.67	2,219	1,876	1,620
- Mainly Renting Land/ Free	19.79	16.05	15.12	536	450	388
Fishing, Forestry, Agricultural Service	14.20	27.80	27.41	49	348	388
Own –account Workers, Non-farm	3.19	4.11	4.06	363	490	506
Professional, Tech, Adm. Workers	1.29	1.36	0.69	80	79	43
Farm Workers	28.19	17.39	16.54	1,193	483	378
General Workers	14.00	12.21	15.43	125	72	83
Clerical, Sales, Services Workers	4.25	3.32	2.85	369	294	248
Production Workers	8.84	7.83	6.70	749	659	574
Economically Inactive	16.12	14.47	12.83	1,335	1,307	1,196
Total	11.16	9.55	8.48	7,019	6,057	5,422

Source: Poverty Assessment Report (NESDB 2009)

Table 1.3.3 Poverty Incidence by Occupation and Region (2007)

Occupation	Poverty Incidence (%)					
	Bangkok	Central	North	Northeast	South	Total
Farm Operator						
- Mainly Owning land	-	4.93	16.06	17.81	3.21	13.67
- Mainly Renting Land/ Free	-	3.15	21.32	17.36	4.46	15.12
Fishing, Forestry, Agricultural Service	-	4.74	40.63	32.89	4.22	27.41
Own –account Workers, Non-farm	0.56	1.77	4.33	8.64	2.02	4.06
Professional, Tech, Adm. Workers	-	0.23	1.62	1.14	1.09	0.69
Farm Workers	-	19.21	22.56	21.46	11.70	16.54
General Workers	5.71	12.42	18.72	24.24	13.85	15.43
Clerical, Sales, Services Workers	2.17	1.19	2.58	4.55	4.95	2.85
Production Workers	2.12	1.93	12.20	10.85	14.92	6.70
Economically Inactive	1.22	6.69	14.55	15.50	9.80	12.83
Total	1.14	3.08	12.93	13.05	5.88	8.48

Source: Poverty Assessment Report (NESDB 2009)

The table shows poverty incidence by land holding size (Table 1.3.4), smaller land holder tends to be relatively higher poverty incidence. Poor are concentrated in small holders of less than 20 rai (3.2ha).

Table 1.3.4 Poverty Incidence and Number of Poor by Land Holding Size (Whole Country)

Land holding size	Poverty Incidence (%)			Number of the Poor (1,000)		
	2004	2006	2007	2004	2006	2007
Less than 5 rai (0.8ha)	25.16	23.82	19.22	258	269	222
5-19 rai (0.8- 3.0ha)	23.29	18.60	16.49	1,339	1,054	939
20 rai (3.2ha) or more	12.63	10.72	9.18	622	553	458
Total	18.97	15.69	13.67	2,219	1,876	1,620

Source: Poverty Assessment Report (NESDB 2009)

Composition of household explains that households without working age, i.e. Elder only and Child only, are high probability of the poor, so that poverty reduction strategy shall focus on welfare policy. Thai Government has been implementing poverty alleviation program through direct provision of social pension to elderly, school lunch for poor pupils, and student loan program as well as indirect support through community development. (See Annex II Poverty Profile)

Table 1.3.5 Poverty Incidence by Household Member

Household member	Poverty Incidence (%)		
	2004	2006	2007
Child, Working Age, and Elder	13.29	13.6	11.86
Child and Working Age	11.93	9.27	8.29
Child and Elder	34.23	24.17	21.12
Working Age and Elder	10.08	8.72	7.95
Child only	n.a.	23.6	11.39
Working Age only	4.99	3.73	2.85
Elder only	19.17	20.37	19.39
Total	11.16	9.55	8.48

Source: Poverty Assessment Report (NESDB 2009)

(5) Multi-dimensional Poverty and Human Development Indicator

Above analysis was made based on Poverty measurement using poverty line set by NESDB derived from income or expenditure necessary for minimum needs. This poverty measurement reflects view on poverty as low income. UNDP, however, present different views on poverty by developing Human Development Index (HDI) based on "Capability Theory" of Sen A., which determine poverty as lack of freedom and opportunity. Human Development Report 1997 introduced Human Poverty Index (HPI), which measure poverty in multi-dimensional approach, e.g. short lives, lack of primary education, lack of access to resources. Thailand is ranked at top 11 among 78 countries measured by HPI.

UNDP Thailand Office introduced Human Achievement Index (HAI) based on the same principle of HDI in 2007. Human development Report 2009 modified and introduced 3rd generation of HAI and measures all the provinces by Health index, Education index, Employment index, Income index, Housing and living environment index, Family and Community life index, Transportation and Communication Index, and Participation Index (see Appendix 2.2.2).

Regional HAI shows that the Northeast is better than national average and other regions in Family and Community Index and Participation Index but lagged behind in other indices. Community life and mutual help is still important in people's life in the Northeast, and participation in social activity and group activity is strong point of communities in the Region, which shall be taken into account when one considers about poverty reduction.

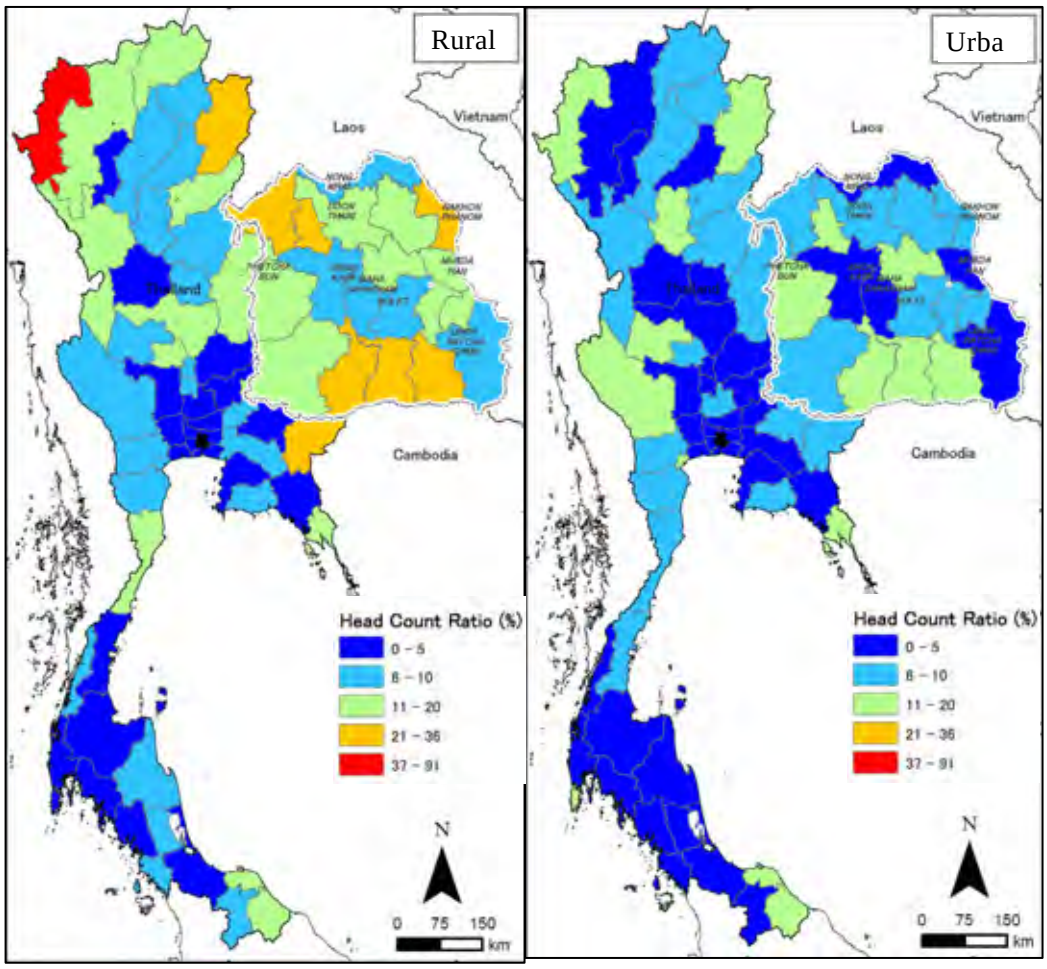


Figure 1.3.7 Poverty Map shows Poverty Ratio in Rural (Left) and Urban (Right), 2007

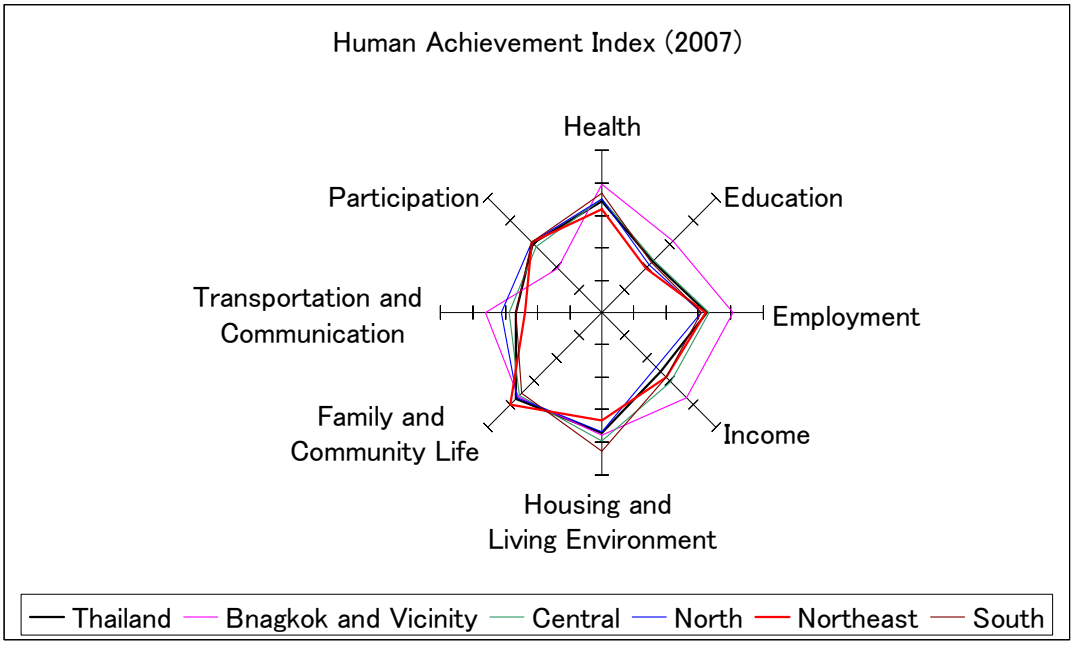


Figure 1.3.8 Human Achievement Index by Region, 2007

1.4 Position of the Northeast Region and Issues on its Development

Thailand is to be a middle income country and poverty incidence becomes lower that 10%. Poverty reduction policy and programs for the poor need to focus on social welfare, and the poverty is not core issue of the socio-economic development anymore. On the other hand, however, income and regional disparity is a serious issue and unbalanced economic development is considered as cause of social unrest. Especially gap between Northeast Region and Bangkok is largest; therefore Northeast region is considered as a region where economic development is necessary.

In this chapter, it is pointed out that;

- Agricultural productivity in Northeast is lower than other region,
- Cause of low productivity in Northeast is due to main produce is rice 90% of which rely on rein fed agriculture,
- Northeast is major production base for export agricultural produce and for raw material of food processing industry, and
- Crop diversification and value-adding by food industry is direction for development based on agriculture and related industry.

But under the “Sufficiency Economy” concept being adopted as the core concept for the national economic and social development in the country, the development vision placing emphasis on human development and balance of environment and development as described as “Green and Happiness Society” but not economic development is indicated. It should be seek sustainable development utilizing local resources for livelihood improvement of local people. Water resources is important for agricultural production and livelihood of local people as well as local ecology and bio-diversity

From the said view point, the directions for Japanese development cooperation with Thailand shall be studied in following chapters, focusing on current situation and issues on agricultural sector and water resources management as well as taking Thai government policy and plan toward such issues into consideration.

1.5 Composition of the Report

This Final Report consists of eight chapters including this chapter as follows: Chapter 2 as Socio-Economic Situation and Current Condition and Issues in Agriculture in the Northeast Region, Chapter 3 as Existing Water Resources Management, Chapter 4 as Natural and Social Environmental Issues in Water Resource Development and Management, Chapter 5 as Review on Projects assisted by GOJ and Other Donors in Water Resource and Agriculture Sectors, Chapter 6 as Development Scenarios for NE Region, Chapter 7 as Framework for Assistance to Reduce Regional Disparity in the Northeast Region, and Chapter 8 as Recommendations.

Annexes are attached as three (3) volumes, namely, Annex I: Appendixes to the main report, Annex II: Poverty profile, and Annex III: GIS theme maps.

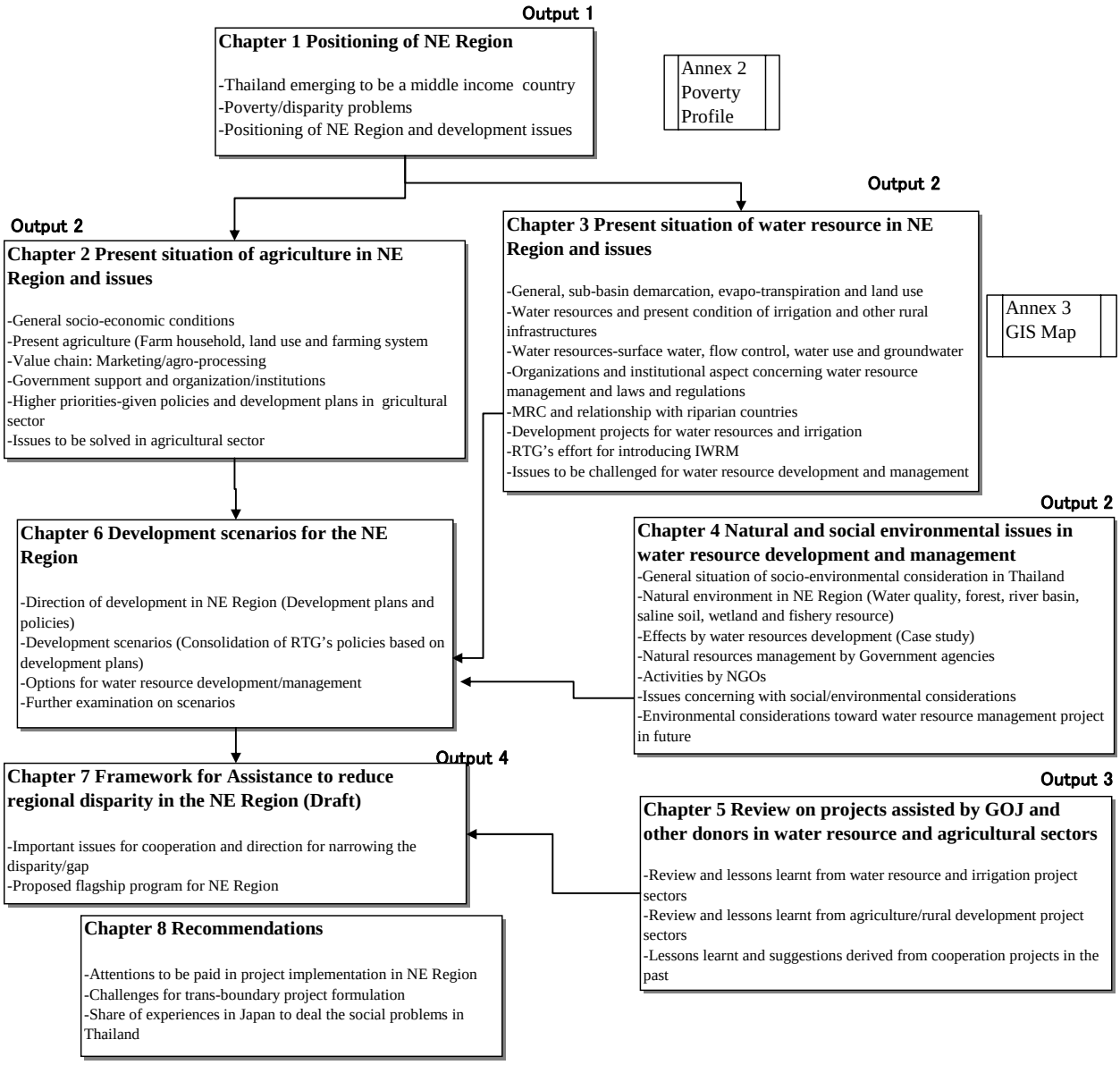


Figure 1.5.1 Scope of the Survey and Composition of the Report

CHAPTER 2 CURRENT CONDITION AND ISSUES IN AGRICULTURE IN THE NORTHEAST REGION

2.1 Socio-Economic Situation of the Northeast Region

(1) General

The Northeast Region of Thailand consists of 19 provinces with having the regional total land area of 169,000 km^2 which shares 33 % of the national total of 513,000 km^2. In 2008 the regional population accounts for 21.4 Million people with 5.8 Million households which shares around 30% of the national total at 63 Million people and 18.2 Million households. Provincial areas and the populations are as shown in the following Table.

Table 2.1.1 Population, Area, Density and Household by Province in the Northeast

Region		Population in '08 (1,000 person)	Area (sq. km)	Density (per sq.km)	Household (1,000 HH)	Average Size of Household
Whole Kingdom		**63,390**	**513,119.5**	**123.54**	**20,608**	3.1
Bangkok and Vicinity		5,711	1,568.7	3,640.43	2,264	2.5
Central Region		15,616	102,336.0	152.60	5,932	2.6
Northern Region		11,879	169,644.3	70.02	3,984	3.0
Northeastern Region		**21,443**	**168,855.3**	**126.99**	**5,695**	**3.8**
Southern Region		8,742	70,715.2	123.62	2,734	3.2
Cluster	**Province in Northeast**					
Central Northeast (Central NE)	Khon Kaen	1,756	10,886.0	161.32	499	3.5
	Kalasin	979	6,946.7	140.87	251	3.9
	Roi Et	1,307	8,299.4	157.51	328	4.0
	Maha Sarakham	937	5,291.7	177.04	245	3.8
Lower Northeast 1 (Lower NE1)	Nakhon Ratchasima	2,565	20,494.0	125.16	764	3.4
	Chaiyaphum	1,123	12,778.3	87.86	326	3.4
	Buri Ram	1,542	10,322.9	149.34	380	4.1
	Surin	1,376	8,124.1	169.32	328	4.2
Lower Northeast 2 (Lower NE2)	Si Sa Ket	1,441	8,840.0	163.06	333	4.3
	Amnat Charoen	369	3,161.2	116.88	94	3.9
	Yasothon	539	4,161.7	129.58	142	3.8
	Ubon Ratchathani	1,795	15,744.9	114.03	467	3.8
Upper Northeast 1 (Upper NE1)	Udon Thani	1,536	11,730.3	130.91	414	3.7
	Loei	618	11,424.6	54.13	180	3.4
	Nong Khai	907	7,332.3	123.68	244	3.7
	Nong Bua Lam Phu	500	3,859.1	129.44	125	4.0
Upper Northeast 2 (Upper NE2)	Mukdahan	337	4,339.8	77.77	90	3.7
	Nakhon Phanom	699	5,512.7	126.86	184	3.8
	Sakon Nakhon	1,116	9,605.8	116.18	301	3.7

Source: Department of Local Administration, Ministry of Interior

In grouping the 19 provinces in the Northeast Region, the 5 clusters grouping as applied by NESDB will be used in the subject study, though different government agencies apply different

grouping in accordance with the juristic sub-division as per their regional office locations. (See Figure 2.1.1)

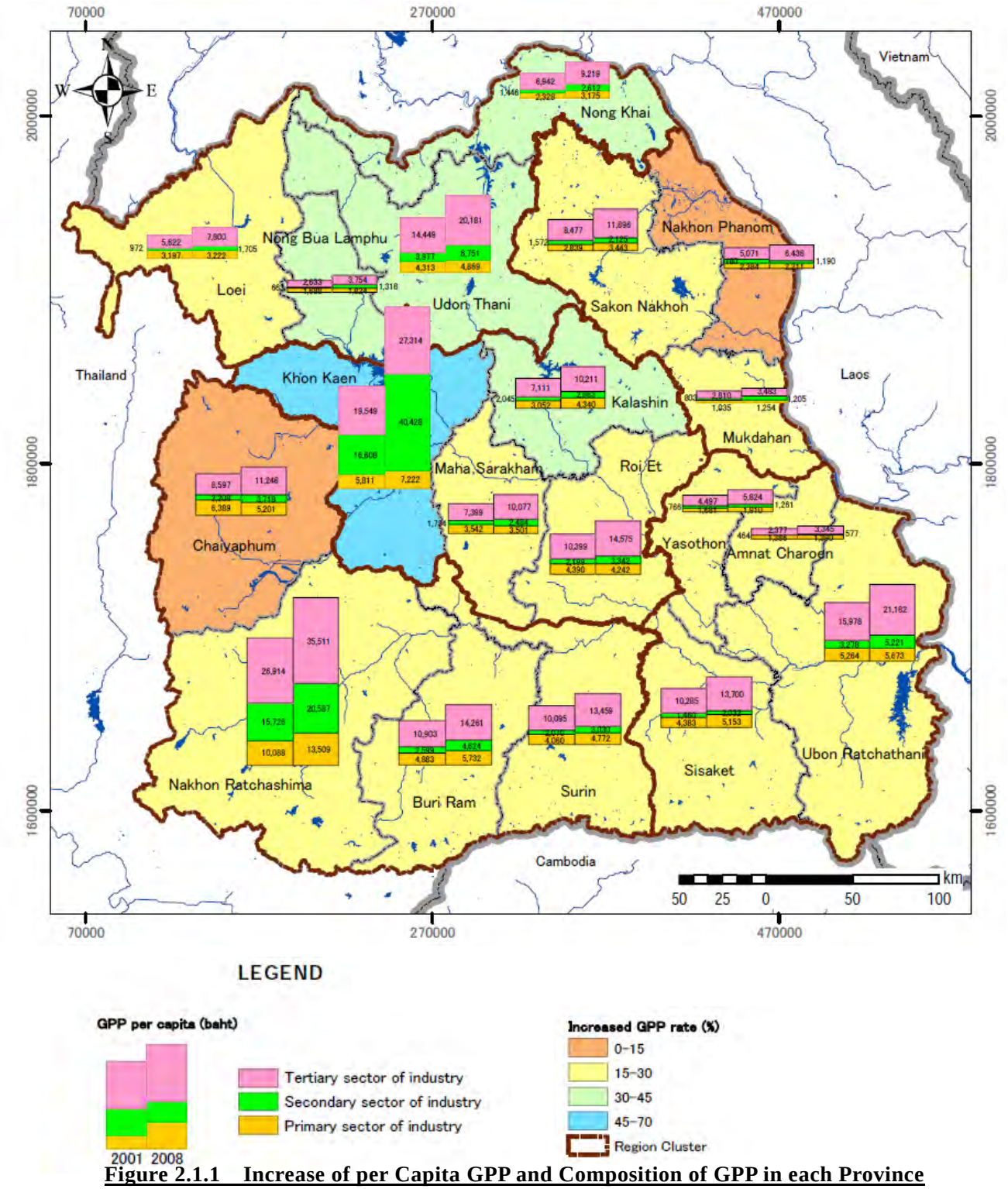


Figure 2.1.1 Increase of per Capita GPP and Composition of GPP in each Province

(2) Socio-economic Situation in Northeast Region

When comparing the scale of economy by GPP of 19 provinces in the Northeast Region, Nakhon Ratchasima is the largest followed by in order Khon Kaen, Ubon Ratchathani, Udon Thani and others. These four (4) provinces including the regional core cities/urban areas shares as much as 45 % of the regional production (GRP). Looking at the GRP growth in the recent past (2001-2008), Khon Kaen attained the highest growth seconded by Kalasin, both in the Central Northeast cluster. Central Northeast cluster was the growth center and the Upper Northeast cluster including provinces of Nong Khai, Udon Thani and Nong Bua Lam Phu showed comparatively good growth as well . (See Figure 2.1.1)

In order to consider the regional disparity/income gap, it is necessary to grasp how the regional economic growth gave impact on the household expenditures. As per the house-hold socio-economic survey, average monthly income during the period from 2000-2007 increased in all the provinces considerably. Main factors contributed to the increase are deemed as the income derived from non-agriculture source. In Nong Khai, Kalasin and Nakhon Ratchasima provinces, large increase of production in para rubber, sugarcane and cassava is found respectively and considered that these led to the higher income in these provinces.

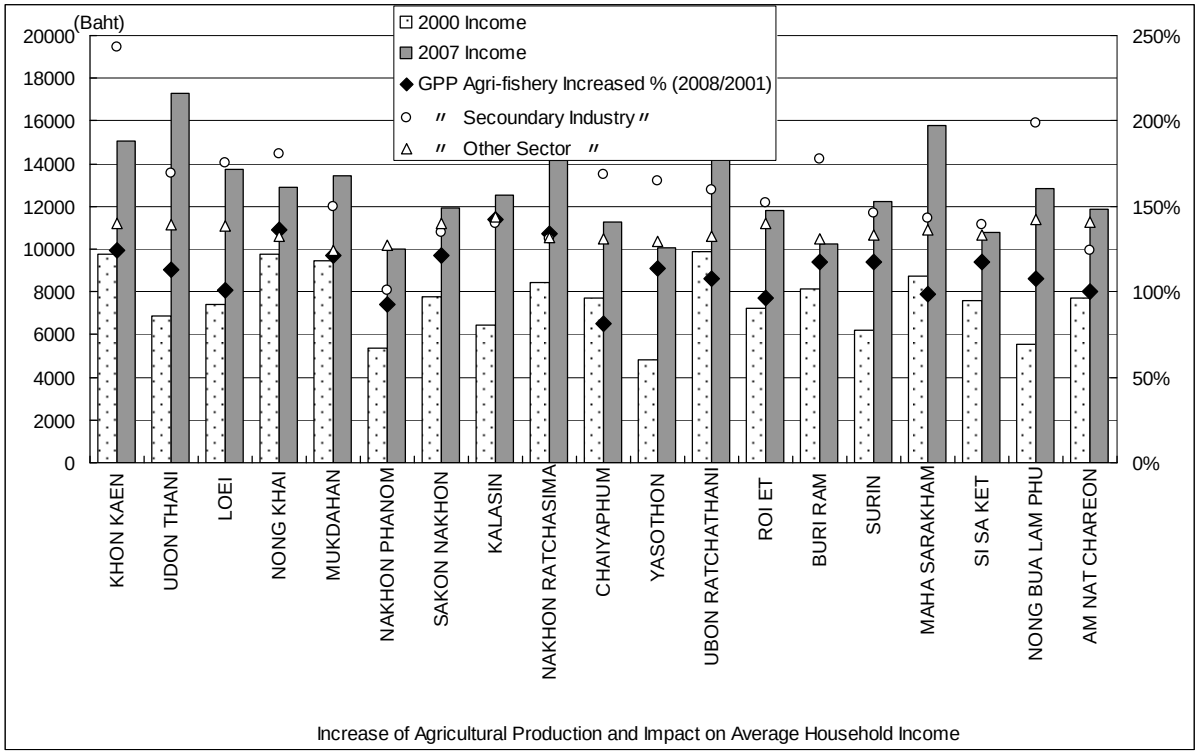


Figure 2.1.2 Increase of Agricultural Production and Impact on Provincial Average Income

2.2 Present Situation of Agriculture Sector in Northeast Region

2.2.1 Present Situation of Farm Household

(1) Number of farm household and employment population in agriculture sector

The proportion of farm households in the Northeast Region had been reduced from 61.3 % in 1993 to 52.1 % in 2003. The number of farm households increased, however, from 2.5 Million to 2.65 Million during the same period. (Agricultural Census) Employment population in agriculture fluctuates seasonally according to the labor statistics. In the wet season, the population shows a decreasing tendency since the latter part of 1990's except the economic crisis in 1997, and the proportion of employment population in agriculture itself has been lowered down as well. But, even in 2009, the proportions are 58 % in wet season and 45 % in dry season, implying that agriculture sector still holds the most important position for the people in the Northeast Region. While in view of the household's income, the contribution by farm income has been reduced constantly and employment opportunities and resultant income from non-farm source become more important year by year.

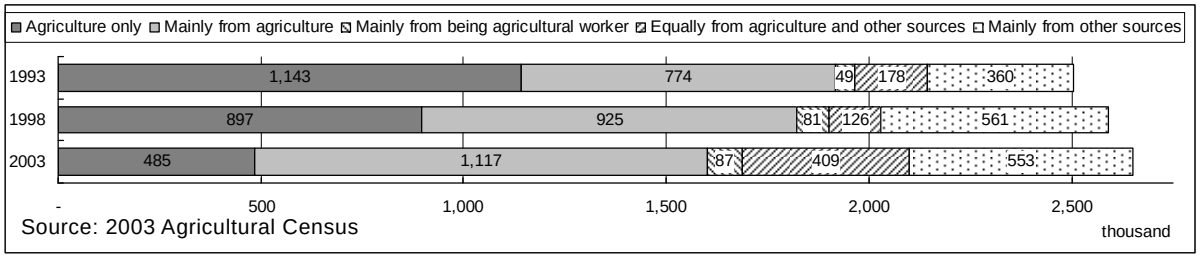


Figure 2.2.1 Number of Farm Household in Northeast Classified by Source of Income,1993-2003

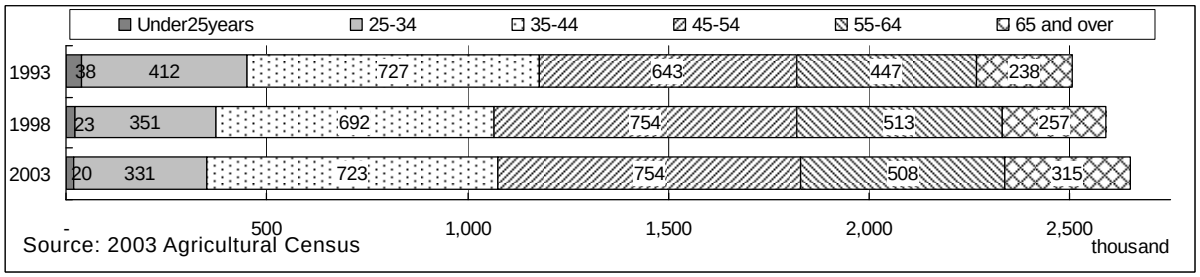


Figure 2.2.2 Number of Farm Household in Northeast by Age Groups, 1993-2003

(2) Aging of Rural and farm household

When reviewing the changes in age distribution of the farming population based on the agricultural census in 1993 and 2003, the population under 35 years of age decreased from 18 % to 13 % and the population over 55 years of age increased. Ageing of regional population and shortage of successors in agricultural sector have been commonly discussed to date and it is predicted that in Northeast Region further ageing in farming population will be accelerated in future.

(3) Migration of Rural and farm household

As per the research/study on migrant workers from Northeast Region[1], there are migrant workers in about half (52 %) of the villages surveyed and the proportion is higher in the rain-fed area (63 %) than in the irrigation area (54 %). Moreover, the survey result indicates the proportion of migrant workers by male and female as follows.

Rain-fed area: Male 34 % and female 23 %
Irrigation area: Male 26 % and female 20 %

(4) Farm income

According to household socio-economic survey (SES) of NSO, proportion of farm income in average household income is decreasing over years in rural (non-municipal) area in the Northeast. Farm income, which consisted 30% of average income in 1981, has been reduced to 15.5% in 2007 (see figure 2.2.3). Reasons behind the phenomena are not only by reducing profit from agriculture but also by increasing non-farm income of farm household as well as increasing non-farmer household in rural area.

Source: SES, NSO

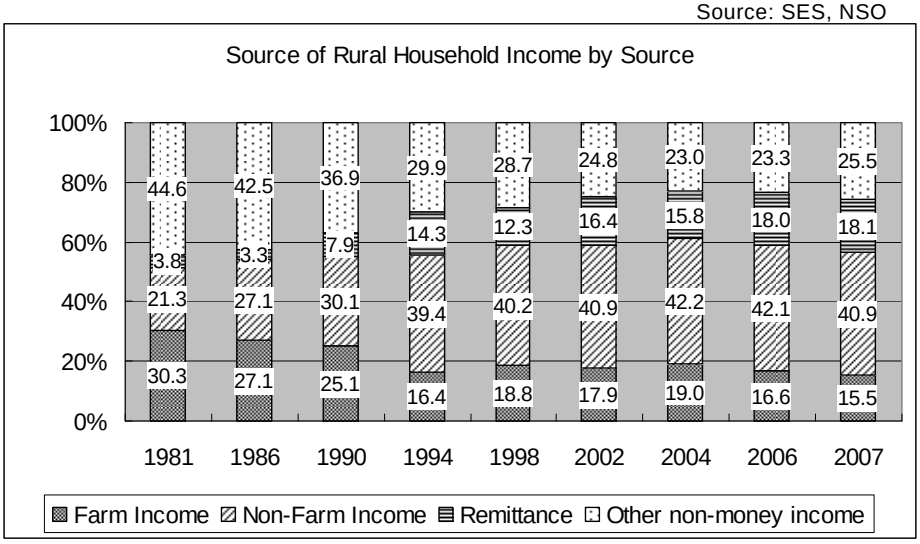


Figure 2.2.3 Source of Average Household Income in Rural Northeast , 1981-2007

However, focusing on income of farm household, farm owner, farm operator mainly renting land, and agricultural service worker (maybe landless) earn income from agriculture as much as 45%, 52%, and 60% respectively. Farm income is major source for farm household, while average income of farm household in the Northeast is 8,500 baht per month equivalent to 2/3 of total average income of the Northeast, 13,000 baht per month.

[1] Paris T. P et al., "Impact of migration and off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems" (2008, Australian Center for International Agricultural Research)

Table 2.2.1 Source of Income of Farm Household in the Northeast (2007)

Source of Income	Total Households		Farm Operators					
			Mainly Owning Land		Mainly Renting Land / Free		Fishing, Forestry, Agricultural service	
	Baht	%	Baht	%	Baht	%	Baht	%
Total Monthly Income	**12,995**	**100.0**	**8,589**	**100.0**	**8,502**	**100.0**	**7,642**	**100.0**
Farm Income	**1,574**	**12.1**	**3,838**	**45**	**4,422**	**52**	**4,616**	**60**
Non-farm Income	**6,367**	**49.0**	**862**	**10**	**697**	**8**	**626**	**8**
Remittance	**2,144**	**16.5**	**990**	**11.5**	**662**	**7.8**	**576**	**7.5**
Other Non-money Income	**2,910**	**22**	**2,900**	**34**	**2,721**	**32**	**1,823**	**24**

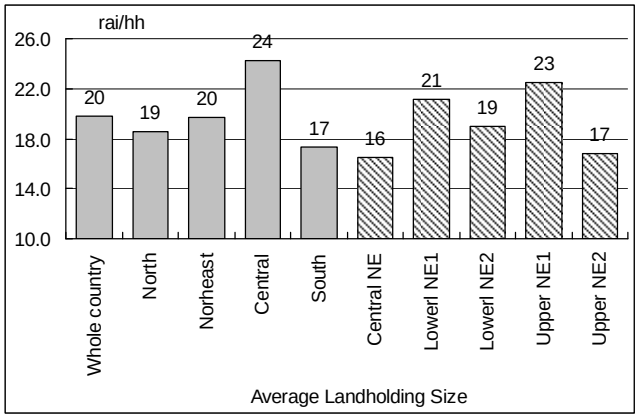
Source: SES, NSO

(5) Agricultural land holdings

Considering the number of farm household classified by scale of holding (Agricultural Census in 2003) too, about 90 % is of small holders with less than 40 rai and the medium/large holders with more than 40 rai is a bit less than 10 %.

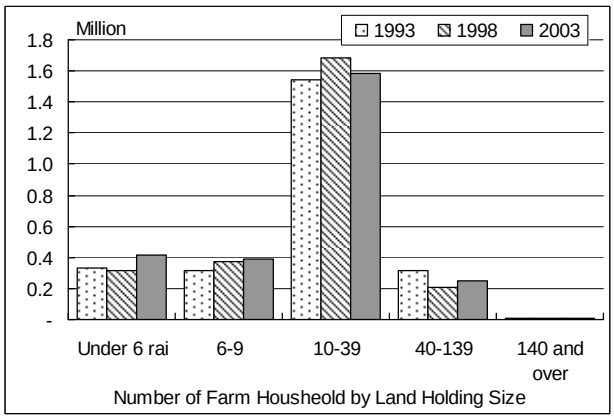
Cluster-wise features of farm land holdings per household are as tabulated below where the average is estimated at around 20 rai in the Northeast Region.

Central Northeast cluster: Comparatively small in Khon Kaen, Kalasin and etc.
Lower Northeast1 cluster: Larger with upland in Nakhon Ratchasima and etc.
Upper Northeast1 cluster: Larger with upland in Udon, Loei and etc.



Source: 2003 Agricultural Census

Figure 2.2.4 Average Land Holding Size in Thailand and Northeast Region



Source: 2003 Agricultural Census

Figure 2.2.5 Number of Farm Household by Size of Land Holding in the Northeast

When looking at the changes in a longer term perspective, the number of households shows increasing tendency while the average holding decreasing tendency. This implies that farm land holding has been fragmented due mainly to the inheritance in general.

According to the hearing from KKU and BAAC, however, in recent years there have been cases that farm lands be confiscated as collateral for loan and such confiscated farm lands have been accumulated in the hands of merchants dealing with informal lending.

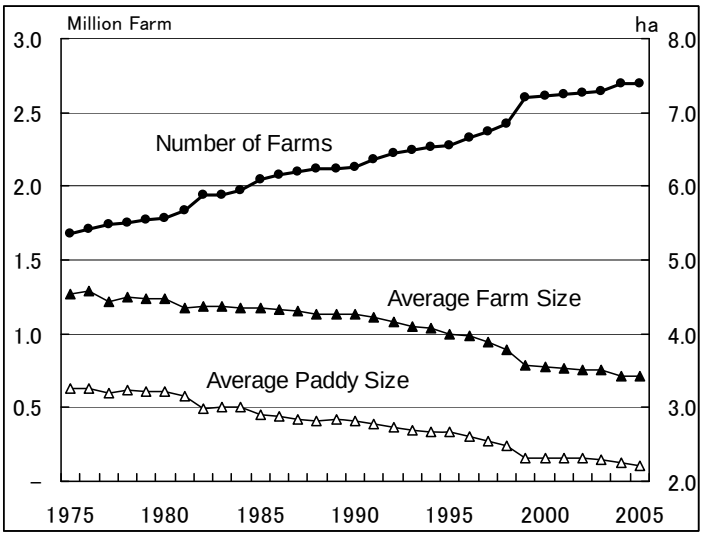


Figure 2.2.6 Trend of Number of Farm Household, Farm Size and Average Paddy Field Size, 1975-2005

Data Source: OAE, Sited from Terry B. et al, "Rainfed Revolution in Northeast Thailand", Southeast Asian Studies, Vol46, No.3, Dec.

From the graph showing the changes during 1997-2005, the holding similar to the portion mortgaged had been converted to rented land, implying the holding was either confiscated or rented for tenant farmers due to the farming labor shortage. In the Central and North Regions the ratio of own land farming has been less than 50 % already, and the tendency shows that the Northeast Region follows the same way.

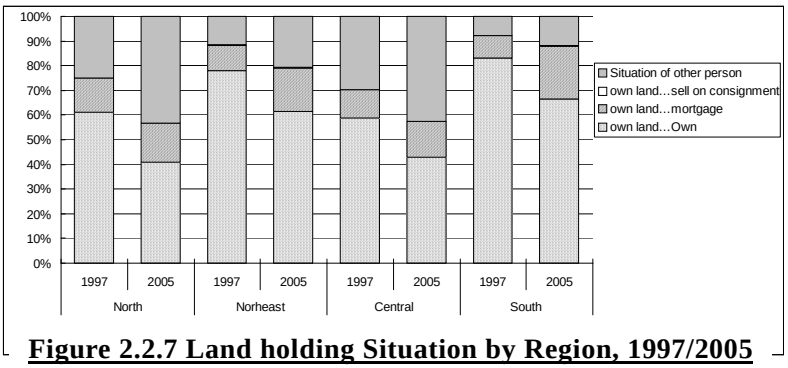


Figure 2.2.7 Land holding Situation by Region, 1997/2005

In the Northeast Region, more particulars in detail can be noted that the ratio of own land farming has remarkably been declining in the provinces of Chaiyaphum and Nakhon Ratchasima (Lower Northeast1) where upland field cropping is major and of Roi-et (Central Northeast), Surin and Buri Ram (Lower Northeast 2) where Jasmine rice cropping is major today. Other than the above, the lowering of own land farming ratio is distinct in the provinces of Sakon Nakhon and Mukdahan (Upper Northeast 2) too.

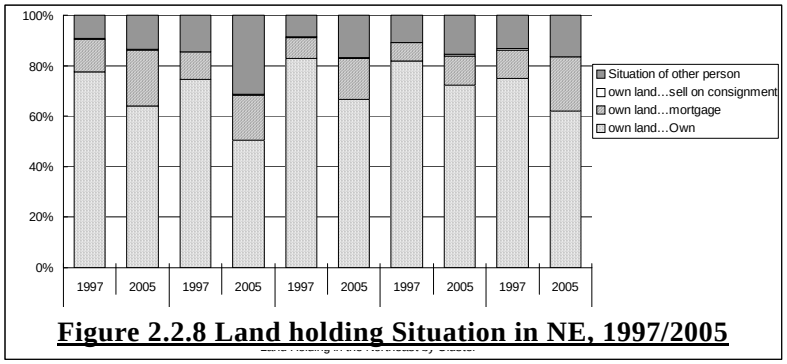


Figure 2.2.8 Land holding Situation in NE, 1997/2005

2.2.2 Present Situation of Agriculture Production in the Northeast

Of the total land area in the Northeast Region, farm lands occupies as large as 63.5 Million rai,

about 60 % which is equivalent to 40 % of the total farm land in the country.

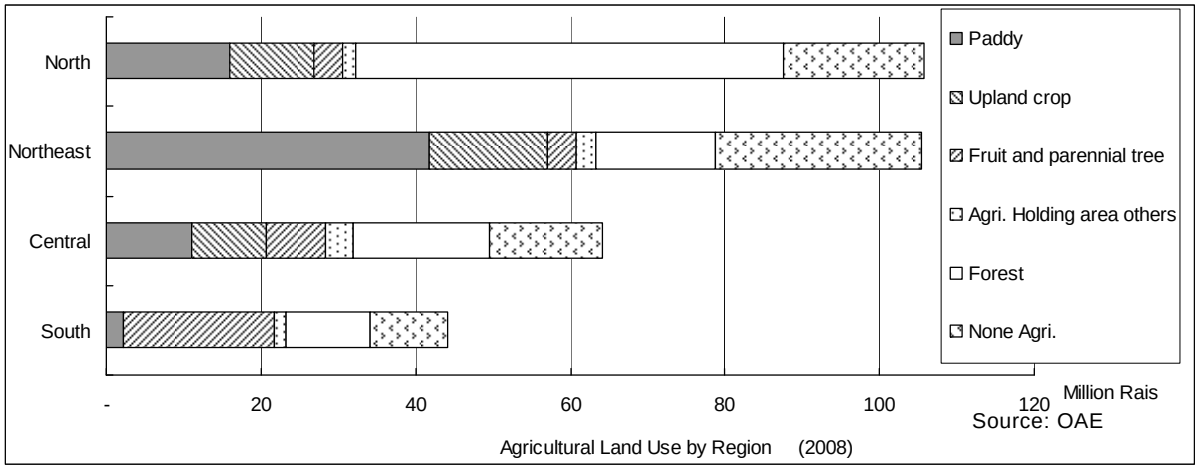


Figure 2.2.9 Agricultural Land Use by Region, 2008

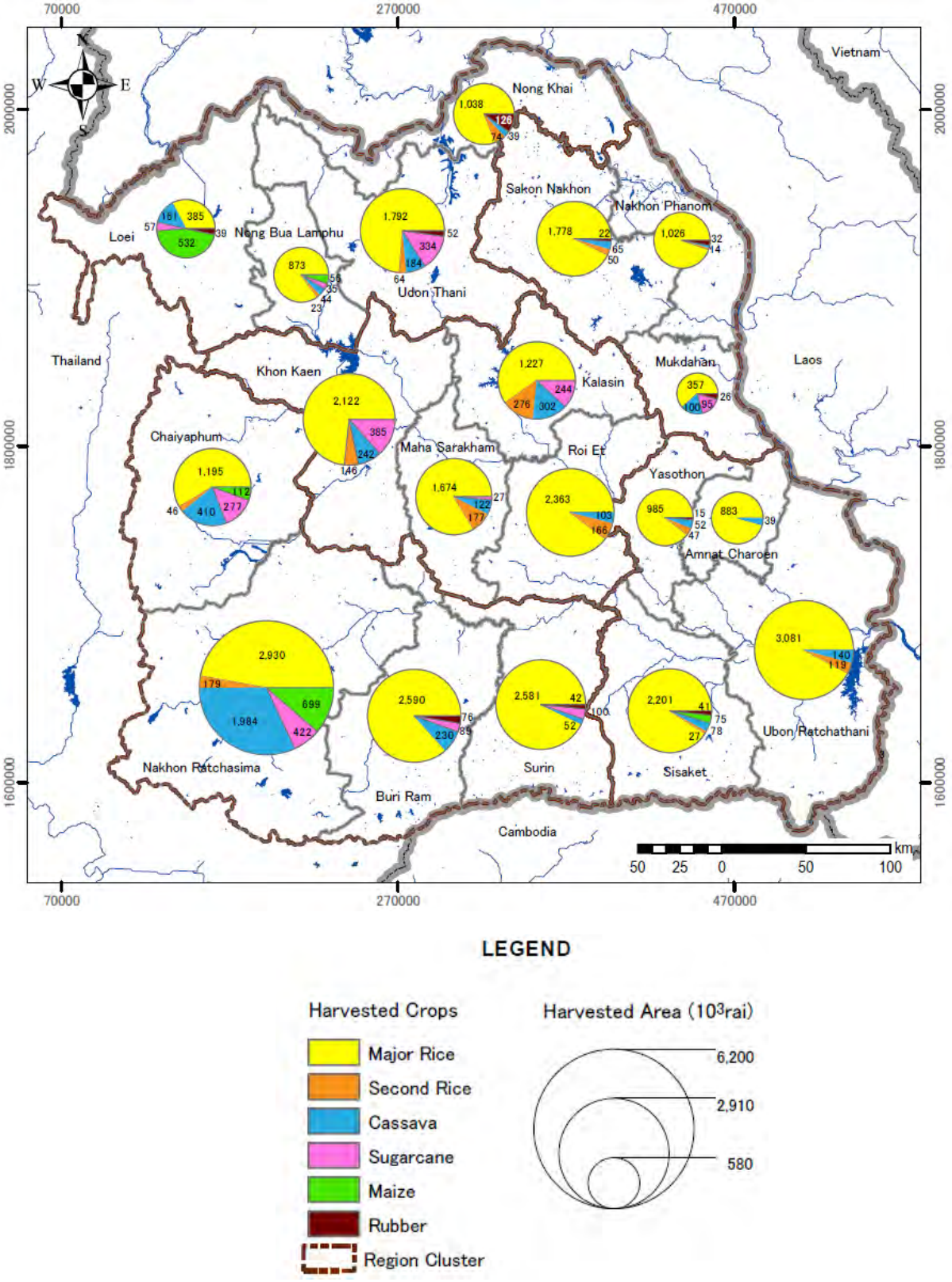


Figure 2.2.10 Harvested Area of Major Crops by Province in the Northeast

In the Northeast Region, the primary and most important crop is Major Rice in wet season with having the largest area planted as well as harvested area. Major rice is followed by some other important crops as cassava and sugarcane, and in recent years planted area for natural rubber has been increasing drastically.

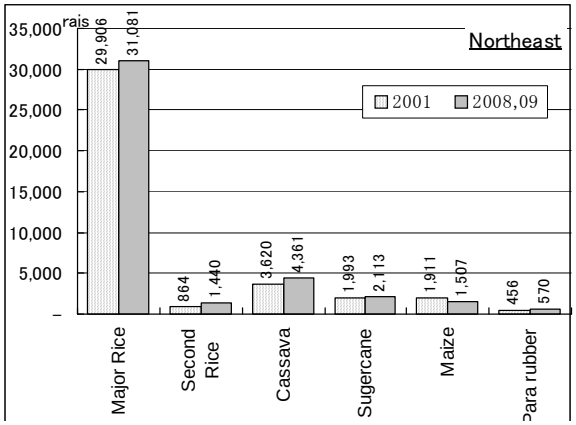


Figure 2.2.11 Harvested Area of Major Crops in the Northeast, 2001/2008

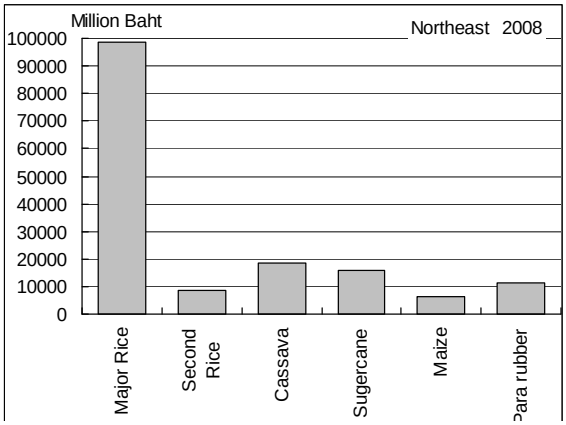


Figure 2.2.12 Value of Major Crops Production in the Northeast, 2008

(1) Dry season crops planted

For the dry season cropping, irrigation is necessary and therefore the area planted is limited. As is the case, those provinces equipped with large scale irrigation facilities with large reservoirs have attained large areas planted for dry season paddy. They are Khon Kaen and Mahasarakham (Nong Wai Project), Kalasin (Lam Pao Project) and Nakhon Ratchasima (Lam Takhong Project, Upper Mun-Lamsae Project). (see Figure 2.2.13)

Expansion of areas planted for dry season paddy is dependent not only on the irrigation facilities existing but also on the behavioral change of farmers derived largely from the fluctuating market prices. In the dry season of 2009/2010, planted area in irrigation area was 1 Million rai, while it was 1.5 Million rai planted outside irrigation area. Farmers, bearing the possible risks as caused by insufficient water source in mind, try to challenge the dry season paddy cropping for higher return through securing water by pumping from rivers, ponds and any other sources.

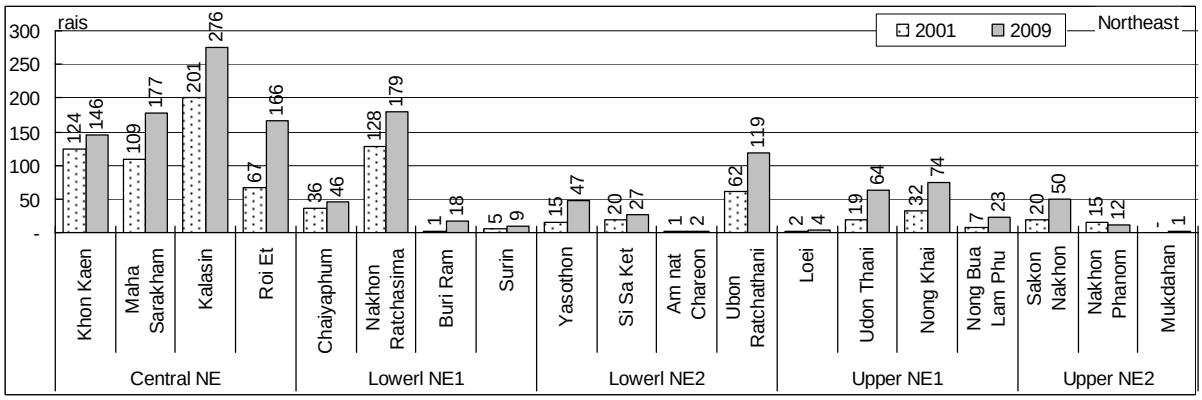


Figure 2.2.13 Harvested Area of Dry Season Paddy by Province, 2001/2009

Table 2.2.2 Planted Area of Dry Season Crops in Irrigated and Non-irrigated Area , 2009/2010

Crop	Planting area (rai)	
	Irrigation area	Non-irrigation area
Minor rice	998,915.00	1,510,073.00
Upland crop	42,744.00	411,769.00
- Maize	1,328.00	37,377.00
- Sweet corn	5,494.00	40,726.00
- Green bean	2,344.00	20,271.00
- Soybean	18,246.00	140,476.00
- Peanut	5,459.00	14,572.00
- Others	98,732.00	158,347.00
Vegetable	32,301.25	243,460.00

Source: DOAE, Khon Kaen Regional Office

2.2.3 Agroecosystem in the Northeast

(1) Geography and Agroecosystem in the Northeast

Major crops in the Northeast are paddy, cassava and sugar cane. These crops are cultivated well adapted to land form of Korat Plateau of the Northeast. As shown in Land Form Map, land in the Northeast is classified into three categories, i.e., 1) flood and non-flood plain in Chi and Mun basin, 2) Mountain range and surrounding hilly area, and 3) undulating land between these two.

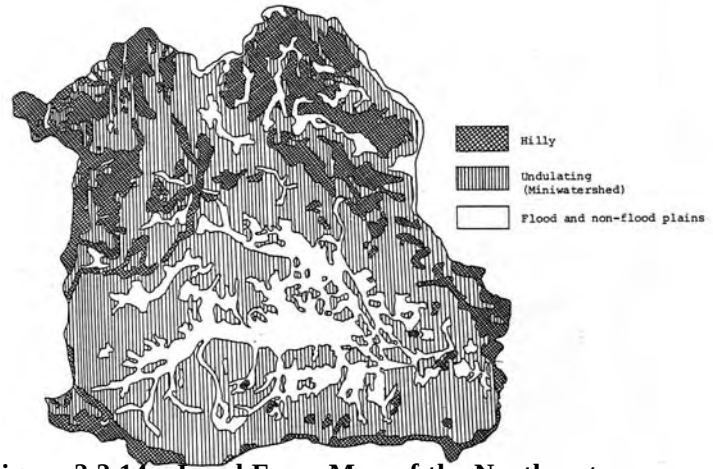


Figure 2.2.14 Land Form Map of the Northeast

source : Reprinted from KKU-Ford Cropping Systems Project (1982) An Agroecosystem Analysis of Northeast Thailand. Faculty of Agriculture, Khon Kaen University.

In the Northeast Region, the irrigation area shares only 10.6 % of the overall farm land and the remaining is practices under rainfed condition by using rainfall and water resources available at nearby areas. Such small scale water resource development like SSIP without distribution canals and small farm ponds are considered as important means for improvement of rainfed agriculture.

	Hilly plains	Undulating (Mini-watershed)	Flood and non-flood
Major Water Source	Rain-fed	Rain-fed, farm pond	Rain-fed, irrigation canal, river and wetland/ swamp
Major Crops	Fruits, Vegetable	High: Sugar cane, Cassava Low: Paddy, Vegetable	Paddy (2 times in irrigated area), Fruits, Vegetable
Issues on Agriculture and Water Manage	Dry spell in rainy season	High: Dry spell in rainy season Low: Dry spell in rainy season, Flood after heavy rain	Inundation in late rainy season

Figure 2.2.15 Land Form Model and Agroecosystem of Northeast

(2) Irrigated agriculture area

In the flood and non-flood plains in Chi and Mun river basin include irrigated land, where double cropping of paddy is possible. It is said that glutinous rice (sticky rice or *Khao Nyiaw*) for household consumption is grown in rainy season, while non-glutinous rice (*Khao Chao*) is cultivated for sale in dry season.

(3) Rainfed agriculture area

Upland in undulating land and hilly area used to be forest and opened up since 1950's by farmers. Soil is sandy and low fertile soil and cash crop such as cassava and sugar cane are cultivated widely. In order to analyze and consider water resources and agriculture development, anyone shall notice different agro-ecosystem exist in flood and non-flood plains and upland or lowland in undulated area.

Where flood happen regularly almost every year, people enjoy fish resources and have local wisdom to cope with inundation and flood. Drought prone area probably has another coping strategy and social safety net. However, rapid change of life style and urbanization change disaster situation from the past.

2.2.4 Rice Production

As previously discussed, rice is one of the important export items for Thailand and the country has been reputed for a long time as the No. 1 rice exporting country in the world. 57 % of planted area for major rice is in the Northeast Region producing 45 % of the national total. In case of the dry season paddy cropping, the planted area as well as the production remain at only around 10 % of the national total due to the low irrigation rate in the Region. The productivity as represented by the yield per a unit area is also considerably lower than the national average.

Table 2.2.3 Planted Area, Production of Paddy by Region, 2007/2008

	Rainy Season					Dry Season				
	Planted Area (rai)	%	Production (t)	%	Yield (kg/rai)	Planted Area (rai)	%	Production (t)	%	Yield (kg/rai)
Whole Kingdom	**57,385,921**	**100**	**23,308,385**	**100**	**433**	**12,801,226**	**100**	**8,791,016**	**100**	**687**
Central	9,814,339	17	5,515,207	24	592	6,725,838	53	4,876,470	55	725
North	12,779,212	22	6,610,217	28	552	4,476,226	35	3,016,153	34	685
Northeast	***32,773,544***	***57***	***10,377,733***	***45***	***338***	***1,263,292***	***10***	***685,058***	***8***	***543***
South	2,018,826	4	805,228	3	425	335,870	2	168,335	2	502

Source: Agricultural Statistics of Thailand 2007, OAE

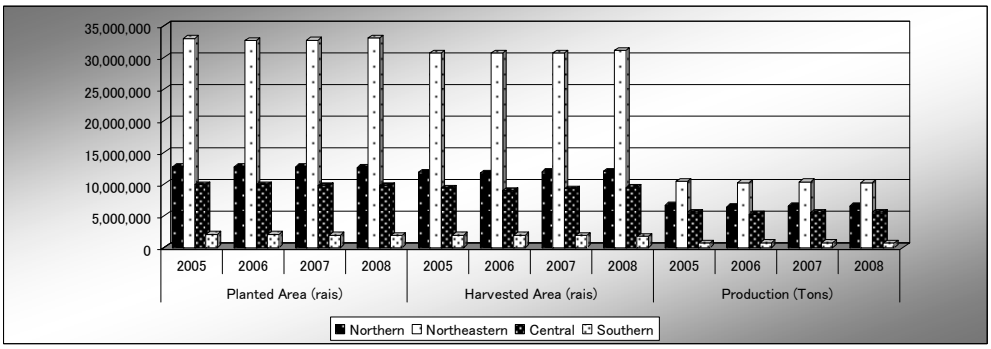


Figure 2.2.16 Planted Area, Harvested Area and Production of Major Rice by Region, 2005-2008

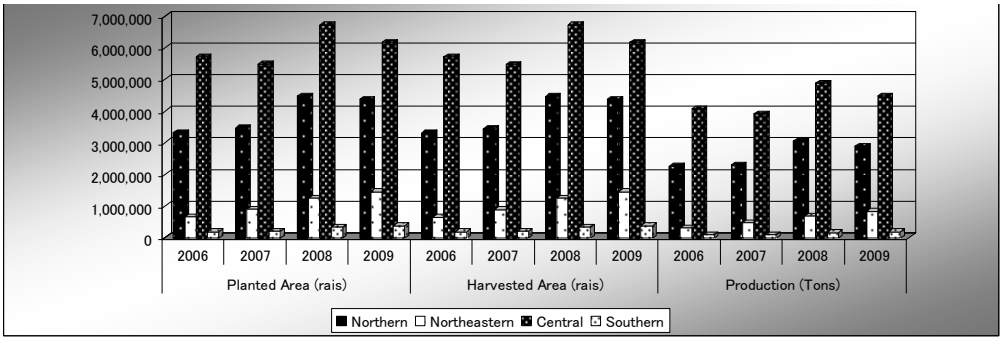


Figure 2.2.17 Planted Area, Harvested Area and Production of Dry Season Rice by Region, 2005-2008

The causes of lower yield in the Northeast Region are in not only the lower irrigation rate but also in the unfavorable soil quality, low yield potential of rice varieties planted and inappropriate farm management.

Concerning the soil, the suitability is indicated by three (3) classes of Most Suitable (S-1), Suitable (S-2) and Marginally Suitable(S-3). While S-1 shares 20.5 % in the national average, that of Northeast Region is only 9.3 %. On the other hand, S-3 occupies 24 % in Northeast Region against 16 % only in the case of national average, implying that the soil quality in the Northeast Region is relatively low. The distribution of such classified soils is as shown in the Map.

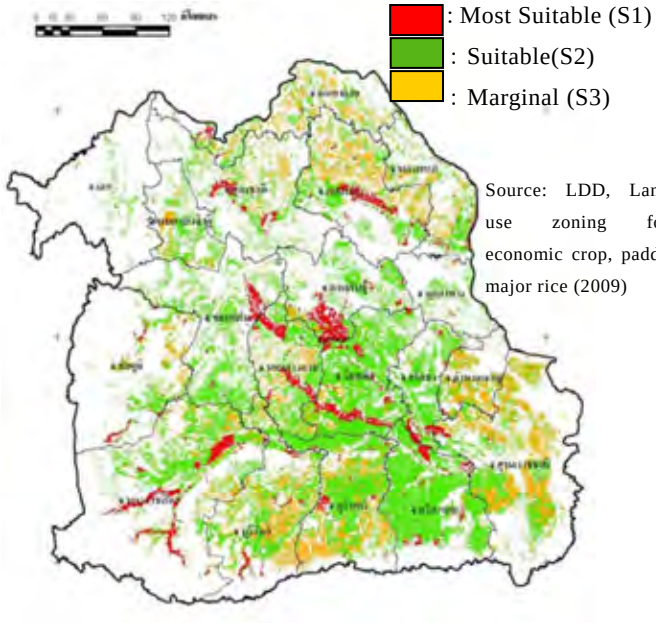


Figure 2.2.18 Soil Suitability Map for Major Paddy

Rice varieties planted in the Northeast Region include mainly RD 6 (Glutinous) and KDML 105 (Non-glutinous) called Jasmine Rice. RD 6 is predominant in the Central to North part of the Northeast Region, while

from the center to the down south of the Region, KDML 105 is predominant. There is a tendency that more and more farmers plant RD 6 for their consumption and at the same time KDML 105 mainly for selling.

2.2.5 Cassava and Sugarcane

Cassava production in Northeast Region accounts for 52% of total production in Thailand. Major cultivation provinces in Northeast are Nakhon Ratchasima, Chaiyaphum, Kalasin and other provinces (see Figure 2.3. 12). Cassava is processed into "Tapioca starch" for various food ingredients, and "Chips" and "Pellets" for livestock feed. Recently it is used for raw material for ethanol production in Thailand.

Table 2.2.4 Planted Area, Production of Cassava by Region, 2006-2009

	Production (Tons)				Yield per rai (Kgs.)			
	2006	2007	2008	2009	2006	2007	2008	2009
Whole Kingdom	22,584,402	26,915,541	25,155,797	30,088,024	3,375	3,668	3,401	3,628
Northern	3,208,418	3,894,434	3,805,126	5,286,978	3,424	3,614	3,459	3,756
Northeastern	12,152,480	14,577,925	13,448,028	15,570,654	3,300	3,607	3,326	3,571
Central	7,223,504	8,443,182	7,902,643	9,230,392	3,485	3,803	3,507	3,657

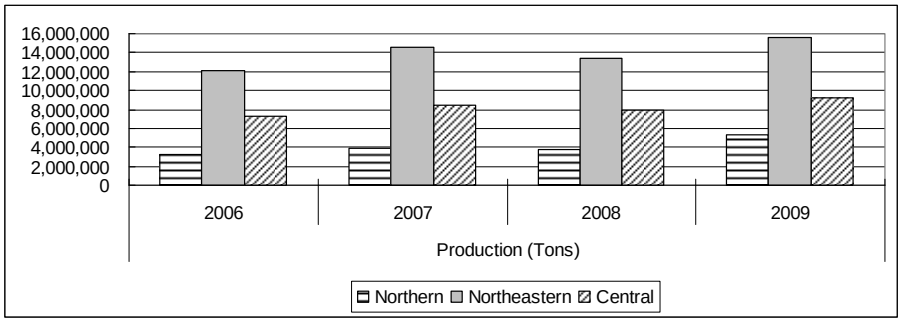


Figure 2.2.19 Cassava Production by Region, 2006-2009

One third (30-35%) of sugarcane is harvested in the Northeast Region. Sugar is major export goods of Thailand and sugarcane cultivation provides seasonal employment opportunity in rural area for harvesting labour. Molasses, byproduct of sugar processing, is used as raw material for bio-ethanol production.

Table 2.2.5 Planted Area, Production of Sugarcane by Region, 2006-2009

	Production (Tons)				Yield per rai (Kgs.)			
	2006	2007	2008	2009	2006	2007	2008	2009
Whole Kingdom	47,658,097	64,365,482	73,501,611	66,782,715	7,899	10,194	11,157	11,094
Northern	13,674,457	19,045,978	20,569,372	20,846,719	8,090	10,785	11,447	11,709
Northeastern	15,666,587	22,469,011	27,890,193	22,839,496	7,529	9,829	11,061	10,815
Central	18,317,053	22,850,493	25,042,046	23,096,500	8,097	10,100	11,033	10,855

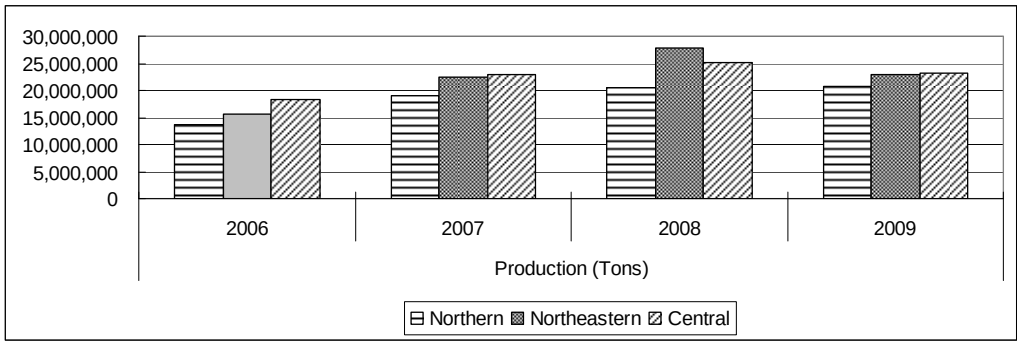


Figure 2.2.20 Sugarcane Production by Region

Planting of cassava and sugarcane are dependent on the market prices in the previous year, and in some areas farmers select either cassava or sugarcane purely based on the price factor.

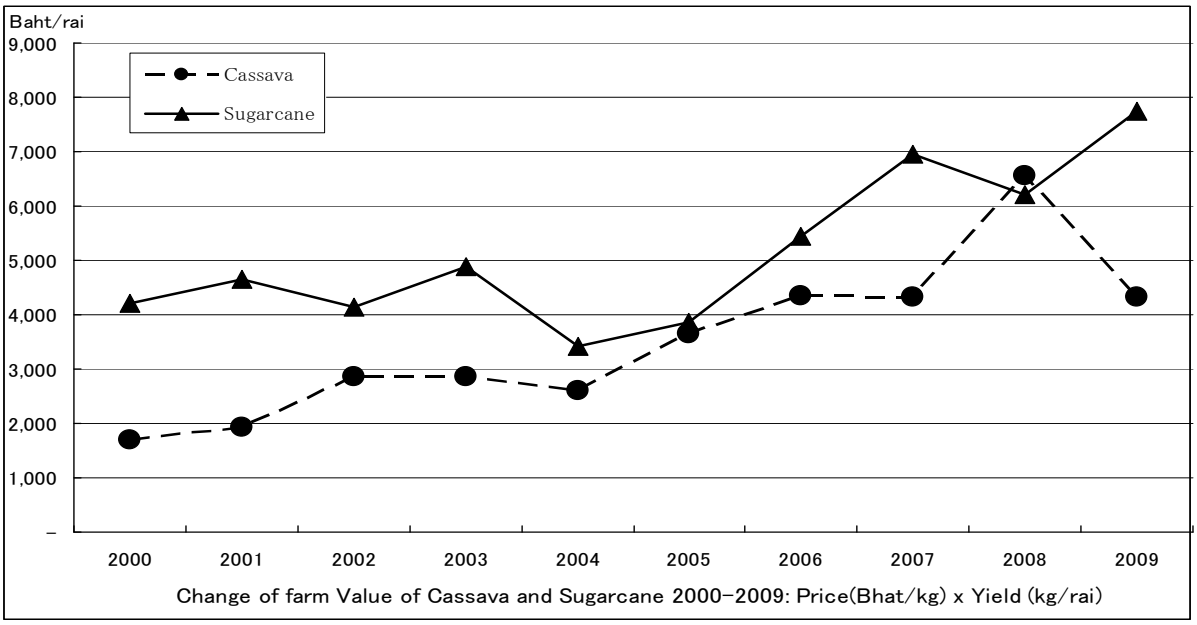


Figure 2.2.21 Trend of Farm Value of Cassava and Sugarcane, 2000-2009

2.2.6 Vegetable and Fruits

In terms of land use and share in value of agricultural produce, production of other field crop, vegetable, fruit and flowers in the Northeast Region is very limited, though there is high potential in future. Cultivation area of “fruit tree and perennial tree”, and “vegetable and flower” account merely 5.2% and 0.5% of agricultural land, respectively. Based on available statistics, current situation of field crop, vegetable and fruit cultivated in the Northeast region are as follows;

- Groundnuts: Approx. 40% of total production in Thailand is cultivated in the Northeast region. Major production provinces are, Sisaket, Buri Ram, Nong Bua Lamphu, Surin and Kalasin.

- Soybean: Approx. 30% of total production in Thailand is produced in the Northeast region. Major Production provinces are Loei, Khon Kaen, Chaiyaphum.
- Shallot: Sisaket province has the largest production area in country and produce 25% of total.
- Garlic: Sisaket is the7th largest production province in country (in 2008).
- Potato: Produced in Nong Khai and Sakhon Nakhon but not so large volume.
- Tomato: No data in statistics but tomato for processing is produced in Nong Khai, Nakhon Phanom and Sakon Nakhon.
- Pineapple: Produced in Nong Khai and Nakhon Phanom
- Longan: Loei has the largest production in Northeast region, but other provinces also produce.

Data on production and cultivation area for above is attached in Appendix 2.2.18.

2.2.7 Livestock

In agriculture in the Northeast region, livestock sector plays important role in addition to paddy and field cash crop production. Number and production of beef cattle is largest in the Northeast region as much as 40% of total in Thailand. Especially Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Chaiyaphum and Udon Thani are famous provinces for beef cattle raising in Thailand. In addition, 80 % of water buffalo is raised in the Northeast region.

However, there is no large scale livestock farm. Most of livestock farmers are small scale and half of them are conducting mix farming with paddy and field crops. In the past, cattle and buffalo used to be raised as draft animal as well as asset. Increasing of farm machinery, however, reduced role of draft animal and changed to meat production as main purpose.

Especially in rainfed area, cattle raising still plays important role. Part of low productivity land can be utilized as common grazing land and cattle can be livestock for asset and saving for small holders and safety net in case of crop failure. Recently cow dung is valuable for raw material of organic fertilizer. Since poor soil fertility in the Northeast region, it is important to put organic matter in farm land for improvement of soil with less production cost than chemical fertilizer.

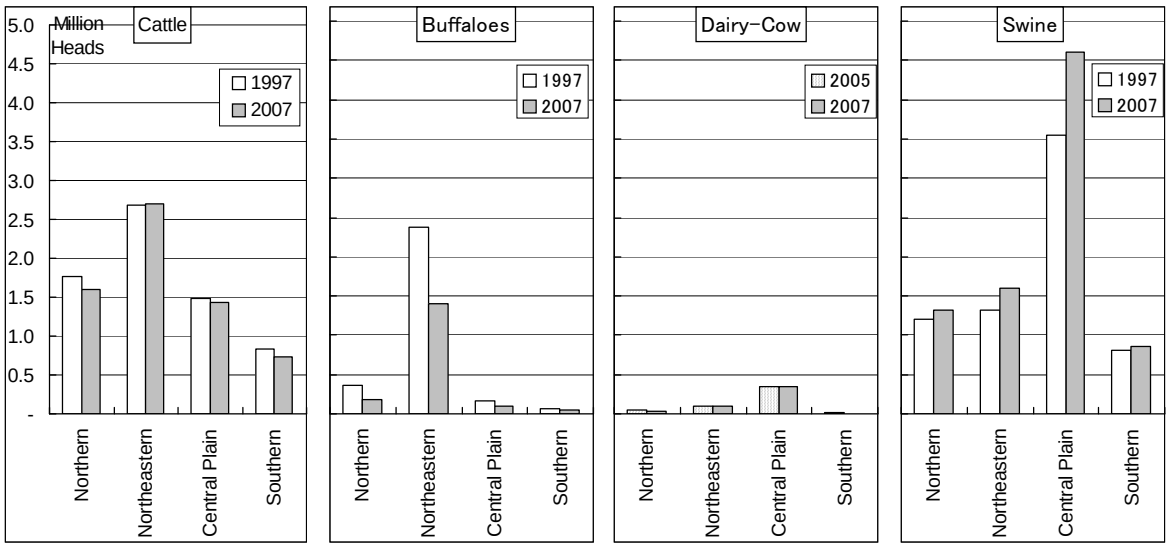


Figure 2.2.22 Number of Livestock by Region, 1997/2007

2.2.8 Inland Fishery

Inland fisheries have high potential for future growth. Volume of production is increasing in the Northeast region, especially highest growth in the central Northeast where large scale reservoirs exist. Raising fish, such as tilapia or snake head fish in individual farm pond as part of mix farming is popular as income generating for farmers in the Northeast region, rather than cage culture in river flow by commercial culture.

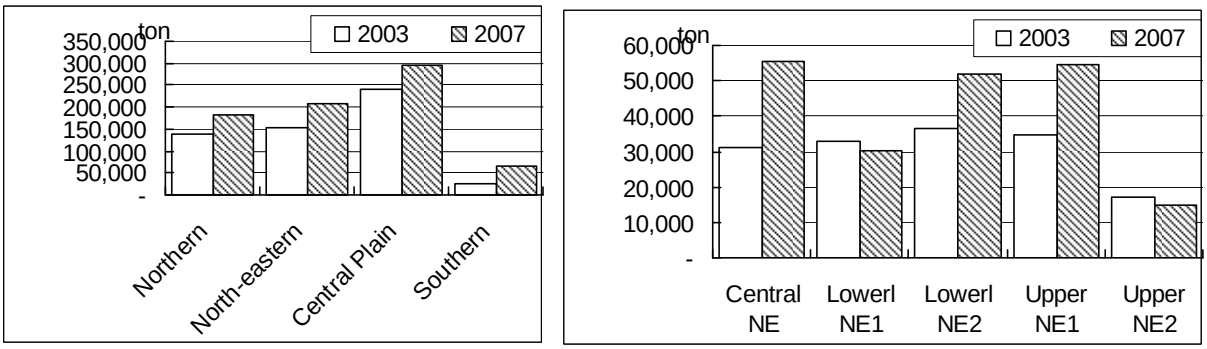


Figure 2.2.23 Production of Inland Fish Culture in the Region, 1993/2007

2.2.9 Para Rubber

Thailand is first ranked in the world in production as well as in export of rubber. Production of rubber is rather concentrated in Asia Region and main rubber producing countries after Thailand include Indonesia and Malaysia who are also the members of ASEAN, sharing as much as 75 % of the overall world production by the said 3 countries. In 2009, Thailand produced 3.3 Million ton of gum from 11.9 Million rai plantation area and exported 3.0 Million ton to the world. The price of rubber has been ranging at higher level in recent years and the export value earned by

Thailand was as much as 223 Billion Baht in the year 2008.

Focusing on the increasing demands for rubber world-wide, the government of Thailand intended to increase further the planted area for rubber especially in Northeast Region and in fact the planted area in the Northeast Region has been rapidly increased as can be seen from the Table below.

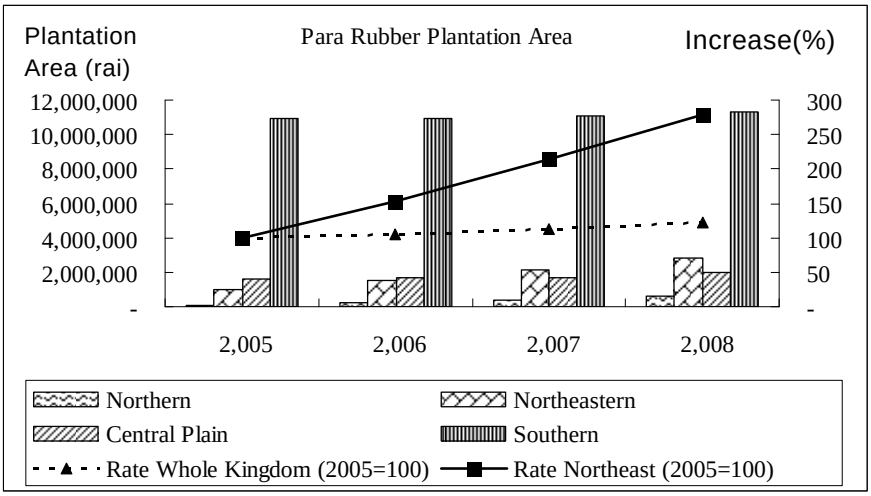


Figure 2.2.24 Increase of Para Rubber Plantation Area, 2005-2008

Table 2.2.6 Increase of Para Rubber Plantation by Region, 2005-2008

	Planted area (Rai)				Production (Tons)			
	2,005	2,006	2,007	2,008	2,005	2,006	2,007	2,008
Whole Kingdom	13,610,062	14,353,567	15,356,703	16,716,945	2,979,722	3,070,520	3,024,207	3,166,843
Northern	112,345	213,692	402,214	600,578	1,442	2,010	4,788	3,710
Northeastern	1,004,136	1,539,623	2,143,206	2,799,209	95,705	117,303	136,128	154,917
Central Plain	1,567,420	1,644,704	1,697,967	1,977,460	295,313	312,393	338,977	364,100
Southern	10,926,161	10,955,548	11,113,316	11,339,693	2,587,262	2,638,814	2,544,314	2,644,116

Table 2.2.7 Plantation Area and Production of Para Rubber in Northeast region, 2005-2008

	Planted area (Rai)				Production (Tons)			
	2,005	2,006	2,007	2,008	2,005	2,006	2,007	2,008
Nong Bua Lam	24,238	30,969	53,930	94,288	1,340	1,584	1,686	2,111
Udon Thani	79,884	101,986	219,270	295,000	10,329	13,470	14,468	14,880
Nong Khai	255,841	425,216	531,520	637,824	21,817	25,367	33,356	36,138
Sakon Nakhon	42,580	62,160	93,240	171,665	2,734	3,689	3,768	4,758
Nakhon Phanom	53,450	82,324	105,876	140,517	5,312	6,771	7,545	8,157
Mukdahan	50,095	67,757	91,895	110,000	4,206	5,661	6,416	6,818
Yasothon	26,005	32,629	43,180	49,657	2,269	2,289	3,330	3,922
Amnat Charoen	16,573	23,197	35,348	42,418	168	370	747	848
Ubon Rachathani	62,394	107,898	159,846	168,523	5,623	7,038	7,162	9,201
Si Sa Ket	69,380	105,965	157,229	176,096	8,942	10,600	11,815	13,595
Surin	51,618	64,452	84,978	90,686	5,047	6,248	6,696	11,316
Buri Ram	89,558	137,632	174,720	178,331	10,942	15,072	17,644	20,660
Maha Sarakham	2,402	2,774	3,234	3,881	278	322	373	449
Roi Et	13,694	17,131	21,441	24,657	1,921	2,102	2,142	2,424
Kalasin	27,971	32,480	50,772	137,398	3,097	3,684	4,440	4,801
Khon Kaen	12,501	18,587	32,089	38,507	1,536	1,558	1,730	1,909
Chaiyaphum	10,455	18,415	26,163	31,431	1,013	1,349	1,349	1,529
Ratchasima	6,357	12,126	16,962	25,833	531	689	772	1,100

As is clearly seen from the Table, the pace of planting area expansion is quite rapid in Northeast Region for which a comparison was made between the national average and that of the Northeast Region as follows.

The Table showing the provincial break-down of rubber planted area and production indicates the expansion rate at 182 % during 2006-2008 as a whole in the Region. Those provinces with higher rate are, in order of higher growth, as follows.

Kalasin	423 %
Nong Bua Lam Phu	304 %
Udon Thani	289 %
Sakon Nakhon	276 %
Khon Kaen	207 %

While those provinces who have the larger planted area for rubber as of the year 2008 are as follows.

Nong Khai	637,824 rai
Loei	382,497 rai
Udon Thani	295,000 rai
Buriram	178,331 rai
Sisaket	176,096 rai
Sakon Nakhon	171,665 rai
Ubol Ratchathani	168,523 rai
Nakhon Phanom	140,517 rai
Total---8 provinces	2,150,493 rai

Higher ranked 8 provinces share as much as 77 % of the total regional planted area for rubber in 2008. Among the above, except 2 provinces of Buri Ram and Sisaket, all the others are located along the Mekong River being favored with comparatively more rainfall amount in the Region.

Regarding the production volume, the Northeast Region shared only 5 % of the national total (155,000/3,167,000) in the year 2008. Taking into account the rapid increase of rubber planted area in Northeast Region in recent years as discussed above, however, in near future the regional production volume is expected to increase greatly to reach 700,000-800,000 ton. In this case the share by the Northeast Region is estimated to be raised-up sharply to around 20 % of the national total.

Natural rubber is welcomed by farmers because it perennial crop and provide stable cash flow throughout year unlike sugarcane and cassava. However, it takes 5 years to cultivate latex therefore it is necessary to combine with other crops for early years. It is necessary to consider negative impact of change land use from paddy field fro household consumption to rubber plantation. Some people are warning about growing rubber boom supported by high price based on experience and lessons learned from Southern Region. Loss of diversity by mono culture and

weaken bargaining power and economic position of rubber farmers. It is recommended to promote integrated agriculture ad value adding in community for fostering economic security as well as conserving bio-diversity and natural resources.[2]

2.3 Value Chain

2.3.1 Value Chain for Rice

(1) Marketing Channel

In general, rice producing farmers bring their produces in paddy to the millers in the villages for milling (In this case, millers take husks and the crumbs as the payment for milling services.) or sell to the paddy collector agent in their localities. In case if there are surpluses, rice producing farmers sell it to either Central Market Exchange and/or private millers. The following figure shows the channels of marketing of paddy/rice as mentioned above.

The statistics available at present is of the year 1997. Based on this information, there were as many as 43,275 mills in the country, of which 28,533 mills, equivalent to 2/3 of the total were in the Northeast Region.

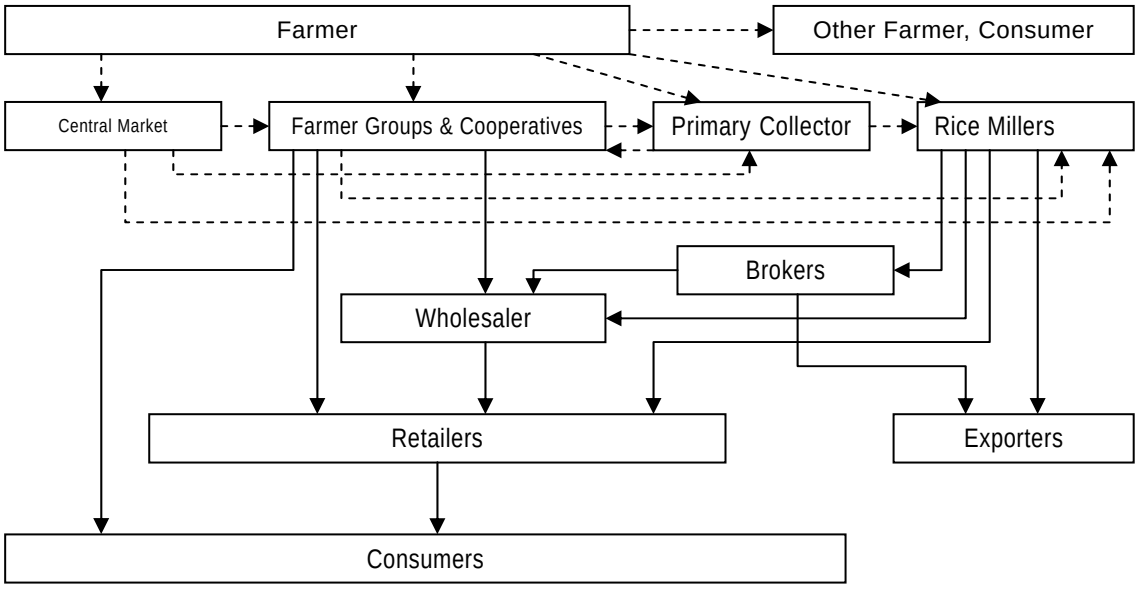


Figure 2.3.1 Marketing Channel for Rice in the Northeast Region

In the Northeast Region, it is said that about 20 % of paddy is stored and consumed by the producer farmers by themselves and the rest, 80 % is sold for marketing to the outside including exporting to foreign countries.

(2) Export

Of the overall production of rice in the country, about half is for domestic consumption and the

[2] Kaiyoorawong S. and Yangdee B. "Rights of rubber farmers in Thailand under free trade"

rest is for exporting and stored in stock. In the recent past of years 2008 and 2009, the rice export by Thailand shared 30-35 % of the world's international rice export, being the first ranked in the world. In the last 5 years, the breakdown of Thai's rice export is as shown below.

*Parboiled rice increasing the export quantity to be shipped to African countries as Nigeria, Benin and South Africa

*White rice to Southeast Asian countries as Philippines and Malaysia

*High quality Jasmine rice to USA, Hong Kong and Singapore

Concerning the export of rice, Thai Rice Exporters Association plays an important role. The Association holds as many as 188 member companies, of which the top five (5) companies share about half of the total export by Thailand. In the international rice market, Jasmine rice is reputed for its high quality and enjoying high demands, and the price is quoted at 1.5-2.0 times higher than the ordinary ones. In Thailand the Jasmine rice is produced mainly in the Northeast Region (82.24 %) with famous producing provinces like Surin (16 %), Buri Ram (14 %), Sisaket (12 %), Nakhon Ratchasima (12 %) and Ubon Ratchathani (10 %), mainly in the Lower Northeast Region. It is considered necessary with this concern to further pursue improvement of the quality and higher value adding with the Jasmine rice.

(3) Processing

For possible value adding for rice, processing is common in making the rice flour first and processed to make various rice noodles, Thai and Chinese confectioneries, crackers and cookies. Manufacturers of rice flour mostly have their factories in and around Bangkok and produces flours both by glutinous and non-glutinous rice.

Today, OTOP products are various including traditional sweets in each locality, wines and liquors and soaps, and in response to the health-oriented life style prevailing lately, there are farmers groups who promote making and selling varieties of organic rice such as brown rice, red/black rice and GABA rice. Value-adding will directly effect on the farmers' income where organic rice can be produced with lower production cost but can be sold with higher price. For this concern, it is remarkable that the extension of organic rice farming is being carried out by the network of NGOs and farmers' groups. Another case is the extension of organic farming by NGOs where produces could be purchased at adequate price levels by NGOs and exported to European countries by applying a fair trading concept.

2.3.2 Cassava

(1) Processing and marketing channel

As per the estimation made in 2008, cassava is processed to be tapioca starch by 55 % and chips/pellets for livestock feed by 45 % out of the annual total production of 25 Million tons. Of the total produces as noted, 65 % of starch and 80 % of pellets are assumed to be exported. Home

consumption of tapioca starch includes the uses as materials for various food produces such as seasoning powder and synthetic sweetening and also for industrial uses for paper manufacturing and glue making. Of the total export volume, 20 % is shipped for Japan.

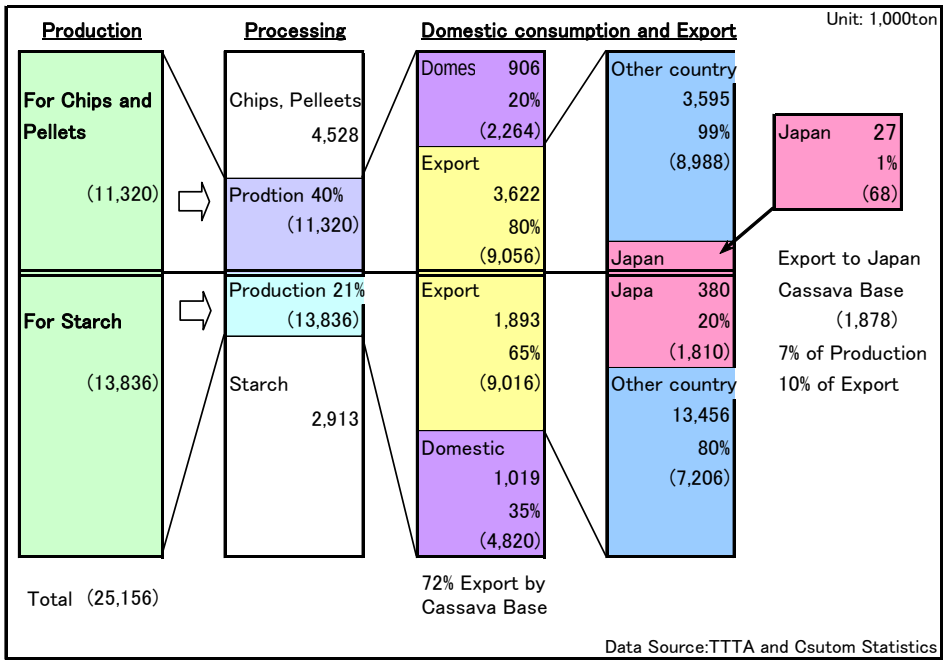


Figure 2.3.2 Production and Marketing for Cassava, 2007/2008

Thai Tapioca Starch Association has as many as 74 member companies, of which 34 companies operate their processing factories in the Northeast Region and 20 factories are located in Nakhon Ratchasima province. Next to Nakhon Ratchasima, many are in Kalasin with 4 factories. In general cases, those starch factories do not make contract farming with farmers, while collectors offer the price based on the market price to farmers and transport the material cassava to the factories. In this case, the transportation cost shall be born by the farmers. The longer the transportation distance, the higher the cost for transportation, and collection is made basically from the producer farmers located within 100 km distance.

(2) Ethanol

In order to promote the production of bio-ethanol, the RTG granted some privileges in constructing the ethanol plant as follows.

*Tax exemption on the import of plant facilities for ethanol production

*Tax exemption on company income taxes for 8 years

At present, in the Northeast Region, there is only one (1) plant (130,000 liter/day, since 2005) operated for ethanol production by using cassava as material in Khon Kaen. Within 2010, another plant (340,000 liter/day) is to start the operation in Nakhon Ratchasima. The purchasing price of cassava by ethanol factory is similar to the case of starch factory. But in case of ethanol

production, dry chip cassava can be used as the material and therefore importing from neighboring countries can be possible if the prices remain low enough.

2.3.3 Sugarcane/Sugar production

(1) Marketing channel for sugarcane

Sugarcane cultivating farmers can be classified into the following 3 categories.

*Member of Sugarcane Planters Association

*Member of Agricultural Cooperatives

*Individual/independent farmer

While, the sugar-mill factory side allocate quotas for the middleman collector and the farmers sell their produces to either of the followings.

*To those collector who has his own sugarcane farm (Contract with other farmers for the surplus in the quotas allocated)

*To those collector who has no own farm

In case the sugarcane farmers sell the produces to the collectors, the prices shall be various depending on the conditions of the produces at the field. There must be then severe negotiations on the purchasing prices between the farmers and the collectors.

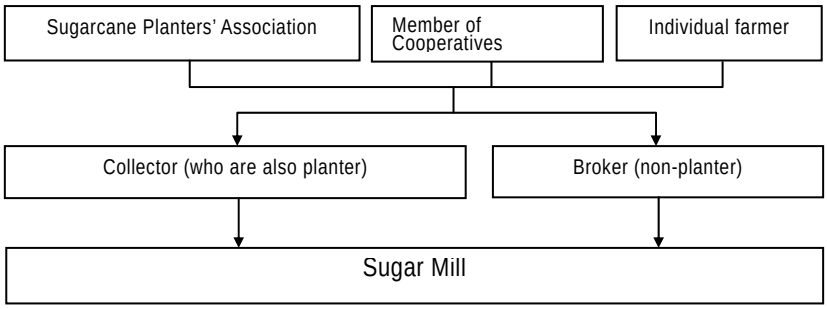


Figure 2.3.3 Marketing Channel for Sugarcane from Planter to Sugar Mill

Sugar factories make contract with the producer farmers for contract farming and for the small scale farmers provide lending for the production cost/investment for plowing and fertilizers etc. in the case of Kasetpol Sugar Co. Ltd. there are as many as 360 farmers with contract farming practices. 50 % of them are of medium-small scale with production less than 1,000 tons and such small scale farmers of less than 500 tons contribute about 5 % of the total. In case of the farmers with production of more than 500 tons usually purchase the sugarcane material from the neighbor farmers. The five (5) large scale farmers supply as much as 40 % of the material to the factory. One of five operates 6,000 rai area and produces as much as 70,000 tons with owning large scale harvesting machines. In some cases, collectors purchase from no contracting farmers,

and this is also important in securing required materials for the factory, though the qualities of the produces are not so good. Considering the transportation cost, materials are collected mainly within the areas of less than 50 km distance, but due to the competition with the other crops like cassava and rubber trees, sustainable supply of sugarcane material for the factories becomes very important to attain higher operation ratio of the plant facilities.

(2) Supply Chain of Sugar

The sugarcane materials transported to the factory from the producers shall be processed for crushing and sugar making and then distributed through sugar marketing channel. The marketing channels are as indicated below based on the quotas as allocated by the government.

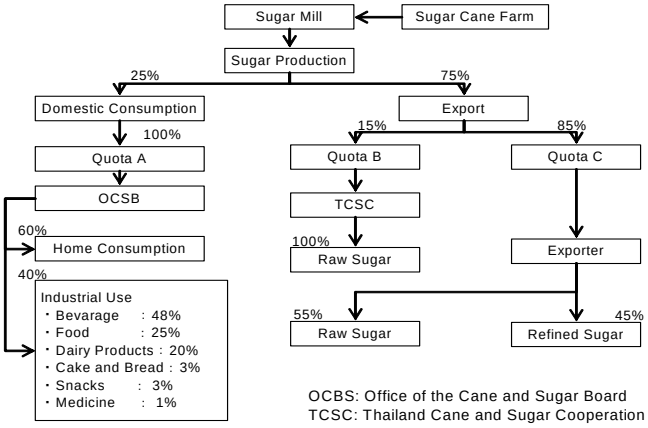


Figure 2.3.4 Marketing Channel for Sugar in Thailand

Quota A (25 %) is white sugar for the domestic consumption and be sold to the Sugar marketing Center under the OCSB, of which 60 % is distributed for domestic consumption in general. The quota B is the raw sugar for export and allocated by 10 %. The quota C is white sugar for export and the sugar factories sell it to the private sugar exporter companies. The quota C is a surplus of A and B and 60 % was allocated in 2008/9 year.

(3) Prices

In Thailand, before the Sugarcane Planters' Association was established, the market was an absolute buyers' market where the sugar factory side offered the price one-sidedly and purchased the sugarcane. The reasons behind this one-sided buyers' market can be explained as follows.

*For the sugarcane planters, there is no buyer except the sugar factory.

*Many of the sugarcane planters made a contract with the factory for advanced money lending

At any rate, the planters were in a disadvantageous position in negotiating the selling/purchasing price.

After the establishment of the Sugarcane Planters' Association, however, the system was changed to fix the price through negotiation by the representatives from the Association (26 Associations in total and 1 Cooperatives of Sugarcane Planters) and the representatives from the private sugar factory operating companies. In case if the negotiation could not reach an agreement, then the government shall play a role of mediator and fix the price. For this purpose, the Cane and Sugar Board is organized based on the Cane and Sugar Act 1984. The Board consists of 9 representatives from the Planters' Associations, 7 from sugar factory side and 6 members from the related government agencies.

As discussed above, sugarcane is a special crop having unique nature in its marketing too, as the prices for each year may be decided through the tripartite meetings among planters, factories and the government. The sugar price fluctuations experienced recently are considered to be effected by the increasing ethanol production in major sugarcane producing countries in the world. In Brazil, the use of sugarcane for ethanol production increases steadily year by year and the ratio of sugar production is declining, leading to higher sugar prices in the international market and accordingly affecting to the domestic sugar price in Thailand.

2.3.4 Marketing of Fresh Vegetables and Fruits

(1) Cultivation of vegetables and marketing in Thailand

Major vegetables in Thailand are peppers, sweet corn, baby corn, long bean, kale, water melon and cucumber and in recent years production for asparagus, baby corn, okra and green soybeans are increasing for the purpose of exporting. In the Northeast Region, however, the vegetable production is not very popular and after the wet season paddy vegetables are planted only in a limited area. Tomatoes and carrots are sent to processing factories and onions, garlic and shallot encounters hard competitions with the imported ones.

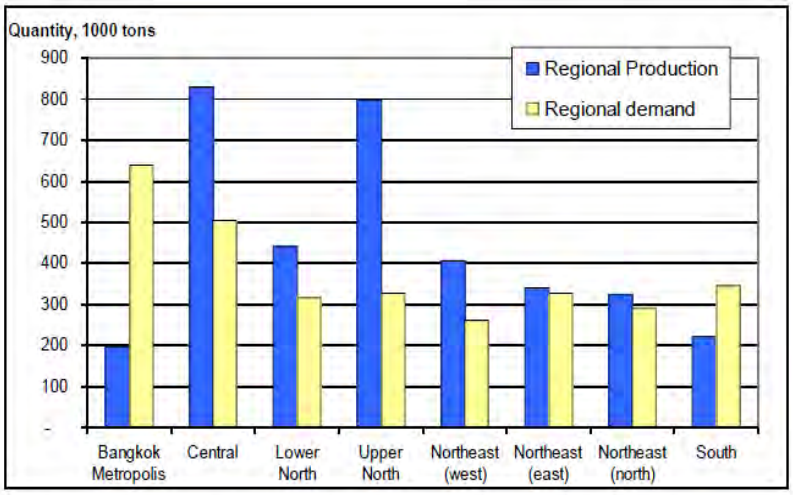
In the Northeast Region, production is more than the demand by a slight surplus which are supplied to either Bangkok and/or central Region. There has been a change in eating habit, however, and even in rural areas, people consume a lot of vegetables today, and in many cases vegetables are supplied to rural villages through the local markets from the outside producing areas. There observed major flows of vegetable marketing channels as follows.

*The route from Phetchabun to the wholesale market in Khon Kaen

*From other producing areas to Nakhon Ratchasima through Bangkok

*From Pakse to Ubon Ratchathani

The routes and flows are as shown in the Figure below.



Source: Figure reproduced with permission, Hardeweg and Waibel (2006)

Figure 2.3.5 Demand and Supply of vegetable by Region

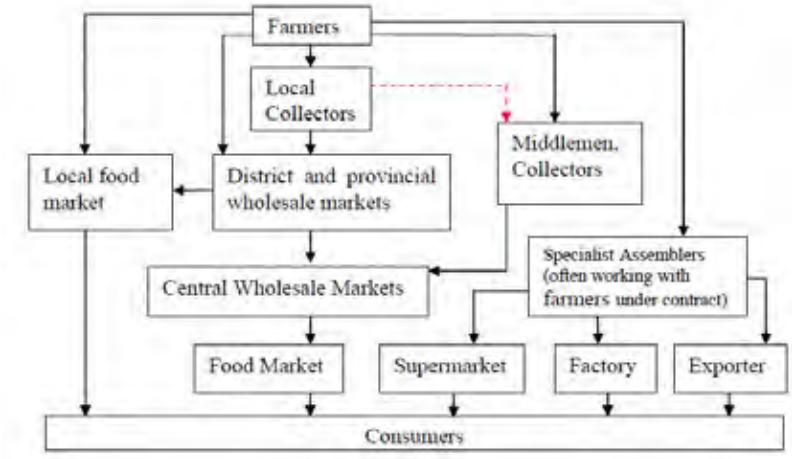


Figure 2.3.6 Marketing Channel for Vegetable in Thailand

Source: Johnson, Weinberger and Wu (2008), The vegetable in Tropical Asia: Thailand, AVRDC-The World Vegetable center

Figure 2.3.7 Vegetable Supply by Region

At the village level, agents collect the vegetables produced and sell them to the markets in Amphoe or farmers sell them directly at the public markets in the nearby Amphoes.

(2) Value adding: Direct market, organic farming and contract farming

As observed trends in the Northeast Region, community markets at villages and Tambons are popular practices aiming at sale of safe vegetables and income raising for farm households. Another practice is opening of green market at the center of Amphoe and or provincial capital aiming at supply of non-chemical organic produces for the people in urban areas. For these activities, NGOs, Universities as well as hospitals and clinics and Thai Health Promotion Institute provide supporting services for further extension.

RTG is promoting contract farming system. For examples, contract farming is practiced in Nong Khai and Nakhon Phanom provinces for production of tomatoes for processing and in Khon Kaen seed production. In other cases, such big business like super market chains are promoting contract farming too.

Safe foods and organic produces are important factors in value adding, with which production costs except the labor cost can be lowered down and purchasing with higher prices can be expected. The differences in the prices are as indicated below.

Table 2.3.1 Price Differential between Safe, Organic and Regular Vegetable in Thailand

Type	Average organic price (baht/kg)	Average safe price (baht/kg)	Average regular price (baht/kg)	Difference between organic and regular (%)	Difference between safe and regular (%)
Hot chili	250.0	211.3	65.0	284.6	225.0
Cucumber	58.2	48.7	19.0	206.1	156.1
Kale	89.3	86.3	45.2	97.8	91.0
Cabbage	60.5	79.5	28.5	112.3	178.9
Shallot	-	210.0	139.8	-	50.3
Water spinach	52.0	52.0	33.4	55.6	55.6
String bean	85.0	102.8	54.1	57.2	90.0
White beans	59.0	77.3	41.7	41.6	85.4
Flowering cabbage	85.0	67.8	38.3	121.7	76.7

Source: Poapongsakorn (2006)

2.3.5 Natural Rubber

(1) Rubber products and production methods

After planting rubber trees, it takes 6-7 years to produce field latex, and during the periods 12-14 years after planting, the productivity shows the highest efficiency. When the trees will be 25-30 years old, the productivity be considerably lowered down and re-planting will be required. For harvesting, the trunk of rubber tree shall be inflicted by special-made knife and the field latex oozed out is collected. This is called as tapping and usually done in early morning since the field latex be naturally coagulated by sunshine. The field latex collected contains 20-30 % of rubber component. In order to prevent the collected material from natural coagulation, some stabilizing agent like ammonia be added to, then by using a centrifugal separator machine the rubber density shall be condensed to 60 % high. This rubber in liquefied condition is called latex and used as the materials of tire-code (Reinforcing of tire), rubber glove and adhesive agents.

Other products include sheet gum and block gum. For sheet gum, acid be added to the material rubber to make it coagulated and then shaped in a sheet form (Un Smoked Sheet, USS). After that, the USS be hanged in a smoking room for 1 week period and dried up. The dried USS is then inspected to classify the quality based on the internationally formal samples. The classification has 5 grades and called as Ribbed Smoked Sheet, RSS, which is most popular in international trading. While Technically Specified Rubber, TSR is called as block gum because of its shape and the standard specifications of block gum are various in country by country. The flow of rubber products processing is a shown in the following figure.

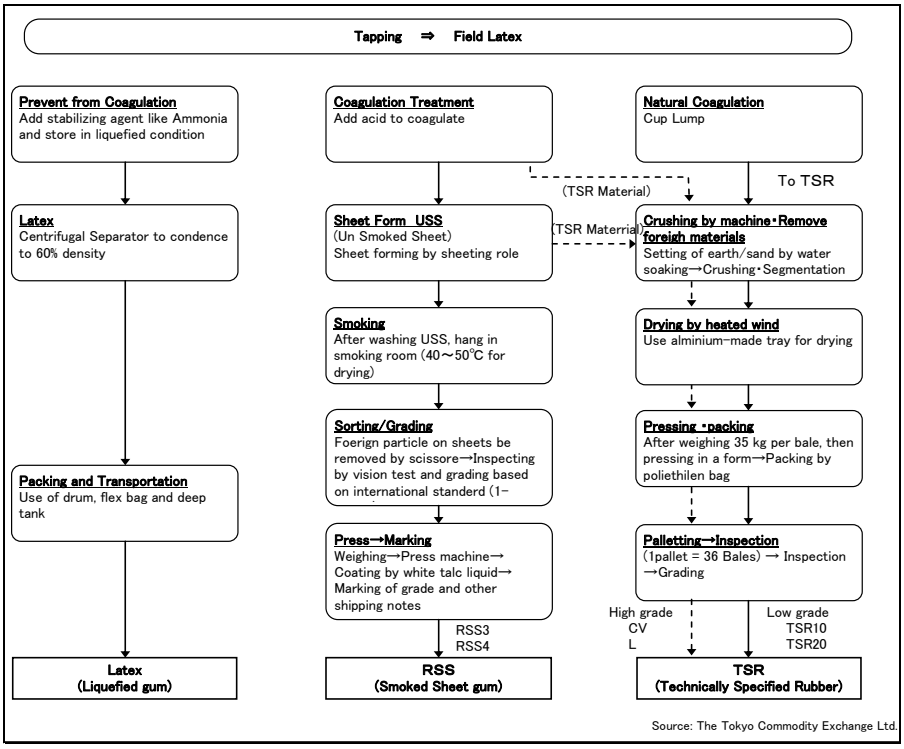


Figure 2.3.8 Production of Natural Rubber Product

(2) Marketing channel of rubber products

In general, producer farmers engage in tapping, preparation of USS and up to cup lump. These material rubber are sold to the collectors who has no store and makes round by bicycle/motorbike. Then, the collected rubber material be sold to dealers who have stores and warehouses. The dealers engage in smoking and packing by using the treatment facilities and then exported by the shipper. Generally, the shipper plays a role of processor too. Dealers do business face to face with the processors and also with the buyers at the publicly installed market called as Central Market, where USS prices be fixed. USS price is very important for producer farmers affecting directly on the income for farmers. The Central Markets are operated at Haadjai, Surathani and Nakhon Sithamarat in the south region, and it was in 2009 that the Market was opened at Buriram. Further, a new Market is to be opened at Nongkhai in near future.

In Thailand, the Agriculture Future Exchange of Thailand was opened in September 2001 and the forward dealings of RSS-3 have been operated since May 2004. It was in the year 2003 that three major rubber producing countries of Thailand, Malaysia and Indonesia agreed on and established the International Rubber Consortium Limited, IRCo aiming at the price support on natural rubber, but to date there have been no market intervention made so far

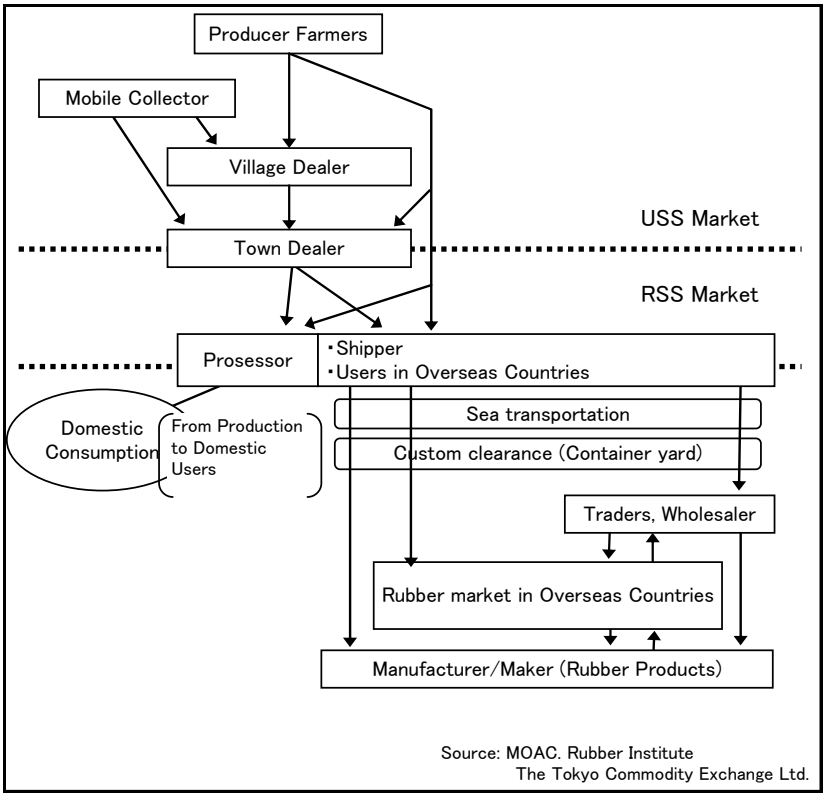


Figure 2.3.9 Structure and Marketing Channel for Natural Rubber

(3) World production and demand for rubber

In the long term perspective, the world production and demand for rubber have been in increasing trend. The primary factor to decide demands for rubber is the situation of world economy. In particular it is affected largely by the trend of production/sales of automobiles as 70 % of rubber is used for production of tires. Among others, it is remarkable that the automobile industry in China has been progressed so rapidly after the joining with WTO in 2002. In China, the production of automobile was 2 million units in 2000 and it was increased to as many as 13.79 million units in 2009.

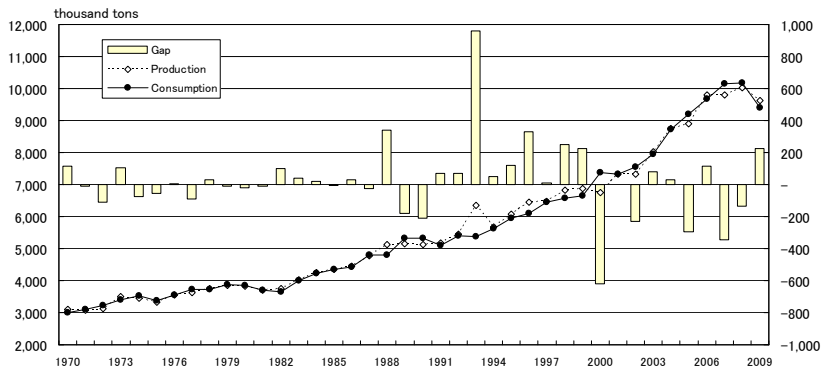


Figure 2.3.10 World Production and Demand of Natural Rubber

Thailand is the largest rubber producing country in the world followed by Indonesia and

Malaysia. In 2009, Vietnam started expansion of rubber production and it is said that in near future Vietnam will be the second largest rubber producing country in the world surpassing Indonesia and Malaysia. While on the consumption aspect, the increase in China is so remarkable. Consumption by China was ranked 2nd after surpassing Japan in 1997 and it was in 2001 the ranking was 1st after surpassing USA. The consumption of rubber by China shares as much as 1/3 of the world consumption in total.

Of the total volume of natural rubber produced in Thailand, as much as 90 % has been exported in the past, but recently the domestic consumption has been in increasing trend due to the increased tire production in Thailand too. Formerly the major importer of rubber from Thailand was Japan for a long time, but today it is China ranked 1st.

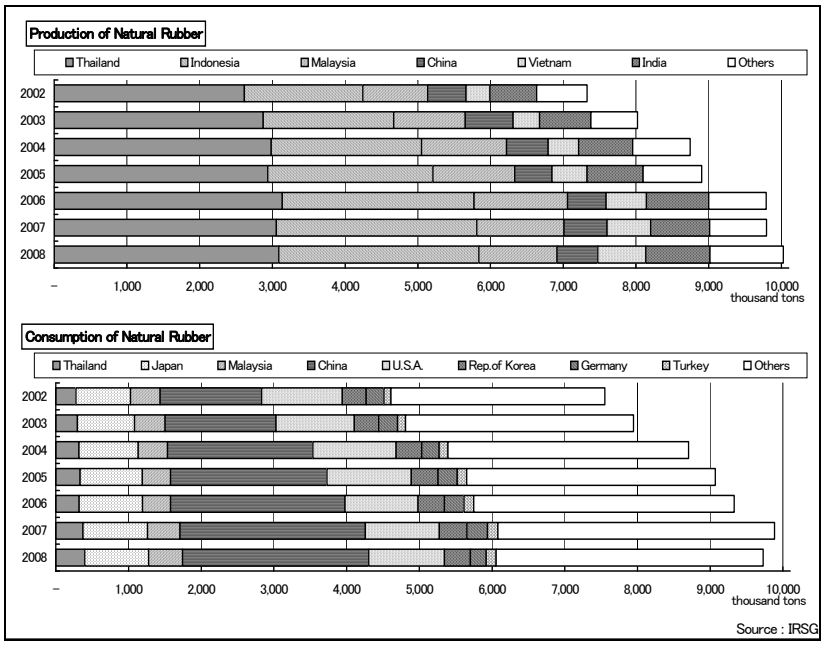


Figure 2.3.11 Rubber Production and Demand of Major Countries

2.3.6 Food Industry

Thailand, being favored with advantageous natural resources and abundant bio-diversities suitable for agricultural production, has been reputed for considerably long time as one of the prominent food exporting countries in the world. Recently it is said that Thailand plays a role of food processing center in Asia in general. According to the "Global Trade Atlas, 2008 version", Thailand is ranked as 7th largest food exporting country in the world next to such big powers as EU, USA, Brazil, China, Canada and Argentine and the position has remained same since 2002. In the year 2007, the value of food export by Thailand amounted to US$ 19,395 Million, which is 94 % increase from the 2002 value of US$ 10,020 Million. (Annual increase rate of about 18 %) During the same period, the proportion of Thai food export in the world export market increased from 1.36 % to 2.39 % too.

Important export items (2007) and the values of each commodity is as noted below.

1) Fishery products: Canned tuna, processed seafood and frozen shrimps (THB200 Bil.)
2) Rice and related: White rice, jasmine rice and rice flour (THB120 Bil.)
3) Vegetables/fruits: Canned pineapple and juice (THB 71 Bil.)
4) Meat and related: Processed chicken (Frozen and ready to cook) (THB 44 Bil.)
5) Spice and seasoning: Spices and seasoning agent -

The government of Thailand has ever been exerting various kinds of efforts in improving the quality of Thai-produced foods and export of the products. In recent years, under the propaganda of "Kitchen of the World", production increase for Halal Foods was challenged and incentives were given to promote chained Thai food restaurants overseas widely in the world. The effort made by the government has been showing some favorable achievement matching with the internationalization of foods on global basis. Thai foods are reputed among international world for its rich varieties and good tastes and it can be expected that Thai brand may be firmly established in gourmet world and export of Thai food products may be further expanded.

Thai government has formulated a Vision to be attained by nation-wide effort and showed a road map as below for further development of Thai food industry.

1) Export of Thai food be expanded by at least 10 % per annum
2) Of all, the ratio of processed/instant foods shall be more than 60 %.
3) Of all the food processing factory, at least 50 % shall secure international standard.
4) PR activities for promotion of Thai foods world-wide on its quality and safety for health
5) Establishment of local standard comparable to international one

Food industries can secure most of the raw materials needed from domestic market and can enjoy good balance in the international payments, which implies the industry can contribute to the development of national economy more efficiently. In view of the employment aspect, the industry is of labor-intensive nature and can be expected to contribute more to the local area of factory location as coupled with the possible adoption of Local Wisdom in the production.

Out of the total number of the factories for food production, more than half is located in Northeast Region, though the scale of the majority are rather small. Therefore, there is a high possibility that these food related factories in the Region may play an important role and contribute to further growth of the Regional economy. As previously discussed the international demand for food will be expanded for sure and taking advantages of positions captured by Thailand to date, the country shall find the ways to expand further the production of farm produces, to add values by longer value chain processing and export it to the world market.

For reference, those food products to be processed for export in Northeast Region as observed during the field survey shall be noted as follows.

* Processed fish fillet, frozen foods ready to cook, vegetable juices, pickles, dried fruits/fruits sugaring, glutinous rice products, sauces, herbs and livestock processed products, Isaan foods specials

2.4 Institutional Aspect of Agricultural/ Rural Development

2.4.1 Government Agencies Concerned

Government agencies involving in the agriculture sector development and community development are many including all the project executing Departments under the MOAC, Community Development Department under the Ministry of Interior, Industrial Promotion Department under the Ministry of Industry and the Bank for Agriculture and Agricultural Cooperatives etc. Their major roles assigned are as shown below.

Table 2.4.1 Central Governmental Agencies regarding Agriculture and Rural Development

Ministry	Department	Main Tasks
Ministry of Agriculture and Cooperatives (MOAC)	Office of Permanent Secretary (OPS)	Coordination of integrated policies, Secretariat to Agricultural Minister
	Department of Agriculture (DOA)	Breed improvement, O&M of test plots, production of elite plants
	Department of Rice (DOR)	Breed improvement, O&M of test plots, seed production
	Department of Agricultural Extension (DOAE)	Agricultural extension, promotion of mechanization, and establish of farmers association
	Land Development Department (LDD)	Support of water use in farmland, crop production and fertilizer application
	Agricultural Land Reform Office (ALRO)	Allocation of cultivation certificate of deteriorated forest, infrastructure building within Land Reform Area, and stabilization of the people's livelihood
	Department of Livestock Development（DLD）	Promotion of livestock industry, animal industry process, prevention from epidemic and so on
	Office of Agricultural Economics（OAE）	General agricultural policy, agricultural statistics and export strategy
	Cooperative Promotion Department (CPD)	Establish and strengthening of cooperatives
	National Bureau of Agricultural Commodity and Food Standards (NACFS)	Promotion of agro-industry, establish of standards and management of safety standards, extension, and promotion of export
	Department of Fishery (DOF)	Sea fishery, inland fishery, aquaculture, process
Ministry of Interior	Community Development Department (CDD)	Enhancement of communities, extension of public participation and collaboration with provincial offices
	Department of Local Administration (DLA)	Coordination with provincial offices and general local administration
Ministry of Industry (MOI)	Department of Industrial Promotion (DIP)	Promotion of Small and Medium Enterprises (SMEs)and One Tambon One Production (OTOP)
	Office of the Cane and Sugar Board (OCSB)	Price determination and preparation for production goal setting
Ministry of Energy (MOE)	Department of Alternative Energy Development and Efficiency (DEDE)	Promotion of renewable energy (e.g. bio-diesel, ethanol, wind power) development, use and extension
Others (under MOAC)	Marketing Organization of Farmers	Policy procurement of agricultural products, adjustment of stock, support of agricultural materials and operation of model markets

Ministry	Department	Main Tasks
Others (under Ministry of Finance)	Bank for Agriculture and Agricultural Cooperatives （BAAC）	The biggest agricultural finance, introduction of insurance for weather risk and financing for infrastructure building and agricultural machines purchase

Details are as shown in the attached Appendix 2.4.1-3.

2.4.2 Non-Governmental Organization

For development of agriculture sector and rural community, not only the related government agencies but also NGOs and Foundations involve in the activities. For the central governmental agencies (Excluding CDD and DOAE), it is recommended to form a partnership with NGOs to study and grasp the needs and conduct extension services at the field, but not conducting by themselves. This is to secure sustainability of the development project even after the termination of the project.

2.4.3 Learning Center, Farmers' Group and Network

The MOAC promotes establishment of Learning Center, based on the confirmed policies to promote the Sufficiency Economy philosophy, aiming at possible extension of agricultural technologies as well as providing opportunities of learning for farmers. This does not involve construction of facilities for learning and training but to nominate and register the advanced farmers and their farm lands as "Learning Center" and share the learning among the participants with having the advanced farmer functioning as the lecturer. By arranging the study tours, group of farmers visits the learning center and receives the training. Various Departments under MOAC either in individual basis or in collaborative manner offer supports for establishment and operation of the learning center.

In the Northeast region, the numbers of the cooperatives are rather limited. After the Royal Decree effected in 2004, the farmers' group (Only registration at Amphoe office) can access to various funds provided by the government even without the status of juristic person without establishing a cooperatives. This provided good opportunities for development for such community enterprises and farmers' group as having no juristic person status.

Under the current 5 years agricultural development plan, promoting establishment of farmer group and networking are stressed. In the Northeast region, there existed some reputed networks like Alternative Agriculture Network, In-Paeng Network and Surin Net and etc. which are active and having rather long history of activities. To this end, it is expected that not only such reputed and widely operating networks but also the smaller level ones may exchange the knowledge and experiences with each other so as to materialize mutual supporting system for attaining the same objectives.

2.4.4 TAO's Role in Agriculture/Rural Development

As discussed in the previous section for water resources management/irrigation development, various project facilities have been transferred to TAOs in accordance with the Decentralization Act and the budget allocated for TAOs has been in increasing trend. In the budget items for TAO,

an item named as “Sufficiency Economy” is included. The budget allocated under the said item is used for purchasing of equipment and materials for production of organic fertilizer, training for mixed farming and support for activities by women’s group for raising-up of standard of living.

Under the “Integrated Agricultural Development Project in NE Region” as implemented by ALRO, community master plans were formulated jointly by TAO, farmer’s group and farmer network, and activities as reforestation of community forest and construction of agro-processing facilities have been undertaken by joint financing by TAO’s budget and the ALRO’s project budget. Also, for those rural infrastructure facilities to be transferred to TAO after the project, TAO participated from the planning stage and committed to be responsible for the post project O & M. In this case, TAO has committed to disburse some of the training costs from its own budget too.

After this, TAO will have to play a greater role in the promotion of agriculture and varieties of activities in seeking off-farm incomes(Including OTOP promotion) in Tambon. Concerning this, it shall be noted that it is necessary to pay due attention not only in leveling up of the TAO’s administrative capability but also in plan formulation with due participation by the local residents and civil society as well as in the allocation of adequate budget.

2.4.5 Roles by Educational Institutions/Training Facilities in the Region

In the Northeast region, the ratio of enrollment to Upper Secondary and vocational level schools exceeds 60 % and it can be said that higher level education is already popular in the Region. During the interviewing in field survey this time, it was rather common that farm families allow their children to study in universities, and the parents preferred to have non-farm occupations for their children for higher income with their higher education records. In the Northeast region, there are many higher educational institutions as below.

Table 2.4.2 Higher Education and Vocational School in Northeast

Category	Number	Province or Name of School (number for vocational
National University	3	Khon Kaen, Maha Sarakham, Ubon Ratchathani
Rajabhat University	10	Kalasin, Chaiyaphum, Nakhon Ratchasima, Buri Ram, Maha Sarakham, Roi Et, Loei, Sakon Nakhon, Udon Thani, Ubon Ratchathani
Raja Mangala University	1	Raja Mangala University of Technology Isan
Independent	1	Suranaree University of Technology
Vocational School	111	Kalasin (6), Khon Kaen (11), Nakhon Phanom (2), Chaiyaphum (5), Nakhon Ratchasima (12), Buri Ram (7), Maha Sarakham (6) Mukdahan (3), Yasothon (3), Roi Et (8), Sakon Nakhon (4), Si Sa Ket (6), Loei (4), Surin (7), Nong Khai (5), Nong Bua Lam Phu (2), Amnat Charoen (2), Udon Thani (9), Ubon Ratchathani (9)

Source: Office of Higher Education Commission, Office of Vocational Education Commission

With having due collaboration with the educational and research institutions in the region, it

seems possible to improve the agricultural productivity and value-adding through raising up the standard, step by step, of agricultural technology, research and development, agro-processing and improved value-chain.

Another example to be proposed is the case of FAO's pilot project. In this rural development project, researchers of universities stayed in the villages and conducted surveys on present conditions and needs of the villagers so that necessary supports by donors/project implementing body could be adequately identified and extracted. This case can be utilized as the places for actual practice too for those students studying agricultural extension and community development and intend to join later in DOAE and CDD after graduated the universities.

2.4.6 Roles of Private Sector in Value-adding and Marketing of Agro-produces

Of the agriculture-related private enterprises operating in Thailand, there are some huge scale agri-businesses like CP, but most of them are food production companies and rice-millers in rather small scale. In future, it is predicted that not only the traditional rice marketing, sugar mills and cassava processing but also newly developing bio-ethanol industry will be taking more important positions. However, it can not be expected that the prices of raw materials will not always be in high level though continuous efforts (Yield increase) shall be needed to lower down the production costs for sugarcane and cassava to survive in the international competition including the efforts to be made by private enterprises.

If that is the case, to derive higher income from agriculture, sale of agro-produces with value-added shall be the necessity for the farmers and the regional economy itself. There are many projects promoting crop diversification, but without adequate marketing, farmers have to take risks in their cultivation of vegetables. It is considered necessary to expand contract farming with the private enterprises to secure stable marketing of farm produces. In this case, the government agencies shall play a role of facilitator.

2.4.7 Safety Net

When pursuing the raise-up of standard of living of farm families by means of agriculture/rural development, the roles of safety net become very important. Agricultural production depends largely on the climate condition which is beyond control and changeable by external factors. Further, the farm gate prices of produces depend also on the external factor of price setting in the international market. The RTG fixed a policy to implement a new price insurance scheme for 3 major crops of rice, cassava and maize from the crop year 2009/10. Farmers register volume of produce to be insured and amount calculated from registered volume and price gap between Government's guarantee price, set once a year, and reference price in market announced twice a month price will be paid to farmers directly regardless how much actual price they sold. Based on the scheme the RTG paid to as many as 200,000 farmers the difference between the guarantee price and the lowered down price due to the low paddy pricing during March-April. It is difficult to assess the scheme since this case is just the beginning of the scheme implementation. However, it is considered that this kind of

counter-measure shall be necessary as farmers alone can not adjust to such drastic and largely fluctuating international market prices. With introducing the said scheme, the former rice mortgage financing scheme was abandoned. Other than the price guarantee scheme, there are systems to pay compensation money or extension of loan repayment period or subsidy for interest payment as well in case of the crop damages due to floods, drought and insects. The climate insurance is newly introduced safety net by derivative with rainfall index, and started actual operation in this year as handled by BAAC. Irrespective to the degree of damages, insured money be paid or not paid depending on the rainfall amount fixed for each locality in a fixed period.

Table 2.4.3 Policies and Measures concerning Safety Net in Agriculture

Policies and Measures	Targets	Description	Responsible Agencies
crop prices insurance	Rice, casaba, and maize	Payment of balance directly to farmers for registered volume if crop market prices are lower than those presented by government	MOAC
Support against agricultural damages	Disaster affected farmers	Compensation to affected farmers, prolongation of repayment deadline to BAAC, supplementation of interest	MOAC
Weather insurance	Rice	Weather derivative based on rainfall index by area	BAAC/JBIC Sompo Japan Insurance Inc.

Aside from the systems/scheme by the RTG, in the rural village, there have been activities by local people applying the local wisdom for possible safety net practices. The followings show merely a part of it. In the areas often hit by flood and drought damages, each community has their own measures, they say.

In the rural areas, people cultivate food grains for their consumption and secured the food safety, and for the needed expenditure in emergency, they sell their livestock to meet the requirement. In 1997, those immigrant workers lost their jobs in Bangkok due to the negative effect by economic crisis and backed to the rural areas for their living. This shows that the agriculture/rural villages itself sufficiently function as a safety net.

Table 2.4.4 Policies and Measures concerning Safety Net in Agriculture

Activities	Target	Description
Rice Bank	Group	Stockpile of unhusked rice at community level, loan of unhusked rice to members in case of flood, drought and bad harvest
Saving Group	Group	The association is traditional grassroots finance and members can borrow sizable amount of money in turn by reserving fund weekly or monthly. There are cases members shoulder cost for funeral each other.
New Theory Agriculture (Integrated	Individual	Mix farming or integrated agriculture making best use of limited water and land resources by means of ponds, and food supply and risk distribution by crop diversification

Activities	Target	Description
Agriculture)		
Agro-forestry	Individual	Agro-forestry is commonly plantation within forest, however, people plant trees in uplands field in Northeast. After certain period, they can get cash by sale of timbers in the event of an emergency

In view of the above, it can be said that strengthening of communities will result in reinforcing the safety net function since it can cause minimizing the shocks by climate changes, economic downturn and varieties of external negative factors and also earlier

2.5 Higher-priorities-given Policies/Development Plans for Agriculture and Future Trend

2.5.1 Related Policy

(1) 10th National Economic and Social Development Plan

The 10th Plan (2007-2011) is currently underway in which there is an appreciation of the situation surrounding Thailand that the country has to face in her development efforts both opportunities and constraints as affected by the varieties of changing contexts to occur internally and externally. There is an understanding that globalization will be further accelerated on one side and the "Sufficiency Economy Concept" as suggested by His Majesty the King of Thailand is an important principle for the country on the other side. The vision is set to move forward to materialize "Green and Happiness Society", and key words are human resource development, promotion of effective, sustainable and equitable economy, ultimate balance between development and environment and good governance. Outlines of the sufficiency economy concept and green and happiness society are described in the Appendix 2.5.1.

(2) Policies to be adopted by the Present Government

Of the varieties of the policies announced by the present government, the followings are the issues to relate with the direction of the subject study.

* Practicing of Sufficiency Economy Concept
* Rectifying the regional income disparity
* Water management/development of irrigation system/increase of irrigation area
  *People's participation and importance of environmental conservation (To secure sustainability)
  *Securing sustainable prices for farm produces and introduction of risk insurance
  *Zoning of farm land and increase in bio-energy crop production
  *Promotion of agro-industries with international standard (Food safety)

(3) Agricultural Development Plan under 10th NESDB Plan (2007-2011)

The Agricultural Development Plan put an emphasis on the country's advantage and suitability in further production increase and expansion of investment through re-confirming the favored

natural conditions and abundant bio-diversities by varieties of ecological systems in the country, in addition to the geographical/logistic advantages. The prevailing globalization will bring about chances for Thailand as assessed in the Plan. Finally the Plan indicates the necessities for reinforcing the country's capability to respond to changes and to strengthen the competitiveness and the resultant possibility for further export expansion.

2.5.2 Changing Contexts and Development Strategy for Northeast Region

(1) Development strategy by NESDB

Based on the 10th Plan, NESDB formulated a development strategy for the Northeast Region during the period 2007-2011. In the said strategy, changing context as predicted was disclosed as in the followings. In the present study the context was reviewed together with the outlines indicated as "From 2007 vision to 11th NESDB Plan" in the NESDB's annual meeting held on July 2009. The content and the policy/strategy direction covers rather wide aspect/sectors, but the descriptions in this paper shall be limited to those concerned with the Northeast Region only.

Such trends and changing contexts with which the Northeast Region encountered, encountering or will encounter in relation with the regional development will be the following five (5) items.

1) Regional basis economic integration will be further enhanced and among others the regional economy of Asian countries will have fast-growing trend. This will cause changes in power balance of the world economy and the presence of Asian countries will be intensified.

2) On global basis, aged population will rapidly increase and younger generation will move from agriculture sector in rural area to non-agricultural industrial sector in urban area. This will lead to further ageing of farming labor.

3) Problems in energy sector will be more crucial. The government promotes the use of bio-fuel and in Northeast Region more sugarcane and cassava will be produced as the material for ethanol production.

4) Global warming and climate changes will cause threats in the form of flooding and drought, damage on farm production and negatively affect on the nature, economy and people's life.

5) Through expansion of FTAs, farm produces in the Northeast Region such as rice, cassava rubber and fruits will find more demands for export expansion.

In view of the changing context as mentioned above, on global basis, such crisis as climate change, energy, food, financial and economic concern will be increasingly occurred.

In particular as to oil, food and water, the demands are predicted to increase much faster and more than the supplies, and the world has to shift its heavy dependence on oil to other alternative energies as much as possible and as soon as possible too.

Concerning the demands for food in the coming 50 years, it is estimated to grow by 50-70 percent due to the population increase, increase in ratio of middle class people and changing

taste of the consumers in general etc. This suggests possible shortages of irrigation water and decreasing areas for planting due to the further expansion of urban areas in future.

(2) Situation of Northeast Region

To grasp generally the Northeast Region's situation and surroundings, the results of SWOT analysis as conducted by NESDB (At the time of 10th Plan formulation) shall be presented as below.

Table 2.5.1 SWOT Analysis on Northeast Region

Strengths at present	Opportunities in future
* 40 % of country's farm land is in Northeast. * Main production area of Jasmine Rice. * 59.6 % of food processing factories in Northeast. * Good location neighboring LMB countries. * Developed communication (Road network)	* Investment in Agri-sector increase due to FTA. * Tourism for benefit creation * Prices for cassava and sugarcane be sustained due to the demands for bio-ethanol
Weaknesses at present	**Threats in future**
* Unfavorable rainfall and poor soil * Low irrigation rate and low productivity * Low education level * Low level welfare * More number of poor (study results suggest) - Poor management of crop production	* Negative effect by FTA (Especially for livestock) * Increased risk by global warming and climate change * Spreading of infectious disease by emigrant workers * Lowering of safety security in rural society (study results suggest) - Aging of agricultural sector, young generation migration to town and future farmer shortage

(3) Problem Areas and opportunities for Thai Economy and Role of Northeast Region

Important points and policy directions to be involved in the plan formulation towards the 11th Plan are as indicated below.

* Maintaining the growth rate and reducing risks

  -Strengthening the production bases
  -Improvement of production structure for balance creation
  -Expansion of domestic demand and fair income dispersion

* Creation of growth matching with the global trend

-Expansion of market and facilitating regional cooperation
-Food export based on the relative advantage of agri-sector
-Value-adding to farm and agro-processing products
-Development of alternative energy with balancing food/energy needs

* Promotion of Green jobs, Green Growth and Green Economy

* Chance by globally changing population composition toward aged society

* Chance for cooperation with neighboring countries to accelerate the growth rate

-Development cooperation for common interests (LMB and ACMECS)
-Policies and manner of operation and management
-Adjustment in economic infra-structures

Further to mention concerning the above issues and opportunities, roles to be accomplished by the Northeast Region are noted as follows.

* To be the major production base for food and energy crops in Thailand
* To be the leading production base for processed foods and ethanol
* To be the gateway for facilitating tourism and trade among Indo-china countries
* To be one of the major tourist sites in the country

2.5.3 Future Agriculture and Related Industries in Northeast Region

From the macro economic view points, further review was made on the following important subjects including export of farm produces, farm mechanization, food industries, potential for ethanol production and effects by FTAs effectuation.

(1) Global Base Food Demand/Supply and Export by Thailand

In September 2009, FAO announced the results of prediction analysis made on world-wide food demands and supplies in a long term perspective. It referred the trend of population increase in future and indicated the necessity of as much as70 % food production increase (2005-2007 base as 100 %) in the world by the year 2050. In order to achieve the target as predicted, FAO recommended to the world to lay out additional investment in agriculture sector by 60 % more.

While for the short/medium term projection, a research institute under the Ministry of Agriculture, Forestry and Fishery, Government of Japan made an analysis in 2009 (Demand/supply projection in 2018) based primarily on the then prevailing situation in the world markets for farm produces and by using the model developed by the institute where trends of increasing food demand/supplies in Asian countries and effects on food supplies by increasing demands for ethanol production are fully taken into account. According to this analysis, major points of projection are as follows.

* World consumption of cereal grain will reach to 2.6 Billion ton by 2018 with having an increase of 0.5 Billion ton during the period of 12 years.

- Consumption of wheat and rice will increase mainly due to demand increase for food
- Consumption of maize will increase due mainly to demands both for feeds and bio-ethanol production

* For all the crops, supply cannot catch up the demand by increased consumption. This will cause lower stock level in the final inventory.

* Prices of grain cereal will rise by 34-46 % in nominal and 7-17 % in real terms as compared with 2006 level.

* The tendency of uneven distribution of cereal trade in the world will be furthered.

- In Asia, Africa and Middle East, production never satisfy the demand and import volume in net will be expanded.
- Europe, South America and Oceania will expand export volume.
- North America will decrease the export volume constantly while Central America will change the position from Importer to Exporter.

* Concerning meat, annual per capita consumption will increase. The price will

be raised by 31-41 % in nominal and 5-13 % in real terms.

Source: "Points of Food Demands/Supplies Projection for 2018" Ministry of Agriculture, Forestry and Fishery, GOJ, January 2009

At any rate, the projection analysis indicates tighter demand/supply situation and probable price up in considerable level in 2018, though production itself will be fairly expanded through world-wide efforts for larger production.

Table 2.5.2 Food Demand/ Supply Projection of Cereals in the World in 2018

(Unit: Million US$)

		Wheat	Maize	Oterh cereal	Rice	Soybean
2006	Producetion	609	734	281	422	225
	Consumption	621	736	288	420	225
	Food	516	206	129	420	210
	Feed	105	530	159	0	15
	Stock	130	120	32	77	55
	Price	202	133	140	374	294
2018	Producetion	751	969	343	511	275
	Consumption	752	970	344	511	275
	Food	623	231	147	511	258
	Feed	129	739	197	0	17
	Stock	119	105	29	71	51
	Price (real)	218	155	155	402	319
	Price (normal)	272	193	193	502	398
Increase (%)	Producetion	23	32	22	21	22
	Consumption	21	32	20	22	22
	Food	21	12	14	22	23
	Feed	23	39	24	-	16
	Stock	-8	-12	-9	-7	-8
	Price (real)	8	17	10	7	8
	Price (normal)	35	46	38	34	35

Throughout 20th century, Thailand was reputed as a stable food exporting country in the world. In the recent past, in particular, Thailand has enhanced further the position by capturing even

more important status in exporting a variety of commodities as rice, cassava and sugar and etc. Under the circumstances, the policies are to further strengthen agriculture sector which is favored with relative advantages already so as to prepare for the world-wide food crisis to come and to play more important role in dealing with food security in the world.

Fortunately, Thailand is favored with rich natural resources as judged comprehensively and has secured to date considerable surplus in foods in spite of the relatively lower unit yield. In future, however, extensional expansion of farm land area as in the past is seemed hardly possible, and it is necessary to secure further sustainable production increase through raise-up of unit yield by improvement of production structure including effective water management and raising-up of irrigation rate and several others. Among other Regions, the Northeast Region holds a larger room for improvement and therefore it is expected that the Region will play a key and bigger role in this important national endeavor.

(2) Farm Mechanization

In Thai economy, the relationship of mutual dependence between agriculture sector and industrial (Manufacturing) sector is quite close. It was the surplus agricultural production capacity who led the stability in Thai society and indirectly stimulated foreign investors to invest in Thailand to function as the leader in such favorable growth of the national economy in the past. Moreover, it was the foreign exchange earned by export of farm produces that supported domestic funding needed for industrial development. Agricultural production increase by means of expansion of cultivation area on one side and improvement of productivity by means of infra-structure improvement and mechanization on the other side are the process which have supported the development of Thai agriculture to date as a whole.

During the field survey under the present study, what was observed with deep impression includes broad-casting of paddy seeds in many parts of the Region and extensive use of large machines for harvesting. As is the case, it was not easy to find transplanting and harvesting works by hands which used to be the very common country view in the Northeast Region a decade ago.

In order to grasp the fast-spreading farm mechanization in Northeast Region, comparison review was made on the numbers of farm machinery and the manner of holding, respectively both national and regional in the years 1998 and 2003 as follows, which indicates a stable and rapid increase of farm machineries especially in the Northeast Region.

Table 2.5.3 Trend of Increasing Number of Farm Machinery Use, 1998-2003 (Whole Kingdom)

Whole Kingdom Nuymber of Holdings Reporting the Use of Machinery and Equipment by Source and Type of Equipmnet

Type of Machinery	Year	Owner by Holder	Cooperatives or farmer's group	Agricultural Service	Government Agency	Others
Tractor 4 weels	1998	139,666	3,813	1,032,337	3,036	8,265
	2003	286,300	69,691	1,203,084	62,053	58,923
Tractor 2 weels	1998	1,930,195	3,111	1,660,112	2,131	91,911
	2003	2,144,947	18,241	1,587,792	18,254	37,953
Water Pump (Engine)	1998	1,304,205	5,357	306,437	11,987	68,448
	2003	1,209,237	16,127	327,191	18,412	28,617
Reeper (Harvesting for Sugarcane)	1998	7,151	807	269,618	84	778
	2003	6,753	3,471	34,982	3,371	4,185
Combine harvester	1998	3,341	1,049	353,390	48	1,441
	2003	37,976	6,520	957,011	5,705	8,819
Truck 4 weels	1998	615,365	10,932	2,233,873	2,547	109,886
	2003	876,901	19,694	2,134,292	17,676	38,224

Souce: NSO Agricultural Census, 1998, 2003

Table 2.5.4 Trend of Increasing Number of Farm Machinery Use, 1998-2003 (Northeast region)

Northeast Nuymber of Holdings Reporting the Use of Machinery and Equipment by Source and Type of Equipmnet

Type of Machinery	Year	Owner by Holder	Cooperatives or farmer's group	Agricultural Service	Government Agency	Others
Tractor 4 weels	1998	30,405	4,192	285,136	1,143	1,121
	2003	78,234	31,100	478,889	24,956	23,578
Tractor 2 weels	1998	1,011,372	2,105	1,124,979	636	46,397
	2003	1,275,074	8,613	1,105,248	9,662	20,925
Water Pump (Engine)	1998	429,909	2,049	196,487	5,044	26,479
	2003	437,717	6,534	205,042	8,825	11,601
Reeper (Harvesting for Sugarcane)	1998	950	572	43,229	-	78
	2003	2,223	1,378	7,727	1,448	1,595
Combine harvester	1998	383	1,049	21,720	-	-
	2003	9,961	1,362	352,054	1,359	1,563
Truck 4 weels	1998	157,414	4,593	1,182,133	1,703	10,616
	2003	265,874	4,487	1,253,337	5,867	5,788

Souce: NSO Agricultural Census, 1998, 2003

As the tendency can be seen clearly from the above Tables, both in national and regional levels, development of farm mechanization by large machines is progressing quite rapidly. 4 wheel tractor and harvester, among others, are extreme in their popularization showing the rapid increase during the 5 years of 1998-2003 as shown in the following Table.

Of the varieties of farm machineries, 4-wheel tractor owned by farm household (Especially in Northeast Region) and harvesters owned by farm household showed a big increase. The harvesters owned by contractor too increased considerably in the Northeast Region. There have been opinions by majority of people interviewed during the field survey stressing the need and firm tendency of on-going farm mechanization. The increasing tendency will be further

accelerated in the country and it will be more in the Northeast Region.

Table 2.5.5 Increasing Ratio of Farm Machinery 1998-2003

Whole Kingdom Increase of Farm Machinary

Holders	Type of Machine	Region	(1) 1998	(2) 2003	(2)/(1)
Individual Farmer	Tractor 4 wheel	Whole Kingdom	139,666	286,300	2.05
		Northeast	30,405	78,234	2.57
Agricultural Service		Whole Kingdom	1,032,337	1,203,084	1.16
		Northeast	285,136	478,889	1.68
Individual Farmer	Combine Harvester	Whole Kingdom	3,341	37,976	11.37
		Northeast	383	9,961	26.01
Agricultural Service		Whole Kingdom	353,390	957,011	2.71
		Northeast	21,720	352,054	16.21

Souce: NSO Agricultural Census, 1998, 2003

In terms of the manner of machinery purchasing and operation, it is common in Thailand as can be seen from the data that the unparalleled majority of large machineries are owned and operated by contractors as the services to be rendered to and paid by beneficiary farmers. The ratios of machinery possession by contractors are very high as shown below.

4-wheel tractor: 90 %
Reaper: 95 %
Harvester: 95 %

While farm households possess more than 50 % of power tiller and engine pumps to be used at on-farm level. The situation as noted above shows the fact that today major part of the farming works is by machineries and undertaken by contractors.

Concerning the water buffalo, traditional drafting animal in the Northeast Region, the number of the heads has been reduced as 1,509,499 in 1999, 1,350,527 in 2000 and 1,204,101 in 2001 which shows as much as 20 % reduce in mere two (2) years period. It is confirmed that the reducing trend continued constantly and the number of water buffalo is reported to be 1,022,639 heads in the year 2009.

It is said that up to the year around 2005 the progress in farm mechanization in the country was centered in the Central Region. However, the Northeast Region will be expected to be the core area in further farm mechanization in Thailand due to the large farm land planted and advancing farming labor shortage in the area. With this concern, it is considered necessary to formulate a plan and policies to promote such agriculture-related manufacturing industries (Including repair service) in Northeast Region as noted below expecting a considerable size of demands for machineries and devices/materials in the Region.

* Farm machineries: Power tiller, tractor and harvesters

* Devices/materials: Small pumps, pipes and sprinkler

In the Northeast Region, taking the local features/characteristics continuously prevailed for a long time into account, idea is that on one hand there must be a traditional farm management pattern centering on the rain-fed paddy cultivation for self-consumption purpose, and at the same time there would be a commercial nature management pattern in larger scale production of paddy and other potential crops for use in the agro-industries mainly in the irrigation area on the other hand. In this case, it can be imagined that some new system of on-farm development and irrigation water supply as noted below could be introduced as a need for entering into the new era for agricultural production in the Region.

* Direct investment for on-farm development by beneficiary's themselves
* Charged irrigation water supply for agro-industries

(3) Influence by AFTA effectuation

AFTA (ASEAN Free Trade Agreement) has been effectuated since the beginning of 2010 as the first important milestone to step forward further towards the foundation of ASEAN community. Original members joined in the Agreement include Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand. Based on the report (May 2010) by the Fiscal Policy Office of the Ministry of Finance (Source: Thai Keizai Weekly), the major points noted in the report including the predicted influence on Thai farm produces shall be briefed as in the followings.

ASEAN countries provide important markets for farm produces and related agro-industry's products made in Thailand and therefore the AFTA effectuated already brings about great influences on the agriculture sector of Thailand. Of the total export by Thailand, the proportion shipped to ASEAN countries shares as much as 13 % with the gross value of 3.15 Billion US$. Generally speaking, accordingly, it is expected that the complete effectuation of AFTA will impact favorably on Thai's export of farm produces and agro-industry products as a whole. The said impact will then bring about a positive effect on Thai economy through increased consumption by majority farmers who shares as much as 38 % of the labor force of the country and gained additional income as caused by AFTA. While on the import aspect, it is expected that the AFTA will not cause any substantial impact to Thailand, as import of agriculture–related products by Thailand from ASEAN countries has been inactive and also the import tariff in Thailand is rather low.

Among the export items of farm produces and agro-industry products shipped to ASEAN countries, rice, rubber, sugar and tapioca are importantly major ones having as high as 83 % share. Analysis results on the AFTA's impact shall be briefed as follows one by one.

1) Rice

Among ASEAN countries, Malaysia, Philippines and Singapore are ranked higher in importing rice from Thailand. Though rice is in the sensitive list in the Philippines, Malaysia and Indonesia, the big reduction of import tariff in Malaysia will provide an opportunity for export expansion.

For the Philippines, re-negotiation is scheduled.

2) Rubber

Rubber exported to ASEAN countries also shares a large portion in the overall export to ASEAN. Especially the export to Malaysia occupies the most. However, the rubber is not any sensitive commodity in the region and the import tariff is just 0-5 % only. As is the case, Thailand will hardly gain any advantageous opportunity from the reduction of import tariff for rubber under the AFTA framework.

3) Sugar

Sugar is also one of major commodities. Among ASEAN countries, Indonesia is 1st ranked in importing sugar from Thailand. Sugar is in sensitive list in Indonesia and in the Philippines the same is listed as one of the exempt items for tariff reduction. The import tariff in said two countries ranges at high level of 30-40 %. Accordingly the expected tariff reduction under AFTA will cause advantageous opportunity for Thailand for substantial export expansion, especially in case of Indonesia.

4) Tapioca products

Indonesia and Malaysia are the major tapioca importing countries from Thailand. The import tariff is not substantial in the ASEAN Region and seems that there will be no advantageous effect for Thailand.

In conclusion, Thailand will be provided with good opportunities as influenced by AFTA effectuation, one for rice and tapioca export destined to Malaysia and the other sugar export destined to Indonesia and the Philippines due to the tariff reductions to be effected in the year 2015.

As is the case, Thailand is to prepare possible production increase in rice and sugar so as to fully utilize the said opportunities. Concerning the rice especially, the unit yield as achieved in Thailand is only 400 kg/rai and much lower than the average of Asian countries as reported at 640 kg/rai. This requires Thailand to improve the situation towards higher unit yield.

(4) Ethanol Production

Based on the predictions on price escalation and resource exhaustion of crude oil, the International Energy Agency (IEA) announced the following prospects at the 8th International Energy Forum held in 2002.

By the year 2030 the world energy demand will increase by 2/3 of the present demand. Within the 30 years to come, the world still be favored with abundant energy resources, but any countermeasures to convert the source to other reliable ones shall be commenced soonest possible.

Thailand imports about half (Mainly in crude oil) of her gross energy consumption. Therefore,

the government formulated a plan and currently implementing the plan to cover 20 % of the gross energy consumption by renewable energy in 15 years from 2008 to 2022 (National Development Plan for Alternative Energy) so that the country can shed its heavy dependence on overseas countries as much as possible. One of the key pillars among the potential renewable energy is bio-diesel made from palm oil and the other is bio-ethanol made from cassava and sugarcane molasses which are major produces in the Northeast Region. The Plan set target to increase consumption of ethanol as follows;

- Year 2008 – 2011 = 3 million liters
- Year 2012 – 2016 = 6.2 million liters
- Year 2017 – 2022 = 9.0 million liters

Trend/situation about the ethanol production in Thailand is described as the followings.

* Jan. 2007: Energy Ministry set the price of Gasohol 95 at 1.5 Baht lower than Benzene 95 to promote the use of gasohol
* April 2007: Domestic sales of Gasohol 95 exceeded the sales of Benzene 95
* Nov. 2007: BOI approved investment promotion for 9 new ethanol production factories
* Dec. 2007: Thai Tapioca Association announced the prediction that cassava production in 2008 will reach 27.6 Million ton while demand is to be lifted to 30 Million ton.
* Dec. 2007: Committee for Energy Policies set the price of E20 to be lower than Gasohol 95 by 1 Baht

In addition to the production increase of ethanol by using cassava as materials and also the increasing demand in China and EU for livestock feeds, the price of cassava shows a rising tendency for some periods.

The most important points in popularizing the use of bio-ethanol are in the way how to secure sustainably the cassava material at the relatively low cost and how to provide incentives for user consumers. The government of Thailand has a confirmed policy to reduce the heavy dependence on crude oil for its gross energy consumption and implementing several policies to promote the use of renewable energy domestically produced. It is, therefore, necessary for the government to promote more production of cassava and sugarcane in the Northeast Region with supporting the producers by means of infra-structural improvement and to avail more intensive farming, so that the industry will be grown further with relatively higher competitiveness.

2.6 Present Problem Areas in Agriculture and Agro-based Industries in Northeast Region and Issues to be Challenged in Future

(1) Low agricultural productivity

The productivity of rice cropping in the Northeast Region is remarkably low as compared with the other Asian countries. As can be seen in the Figure below, China, Vietnam and Indonesia have improved their productivities to date, while Thailand attained a limited improvement in its rice productivity. It can be said that Thailand is the country where the rice productivity per unit area is the lowest in the Asian Region. This is particularly true in the Northeast Region with the lower productivity at only 78 % of the national average and mere 57 % of the Central Region average (See Table 2.2.3). To improve the productivity of rice cropping is an important issue to respond to the increasing demand for food in future, and varieties of efforts have been made by the relevant government agencies on varieties improvement, soil improvement, leveling up of farming technologies as well as provisions of irrigation facilities and etc.

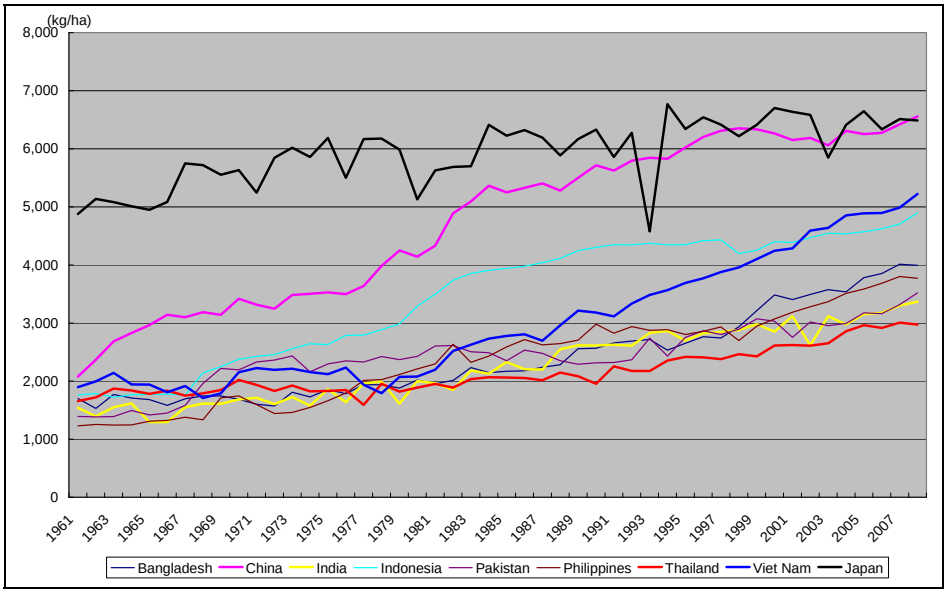


Figure 2.6.1 Improvement of Rice Yield in Asian Countries

Concerning the productivity improvement in rice cropping, after all important factors are left for farmers' own efforts in farming activities except the expansion of irrigation areas and due extension of higher-yield improved varieties. Accordingly, it is considered necessary to classify the cases as follows taking into account the prevailing agricultural systems in the Northeast Region. In this case, it is necessary to consider not only the increase of production quantity but also the value-adding for possible income increase for the farmers.

1) Rain-fed paddy field in gently rolling zone: In this zone, rice is a staple food by home consumption and has the importance in food security at micro-level. At the same time, it is important as one of the economic crops to cause income for farmers. Especially the glutinous rice is mainly for home consumption, but if the productivity could be improved in

parallel with the declining farming population, farmers can secure their own consumption quantity with less area planted for glutinous rice and they can increase the planted area of non-glutinous rice for selling purpose. In this case, provision of irrigation system can not be expected and introduction of mixed farming with livestock and green manure are to be enhanced, where combination with other diversified crops may be practiced with productivity improvement by means of soil improvement and better farm management. Value-adding by organic farming of rice for selling can be expected too.

2) Rain-fed paddy field in lowland: In this area, KDML105, the popular variety of famous Jasmine rice (Non-glutinous) is mainly planted. This variety is not the high yielding, but important for exporting with high value because of the high quality. As high as 82.24 % of the planted area for Jasmine rice is in the Northeast Region and the main production areas are in either Mun basin and the cluster Northeast 1 and 2. KDML105 is tolerant to both drought and salinity and suited to the planting in rain-fed areas. Though the unit yield is rather low and effects in lowering the Regional average yield, but the farmers do not mind much due to the higher price. LDD has a plan to raise up the unit yield by applying organic fertilizers. Besides, it is noted that attention shall be paid on use of guaranteed produces and possible protection measures not to mix the varieties during the post harvest handlings.

   In the areas where non-Jasmine rice is mainly planted, the followings are considered necessary. For this sake, measures to be taken are processing of glutinous rice and provision of small scale irrigation facilities (Especially pumping irrigation).

   *Price incentives to allow sufficient labor input for soil improvement and farm management
   *Safety net to insure labor input against drought and flood

3) Irrigation areas: In the areas served by the existing irrigation system, it is desired to maximize the advantages of irrigation to improve the productivity. For this purpose, government agencies shall concentrate its efforts in securing supply of guaranteed seeds/produces and improvement in farming technologies including water management. Provided, however, under the circumstances labor shortage problems getting more serious, it is necessary to absorb the increased working hours for farm management, and to cope with this, the followings may be considered as the candidates for supporting measures.

   *Commissioning of a part of farming activities to external labor sources
   *Collective (Group) working
   *Rehabilitation of deteriorated facilities
   *On-farm development including farm road to ease farm mechanization

(2) Behavior of farmers responding to price changes

Behavior of farmers depends so much on the prices of their produces. In case of sugarcane and cassava, the changes in selection of crops blur so significantly and endanger the sustainable supply of materials for sugar factories and tapioca products processing factories. As to cassava,

there observed during the field survey some farmers harvest too early before the crop grow to have enough starch content and bring the harvest to the factories because of the high market price for cassava. In this case, the quality of starch processed at the factory is of poor standard as the result.

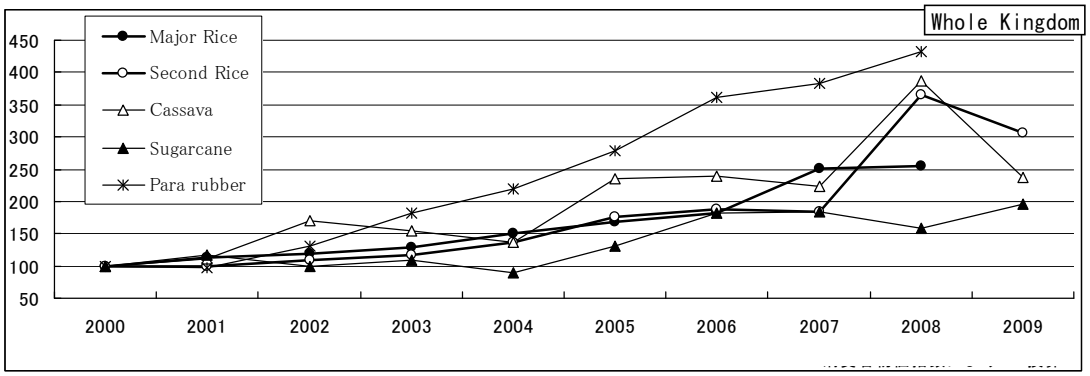


Figure 2.6.2 Price Change of Major Crop

Planted area in dry season is also largely affected by the price of the rice. In this dry season, there have been excessive planting of rice in the irrigation areas. In the non-irrigated areas too, areas planted for rice expanded largely expecting possible water intake from rivers and ponds as well as special rainfall and these activities cause various effects in water allocation aspect.

In the future, it is predicted that the demand for ethanol will be increased substantially, and it is afraid that invasion to food crop planting area by the bio-energy crop may be increased due to the high ethanol price, and the sustainable food supply might be disturbed as the result. This requires firm policies and plans for each basin on the land use, cropping schedule and price stabilization for farm produces.

(3) Weakness caused by soil deterioration by repeated cultivation and insect damage by mono-culture cropping

In the Northeast Region, the farm land had been extensively expanded through reclaiming the forest areas since 1950's. Due to the repeated cultivation of same cash crop for long time, the soil has been deteriorated to a great extent and further soil erosion caused by high intensity rainfall caused serious problems in the Region. Repeated cultivation of cassava and mono-culture is fragile to diseases and insect damages and it was in this year 2010 that cassava production was largely reduced due to the insect damages.

In the case of rice too, there is a fear that KDML105 and RD6 are too dominant in the area and the damages by diseases and insects occurred periodically may result in severe damages on rice crops in future. Rotational cropping and diversification are the measures to be taken for this case, but it is necessary to solve the problems on marketing as well as securing of farm labors.

(4) Crop diversification and marketing

Marketing is usually the problem issue when pursuing the crop diversification. There are many

cases that crop diversification is recommended to replace the rice planting in dry season to gain benefits from the use of limited water resources[3] and/or to increase the benefits and avoid risks of mono-culture, but for fresh vegetables, usually the challenge is to be delayed due to the lack of adequate markets. Even in the case the crop diversification be promoted by the policy, production of vegetables with quantity more than the own consumption would be difficult if marketing facilities could not be duly secured.

Under the "Sky Irrigation Project" supported by a NGO (PDA: Population and Development Association), water supply throughout the year and marketing are sustainably secured and vegetable production at the beneficiary villages are sustained quite successfully. Though the planted area by each farm is not large, but the collectively practiced cultivation is intensive and several numbers of collector merchants come to the farms. In the village, there observed some circumstances of fair competition and farmers can enjoy reasonable bargaining power in price negotiation.

Contract farming with the private enterprises is also being promoted. However, the uses of insecticide/pesticide and chemical fertilizer are much, and there are some reports on food security problems and also the negative effects on the farmers' health by chemical application. In order to solve these problems, green markets have been organized and operated in many localities where organic farm produces and the processed foods are on sale by producer farmers with direct system to the consumers.

(5) Strengthening of food industries, linkage with agriculture sector and quality control

Thai foods are very popular in the neighboring countries as Laos, Cambodia, Vietnam and China. It can be said that the local food industries in the Northeast Region has a good potential to expand their markets to these overseas countries if the industries could be intensified and strengthened. In the Northeast Region, there are as many as 60 % of the food processing enterprises of the country, but most of them are of small scale and their capability in quality control is not high enough to level with international standards.

For the expansion of the markets, development of local products based on locally available resources and quality improvement in general are crucially important. The Northeast Region itself is a big market with having 1/3 of the national population and in this sense expansion of market to the overseas countries is not the requirement with high priority, but rather, it is important to support the industry in their efforts to develop new products and secure high standard quality control to meet the changing taste of the consumers with awareness on safety along with the progressing economic development in the country.

(6) Ageing society, labor shortage and lack of successor

The ratio of farm labors at the age older than 55 years is rapidly increasing, and in rural villages,

[3] Water requirement of dry season for different crops; paddy as 100, of vegetable is 32, of ground nuts is 35 and of sugarcane is 70. See Appendix 3.8.3

ageing society is the reality already. There are no much people in the next generation who wish to work as a farmer, then again the ageing will further be accelerated. Labor shortage causes higher wage for employed labor and it surely causes low profitability of agriculture. In case of paddy cultivation, transplanting was managed by members of farm household before but today employment is required and causes higher production cost.

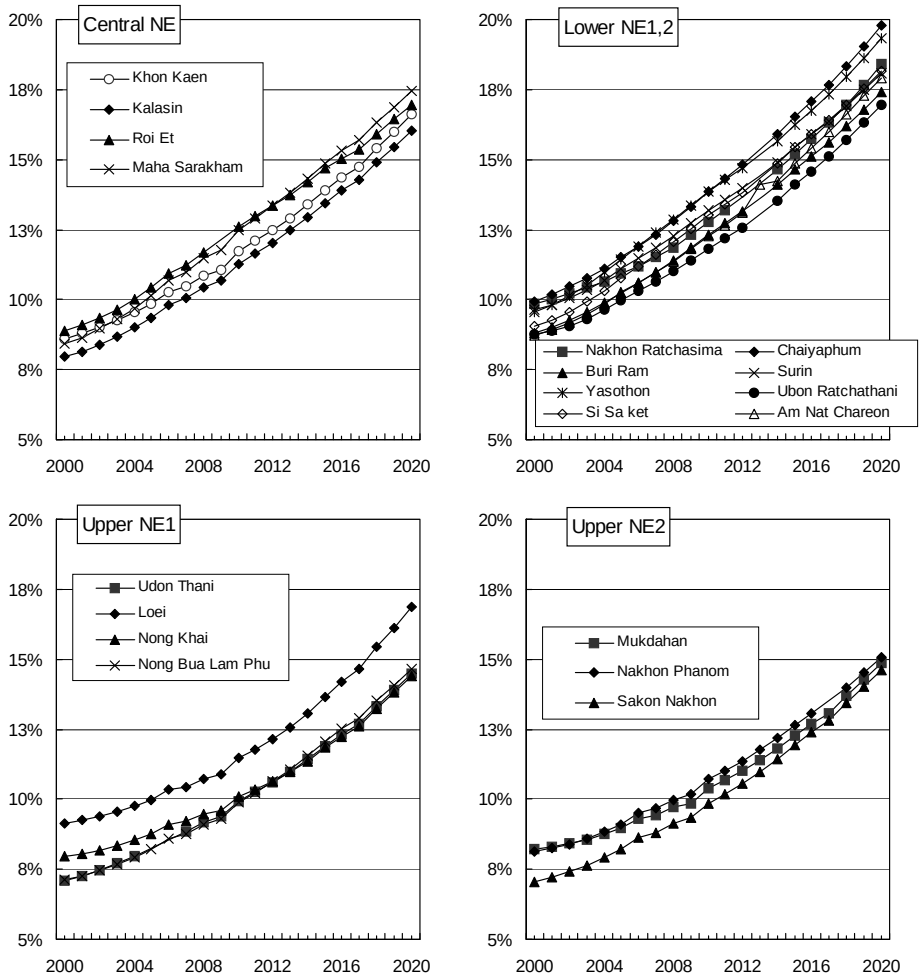


Figure 2.6.3 Projection of Aged Population (over 60 years) in Northeast 2000-2020

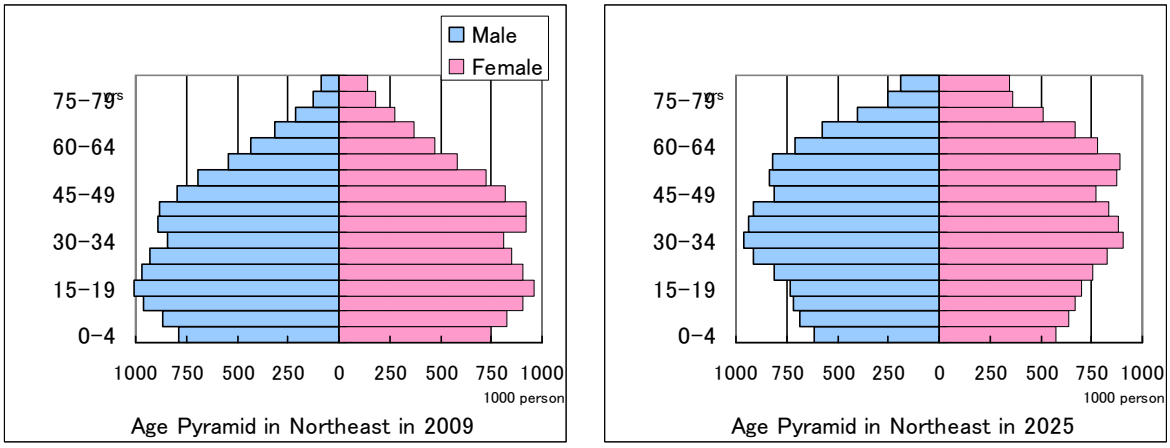


Figure 2.6.4 Age Pyramid in Northeast 2009, 2025

Even the farm household in the irrigation area who can gain comparatively higher income than the rain-fed areas, successors are not enough, and if agriculture can not be changed to be attractive enough for the next generation, there will be necessities to import farming labors from the neighboring countries or farm mechanization would be fully introduced to meet the requirement.

(7) Inviting agriculture support manufacturing industries to Northeast Region for competitiveness reinforcement

Due to the effectuation of AFTA, the produces in Northeast Region will encounter due competition with the produces by neighboring countries which could be produced with much lower farm labor cost. Price competitiveness is important even in the cases of materials for bio-ethanol and food processing, requiring basically the higher productivity in its production. In order to support this, cost down shall be secured by introducing production material and labor cost as low as possible. This can be attained if the mechanization could be accomplished with less cost and farm management requires low cost equipment and materials for irrigation facilities and upland irrigation devices (e.g. gates, pipes and farm machineries), and it is considered necessary that some of the manufacturing industries related with such farm materials and equipment might be invited under the government policy to build plants and operated in the Northeast Region.

CHAPTER 3 EXISTING WATER RESOURCES MANAGEMENT

3.1 General Feature of Northeast Region

Northeast Region (the Northeast Region) is located at Central Area[1] in the lower Mekong basin and the basin area is 165,700 km^2, which is divided into three large basins of Khong (46,500 km^2), Chi (49,500 km^2) and Mun (69,700 km^2).

(1) Khong Basin

Khong basin covers the northern and eastern area of the Northeast Region along Mekong river and is formed with many tributaries originating from the central plateau of the Northeast Region and flowing into Mekong river. The upstream to middle of tributaries consists of undulated plateau area with the elevation of 500 to 300 m, where large rainfed paddy and field crop area are extending. The downstream basin of tributaries is adjoining to Mekong river and formed with large alluvial plain, where rainfed paddy field also is extending. As the water level of Mekong river reaches more than 10 m in the wet season, its back water is invading upward into tributaries. The large scale wet land exists in the downstream of tributaries with the length of 20 to 30 km and the width of 1.0 to 3.0 km. The wetland, however, is dried up in the dry season caused by lowering of Mekong's water level.

(2) Chi Basin

Chi river originates from the Petchabun mountain range with the elevation of 500 to 1,000 m. lying on the western side of the Northeast Region, flows down to the eastern direction in the central plain of the Northeast Region with the elevation of 120 to 150 and joins with Mun river finally. Chi river has long length with 700 km, where three large tributaries of the Nam Phong, Lam Pao and Lam Yang and many medium tributaries are existing. Chi main stream flows down with very gentle slope of 1/15,000 to 1/10,000, meandering and forming many retarding ponds. The river depth shows the large fluctuation of 8 to 10 m in the flood months from August to October and 0.5 to 1.0 m in the severe dry month of February to March. Accordingly the plain along Chi river has suffered from flood and drought problems in many years.

(3) Mun Basin

Mun basin is located at the southern area of the Northeast Region bordering with Cambodia, where many medium tributaries are flowing down to Mun. Mun river is originating from Dongrek mountains forming the national border between Thai and Cambodia and is flowing toward the east in the plateau and plain and finally entering into Mekong river after joining with Chi river. The river length is about 650 km. Mun basin is composed of many medium scale tributaries, which are flowing down from Dongrek mountains along Cambodian border in the right bank and from the central plateau of the Northeast Region adjoining with Chi basin in the left bank. Mun river also is flowing down with very gentle slope of 1/15,000 to 1/10,000 and

[1] 'Central Area of lower Mekong basin' lies along Mekong river with the length of 850 km between Chiang Khan and Pakse where is covering 277,000 km^2 of watershed area, the left bank belongs to Lao territory while the right bank lies on Northeast Thailand with 165,000 km^2

meandering shape. In the middle Mun river, large flood plain with width of 2 to 3 km and length of more than 100 km is formed with sediment load and the river is flowing down with many and large meanderings.

While large salt rock layer underlies at the left bank plateau of the upper and middle Mun basin and the plain lying on the salt rock is suffered from saline soil problem.

3.2 Division of the Northeast Region

3.2.1 Administrative Division

The Northeast Region is divided into 19 provinces and Nakhon Ratchasima province is the largest one with an area of 12,810 km^2 in Thailand. Provincial boundary is shown in Annex III 1-1.

3.2.2 Basin Division

National Water Resources Committee[2] (NWRC) then belonging to Prime Minister's Office set up Integrated Water Resources Management (IWRM) Policy in 1990s to manage the water resources properly and effectively and supply it in accordance with inhabitant demand with priority. In order to achieve the above objective, NWRC divided the country into 25 large river basins consisting of 20 to 30 tributary basins (tributary basins: TB) and further small tributary basins and commenced Master Plan[3] study to grasp the existing conditions for climate, land use, potential surface and ground water, river flow, water resources development projects irrigation projects, water uses, etc. in each tributary basin.

The Northeast Region is divided into 3 large basins of Khong, Chi and Mun and 29, 20 and 31 (80 T.B) of tributary basins respectively. In the study, in accordance with the general condition for rainfall, land use, surface water resources, river flow, water uses, etc, eight (8) sub-basins: two (2) of Upper, and Lower in Khong basin, six (6 = 3 x 2) of Upper, Middle and Lower sun-basin of Chi and Mun basin; are divided, as follows.

- Khong Basin: Upper (TB 0210-0223) and Lower (TB0224-0238) is divided at Khong part 7 tributary,
- Chi Basin: Upper (TB 0402-0408) lies on the most upper stream to the confluent point of Phong tributary and Chi main channel, Middle(TB 0409-0408) is by the confluent point of Lampao tributary and Chi, and Lower (TB0417-0421) until the outlet to Mun river.
- Mun Basin: Upper (TB 0502-0514) is by Ban Talung weir, Middle(TB 0515-0525) is by Huana weir and Lower (TB 0526-0532).

[2] National Water Resources Committee (NWRC) had been initially established in Prime Minister Office, however, it was transferred to Ministry of Natural Recourses and Environment, when the national reform of central government was enforced in 2002.

[3] Master Plan has been reviewed by RID and DWR at 4 to 5 years' interval. Latest review was made in 2006 for Chi, Mun and in 2007 for Khong basin.

In Annex III 1-5, the boundary and division of tributaries are shown[4], and the outline of Sub-Basin is shown in Table 3.2.1 and 3.2.2.

Table 3.2.1 Sub-Basins of Khong, Chi and Mun

Sub-Basin	Area Location	Beginning and Terminal T.B	No.of T.B
Upper Khong	Northern Khong Basin	210 Khong Part 3 to 223 Khong Part 7	14
Lower Khong	Eastern Khong Basin	224 U. Songkhram to 238 Lower Khong	15
Upper Chi	Area up to station E16A	402 Upper Chi to 408, Chi Part 3	7
Middle Chi	Area up to station E66A	409 Upper Phong to 416, Chi Part 4	8
Lower Chi	Area up to Chi River Mouth	417 Upper Lam Pao to 421 Lower Chi	5
Upper Mun	Area up to station M6 A	502 Upper Mun to 514 Lam Phang Chu	13
Middle Mun	Area up to Huana Barrage	515 Huai Takong to 525 Huai Khayang	11
Lower Mun	Area up to River Mouth	526 Huai Phoeng to 532 Lam Don Yai	7

Table 3.2.2 Outline of Sub-Basin

Sub-basign	Basin Area (km^2)	Popula-tion (10^3)	Annual Rainfall (mm.)	Land Use (km^2)				Potential Water (MCM)	Water Uses (MCM)	Reservoir Capacity (MCM)
				Forest	Farm	Others	Total			
1.Khong Basin										
(1) Upper	20,500	2,180	1,442	4,784	8,880	8,688	22,352	8,470	1,080	310
(2) Lower	25,960	2,990	1,712	4,544	10,640	10,880	26,064	12,170	1,380	1,110
(3) Sub-total	46,460	5,170	1,593	9,328	19,520	19,568	48,416	20,640	2,460	1,420
2.Chi Basin				0	0	0	0			
(1) Upper	13,550	1,440	1,126	5,312	5,312	4,384	15,008	2,680	570	320
(2) Middle	21,030	2,880	1,253	1,760	12,544	7,376	21,680	4,760	2,190	2,340
(3) Lower	14,900	2,120	1,448	1,312	7,408	5,264	13,984	4,510	1,780	1,790
(4) Sub-total	49,480	6,440	1,277	6,704	25,264	17,024	48,992	11,950	4,540	4,450
3.Mun Basin						0				
(1) Upper	29,170	3,630	1,110	3,728	17,600	9,488	30,816	4,510	3,080	1,560
(2) Middle	24,390	4,470	1,369	2,064	14,864	5,744	22,672	5,540	1,760	890
(3) Lower	16,140	1,880	1,601	2,720	7,648	7,584	17,952	8,920	940	1,760
(4) Sub-total	69,700	9,980	1,314	8,512	40,112	22,816	71,440	18,970	5,780	4,210
4. Total NER	165,640	21,590	1,381	24,544	84,896	59,408	168,848	51,560	12,780	10,080

Note: The areas indicated as land use are the accumulation of river basin-wise provincial areas based on the "Agricultural Statistics of Thailand 2008" which includes some parts of Pasak river basin by 3,200 km^2 located in Loei and Chaiyaphum provinces. Therefore, the total land use area is not equivalent to the total basin area of Khong, Chi and Mun (refer to Appendix 3.6.1).

3.3 Rainfall and Evaporation

3.3.1 Rainfall

(1) Analysis of Rainfall Data

Rainfall is the sources of water and has been measured at many stations in the Northeast Region by Thai Meteorological Department (TMD), RID, DWR, etc. In the study, the records were collected from TMD's synoptic stations (11 stations for 60 years) and RID stations (80 stations for 40 years). Using the data, the processing was made to conform a long-term fluctuation and understanding the meteo-hydrological condition of the project area, as below.

[4] Total area of 80's tributaries (Khong, Chi, Mun basin) is different from total area of NE's provinces since a part of tributaries belong to Central Thailand (Phetchabun Province). However, this part is regarded as 'Project area' because of small difference.

(2) Long-term Fluctuation

Using long-term records for 60 years from TMD's station, the mean annual rainfall is shown in Appendix 3.3.1. In the records, the clear change in annul rainfall is not seen. However, a periodical change at 10 to 15 years' interval is obscurely recognized in 60 years. In last 30 years, early 80's to late 90's is correlative to dry period while early 2000 to 2008 being wet period. Conversely, in last two years, dry climate again took place until the dry season of 2010.

(3) Rainfall Characteristics in Khong, Chi and Mun Sub-Basin

The following drawings were prepared in the study as referred to rainfall characteristics in Khong, Chi and Mun Sub-Basin.

Appendix 3.3.2 Mean Monthly Rainfall for Major Station
Appendix 3.3.3 Isohyetal Map of Mean Annual Rainfall (1970-2010)
Appendix 3.3.4 Area Rainfall and Rainwater Amount Estimated for Tributaries
Appendix 3.3.5 Isohyetal Map of Annual Rainfall in Dry/Wet Year
Appendix 3.3.6 Isohyetal Map of Annual Rainfall in Wet Month (September- October)

Table 3.3.1 Area Rainfall and Rain Water in Khong, Chi, Mun Sub-Basin

Sub-basin	Basin Area	Area Rainfall (mm.)			Rain Water Amount (MCM)		
	(km^2)	Wet	Dry	Annual	Wet	Dry	Annual
1. Khong Basin							
Upper	20,500	1,201	241	1,442	24,620	4,940	29,560
Lower	25,960	1,431	281	1,712	37,150	1,00	44,450
Subtotal	46,460	1,329	264	1,593	61,770	12,240	74,010
2. Chi Basin							
Upper	13,550	914	212	1,126	12,390	2,870	15,260
Middle	21,030	993	260	1,253	20,880	5,470	26,350
Lower	14,900	1,185	263	1,448	17,660	3,920	21,580
Subtotal	49,480	1,031	246	1,277	50,930	12,260	63,190
3. Mun Basin							
Upper	29,170	882	228	1,110	25,730	6,650	32,380
Middle	24,390	1,132	237	1,369	27,610	5,780	33,390
Lower	16,140	1,342	259	1,601	21,660	4,180	25,840
Subtotal	69,700	1,076	238	1,314	75,000	16,610	91,610
Total	165,640	1,134	247	1,381	187,700	41,110	228,810

The Lower basin in Khong, Chi and Mun basin shows fairly rich annual rainfall of 1,500 to 1,700 mm. but Upper Chi and Upper Mun show slightly less rainfall of 1,100 mm. because the rainfall in the Northeast Region is changed by the monsoon of South China Sea coming through Vietnam.

Although average annual rainfall[5] shows 1,380 mm which is not very low and estimated as large rain water volume of 228,000 MCM, the wet season rainfall in whole Chi basin and Upper and Middle Mun basin holding the large paddy area of 25 million rai (70% of total paddy area of the Northeast Region) shows less than 1,100 mm. It is not sufficient to meet the water demand of more than 1,200 mm in the rainfed paddy. Especially Upper Mun basin with the wet season

[5] Average annual rainfall is same as 'area rainfall' which is calculated by Theissen Polygon Method. Firstly, the rainwater amount is calculated, then divided by the area of 3 basins' to obtain the average annual rainfall.

rainfall of 900 mm[6] has serious problem with large water shortage. While 60 to 70% of the wet season rainfall is appearing in August to October, which has often brought the flood disaster at the low land area along Chi and Mun river.

The dry season rainfall is 200 to 280 mm. in every basin which is too few to use for agriculture. Especially the severe dry month from January to March has no or very scarce rainfall. Accordingly the crop cultivation in the dry season is suspended except for the area having saturated sub-soil by excess wet season, rainfall or irrigation by reservoir dam. Of course, dry season paddy can not be cultivated under the rainfed in the dry season.

Although Lower Khong and Lower Mun extending along Mekong river have fairly rich rainfall such as annual runoff of 1,600 to 1,700 mm. and the wet season rainfall of 1,300 to 1,400 mm. The river runoff brought from the rich rainfall could not be used for the upper basin but released to Mekong river.

3.3.2 Evaporation

Potential Evapotranspiration is 1,500 to 1,600 mm per annum, of which the wet and dry season value is 600 to 700 mm. and 700 to 800 mm. respectively. Although evaporation value is not so high, the particular care shall be paid for the evaporation loss at the extensive wetland and reservoir area with shallow depth. The area is stored with water at the end of wet season but its water is lost by about 700 mm/year[7] as actual evaporation in the severe dry months of December to February. Saturated sub-soil by the excess rainfall in the wet season also is lost by evaporation from January to March. Appendix 3.3.7 shows the Potential Evapotranspiration (ET0) in Khong, Chi, Mun basin.

3.4 Land Use

3.4.1 Land Use in the Northeast Region

The Northeast Region has a large area of 168,800 km^2 and its land use is considerably different from the other Regions in Thailand and gives large influence to the water resources and water uses in the Northeast Region.

Forest area rate in the Northeast Region is very low as 15% as compared with other Regions ranging with 25 to 52%. Accordingly the Northeast Region has not enough control capacity for excess rainfall in the wet season and as a result the lowland area along the river has suffered always from flood disaster. Paddy area rate in the Northeast Region is very high as 35% as compared with the other regions with 5 to 16%. Accordingly the Northeast Region has poor regulating function for rainwater and as a result available runoff in the river is scarce and water shortage problem has often taken place.

[6] In the ordinary river basin, the upper basin has rich rainfall and runoff generally and the lower basin can use them easily. However, the rainfall distribution in the Northeast Region is not common as compared with t many of other countries. Accordingly the water resources management in the Northeast Region could not be achieved by the ordinary approach.

[7] According to Landuse map (2005-2007, LDD), the area of water body including reservoir, pond and lake and swamp reaches 8,975 km^2. If ET0 in dry season is estimated as 700 mm, the loss of evapotranspiration is calculated as 6,156 MCM/year.

Table 3.4.1 Comparison of Regional Land Use (2007) Unit 10^6 rai

Region	Total Area	Forest area	Paddy	Field crops	Tree crops	Others	Sub Total	Others
Northeast Area	105.5	15.3	37.1	10.7	5.2	4.1	57.1	33.1
(Rate)	(100)	(1.5)	(35)	(10)	(5)	(4)	(54)	(31)
North Area	106.0	55.2	13.9	8.6	3.9	1.4	27.8	23.0
(Rate)	(100)	(52)	(13)	(8)	(4)	(1)	(26)	(22)
Central Area	64.9	17.8	10.4	7.3	6.3	1.7	25.7	21.4
(Rate)	(100)	(27)	(16)	(11)	(10)	(3)	(40)	(33)
South Area	44.2	10.8	2.4	0.1	16.0	1.3	19.8	13.6
(Rate)	(100)	(24)	(5)	-	(36)	(3)	(45)	(31)
Total Area	320.7	99.1	63.8	26.7	31.4	8.5	130.4	91.2
(Rate)	(100)	(31)	(20)	(8)	(10)	(3)	(41)	(28)

Land use rate for field crops and tree crops in each region is mostly same except for the south region[8], Other lands in the farm area is composed of village area and fallow area, which are not much different in each Region.

However, the other land use except forest and farm area in the Northeast Region shows high rate of 31% because there are many wet lands, saline lands and also abandoned lands due to lack of water, etc. in the Northeast Region[9].

As for the irrigation rate which is the rate of the irrigation area against the farm land, northeast region has the lowest one in the whole country as shown in the table 3.4.2 which implies that the rainfed paddy is dominant.

Table 3.4.2 Irrigation Rate by Regions in Thailand

As of 2007 (Unit : Million rai)

Region	①Farm Land	②Irrigable Area	③Beneficial Area	④Irrigated Area = (②Irrigable + ③Beneficial)	⑤Irrigation Rate = [④/ ①×100] (%)
Northeastern	57.1	3.74	2.31	6.05	10.6
Northern	27.8	4.49	4.17	8.66	31.2
Central	25.7	13.11	1.75	14.86	57.8
Southern	19.8	2.39	1.19	3.58	18.1
Whole Thailand	130.4	23.73	9.42	33.15	25.4

Data Source : Agricultural Statistics of Thailand 2008

Note

Irrigable Areas : mean the areas under the services of large and medium - scale irrigation projects of the Royal Irrigation Department, where thereare the systems to provide water for agriculture, consumption, industry, tourism, etc. and to control flood as well as water quality.

Beneficial Areas : mean the areas that cannot get direct services from large and medium - scale irrigation projects but people can get benefit from such projects indirectly through small scale irrigation project initiated by government or farmer agencies.

3.4.2 Land Use in Khong, Chi, Mun Sub-Basin

Land use area in Upper, Middle and Lower Sub-Basin in Khong, Chi and Mun basin is estimated by the rate of provincial area, being partially belonging to respective sub-basin shown in

[8] South region (southern region of Thailand) has large tree crop area of rubber and oil palm is planted.

[9] Central region and south region shows the high rate of the other land more than 30%, the former has due to high rate of urban and industrial development area and the latter is covered by mountain areas.

Appendix 3.4.1 and as summarized in Table 3.4.3.

Table 3.4.3 Estimated Land Use Area in Khong, Chi and Mun Sub-Basin (Unit 10^6 rai)

Sub-Basin	Total Land		Forest Land		Farm Land								Other Land	
					Paddy		Field crop		Tree crop/othe		Subtotal			
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
1. Khong Basin														
(1) Upper	13.97	100	2.99	21	2.68	19	1.69	12	1.18	9	5.55	40	5.43	39
(2) Lower	16.29	100	2.84	19	4.94	30	0.65	4	1.06	7	6.65	41	6.80	42
(3) Subtotal	**30.26**	**100**	**5.83**	**19**	**7.62**	**25**	**2.34**	**8**	**2.24**	**7**	**12.20**	**40**	**12.23**	**40**
2. Chi Basin														
(1) Upper	8.33	100	2.27	27	1.70	20	1.37	16	0.25	3	3.32	40	2.74	33
(2) Middle	13.55	100	1.10	8	5.84	43	1.43	11	0.57	4	7.84	58	4.61	34
(3) Lower	8.74	100	0.82	9	3.26	37	0.99	12	0.38	4	4.63	53	3.29	38
(4) Subtotal	**30.62**	**100**	**4.19**	**14**	**10.80**	**35**	**3.79**	**12**	**1.20**	**4**	**15.79**	**51**	**10.64**	**35**
3. Mun Basin														
(1) Upper	19.26	100	2.33	12	6.87	36	3.50	18	0.63	3	11.00	57	5.93	31
(2) Middle	14.17	100	1.29	9	7.82	55	0.74	5	0.73	5	9.29	65	3.59	26
(3) Lower	11.22	100	1.70	15	4.02	36	0.34	3	0.42	4	4.78	43	4.74	42
(4) Subtotal	**44.65**	**100**	**5.32**	**12**	**18.71**	**42**	**4.58**	**10**	**1.78**	**4**	**25.07**	**56**	**14.26**	**32**
Total	**105.53**	**100**	**15.34**	**15**	**37.13**	**35**	**10.71**	**10**	**5.22**	**5**	**53.06**	**50**	**37.13**	**35**

Note: As reference information, Estimation of Unit Water Use Value by Land Use is shown in Appendix 3.4.2.

(1) Khong Basin

Khong basin has a little large forest area of 5.8 million rai with land use rate of 20%. However paddy area is not so large at 7.6 million rai (25%) because the large alluvial plain at the downstream of tributaries is covered with pounding water in the wet land in the wet season due to high back water of Mekong river and can not be used for paddy land. Khong basin has rich rainfall as compared with Chi and Mun basin. The rubber plantation has been accelerated in the recent year, so that the tree crop area rate shows a little high rate of 7%.

There are existing large other land of 12.2 million rai in Khong basin without any utilization. In the other lands, the land and water uses in the wet land such as fish culture and irrigation water are important issues in future.

(2) Chi Basin

Although Upper Chi has a little large forest area of 2.3 million rai (land use rate of 27%) covering a part of Phetchabun mountain areas, the forest area of Middle and Lower Chi basin is very small as 1.1 million rai (8%) and 0.9 million rai (9%) respectively. Accordingly, the basin has not enough flood control capacity for excess rainfall and has been placed at the largest flood disaster area in the Northeast Region. However, Middle and Lower basin has large paddy area of 5.8 million rai (40%) and 3.3 million rai (37%), which requires large rain and river water in the Northeast Region. Although the large scale reservoir dams of Ubonrat, and Lam Pao have been operated for the flood control, irrigation and hydropower purpose, the basin has been still suffered from flood and drought. In order to stabilize the basin, the more effective IWRM shall be required in the basin.

Provinces of Chaiyaphum, Khon Kaen and Kalasin in Chi basin have increased sugarcane cultivation area rapidly and require the dry season irrigation water.

(3) Mun Basin

Mun basin also has a few forest area of 5.3 million rai (12%) in total. Especially Middle Mun has very few forests of 1.3 million rai (9%) and its lower land along tributaries and Mun main river has suffered from flood problems. Upper and Middle Mun basin has large paddy area of 6.9 million rai (36%) and 7.8 million rai (55%), which are the largest paddy area occupying 40% of total paddy area in the Northeast Region. However, the paddy area is mostly placed under rainfed cultivation except for the most upstream tributary basins of Upper Mun, where irrigation projects by large reservoir dams had been implemented. Accordingly Upper and Middle Mun basin becomes the important basin to provide more water.

3.5 Present Condition on Water Resources, Irrigation Development and Rural Infrastructures

3.5.1 Existing Irrigation Facilities

There are 3 main basins situated in the Northeast Region of Thailand (NE) namely, Mun, Chi and Khong basin. Water resources and irrigation development project in the NE are composed of large scale, medium scale, small scale and pumping projects, which are mostly operated by 3 main agencies, Royal Irrigation Department (RID), Department of Water Resources (DWR), and Electric Generating Authority of Thailand (EGAT). There are in total 6,831 existing projects in the NE, total water storage capacity of 10,995 MCM and total irrigable area of 6,048,711 rai. Details are shown in Table 3.5.1.

(1) Large Scale Project

Large scale project shall be defined as a project which has storage capacity more than 100 MCM or has the surface water area of the reservoir more than 15 sq.km., or has the irrigable area more than 80,000 rai (12,800 ha). There are total 21 existing large scale projects operated by RID including 5 projects in Khong basin, 7 projects in Chi basin and 9 projects in Mun basin. Total water storage of 3,750 MCM and total irrigable area of 2,454,276 rai. Beside, there are total 4 hydro power dams under operation by the Electric Generating Authority of Thailand (EGAT), including 1 project in Khong basin, 2 projects in Chi basin and 1 project in Mun basin, with the total water storage of 4,583 MCM. List of Large Scale projects and EGAT's Hydro Power Dams are shown in Table 3.5.2 and Table 3.5.3.

(2) Medium Scale Project

Medium scale project shall be defined as a project which has storage capacity less than 100 MCM., or has the surface water area of the reservoir less than 15 sq.km., or has the irrigable area less than 80,000 rai (12,800 hectares). There are total 356 existing medium scale projects, including 102 projects in Khong basin, 82 projects in Chi basin and 172 projects in Mun basin. The total water storage is 1,671 MCM and total irrigable area is 1,485,096 rai.

Table 3.5.1 Existing Water Resources Project in the Northeast Region of Thailand

Basin	Large Scale			Medium Scale			Small Scale		
	No. of Project	Water Storage (MCM)	Irrigable Area (rai)	No. of Project	Water Storage (MCM)	Irrigable Area (rai)	No. of Project	Water Storage (MCM)	Irrigable Area[10] (rai)
Khong	5	819	395,495	102	310	404,375	1,678	422	241,000
Chi	7	1,662	1,130,496	82	451	305,358	1,318	242	138,000
Mun	9	1,269	928,285	172	910	775,363	2,458	327	186,000
Total	21	3,750	2,454,276	356	1,671	1,485,096	5,454	991	565,000

Basin	Pumping			EGAT's Power Plant			Total		
	No. of Project	Water Storage (MCM)	Irrigable Area (rai)	No. of Project	Water Storage (MCM)	Irrigable Area (rai)	No. of Project	Water Storage (MCM)	Irrigable Area (rai)
Khong	297	-	479,412	1	165	-	2,083	1,716	1,520,282
Chi	447	-	725,536	3	2,452	-	1,857	4,807	2,299,390
Mun	252	-	339,391	3	1,966	-	2,894	4,472	2,229,039
Total	996	-	1,544,339	7	4,583	-	6,834	10,995	6,048,711

Remark: Reference from RID "Irrigation Project Information System 2552" and National Irrigation Sector Review by MRC 2009.

(3) Small Scale Project

Small scale project shall be defined project type as reservoir, weir, irrigation distribution canal, re-dredging of swamp or pond or monkey cheek. Previously, the small scale projects have been implemented by many agencies such as, Royal Irrigation Department (RID) of Ministry of Agriculture and Cooperatives (MOAC), the Farmer Office of Accelerated Rural Development (ARD) of Ministry of Interior, etc. RID has been undertaking implementation of small scale Irrigation Program (SSIP) since 1976 (FY 1977) as part of the accelerated rural development of the Government. The project implementation must be initiated by the request of the beneficiary farmers through specifically designated channel of the request with free offering of right-of-way for major facility construction and promise to take part in the post project O&M activities. The major objective of SSIP is defined to solve or lessen the water shortage problem in the remote rural area. There are total 5,454 existing projects, including 1,678 projects in Khong basin, 1,318 projects in Chi basin, and 2,458 projects in Mun basin. The total water storage is as much as 991 MCM and total irrigable area is 565,000 rai. At present, under the 1997 Constitution, all of the small scale project shall be transferred from RID to the local authorities to undertake the project O & M instead of RID.

(4) Pumping Scheme

Pumping scheme shall be defined as a project without the storage capacity. The type of project is to pump water from the main river or its branches and distribute the pumped water into farmland. Originally, pumping irrigation projects have been undertaken by the Department of Energy Development and Promotion (DEDP), but at present were transferred to the responsibility of

[10] Since it is considered to be possible to irrigate approximately 660 thousands rai by the storage volume of 991 MCM of the small scale project, the actual irrigation area is estimated as mach as 565 thousands rai by the study team which is correspond to 20% of the summarized irrigation area.

RID.

There are total 996 existing pumping schemes in NE, including 297 projects in Khong basin, 447 projects in Chi basin, and 252 projects in Mun basin. The total irrigable area is 2,464,894 rai.

Table 3.5.2 List of the Existing Large Scale Project in the Northeast Region of Thailand

No.	Project	Province	Water storage (MCM)	Irrigation area (rai)	started	completed
Khong River basin						
1	Huai Luang O&M Project	Udonthai	113.00	86,987	1970	1984
2	Huai Mong O&M Project	Nongkhai	-	61,708	1983	1987
3	Nam Oon O&M Project	Sakhon Nakhon	520.00	185,800	1967	1981
4	Nong Harn Project	Sakhon Nakhon	186.00	-		
5	Kam Basin Development Project	Nakhon Phanom	-	61,000	1995	2001
5		total	819.00	395,495	-	-
Chi River basin						
1	Nong Wai O&M Project	Khonkaen	81.00	264,020		
2	Lam Pao O&M Project	Kalasin	1,430.00	315,098	1963	1985
3	Thung Sang Badon	Roi-et	-	180,000	1939	1955
4	Prom Chern		-	80,000	1977	1995
5	Upper Chi O&M Project		56.00	47,500	1994	1996
6	Middle Chi O&M Project		38.40	133,678	1991	2005
7	Lower Chi and Lower Sebai O&M Project		56.10	110,200	1991	2005
7		total	1,661.50	1,130,496	-	-
Mun River basin						
1	Siaw Yai O&M Project	Mahasarakham	-	41,940	1990	2002
2	Dom Noi O&M Project	Ubonratchathani	-	150,000	1968	1984
3	Lam Phra Phloeng O&M Project	Nakhon Ratchasima	149.00	78,100	1963	1984
4	Lam Takhong O&M Project	Nakhon Ratchasima	314.00	123,125	1964	1969
5	Thung Samrit O&M Project	Nakhon Ratchasima	-	153,000	1939	1958
6	Lam Nangrong O&M Project	Burirum	121.00	68,400	1980	1991
7	Upper Mun - Lamsae O&M Project	Nakhon Ratchasima	416.00	142,500	1980	2008
8	Lam Plai Mass O&M Project	Nakhon Ratchasima	98.00	56,800	1986	2002
9	Lower Mun O&M Project	Srisaket	171.38	114,420	1991	2004
9		total	1,269.38	928,285	-	-
Khong,Chi,Mun River basin						
21		total	3,749.88	2,454,276	-	-

(5) EGAT's Hydro Power Dam

There are total of 7 existing hydropower dams in NE including 1 project in Khong basin, 3 projects in Chi basin and 3 projects in Mun basin. List of EGAT's Hydro Power Dams is shown in Table 3.5.3.

Table 3.5.3 List of Hydro Power Dam in the Northeast Region of Thailand

Reference: RID Annual Report

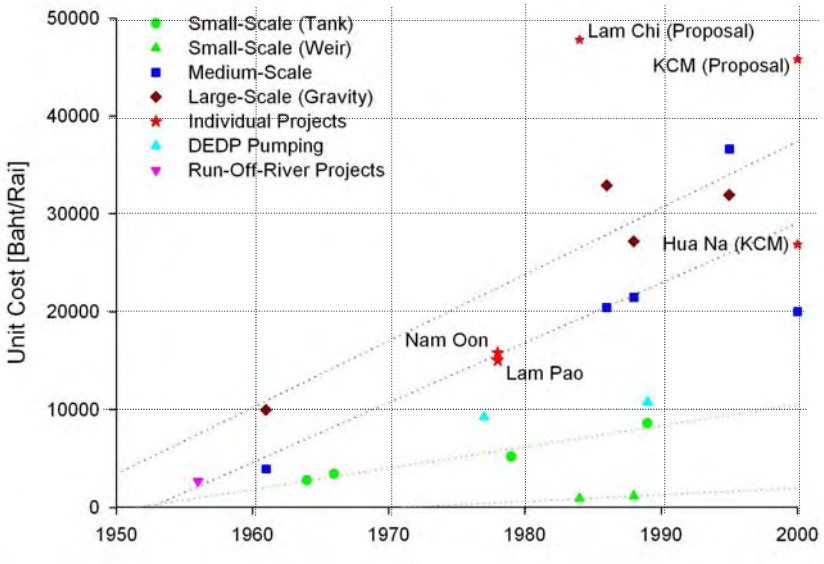
No.	Project	Province	Water storage (MCM)	Irrigation area (rai)	started	completed
Khong River basin						
1	Nam Phung Dam	Sakon Nakhon	165.48	-	NA	1965
1		total	165.48	-	NA	NA
Chi River basin						
1	Chulaporn Dam	Chaiyaphum	188.00	-	NA	1972
2	Huai Kum Dam	Chaiyaphum	-	-	-	-
3	Ubonrattana Dam	Khon Kaen	2264.00	-	1965	1985
3		total	2452.00	-	-	-
Mun River basin						
1	Sirinthorn Dam	Ubonratchathani	1966.00	-	1969	1984
2	Pak Mun Dam	Ubonratchathani	-	-	NA	NA
3	Lam Takong Dam	Nakhon Ratchasima	1966.00	-	-	-
2		total	1,966.00	-	-	-
Khong, Chi, Mun River basin						
7		total	4,583.48	-	-	-

Note : N.A. = Not available

Remark : Lam Takong Dam is under RID operation, EGAT extend the reversible pumping for hydropower upstream of the dam.

(6) Construction Cost

The Figure 3.5.1 shows the changes in project construction costs per unit area developed in project-type-wise as well as in time-wise in 45 years in the past.



Notes: all unit costs expressed in 2000 price level.

Figure 3.5.1 Unit Cost of Various Irrigation Development Project

(Data Source: Marshalling Water Resources: A Chronology of Irrigation Development in the Chi-Mun River Basin, Northeast Thailand, Phillip Floch, Francois Molle and Willibald Loiskandl, Working Paper)

Based on the Figure 3.5.1, an estimate was made for construction cost per unit area for each type of project with 2010 price level as follows.

*Large scale project	45,000 Baht/rai
*medium scale project	40,000 Baht/rai
*Small scale project	15,000 Baht/rai
*Medium pumping project	20,000 Baht/rai
*Small pumping project	15,000 Baht/rai

3.5.2 On-farm Project and Other Rural Infrastructure Development Project

(1) On-farm development project

In Thailand, the government projects cover main facilities including main canal and lateral canal under the large/medium scale irrigation development projects, but provision of those on-farm facilities are in principle left for the efforts by the beneficiary farmers. In fact, however, there are government projects in the form of Ditch and Dyke project as well as Land Consolidation project to provide on-farm facilities by using the government budget.

In the past, there have been on-farm development projects implemented for 1.9 Million ha in the existing irrigation areas, of which, 17.7 % is located in the Northeast Region. Of the total on-farm development ever implemented, 0.3 Million ha, 16 % is under the manner of land consolidation and the rest, 84 % is by Ditch and Dyke project. This implies that in the NE Region, as large as 337,000 ha has been completed with the on-farm development sharing about 56 % of irrigation service areas under the large/medium scale projects in the NE Region.

Table 3.5.4 Comparison on On-farm Development Project (Dyke and Ditch and Land Consolidation)

Item	D&D	L.C (Extensive)
Supporting Act	Dykes and Ditches Act B.E.2505	Agr. Land Consolidation Act B.E.2517 and revision in 1991
Decision for implementation	RID	Agreement over 50%
Irrigation infrastructure	Only irr. Ditches, related structures	Ditches, drains, farm roads and related structures
Density of ditches (m/rai)	5-6	9-10
Individual Plot directly connected to irrigation ditches	80%	100%
Capital Cost recovery	NO	Yes
Responsibility of O&M	Yes	Yes
Title deed issued	No	Yes
Land Use protection	No	Yes
Owner of land for common use	Landowners	MOAC
Transferring land ownership	Yes	Under permission within 5 years from the date of receipt title deed
Policy formulation	RID	Central Land Consolidation Committee
Refusal project work	If any land owner is unwilling to join RID can not carry out activities in their field	If farmer's agreement over 50%, some farmers can not refuse

Data source: Section Study on Sustainability Improvement for Irrigation Projects in the Kingdom of Thailand (JBIC, September 2004)

(2) Land consolidation (LC) projects

Ditch and Dyke project (D&D) provides only distribution canals at on-farm level, while the land consolidation scheme covers also drains and farm roads together in addition to on-farm ditches. In case of wet season paddy cropping, there is no much difference in LC and D&D, but in case of dry season cropping, drainage facility is crucial for cultivating non-rice cropping. Further to mention, securing of easy access to farms by farm road construction is considered as an inevitable requirement for saving of working time and improvement of convenience in farming activities where considerable cares are needed for vegetable cultivation.

Under the land consolidation project, there are two (2) types of development. One is Extensive type in which there is no re-shaping of plot boundary and the ditches and farm roads be aligned along the existing boundaries. Another type is Intensive one in which plots be re-shaped in rectangular including land leveling. If the average holding is small, extensive type is preferable, while intensive type is to be introduced if pursuing higher efficiency.

Construction cost for land consolidation project is estimated at about 15,000 Baht/rai for intensive type and about 9,000 Baht for extensive type, of which 20 % (Leveling cost is to be fully born by the beneficiaries) is to be shared by the beneficiary farmers[11].

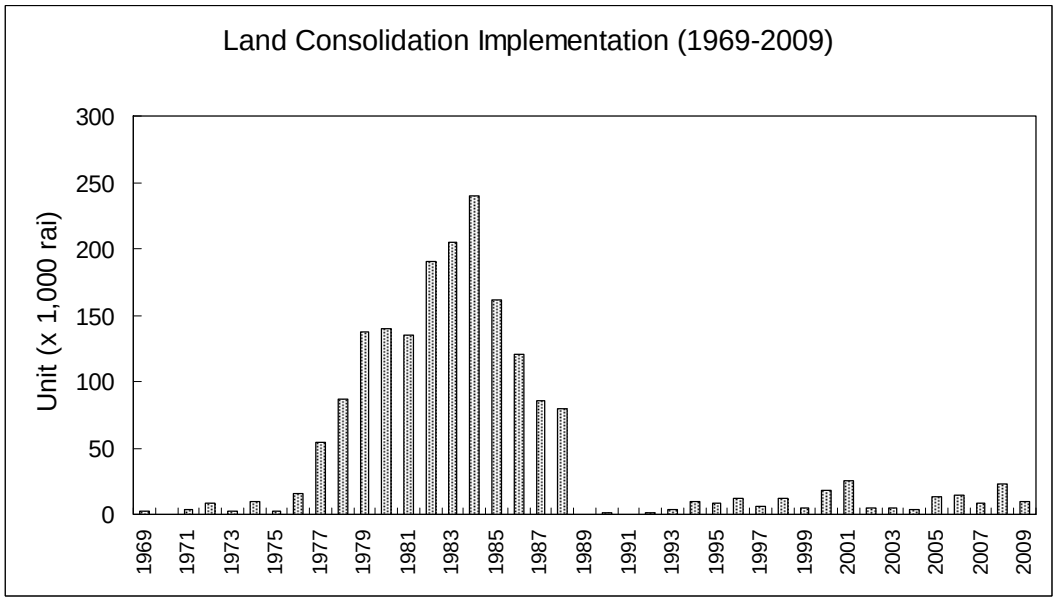


Figure 3.5.2 Transition of Annual Development Area by Land Consolidation Project (Whole Country)

As can be seen from the Figure 3.5.2, the land consolidation project was started from the late 1960's and with due assistance from the international aid agencies the number of projects were

[11] In general, the conditions applies are 15 years of repayment period (2 years of grace period) with an interest rate of 5% per annum. Payment is to be made through BAAC and BAAC charges 2% of handling fee. The repaid amount is pooled at the land consolidation fund and used for payment of F/S cost for new land consolidation project and also for rehabilitation/improvement of the existing projects.

much increased during 1970's and 1980's[12]. In the NE Region, Nong Wai project was implemented in 1980's as a large scale on-farm development project with assistances from ADB and WB and thereafter in other large scale irrigation project areas one by one. After 1990, however, the implementation of land consolidation project was shifted to use the government fund alone and the pace of implementation in terms of area developed was much slowed down.

Table 3.5.5 Implementation of LC and Rate in Northeast during Last Five Years

Year	Construction Area (rai)	Implementation in Northeast (rai)		Total Construction Cost (Million B)	Provinces in Northeast
2005	13,494	6,400	47.4%	102.200	Maha Sarakham, Udonthani, Nongkahi
2006	14,339	3,694	25.8%	138.078	Udonthani
2007	8,435	5,650	67.0%	77.644	Maha Sarakham, Sakhon Nakhon
2008	22,500	13,980	62.1%	142.051	Maha Sarakham, Udonthani, Nongkahi, Sakhon Nakhon
2009	9,575	5,945	62.1%	144.471	Maha Sarakham, Udonthani
Total	68,343	35,669	52.2%	604.444	

During 5 years in the recent past, the implementation in the NE Region has been gaining more weight in the overall implementation in the country, but the progress itself is still not very impressive being continuing the remaining works (Improvement in the areas ever implemented by D&D) under Nong Wai project. According to RID, after Nong Wai project, the land consolidation project is to be implemented in Lam Pao area in Kalasin and in future the schedule is confirmed that land consolidation project be continued for medium scale project after Large scale project service areas.

(3) Other rural infrastructure development projects

In the past, the Office of Accelerated Rural Development (ARD) under the Ministry of Interior was in charge of the integrated development in the remote rural areas including water resource development, road construction and rural water supply and etc., however the ARD was re-organized/dissolved under the government's administrative reform done in 2002. At present, therefore, major rural development implementing bodies are LDD and ALRO under MOAC for infrastructures and DWR for small scale water resources development and DWR, DGWR and PWA for rural water supply. Under the trend of decentralization, however, major roles are to be shifted to TAOs for fulfilling the tasks assigned.

For those projects closely related with the subject study, it is noted that small farm ponds (1,200 m3 capacity) are being implemented by the LDD and ALRO (Within ALRO area) under MOAC. The project cost for pond excavation is estimated at 30,000 Baht per place to be used as water source for mixed farming for fruits and vegetables with irrigation for 1-2 rai per farm.

[12] JICA has ever carried out the following technical and economic cooperation projects (Land Consolidation) in Thailand. – Irrigated Agriculture Development projects in Mae Klong Area (project-type cooperation, 1977), - Chao Phya Irrigated Agricultural Development Project (Yen-loan, 1979)

3.5.3 Operation & Maintenance and Water Cost

(1) Operation & Maintenance (O&M) and Water Cost

In case of large scale project, O & M project Office under the RID is organized. Activities for operation and maintenance of the reservoir, the main canals and lateral canals of the large scale project are secured by the said O & M office. In addition, the O & M for tertiary canals is to be carried out by the WUGs which have been organized for a tertiary canal. Independent office , budget and staff are provided for the large scale project for O&M in considerably good conditions.

While in case of medium scale project, one responsible officer from the O & M division of the provincial office of RID is assigned. The officer takes responsibility to operate 4 to 5 projects of the medium scale.

Among the medium scale projects, it is observed that the Huai Sub Padu project is maintained in good conditions by introduction of the PIM (Participatory Irrigation Management of Operation and Maintenance), however, there are many projects being poorly maintained due to insufficient man power, deterioration of the facilities and malfunction of WUG as caused by insufficient budget allocation for maintenance. In case of Huai San Phat project, approximately 60 % of water is lost in the water distribution system due to poor maintenance.

In case of the small scale project, maintenance works of the facilities has been transferred to TAO, and mostly projects have no adequate maintenance at all. On the other hand, the pump irrigation projects are maintained in comparatively favorable conditions with subsidy of pump electric cost by TAO.

Water costs are estimated as follows for Huai Mong O& M project, the typical pump project in NE, and Huai Phat Reservoir Project, by gravity flow, in Udon Tani Province.

Table3.5.6 Maintenance and Water Costs

Expenditure items	Unit	Huai Mong O & M Project	Huai Sam Phat Reservoir Project
1. Total salaries	baht	7,002,120	106,210
2. Improving structure for modernization	Baht	-	-
3. Maintenance	baht	1,326,000	-
4. Rehabilitation	baht	9,025,000	1,823,000
5. Other Operations	baht	3,700,000	-
6. Administration and others	baht	155,000	-
7. Total Annual Maintenance Cost	baht	21,208,120	1,929,210
8. Total annual volume of irrigation supply	mcm	39.83	15.00
9. Irrigation water delivered to users	mcm	35.86	5.84
10. Average cost per supply volume (item7/item8)	baht/m^3	0.5325	0.1286
11. Average cost per delivered volume (item7/item9)	baht/m^3	0.5914	0.3305
12. Command area	rai	61,183	16,910
13. Dry Season	rai	21,869	2,031
14. Total (item12+item13)	rai	83,052	18,941
15. Average budget to command area (item7/item12)	baht/rai	347	114
16. Average budget to total irrigation area (item7/item14)	baht/rai	255	102

Data source: Technical Cooperation Program, Policies and Strategic Planning for the Thailand irrigation Sector

Reform Program, Thailand, Final Report, Review and Assessment of Irrigation Sector Financing in Thailand, FAO, Bangkok, July 2008

As the water cost is various among the projects as shown in the table 3.5.6, the water cost is only 0.13 baht/m^3 in the Huai Sam Phat project at the water supply side and 0.53 baht/m^3 in the Huai Mong O&M project. The difference of water costs between two projects is probably caused by insufficient maintenance due to lack of budget in the Huai Sam Phat project and the large difference of water quantity between supply and receiver is also considered to be lack of maintenance budget causing insufficient gate operation and maintenance.

(2) Pump Operation cost and Charge

While there is no charge imposed for water in case of irrigation by gravity flow, the charge is required for farmer in case of pump irrigation. The following electric cost sharing methods are applied in the NE at present.

① Sharing rate and payment method of pump electric cost are discussed and agreed between RID and WUG in the Project constructed by RID. At present, this method is applied as the unified manner to the most projects.

- Pump Operation Cost in Rainy Season: 100% of cost by RID
- Pump Operation Cost in Dry Season: 100% of cost by Farmer

② In case of Pump Irrigation Project transferred from the DEDP and presently managed by RID:

Depending on the agreement for each project, however, sharing method established at the time of construction by DEDP is broadly applied to the most project transferred as follows:

Total Electric Unit Cost:	2.6 baht / kWh
Burden charge by Farmer	0.6 baht / kWh
Burden Charge by RID	2.0 baht / kWh

③ The Pump Irrigation Project transferred to TAOs or constructed by Tambon (basically irrigation area is less than 3,000 rai):

Depending on the agreement for each project, however, 100% by Farmer

In case of Huai Mong O&M Project, method of (burden charge of farmer is 0.6 baht / kWh and 2.0 baht / kWh by RID) is applied. Approximate estimation of electric cost is as shown in the table 3.5.7.

Based on the interview at the site, annual electric cost for ten pump stations (actual irrigation area is 23,000 rai) was shared at 0.75 million baht (32.6 baht / rai) by the farmer and 3.5 million baht (152 baht / rai) by RID which is similar to the estimated cost in the table 3.5.7.

As the payment method of pump cost in the dry season is decided between irrigation area base or kWh base depend on the WUGs' selection. Payment amount by farmer is approximately 80 to 100 baht / rai in the season. Electric cost is collected by WUG for almost 100% and paid to the

RID. The electric cost for other purpose than the irrigation pump such as drainage is paid by RID.

Table 3.5.7 Pump Operation Cost and Burden Charge of Farmer

Items	Unit	Computa-tion	Cost per season		
			Wet		Dry
			Wet Total	Farmer	Total
1. Amount of electricity consumed per hour	kWh/hr	-	45	45	45
2. Price of electricity	baht/kWh	-	2.6	0.6	2.6
3. Total electricity cost per Hour	baht/hr	1x2	117	27	117
4. Discharge rate	m^3/sec	-	0.2	0.2	0.2
5. Discharge rate per hour	m^3/hr	4x3,600	720	720	720
6. Amount of water pumped per kWh	m^3/kWh	5/1	16.00	16.00	16.00
7. Electricity cost per m^3	baht/m^3	2/6	0.1625	0.0375	0.1625
8. Amount of water demand per rai of rice	m^3/rai	-	1,000	1,000	2,000
9. Electricity per rai	baht/rai	7x8	163	38	325

Data source: Technical Cooperation Program, Policies and Strategic Planning for the Thailand irrigation Sector Reform Program, TCP/THA/3101, Thailand, Final Technical Report, FAO, Bangkok, August 2008, and reviewed by Study Team

3.6 Surface Water Resources

3.6.1 Data Collection for Study of Potential Surface Water

According to the policy of Integrated Water Resources Management (IWRM) set up by National Water Resources Committee (NWRC), water resource potential of the country has been evaluated respectively for 25 basin. Since 1990s', DWR and RID have been reviewed once a four to five years[13].

Table 3.6.1 Data Source of Surface Water Resources Review

Item	Data Source	Data Processing
Basin Area	Strategic Plans for Water Resources Management in 25 Basins(DWR,2006)	Area of 80 basins was referred from DWR report.
Rainfall/ Rainwater	RID rainfall data（787 stations, 1970-2010） TMD rainfall data（11 stations, 1951-2010）	Processed by Study team
Surface Runoff	RID runoff station data (25 station, 1960-2007) DWR data (60 station,1960～2007)	Processed by Study team based on primary data Appendix 3.6.2shows the records of major stations (location map and hydrograph), Appendix 3.6.3 shows the monthly records of selected stations
Land use	Land use map(LDD), Provincial statistics	Processed by Study team based on Annex III 1-8 (land use map) and national statistics.
Irrigation Area	National irrigation sector review(MRC, 2009)	Processed by Study team based on Annex III 3-6 (inventory survey data) and MRC database.
Irrigation Water	RID (primary data and inf. of methodology)	Processed by Study team applied by RID methodology and information(crop water requirement, cropping calendar)
Developed Water	Irrigation system information (RID annual book)	Processed by Study team based on RID annual book, MRC survey report and Annex III 3-5

As recent reviews, DWR prepared the strategic plan[14] (2006) and RID is preparing EIA and SEA report[15] (2010, unpublished) and MRC made the irrigation survey[16] (2009). However, those

[13] RID and DWR has contracted local consultant at the interval of 4 to 5 years to review 25 basins' water resource.
[14] Strategic Plans for Water Resources Management in 25 Basins(DWR, 2006)
[15] Environmental Impact Assessment (EIA) and Strategy Environmental Assessment (SEA) - Water resource management of Khong Loei Chi Mun in North-East region (RID, 2010) -

reports have a contradiction each other in their methodologies and even basic hydrological information. Accordingly, the necessary value for the study is evaluated from raw data provided by RID and DWR. The data source used in the study is shown in Table 3.6.1.

Table 3.6.2 Surface Water and Related Data in Sub-Basin of Khong, Chi and Mun Basin

Basin[*1]	Basin Area (km^2)	Annual Rain (mm)	Annual Surface (MCM)	Paddy Area (10^3 rai)	Rain-fed Paddy (10^3 rai)	Irrigation Area (10^3 rai)	Water Use (MCM)			Water Balance[*4] (MCM)
							Irrigation	Others	Total	
1. Khong										
Upper	20,500	1,442	8,360	2,680	1,990	690	920	160	1,080	7,280
Lower	25,960	1,712	17,230	4,940	3,970	970	1,160	220	1,380	15,850
Subtotal	**46,460**	**3,154**	**25,590**	**7,620**	**5,960**	**1,660**	**2,080**	**380**	**2,460**	**23,130**
2. Chi										
Upper	13,550	1,126	(2,500)[*2]	1,700	1,390	310	470	100	570	(1,940)[*3]
Middle	21,030	1,253	6,320	5,840	4,620	1,220	1,980	210	2,190	4,030
Lower	14,900	1,448	5,370	3,260	2,280	980	1,620	160	1,780	3,390
Subtotal	**49,480**	**3,827**	**14,190**	**10,800**	**8,290**	**2,510**	**4,070**	**470**	**4,540**	**9,360**
3. Mun										
Upper	29,170	1,110	5,160	6,870	5,290	1,580	2,820	260	3,080	2,080
Middle	24,390	1,369	9,300	7,820	6,700	1,120	1,440	330	1,760	4,540
Lower	16,140	1,601	10,520	4,020	3,390	630	800	140	940	9,580
Subtotal	**69,700**	**4,080**	**24,980**	**18,710**	**15,380**	**3,330**	**5,060**	**730**	**5,780**	**16,200**
Total	**165,640**	**11,061**	**64,760**	**37,130**	**29,630**	**7,500**	**11,210**	**1,580**	**12,780**	**48,690**

Note *1 Basin data is based on Appendix 3.6.1 except for paddy area

*2(2,500) is estimated value by JICA Team. Original value is 4,000 MCM

*3 (1940) is from observation data at E16A sation

*4 Total loss(2,690) is calculated by Water balance(48,690)-Annual Surface Water(64,760)-Water Use(12,780), it includes transmission loss(evaporation, seepage) from river-reservoir system, error on estimation of water use, etc.

The collected data and processed results are shown in the following Appendixes.

Appendix 3.6.2 Records of Major Runoff Station (Location map and Hydrographs)
Appendix 3.6.3 Monthly Records of Selected 18 Stations
Appendix 3.6.4 Daily Runoff of Mekong River
Appendix 3.6.5 Mean Wet/Dry Season Runoff of Major Station
Appendix 3.6.6 Mean Monthly Runoff of Major Station
Appendix 3.6.7 Isoline Map of Runoff Yield

Using with the processed result, the interpretation of water balance is shown in following Appendixes.

Appendix 3.6.8 Estimation of Runoff Yield in Khong, Chi and Mun Basin
Appendix 3.6.9 Estimation of Potential Water and Rain Water Use in Khong, Chi and Mun Basin

Referenced data and processing result of the water balance prepared for each tributary is shown in Appendix 3.6.1 Summary of Basin Balance and Table 3.6.2 Surface Water and Related Data in Sub-basin of Khong, Chi and Mun Basin.

[16] National Irrigation Sector Review (MRC, 2009)

3.6.2 Surface Water Resources in Khong Basin

(1) Upper Khong

Upper Khong has rich annual rainfall[17] (referred to as Rainfall) of 1,442 mm (29,560 MCM) and annual surface water of 8,360 MCM showing high runoff yield[18] (referred to as Water Potential) of 407 mm. Although the basin holds large paddy area of 2.7 million rai (432,000 ha) and the rain water use of 5,400 MCM (2,000 m^3/rai x 2.7 million rai) the basin has still large surface water due to rich rainfall. While the irrigation area is small as 690,000 rai (110,400 ha) and the water use amount[19] (referred to as Developed Water) including domestic water supply is few as 1,080 MCM. Accordingly large surplus water of 7,280 MCM is presently flowing[20] (referred to as Runoff) to Mekong river (refer to Figure 3.6.1).

(2) Lower Khong

The Lower Khong also holds large paddy area of 4.9 million rai (784,000 ha) requiring large rain water of 9,800 MCM but keeps still large surface water of 17,200 MCM showing the high Water Potential of 664 mm due to the richest Rainfall of 1,710 mm (44,455 MCM) in the Northeast Region.

However, irrigation area is few as 970,000 rai (155,200 ha) and Developed water is very small as 1,380 MCM in the basin and as a result large surplus water of 15,850 MCM is released to Mekong river(refer to Figure 3.6.1).

(3) Whole Khong Basin

As mentioned in the above, the whole Khong basin has very rich Water Potential as large as 25,580 MCM occupying about 40% of total Water Potential in the Northeast Region (64,750 MCM) but has released the large surplus surface water of 23,130 MCM to Mekong river without any development. Developed Water is only 2,460 MCM showing very low development rate of 10%.

From August to October; basin is covered by surplus water with many wetlands inundating in the wet season by Mekong's high back water, where the wet season paddy can not be cultivated[21].

[17] Annual rainfall is the mean rainfall in the basin using with Isohyetal method. The isohyetal method involves the contours of equal precipitation drawn by RID data. Calculating the area between these curves and adding up the volume of water and divided by basin area is to obtain the mean value of rainfall.

[18] In the study, runoff yield is calculated by the empirical formulae based on RID's observations. The calculated value indicates the local-runoff into tributary channels which implies the initial evapotranspiration from rainfall and water consumption in rain fed area.

[19] In the study, irrigation water developed by dams, weirs, and pumps, and other purposes of drinking, domestic and industrial us are in a lump called as developed water.

[20] In the study, river discharge amount at outlet of each sub-basin is called as runoff amount.

[21] RID (DEDP in the past) intends to use the large surplus water for irrigation but has faced the difficulty that the basin has no more suitable large reservoir dam sites to control the surplus water Accordingly RID has studied to increase the medium scale reservoir dams in the upstream tributary basins, by using the wetland water and divert surplus water to the Lam Pao and Ubon Rat reservoir which can not be filled up at the end of wet season due to lack of the wet season inflow.

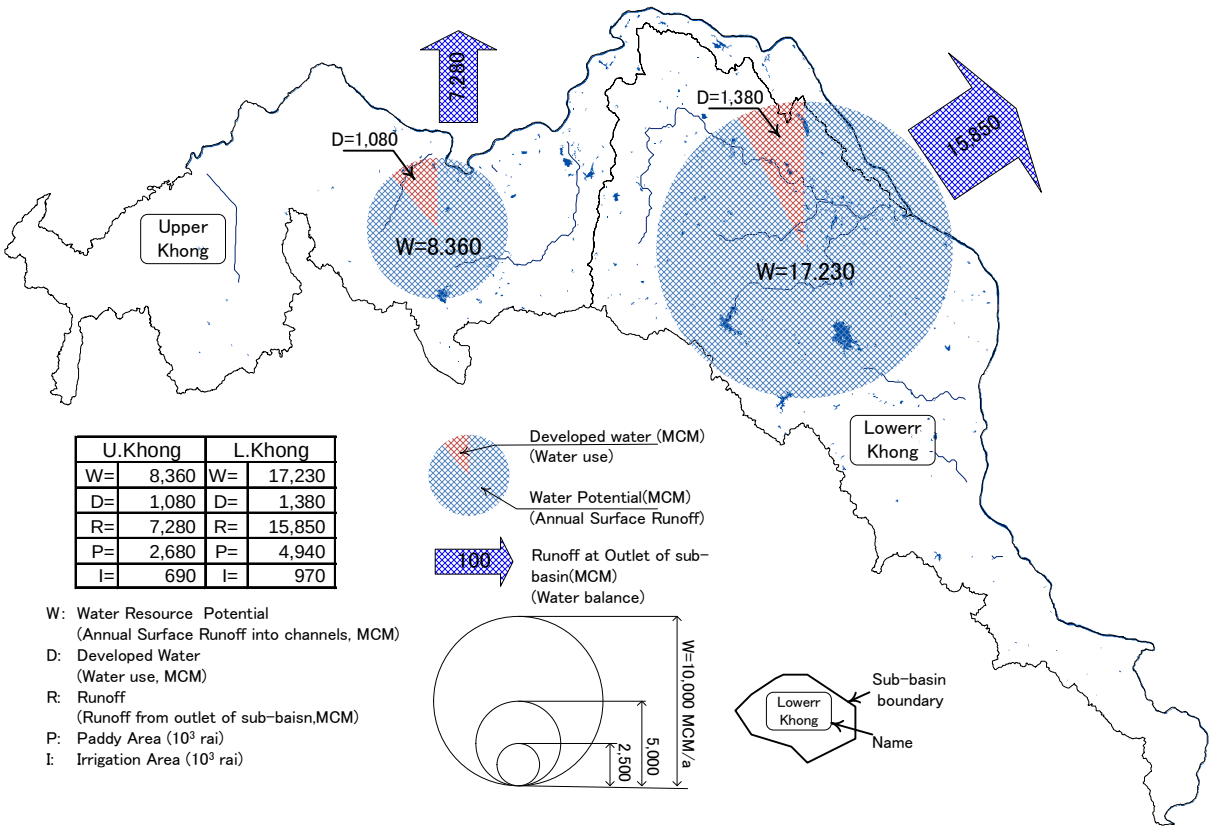


Figure 3.6.1 Water Balance of Khong Basin

3.6.3 Surface Water Resources in Chi Basin

(1) Upper Chi

Upper Chi has a little rainfall of 1,126 mm, but rich Water Potential of 4,000 MCM[22], equivalent to Runoff yield of 295 MCM, was estimated by the empirical runoff formula. However, Rainfall in the Upper Chi is only 1,100 mm, therefore Runoff yield is supposed to be less than 200 mm. With a rational rate on basin-water balance as well as Runoff of 1,900 MCM at E16 station located at terminal point of Upper Chi, Water Potential is assumed as 2,500 to 3,000MCM.

On the other hands, Developed Water is as small as 570 MCM due to the restriction of paddy and irrigation area of 1.7 million and 0.3 million rai respectively. Accordingly Water Potential in Upper Chi is assumed to be 2,500 MCM.

As the Upper Chi basin has not large scale reservoir dams such as Ubonrat in Middle Chi and Lam Pao in Lower Chi, the river flow shows large fluctuation such as 1,800 MCM in the wet season and 100 MCM in the dry season (refer to Figure 3.6.2).

[22] Runoff of 4,000 MCM was calculated by the empirical runoff formula prepared by RID survey, However, the calculation is seems to be much higher than the estimation from basin rainfall of 1,130 mm/year. It may be miss-judgment in application of formula due to insufficient density of observatories in Upper Chi.

(2) Middle Chi

Middle Chi basin includes the large tributary of Phong with the area of 14,900 km^2 where the Ubonrat reservoir is located. Other tributaries lie on the plateau and plain in Khon Kaen, Maha Sarakham and Roi Et provinces with the area of 5,400 km^2. Although the basin has large paddy area of 5.84 million rai (934,400 ha) and consumes large rain water of 11,700 MCM, the basin still keeps rich Water Potential of 6,320 MCM showing the runoff yield of 301 mm because of the basin having moderate Rainfall of 1,253 mm.

As the basin holds large irrigation area of 1.22 million rai (195,200 ha) including Nong Wai large project area of 260,000 rai (41,600 ha), developed water in the basin is also large as 2,200 MCM occupying 35% of the surface water in the basin.

Accordingly, Runoff is estimated as 4,030 MCM and total river runoff at the terminal point of Middle Chi reaches to about 6,000 MCM by adding the surplus water of 1,940 MCM in Upper basin. The observed river runoff at E66A station located at the upstream of tributary's outlet is 5,600 MCM (refer to Figure 3.6.2).

(3) Lower Chi

Lower Chi basin is consisting of the large tributaries: Lam Pao of 8,200 km^2 located Lam Pao reservoir dam, Nam Yang of 4,150 km^2 and Lower Chi of 2,550 km^2 included Yasothon Phanom Phrai barrage. The basin has large Water Potential of 5,370 MCM showing the high runoff yield of 360 mm because of rich Rainfall of 1,448 mm while the limited paddy filed of 3.3 million rai (528,000 ha). The irrigation area in the basin is a little as 980,000 rai (156,800 ha), consequently Developed Water is also small as 1,780 MCM.

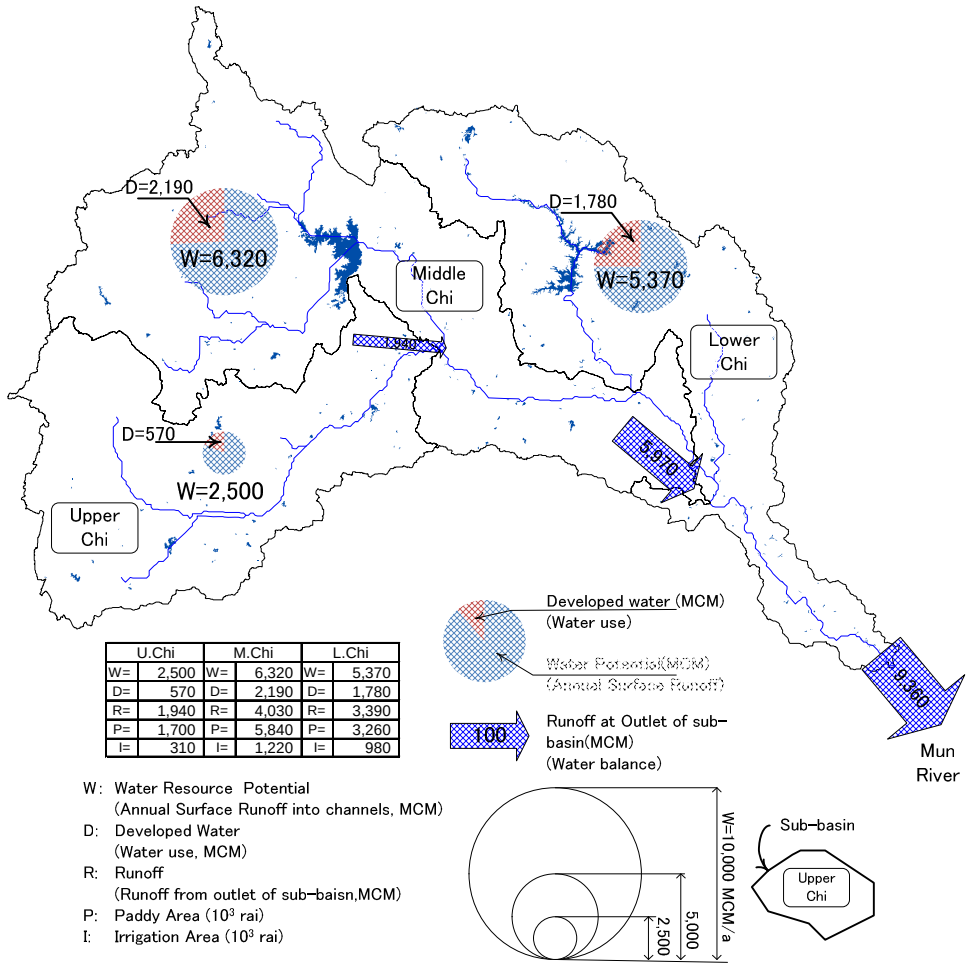
Accordingly, Runoff water at the terminal point of the basin is estimated as fairly large amount of 3,590 MCM, which is the remaining amount after subtraction of transmission loss[23] of 200 MCM in the reservoirs and barrages.

As the result, the river runoff at the terminal point of Chi basin is estimated as 9,400 MCM by adding 6,000 MCM of Middle Chi on Lower Chi of 3,400 MCM. The observed river runoff at E20A station located at the upstream of tributary's outlet is 8,970 MCM (refer to Figure 3.6.2).

(4) Chi whole Basin

As mentioned in the above sub-sections, the potential surface water in Chi basin is 14,200 MCM. Out of 14,200 MCM, 4,540 MCM is consumed by the water use and about 500 MCM is lost by evaporation and seepage from reservoirs and channels. The remaining water of 9,000 MCM is flowing to Mun river. As the basin has two large reservoir dams, 6 large scale barrages as well as large irrigation area of 2.5 million rai (400,000 ha), the water management in the Chi basin is very complicated.

[23] Transmission loss is the water loss by evapotranspiration and seepage from river, reservoir and channel during water transmission from sub-basin to sun-basin along with river system.



U.Chi		M.Chi		L.Chi	
W=	2,500	W=	6,320	W=	5,370
D=	570	D=	2,190	D=	1,780
R=	1,940	R=	4,030	R=	3,390
P=	1,700	P=	5,840	P=	3,260
I=	310	I=	1,220	I=	980

Figure 3.6.2 Water Balance of Chi Basin

3.6.4 Surface Water Resources in Mun Basin

(1) Upper Mun

Upper Mun has the largest basin area of 29,170 km^2 in the sub-basin of Khong, Chi and Mun basins. However, Water Potential in the basin is limited to 5,160 MCM because the basin has small Rainfall of 1,110 mm and large paddy area of 6.9 million rai (110,400 ha) consumes a lot of rain water of 13,800 MCM.

As the irrigation area in the basin also is large as 1.6 million rai (256,000 ha) and Developed Water therefore reaches 3,080 MCM. Accordingly Runoff water in the basin decreases by 2,080 MCM (refer to Figure 3.6.3).

There are five (5) large scale reservoir dams in the tributary basins of the Upper Mun and the downstream beneficial area of the dams is to use the water resource with priority, so that the other area is suffered from water shortage. In the dry season, Mun river looses necessary water for the river maintenance.

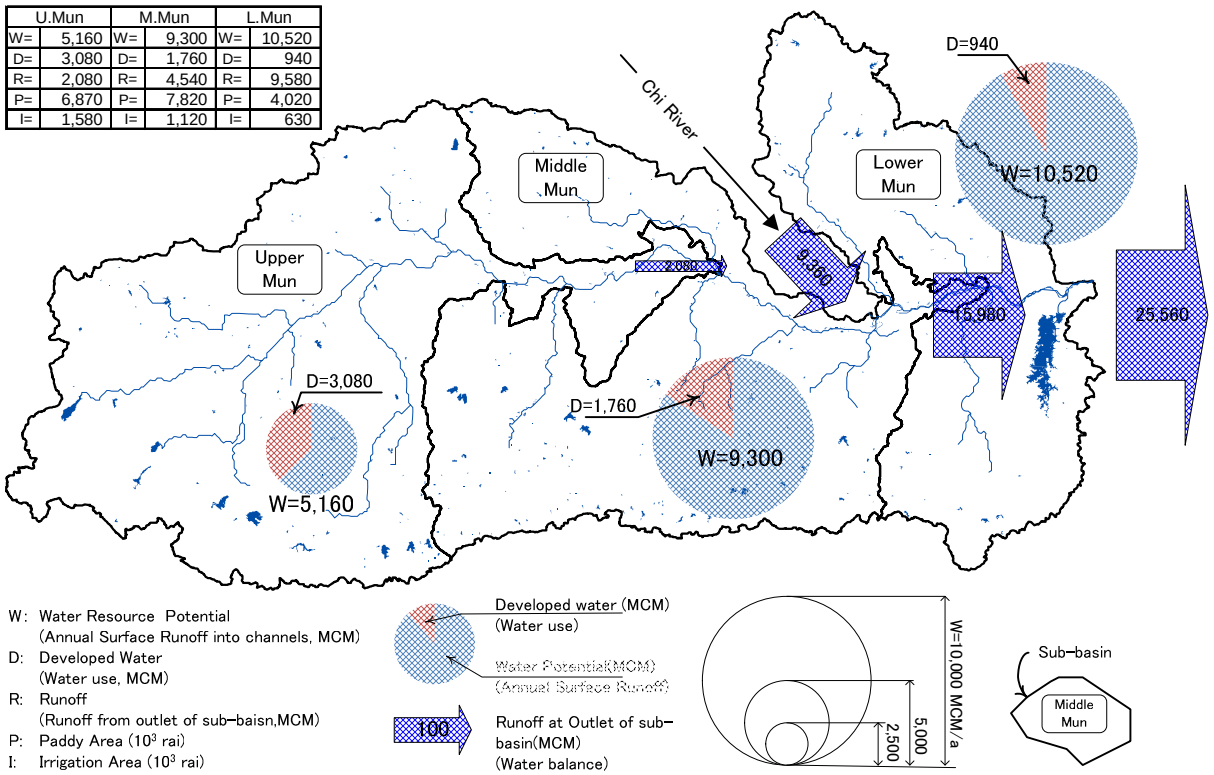


Figure 3.6.3 Water Balance of Mun Basin

(2) Middle Mun

Middle Mun also has the large basin area of 24,390 km^2, and rich Water Potential of 9,300 MCM showing the high runoff yield of 381 mm because the basin has rich rainfall of 1,370 mm. The basin has the largest paddy area of 7.8 million rai in Sub-Basins, therefore the large irrigation area of 1.1 million rai (176,000 ha) uses the water of 1,760 MCM.

However, the basin has still much surplus water of 4,540 MCM, adding 2,080 MCM of inflow amount from Upper Mun and 9,360 MCM of inflow of Chi basin, total 15,980 is flowing down to Lower Mun as runoff. This causes the flood at August to October (refer to Figure 3.6.3).

Accordingly the river reaches of about 100 km in Middle Mun has large width of 2 to 3 km. by the accumulating of sediment load, and Mun river is flowing down with large meandering shape.

(3) Lower Mun Basin

Lower Mun basin has small basin area of 16,140 km^2 but the largest Water Potential of 10,520 MCM due to the rich rainfall of 1,601 mm. However, the basin has not large paddy area of 4.0 million rai (640,000 ha) and irrigation area of 0.6 million rai (100,800 ha). Accordingly the large surplus water of 9,580 MCM remains in the sub-basin, and adding 15,980 MCM of inflow from Middle Mun, total 25,560 MCM is released to Mekong river.

3.7 River Flow

3.7.1 Basic Data of River Flow

The river flow in Khong, Chi, Mun is changed due to rainfall, reservoir operation, land use, and river shape such as slope and cross-section. In particular water operation, such as operation of reservoir dams, barrages, weirs, pumping stations, water diversion canal, retarding pond, etc, directly interfere with river flow condition. Accordingly, the management of water operation is one of important key in IWRM. In the next sub-sections, the collected data and their processing are described.

(1) Hydrological Data for JICA Study

In order to measure and analysis the variation of the river flow, the records of 85 stations[24] are collected, as below.

Appendix 3.6.2 Records of Major Runoff Station (Location map and Hydrographs),
Appendix 3.6.3 Monthly Records of Selected 18 Stations,
Appendix 3.6.4 Daily Runoff of Mekong River.

With the hydrological data, preliminary analysis was made and compiled, as follows,

Appendix 3.7.1 Max / Min River Stage in Khong, Chi and Mun River
Appendix 3.7.2 River Profile of Khong, Chi and Mun River with Max/Min River Stage
Appendix 3.7.3 Flow Diagram of Tributaries in Khong, Chi and Mun Basin
Appendix 3.7.4 Summary of Surface Runoff in Khong, Chi and Mun Basin
Appendix 3.7.5 Station Observed Max. Runoff (Flood) in 1966-2007
Appendix 3.7.6 Drought Records in 2009

In accordance with the above river flow data, the characteristics and issues of the river flow in the sub-basin of Khong, Chi and Mun Basin are described as follows.

3.7.2 Khong Basin

(1) Selected Control Points[25]

Through the review of hydrological data, the station applicability was evaluated in terms of the representativeness in the sub-basin's river flow, and following stations were selected as control points.

- Kh 58A sta. at the Loei river in the Upper basin,
- Kh 74 sta. at the Songkhram river and
- 23303 sta.at the Nam Kam river.

[24] RID and DWR have installed gauging stations more than 200 points in Khong, Chi and Mun basin.

[25] Control point is placed as a typical (monitoring) point for the river management plan. Therefore, their locations are selected as adequate pints to grasp the basin's river flow condition. The observation records are utilized for the flood water utilization program and flood disaster prevention plan.

(2) Average Annual Runoff Yield

Average annual runoff yield in Khong basin is fairly high as 321 mm at Kh58A sta., 597 mm at Kh74sta. and 511 mm at 23303 sta. Accordingly the wet season paddy in Khong basin could be sufficiently irrigated by the weirs without reservoir dams.

(3) Wet and Dry Season Runoff

The wet season runoff occupies 90% in Upper Khong and 95% in Lower Khong for annual runoff and the dry season runoff in Upper and Lower is very small as is only 10% and 5% respectively. Runoff in the peak wet months from August to October shows about 65 to 70% of annual runoff, while the runoff in the severe dry month from January to March shows only 3% in Upper and 5 to 10 % in Lower for the annual runoff. Accordingly, the both basins have been suffered from flood and drought problem in the wet and dry season. Different water depth between the wet and dry season is very large as 8 to 11 m due to the influence from the high back water of Mekong river. The maximum flood discharge is 450 m^3/sec at Kh58A station indicating as the specific flood yield of 0.145 l/sec/km^2, while 320 m^3/sec at Kh74 sta. as the yield of 0149 l/sec/km^2.

3.7.3 Chi Basin

(1) Selected Control Points

In Chi basin, eight (8) control points are selected for Upper, Middle and Lower Chi sub-basin, as follows.

- E16A sta. for the Upper Chi,
- Ubonrat reservoir dam,
- 40103 sta, at Ban Kok,
- E66A sta. in the Middle Chi,
- Lam Pao reservoir dam,
- 141901 sta.at Kamala Sai,
- E18 sta. in the Lower Chi and,
- E20A sta. in the Lower Chi.

(2) Summary of Chi River Flow Conditions

Chi river flow conditions at the selected control points are summarized in Table 3.7.1

a) Upper Chi

Average annual runoff at E16A sta. locating at the terminal point of the Upper basin is measured as 1,850 MCM showing the runoff yield of 136 mm. As Upper Chi rainfall is few as 1,100 mm the runoff yield is clearly low as compared with the other control points in the Middle and Lower Basins.

b) Middle Chi

The large reservoir dams of Ubonrat is existing at the upstream basin of the Phong large tributary

in Middle Chi basin. Although the reservoir inflow is estimated as 3,450 MCM per annum., the outflow decreases to 1,940 MCM showing the slightly small runoff yield of 162 mm. because the reservoir water is used for farm area at the surrounding area of the reservoir by pumping system and lost by evaporation and seepage from the large reservoir area of about 360 km^2. The reservoir outflow decreases by the irrigation water use for Nong Wai large project and the other irrigation projects. As the result, annual runoff at the Ban Kok Station locating at the confluence of Upper Chi and the lower Phong is measured as 3,700 MCM as the merged runoff of the Upper Chi and the Phong. Middle Chi river is flowing down E66A sta. at the terminal point of Upper Chi collecting runoff from many tributaries and using irrigation water at many medium pump stations and small irrigation projects and average runoff at E66A sta. is observed as 5,600 MCM[26].

Table 3.7.1 Chi River Flow Conditions at Control Point

Item	Unit	Upper Chi	Middle Chi			Lower Chi			
		E16A	Ubonrat	Ban Kok	E66A	Lam Pao	Kamala Sai	E18	E20A
1. Catchment area	Km2	13,512	12,000	28,500	32,190	5,960	8,218	41,187	47,800
2. Average Runoff									
Wet	MCM	1,700	1,280	3,050	4,800	1,240	1,330	5,650	7,800
Dry	MCM	150	660	650	800	600	380	1,150	1,150
Total	MCM	1,850	1,940	3,700	5,600	1,840	1,710	6,800	8,950
3. Runoff Yield	mm.	136	162	130	174	309	208	165	187
4. Peak wet month	MCM	1,300	750	2,050	3,100	870	960	3,800	5,390
5. Severe dry month	MCM	40	120	200	270	330	110	420	410
6. Water dept variation	m.	10~12	-	-	8~10	6	-	8~10	7~9
7. Flood discharge	M3/sec	900	(1,200) 850	1,000	1,000	(800) 650	450	2,100	2,700
8. Specific flood yield	l/sec/km2	66	(100) 70	35	31	(135) 110	55	51	65

Note: (1,200) and (800) are flood discharge in the reservoir inflow
850 and 650 are flood discharge by the reservoir outflow.

c) Lower Chi

The large reservoir dam of Lam Pao is located at the upstream basin of Lam Pao tributary in the Lower Chi basin. The reservoir inflow is estimated as 2,070 MCM but the outflow decreases to 1,840 MCM by the reservoir water loss due to large reservoir area of 250 km^2. In the lower Lam Pao basin, a lot of irrigation water is used for Lam Pao large project and other irrigation projects, while the side flow of many tributaries is joining. As a result, average annual runoff at Kamara Sai sta. locating at the terminal point of the Lam Pao basin is measured as 1,700 MCM. Merged 1,700 MCM with the inflow from Middle Chi of 5,400 MCM, total of 7,300 MCM is flowing to Roi Et large barrage. However, it is used by pumping irrigation near by the barrage, as a result annual runoff at E18 station locating at the downstream of Roi Et barrage is measured as 6,800 MCM. After E18 sta., Lower Chi river collects the runoff at the large tributary of Lam Yang without large dam and reaches E20A sta. locating near Chi river mouth. The annual runoff at E20A sta. is measured as 9,000 MCM, which is judged as total annual runoff of Chi river.

[26] Annual runoff in the Middle Chi basin is estimated as 3,750 MCM by reduction of 1,850 MCM in the Upper Chi from 5,600 MCM (5,600-1,850=3750 MCM/year). This can converts 200 mm of runoff yield.

(4) Others

The percentage of runoff of peak wet month to annual is 70% at E16A sta. in Upper Chi due to no controlled runoff by large reservoirs but decreases to 50 to 60% at the control points in Middle and Lower Chi because runoff is controlled by two large reservoirs. The percentage of runoff in severe dry month is only 3% at E16A sta. due to no improvement dry season runoff by reservoirs but increases to 6 to 10% in Middle and Lower basins because of runoff control by two reservoirs. The specific flood yield without reservoir control is very high as 100 to 135 l/sec/km^2 in Ubonrat and Lam Pao, which decreases to 70 to 110 l/sec/km^2 by the reservoir control.

3.7.4 Mun Basin

(1) Selected Control Points

In Mun basin, 10 stations are selected as control points for Upper, Middle and Lower sub-basin, as follows.

Upper Mun: 50103sta. at Tha Wha near the confluence of Mun and Lam Plai Mat,
M6A sta. at Terminal point of Upper Mun at Ban Kua rubber weir,
Middle Mun: 50105 sta. at Ban Satuk in Sathad tributary of Mun left bank,
M26 sta. at the Lam Chi tributary of Mun right bank,
52001 sta. at Ban Ku Pra Go Ma in Siaw Yai tributary of Mun left bank,
52101 sta. at Ban Huai Thap Than in Thap Than tributary of Mun right bank,
M9 sta. at Samran tributary of Mun right bank,
50112 sta. at Rasi Salai in Mun main river near Rasi Salai barrage,
Lower Mun: M7 sta. at Mun main river near Ubon Ratchathani and
50127 sta. at Pak Mun at Mun main river mouth.

(2) Summary of Mun River Flow Conditions

Mun river flow condition at the selected control points are summarized in Table 3.7.2.

Table 3.7.2 Mun River Flow Conditions

Item	Unit	Upper Mun		Middle Mun						Lower Mun	
		BanTha Wha	M6A	Ban Satuk	M26	Ban Ku Pra	Thap Than	M9	Rasi Salai	M7	Pak Mun
1. Catchment area	Km^2	15,100	28,280	26,000	2,930	3,230	2,030	3,026	44,600	106,670	117,000
2. Average Runoff											
Wet	MCM	800	2,000	1,880	620	400	750	630	5,400	1,750	19,800
Dry	MCM	90	200	0	20	0	30	10	350	1,900	2,600
Total	MCM	890	2,200	1,880	640	400	780	640	5,750	1,9400	22,400
3. Runoff Yield	mm.	59	78	70	218	123	384	211	129	182	197
4. Water dept variation	m.	7~6	7~6	7~6	10~8	10~9	10~9	12~10	10~8	11~9	11~9
5. Flood discharge	m^3/sec		850						1,700	5,600	4,600
6. Specific flood yield	l/sec/km^2		38						38	53	39

(3) Average Annual Runoff

a) Upper Mun

Annual runoff at Ban Tha Wha station locating at the confluence of Mun and Lam Plai Mat in the Upper Mun basin is measured as 890 MCM showing very low runoff yield of 59 mm.As many large dams have been constructed and supply irrigation water to their beneficial area in the tributaries of Lam Takhong, Lam Phraphloeng, Lam Sae etc., the annual runoff at Ban Tha Wha has decreased. M6A station is locating near Ban Kua Weirs and collects the tributaries runoff of Huai Aek, Lam Sathad and Lam Phang Chu. Annual runoff at the station is measured as 2,200 MCM showing the low runoff yield of 78 mm because large farm area of about 5.0 million rai lies on the above tributaries and has used much rain water.

b) Middle Mun

In Middle Mun basin, many tributaries of Huai Takhong, Lam Chi, Huai Thap Than at the right bank and Lam Phla Phla, Lam Siaw Yai at the left bank are flowing into Mun main river. The tributaries in the right bank has fairly rich runoff showing the runoff yield of more than 200 mm, originating from Dongrek mountains near the border of Cambodia, while tributaries in the left bank flows in the central plateau and plain with less rainfall of 1,300 mm. per annum and show the few runoff yield of 100 to 150 mm. Those tributaries runoff is estimated as 4,500 to 5,000 MCM in total, which flows to Rasi Salai station. The river then passes Ban Talung rubber weir site and flows to Rasi Salai barrage after collecting runoff of many tributaries as mentioned in the above. However, the large flood plain with the length of more than 100 km and width of 1 to 3 km. lies on the upstream basin of Rasi Salai barrage and a part of tributary water is lost by evaporation and seepage from the large flood plain. Accordingly, annual runoff at Rasi Salai barrage site is measured as 5,750 MCM by adding the runoff of 3,500 MCM in Middle Mun to 2,200 MCM at M6A station in the Upper Mun. After passing the Rasi Salai barrage, Middle Mun river flows to Huana barrage locating at the terminal point of Middle Mun, where Mun river merges Chi river with large runoff of 9,000 MCM. Although the annual runoff at the terminal point of Middle Mun is not measured, it is assumed as 8,500 to 9,000 MCM judging from the tributary runoff of Samran, Tah, Khayand etc., which are flowing into Middle Mun river after Rasi Salai barrage.

c) Lower Mun

M7 station is located at Ubon Ratchathani City and its runoff is measured as the large amount of 19,400 MCM consisting of Middle Mun of 8,500 MCM, Chi river of 9,000 MCM and Sebai large tributary of 2,000 MCM and others in Lower Mun. Mun river after passing M7station flows to Pak Mun hydropower barrage constructed at the river mouth. Annual runoff at Pak Mun station is measured as 22,400 MCM, of which 19,400 MCM is supplied by M7 station and 3,000 MCM by the tributary of Dom Yai, Se Bok etc. in the Lower Mun.

(4) Others

The water level of Mun river shows a large variation of 7 to 10 m. at every control points. However, the specific flood yield is not so large due to sluggish flood with slow velocity less

than 1.0 m/sec resulting from very gentle slope of 1:15,000 to 1:10,000.

Mun basin has not very large scale dams like Ubonrat and Lam Pao in Chi basin, and flood control can not be made by the reservoir. If the effective reservoir capacity is estimated for Rasi Salai barrage, regulating capacity is only 400 MCM[27] to the annual runoff of 5,750 MCM.

3.8 Water Use

3.8.1 Irrigation Water

In the Northeast Region, the irrigation water is mostly consumed by paddy fields and the water demand estimation is made only for rice cropping. Using cropping calendar (MRC, 2009) of Khong, Chi, and Mun basin, the irrigation water demand was calculated for both of dry and wet season with following equation.

$$CWR = ET0 \times Kc + LP + P$$

$$Irr.Req = \sum Ac \times CWR/Ec$$

Here,
CWR: crop water requirement, ET0: potential evapotranspiration, Kc: crop coefficient
LP: puddling depth, IrrRq: gross water requirement, Ac: cropping area,
Ec: irrigation efficiency.

In accordance with the specification of RID, the calculation was followed by CROPWAT (FAO, 2004), At first, evapotranspiration (ET0) and crop water requirement (CWR) was calculated, then the cropping area of each sub-basin multiplied by CWR to obtain Net irrigation water requirement (NIWR)[28]. Introducing 0.5 of irrigation coefficient[29], Gross irrigation water requirement (GIWR)[30] was estimated. The process of calculation is described in following sub-sections.

(1) Potential Evapotranspiration

In order to calculate ET0, the climatic data of 11 stations were collected from the climatic database called CLIMWAT (FAO CLIMWAT database) as shown in Appendix 3.3.7 Potential Evapotranspiration (ET0) in Khong, Chi, Mun Basin.

Evapotranspiration in the Northeast Region is not high and is calculated in a range of 1,440 to 1,680 mm/year. The lowest value is seen along Mekong river of Khong basin (Udon Thani, 1,440 mm/year). Toward the south, it increases, as is 1,500 mm/year of Chi basin, 1600mm/year of Mun Basin and the maximum of 1,680 mm/year at Ubon Ratchathani.

[27] As the flood plain has the area of 200 km^2 and effective water depth of 4 m based on the lowest and controlled water level, respectively 115 m and 119 m. The effective reservoir capacity is therefore estimated as 400 MCM at least (200 km^2 x 4m x 50%).

[28] Net irrigation water requirement (NIWR) is the quantity of water necessary for crop growth. It is expressed in millimeters per year or in m^3/ha per year (1 mm = 10 m^3/ha). It depends on the cropping pattern and the climate.

[29] Irrigation coefficient of 0.5 is applied based on interview in the field survey.

[30] Information on irrigation efficiency is necessary to be able to transform NIWR into gross irrigation water requirement (GIWR), which is the quantity of water to be applied in reality, taking into account water losses. Multiplying GIWR by the area that is suitable for irrigation gives the total water requirement for that area. GIWR=NIWR/(1-Irrigation cof.)

(2) Crop Water Requirement

Crop water requirement (CWR) is estimated by four (4) parameters, consisting of Potential Evapotranspiration (ET0,11 stations), Crop coefficient[31](Kc) and Effective rainfall(Eff, 80% of rainfall). At first, ET0 multiplied by Kc to calculate the Potential Water Requirement (Etc), and is deducted by Eff to obtain the CWR. CWR for each tributary is shown in Appendix 3.8.1, Parameter applied is shown in Table 3.8.1.

Table 3.8.1 Parameter Applied for Irrigation Demand

Parameter	Value Applied
Cropping pattern	Wet season: Middle of June to End of November Dry season: Middle of January to Middle of May
Crop coefficient (Kc)	Kc(wet) : Kc1.05 to 1.20, Kc(dry):0.3 to 1.05
Potential water requirement (Etc)	ETc (wet):571 to 684 mm、Etc (wet):653 to 794 mm
Effective rainfall (Eff rain)	Eff rain(wet):547 to 796 mm, Eff rain(dry):166 to 220 mm
Crop water requirement （CWR）	CWR(wet):301 to 521 mm, CWR(dry):822 to 1059 mm

(3) Irrigation water demand

The result of calculation is shown in Appendix 3.8.2 Agriculture Water Demand of Sub-basin and Table 3.8.1. The irrigation water is calculated as 2,100 MCM/year in Khong, 4,050 MCM/year in Chi basin and 5,050 MCM/year in Mun Basin. Total requirement is 11,200MCM/year for three (3) basins, and it is consumed in the existing irrigation area of 7.5mililon rai (1.20 million ha). Highest irrigated area is located at Lam Pao irrigation project area, 770 MCM/year, 770 MCM/year, 920 MCM/year is respectively used in Lower Phong, Lower Lam Pao and Chi part4 tributary basins. As for sub-basin, Middle Chi sub basin including two of high demanded tributaries is therefore recognized as the higher consumed sub-basin. The highest is Upper Mun of 2,800 MCM/year, which has the most extensive area among sub-basins.

3.8.2 Domestic Use and Others

In the Northeast Region, there are 664 of administrative areas, comprised of 321 districts (Amphoes) and 372 municipalities (Tessaban Nakorn, Tessaban Muang, Tessaban Tambon) Population in NRE is estimated as 22 million (2009), which is of 18 million in rural and 4 million in urban area. The number of households is 4,500,000 in rural area, while 1,200,000 households of urban area.

As for water supply, Provincial Waterworks Authority (PWA) is operating the large scaled water supply system in urban area, which has large capacity as is several ten thousand to over 200 thousands. While in rural water area, local public body is maintaining the small water supply system, as is for thousands beneficiaries, and rainwater collection are also carrying on as second source. To estimate water demand for domestic use, the unit supply amount/person is used and multiplying it by population is to obtain domestic water demand in the Northeast Region.

[31] Kc is simply ratio of ET observed for the crop and is series of values through its growing season .RID and FAO provide Kc values.

(1) Unit water supply amount

In order to estimate unit supply amount, the latest performance data (2010) of each province is referred as shown in Table 3.8.2.

The unit supply amount of each provincial capital is 140 to 240 lit/person, and the maximum rate is 236 lit/person at Nakhon Ratchasima and the minimum rate is 143 lit/person at Nong Bua Lam Phu. The average value of 19 provincial capitals is 187 lit/person.

Table 3.8.2 Performance of Each Provincial Water Supply in the Northeast Region (2010)

Province	Amphoe Muang (pop.)	Amphoe Muang (house hold.)	Household Make-up person	Customer (connec-tions)	Costomer (pop.no.)	Water Sale (cum/ mon)	Amount/ Tap (lit/tap/ day)	Unit Water Amount (lit/ paerson)	Reqr.Water Source (lit/ person)	Service Area (sq.km)
Nakhon Phanom	114,247	30,916	3.7	28,264	104,447	499,372	581	157	221	91
Loei	88,167	27,838	3.2	30,395	96,265	542,726	587	183	258	59
Sakon Nakhon	123,953	34,579	3.6	30,059	107,750	630,610	690	192	270	122
Nongkhai	69,913	18,455	3.8	28,370	107,474	558,521	647	170	240	79
Nong Bua Lam Phu	97,911	23,761	4.1	11,213	46,205	200,671	588	143	202	108
Udon Thani	174,531	49,376	3.5	78,716	278,240	1,783,800	745	213	300	431
Kalasin	82,323	20,924	3.9	24,000	94,425	460,285	631	162	228	91
Khon Kaen	207,256	68,039	3.0	138,734	422,603	2,821,525	669	223	314	220
Chaiyaphum	136,458	42,469	3.2	72,595	233,256	1,090,177	494	154	217	81
Maha Sarakham	97,746	26,193	3.7	28,871	107,740	670,792	764	206	291	40
Roi Et	120,169	35,491	3.4	32,097	108,677	629,946	645	190	267	89
Nakhon Ratchasima	191,621	69,532	2.8	89,656	247,080	1,805,634	662	236	333	150
Buri Ram	179,628	45,523	3.9	45,526	179,640	916,590	662	170	239	123
Muk Da Han	73,563	19,882	3.7	12,607	46,646	266,003	694	188	264	56
Yasothon	109,159	30,976	3.5	16,578	58,421	349,187	692	198	278	43
SiSaKet	95,345	22,368	4.3	20,170	85,976	451,842	736	171	241	79
Surin	215,564	56,815	3.8	37,942	143,957	965,480	837	220	310	46
Amnardjarean	93,589	23,845	3.9	10,686	41,941	204,875	630	162	228	67
Ubonratchathani	84,295	23,823	3.5	53,787	190,319	1,277,837	781	223	314	121
Total(Avg)	2,355,438	670,805	(3.6)	790,266	2,701,062	16,125,873	(670)	(187)	(264)	2,096

Note 1 : the Office of Accelerated Rural Development (ARD)
Source : Provincial Waterworks Authority
Data : Feb 2010

By the interview at PWAs (Udon Thani and Khon Kaen), the rate of ineffective water[32] + on-revenue water[33] was obtained as 40 to 45%.Considering the rate, the water demand (i.e. amount of watering from a water resource) was presumed.

If 40 % of ineffective water + non-revenue water is taken into consideration, gross water demand is calculated as over 335 lit/person in Nakhon Ratchasima. As other information source for the middle scale of supply system, unit water supply amount is published based on last five (5) year records as shown in Table 3.8.3. On the other hand, as rural demand, MRC (2009) estimates it as 160 lit/person.

[32] Ineffective water means total loss including leakage deduced consumption by settlement, water loss due to damage of system. etc.

[33] Non-revenue water(NRW) represents the difference between the volume of water delivered onto a network and billed authorized consumption. It includes the loss of metering inaccuracies, unbilled authorized consumption.

Table 3.8.3 Population and Water Demand

Population (person)	Required Water Source (lit/person/day)
< 2000	(175)
2,000 - 4,000	185
4,000 - 18,000	189
18,000 - 26,000	198
26,000 - 40,000	289
40,000 - 170,000	307
> 170,000	395

Note 1: Calculation based on average rate of water use by population in the service zone of Provincial Waterworks Authority in each tributary. Five year historical data (years 2004-2008).

Note 2: As for Rural water supply less than 2000 pop. 175 lit/person is added by Study team.

Since the value indicated in Table 3.8.3 (Population and water demand) is regarded as the same level as those in Table 3.8.2 (The performance of each provincial water supply in the Northeast Region (2010)), unit water supply amount in Table 3.8.2 is applied for the calculation of domestic water supply. As additional information for small town, 175 lit/person is used.

(2) Domestic water demand and other demands

The calculation result of domestic water demands is summarized in Table 3.6.2. Total amount is 1,580 MCM, which is of 380 MCM/year in Khong, 470 MCM/year in Chi and 730 MCM/year in Mun basin.

As for other sectors' demand such as for industry, truism, livestock, their amount is seemed to be few, and is thought to be as an insignificant influence in the basin water balance. They were not reviewed in main enumeration. In the existing reports, the trial calculation was even so made and obtained as 89MCM MCM/year and 14 MCM respectively for truism and industrial use.

3.9 Groundwater

Ministry of Natural Resources and Environment, Department of Groundwater Resources (MONRE, DGR) has managed the country's groundwater resources with 30 groundwater basins classified by underground structure and aquifer's continuity. In the Northeast Region, there are three (3) groundwater basins, consisting of

- Chi-Mun river (Chi-Mun River Deposit Basin),
- Udon-Sakon (Udon-Sakon Deposit Basin) and
- Loei river (Loei River Deposit Basin).

Chi-Mun River Deposit Basin is a large basin which occupies two third of the Northeast Region with 121,000 km^2 of area, where includes the whole surface watershed of Chi and Mun river. In the basin, Cretaceous formation (Maha Sarakham Formation) underlies, and intercalated permeable and arenicolous layers behave as a main aquifer system(refer to Appendix 3.9.2 Hydrogeologic Map of Khong, Chi and Mun Basin. separate attachment 3.9.1 and Appendix 3.9.2). Moreover, along the Chi and Mun river, Quaternary alluvium to Pleistocene terrace deposit overlies Cretaceous aquifer, so a multiple aquifer is formed. While at the fringe of the basin, Jurassic formation, of which is older and including semi-permeable layer, is cropping out

in three sides: southern part (Cambodian boundary)-northern part (Puphan mountain)-western part (Central Thailand), and they have become a groundwater divides.

Therefore, the outflow of the groundwater is restricted to only the eastern side (Mekong river side), and groundwater flow then converges along with the river flow of Chi and Mun river.

On the other hand, Udon-Sakon basin and Loei basin are located in Khong basin with the area of 38,000 km^2 and 8,000 km^2 respectively. Udon-Sakon basin lies on the center to eastern part, and Loei basin occupies its western end of Khong basin. Two groundwater basins are classified by their geologic features: Udon-Sakon basin is formed by Cretaceous to Jurassic formation, while Loei basin is mainly made up of Paleozoic formation. The groundwater recharge is executively taken place in the Puphan Mountain and groundwater flows to Mekong river. In the lowland, it has the strong interferences by the seasonal changes of Mekong river.

3.9.1 Groundwater Characteristics

(1) Shallow Aquifer

DGR is studying the characteristic of a shallow aquifer, and its general feature is summarized in

Appendix 3.9.3 Well and Hydrogeologic Information of Khong, Chi and Mun Basin, and
Appendix 3.9.4 Groundwater Infiltration and Withdraw of Khong, Chi and Mun Basin.

Groundwater level: Groundwater level is generally shallow. Although few wells have the deeper groundwater level than 20 m, the most of them show five (5) to 10 m deep. Especially along river channel of Meddle Mun, water level is very shallow less than 3 m deep. Besides, seasonal change is large in response to rainfall.

Aquifer productivity (well yield): Although there is a very productive well exceeding 100m^3/hr, average yield is shown as 1 to 2m^3/hr. The well yield is not so large, and aquifer capacity is classified as medium (to low) grade.

Water quality: Groundwater has high TDS[34] (dissolved solid) of 400 to 1,000 mg/lit (it converts to electrical conductivity[35] at 700 μS/cm to 2,000microS/cm). Water quality is therefore not so good, and high content of iron (Fe) and manganese (Mn) is also found.

Groundwater level is almost same level as riverbed and has close relationship with river water. In dry season, groundwater is flowing out river as base flow. While in wet season, river water seeps into shallow aquifer. By exchange between river and aquifer, the water quality also changes seasonally, which is observed low salinity in the rainy season while high salinity in the dry season. It accelerates a saline contamination to surface water and soil in dry season. Especially in Mun, there is unfavorable condition for soil chlorination by leaching.

[34] Total Dissolved Solids (often abbreviated TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form.
[35] Electrical conductivity is a measure of a water's ability to conduct an electric current, and reflects the capacity of water to conduct electrical current. It is directly related to the concentration of salts dissolved in water, Unit is used as S/cm (micro Siemens/cm) at 25°C.

(2) Deep Aquifer

The aquifer property is related to Maha Sarakham formation. Eight (8) layers of rock salt are contained in the formation. The rock salt has over 600m thickness[36], and distributes 50,000 km^2 wide occupying almost 30 % of the Northeast Region. Two (2) groundwater basins of Chi-Mun and Nakhon-Sakon basin is also underlain by thick salt layers (refer to Appendix 3.9.1) .The deep aquifer, where rock salt rises up near the surface, frequently contains high saline water. In DGR survey, highest concentration same as sea water's (Cl=32,000 mg/lit) was reported. Although the depth of salt water is various, it abruptly rises up through a shallow aquifer in dry season when groundwater level is lowered.

From the viewpoint of the geologic history, lowlands locating (Upper Mun-Middle Mun) along the rivers or the natural depressions (Siaw Yai, Kumpawapi, etc.) is supposed to be a remnant of old collapsing, which resulted in salt solution in the past (DMR, 1999).

Deep groundwater is used for the salt mining in particular Middle Mun, It is now controlled by government for preventing contamination to the outside. In the area not underlain by rock salts, development potential of deep groundwater is investigated by DGR.

3.9.2 Groundwater Potential

The groundwater resource survey is being carried out by DGR. Throughout the two or more years' field measurement, the rate of groundwater recharge is obtained as about 160mm/year[37] per annum. Extrapolating the rate to whole basins, 26,600 MCM/year of groundwater potential is estimated as shown in Table 9.3.1. As for sub-basin's potential, Ubon Ratchathani tributary has the maximum potential (refer to Appendix 3.9.4). It attains even 12% of total rainwater of the Northeast Region, and reaches almost the half of surface water's rate. However, the high rate is through to be unrealistic if it compares with the basin water balance. It may regard as 'primary infiltration' which the most of it is lost by flowing-out to river as base flow, evaporation and even transpiration though plants. On the other hand, the age of groundwater in shallow aquifer was dated as 30 to 40 years[38]. It implies infiltrated water persists long time as is tens of years in

[36] The salt layer is found in Khorat Plateau and Sakon Nakhon basin and is derived from inland salt-lake in Mesozoic age. The salt domes was deeply buried, it mobilized and flow upwards to form salt domes. The salt might also be deformed into discordant bodies and filling in surrounding gaps and dragged adjacent strata. The sequence is not always consistent throughout the basin because of erosion, salt flowage, tectonic and natural dissolution. The geologic deformation of the Khorat Plateau caused some fissures or fractures to stimulate and give way to fresh water going down to rock salts beneath and dissolving those rock salts as well. With the time this create first a topographic high, then, as the salt breached, it transformed into a dissolution collapse graben often marked by a lake or depressions e.g. marshes, swamps and paddy fields, which are mostly located in low-lying areas, and along the river courses or lineaments, in the present-day landscape. On contrast, the highland topography indicates salt sub-basins (three or two salt beds) beneath where less dissolution by groundwater and mostly discharge took place.

[37] In the infiltration experiment conducted in sandy soil at Nakhon Ratchasima,167-303 (1985), 69-106(1986) and 179-360(1987) mm/year was observed to annual rainfall 1,254mm (1985), 762mm (1986), and 1254mm (1987), (D.R.Williamson, 1989).

[38] By the age determination of the groundwater using the tritium isotope performed in Khon Kaen, 30 years was obtained by recharge in the experiment using a well (5m, 10m, and 15m),(JIRCAS working paper vol.30 besides IMAIZUMI).

the unsaturated zone. Considering water balance of whole the Northeast Region basins into account, the potential (renewable) amount is the same level of groundwater runoff to the outside, so the amount produced by 'primary infiltration' should be deducted as the water loss including base flow to river, evapotranspiration during root zones and others.

Table 3.9.1 Groundwater Recharge and Uses

Groundwater Basin	Area	Storage	GW. Recharge	Groundwater Use (Governmental Wells)							
				New well		Hand pump		Electric Pump		No. of Well	Amount Use
	km^2	MCM	MCM	No.	CM	No.	CM	No.	MCM	No.	MCM
Chi-Mun River	120,972	299,167	19,781	2,681	29.87	30,847	67.56	16,979	174.48	50,507	272
Udon-Sakol	37,654	61,000	5,641	701	7.23	10,208	22.36	3,793	39.44	14,702	69
Loei River	8,428	14,166	1,172	87	0.76	1,465	3.21	675	6.58	2,227	11
Total	167,054	374,332	26,594	3,469	38	42,520	93	21,447	221	67,436	351

Groundwater Basin	Groundwater Use (Private Wells)								Groundwater Use (Total)		Balance
	Domestic		Agriculture		Industrial		No. of Well	Amount Use	No. of Well	Amount Use	Balance
	No	MCM	No	MCM	No	MCM	No	MCM	No	MCM	MCM
Chi-Mun River	1,288	12.63	1,148	15.37	1,811	35.22	4,247	63.21	54,754	335	19,446
Udon-Sakol	435	4.54	54	0.67	470	2.85	959	8.06	15,661	77	5,564
Loei River	261	0.58	66	0.31	41	0.45	368	1.33	2,595	12	1,160
Total	1,984	18	1,268	16	2,322	39	5,574	73	73,010	424	26,170

Data source: Department of Groundwater Resource, MoNRE

3.9.3 Water Use

As for groundwater use, the trial calculation was made by DGR based on 73,000 wells. Total withdrawal was 424 MCM/year at 2009 in the Northeast Region, consisting of 335 MCM/year of Chi-Mun, 77 MCM/year of Ubon-Sakhon and 12 MCM/year of Loei river deposit basin as shown in Table 3.9.1. Among tributaries used groundwater resource, a part of Middle Chi and Mun is indicated as high withdrawal area (refer to Appendix 3.9.4).

3.10 Institutional Organization for Water Resource Management

3.10.1 Government agencies

Under the Thai Government, there are various Departments and agencies who engage in the water resource management including as many as 5 Ministries, 10 Departments, 5 State Enterprises and many numbers of local administration bodies as provinces and Tambons as shown in the Table 3.10.1.

Among those agencies so many in the numbers, DWR and RID are the two (2) key agencies in charge of water resource development/management under the national level neutral committee of the National Water Resource Committee (NWRC). Details on the said 3 agencies/institutions shall be further discussed in the followings.

Table 3.10.1 Central Governmental Agencies and State Enterprises regarding Water Resource Management

Ministry	Department	Main Tasks
1. Ministry of Agriculture and Cooperatives (MOAC)	1.1 RID	- Water resource development and irrigation development in watershed - Efficient, equal and sustainable operation and management of water - Measurement and evaluation of the water resources data - Control and alleviation of flood damage
	1.2 Royal Artificial Rain Unit	- Research and practice of artificial rain
	1.3 Land Development Department (LDD)	- Support of water use in farmland, crop production and fertilizer application
2. Ministry of Natural Resources and Environment (MoNRE)	2.1 DWR	- Formulation of master plan regarding water resource development and management, policy making of water management, and political response to water crisis
		- Establish of standards related to water (water supply, industry and environment)
		- Monitoring and evaluation of water resource development and management
		- Measurement and evaluation of the basin water resources data
	2.2 DGR	- Policy making and research regarding groundwater resource
	2.3 PCD	- Water quality monitoring, establish of standard concerning environment and pollution
	2.4 ONEPP	- Policy making related to natural resource and environmental management
		- Coordination of natural resource conservation
		- Environmental impact assessment of private and governmental projects
	2.5 Department of National Parks (DNP)	- Conservation of wetlands and water resource recharge forest - Conservation of bio-diversity
	2.6 RFD	- Forest policy making and promotion of forestation
3. Ministry of Interior	3.1 Disaster Prevention and Mitigation (DDPM)	- Plan, monitoring and prevention measures
		- Support for victims
4. Ministry of Information and Communications Technology (MICT)	4.1 Meteorological Department of Thailand (TDM)	- Weather forecast, prevention of natural disasters and release of alert
		- Observation and Consolidation of metrological information
5. Ministry of Industry (MOI)	5.1 Department of Industrial Works (DIW)	- Securement of industrial water and water quality monitoring
6. State Enterprise	6.1 EGAT	- Water power plant development and management of reservoirs
	6.2 Metropolitan Waterworks Authority (MWA)	- Water supply projects in metropolitan
	6.3 Metropolitan Waterworks Authority (PWA)	- Water supply projects in provincial areas
	6.4 Industrial Estate Authority of Thailand (IEAT)	- Establish of infrastructure for operation of power, water supply, prevention from inundation, drainage treatment, waste treatment

(Detail information is in Annex I.3.10.1)

3.10.2 Department of Water Resources (DWR)

Under the governmental reform as effected in the year 2002, the DWR was newly established

under the Ministry of Natural Resources and Environment. The Department's mandates were in policy formulation on the overall water administration in the country and in the promotion of policies and plans for integrated water resources management at basin levels. Big majority of the administrative and technical staff of the DWR was formed by those transferred from ARD and PWD of the Ministry of Interior, DEDP of the then Ministry of Science and Technology, RID of the Ministry of Agriculture and Cooperatives and the Office of the National Water Resources Committee under the Prime Minister's Office.

(1) Vision/Missions

The vision and missions conceived by the DWR are as follows.

Vision: "Materialize the integrated water resources management in efficient and Sustainable manner under good governance"

Mission: "To formulate policies, plans and counter-measures for water resources. It encompasses conservation, development and management of water resources, improvement/ monitoring, guidance, coordination as well as assessment of water resources and solution of water related problems, research, standard setting and transferring of water management technologies to the national as well as basin levels

(2) Organization

Organization chart of the DWR is shown below. The duties/scope of work assigned to DWR cover the secretariat office functions to serve for the National Water Resources Committee (NWRC) and the Thai National Committee for the MRC.

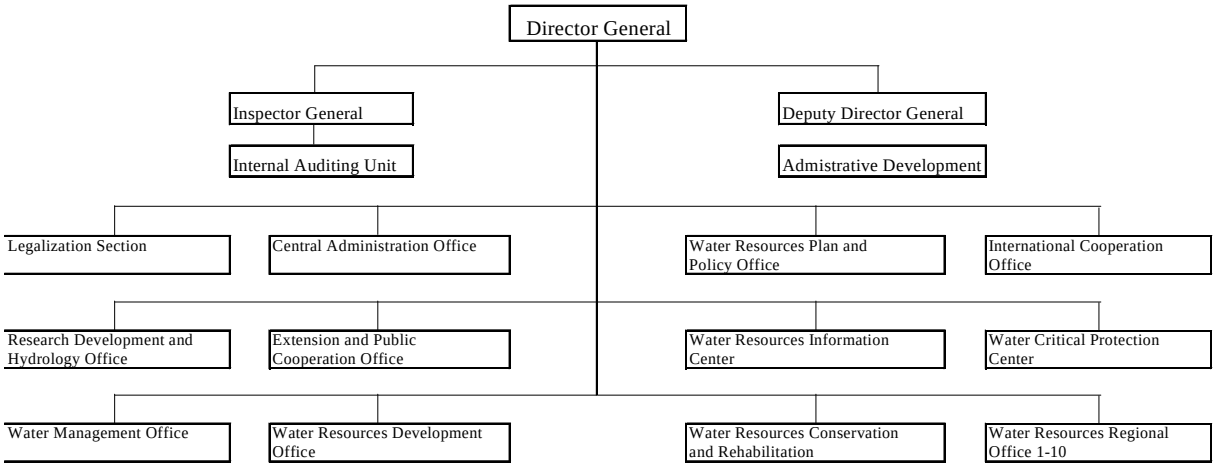


Figure 3.10.1 Organization Chart of DWR

There are as many as 10 Regional Offices nation-wide under the DWR. In the NE region, three offices of Region 3, 4 and 5 are operated in Khong basin, Chi basin and Mun basin, respectively. Water management at the basin level is undertaken with each basin bounded by basin boundary, while for village water supply, administrative divisions is applied and by province-wise control. Regional offices of DWR serve to the RBCs with the function as the secretariat office. In case of Chi basin, the activities of working group are divided into three (3) sub-basins of Upper-stream, Middle-stream and Lower-stream separately and it was found that different approaches are

applied by different staff in charge of each sub-basin.

Table 3.10.2 Regional Offices of DWR in Northeast

Regional Office	Regional Natural Resources Office 3	Regional Natural Resources Office 4	Regional Natural Resources Office 5
Location	Udon Thani	Khon Kaen	Nakhon Ratchasima
Basin	Khon Basin	Chi Basin	Mun Basin
Province	Loei Nong Khai Udon Thani Nong Bua Lam Phu Sakon Nakhon Nakhon Phanom Mukdahan Amnat Charoen (8 Provinces)	Khon Kaen Kalasin Maha Sarakham Roi-et Yasothon Chaiyaphum (6 Provinces)	Nakhon Ratchasima Buri Ram Surin Ubon Ratchathani Sisaket (5 Provinces)

(3) Budget

The annual budget for DWR was 3,605 Million Baht in 2009 of which 2,565 Million Baht, 71 % of the total was allocated for investment nature of project development/implementation. (see Appendix 3.10.2) The budget scale is judged of limited amount when compared with the RID budget, showing only 9.7 % of RID (37,132 Million) as the total and 8.6 % of the investment nature (RID's investment at 29,990 Million).

3.10.3 Royal Irrigation Department (RID)

The predecessor of RID is the Canal Department founded in the year 1902. The Canal Department was reorganized to be RID in 1927. The RID is such an old and historically important Department. As the infrastructure development project implementing body under the MOAC, the share of RID budget within MOAC stands for as big as 60 % every year. The RID ever engaged in construction of facilities for as large as 27 Million rai irrigation area and be responsible for construction of new development project and O & M activities of the said existing facilities.

(1) Vision/Missions/Strategic Issues

In the recent past, RID formulated, based on the participatory approach concept, a new vision, missions and strategic issues as follows. For this, those high-ranking and working level officials gathered together and participated in the formation of the strategies which have been actually introduced and adopted for the planning and implementation of irrigation development in the years after 2007. The strategy includes as many as 40 strategic issues and 20 goals as the main contents as outlined below.

Vision: "By irrigation water supply by RID, higher agricultural productivity shall be attained so as to contribute to raising-up of farmers' living standard and sustainability of the national economy"

Missions: There are 5 items of mission assigned as follows.

- Water resources shall be developed in the way to meet the potential of each basin so as to maintain good balance and sustainability
- Good quality water management shall be availed to serve various users in efficient, equitable and sustainable manner
- To allow participation of all the parties concerned such as local people, community and agencies in integrated water development and management
- To protect and mitigate the water related problems
- To conserve good agricultural lands within the irrigation service area

Strategic Issues: To accomplish the missions, 4 items of strategic issues were confirmed.

- To develop water resources to meet sufficiently with demands by all sectors
- Efficient water management
- Protection and mitigation of water related problems
- Agricultural land conservation within the irrigation service area

(2) Organization

Organization chart of RID is shown below.

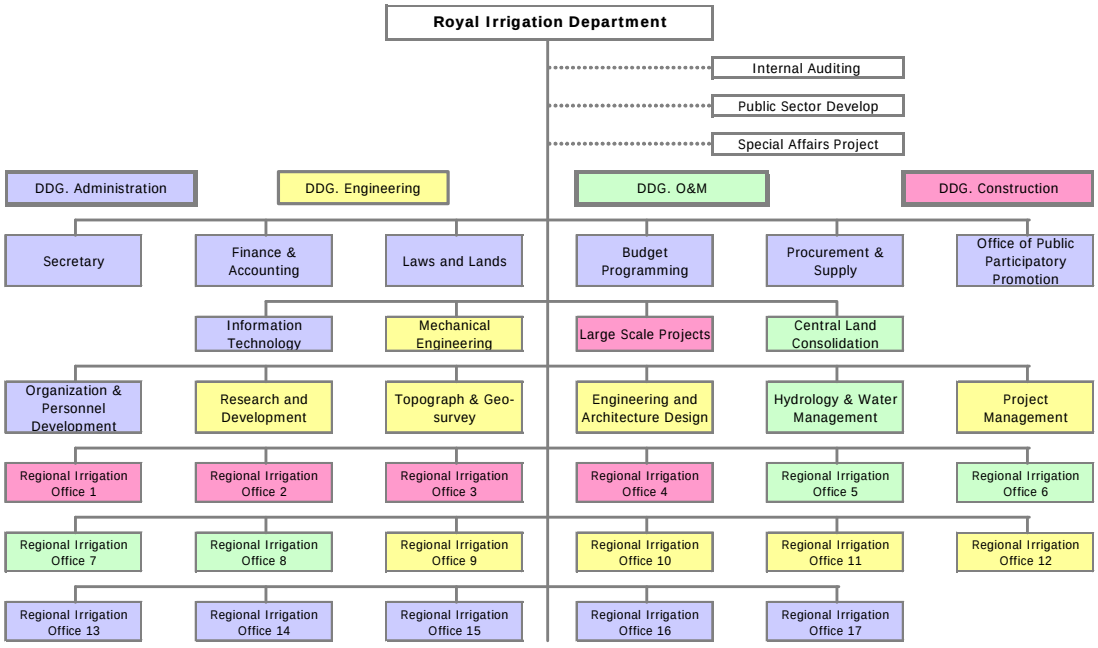


Figure 3.10.2 Organization Chart of RID

There are as many as 17 Regional Irrigation Offices nation-wide. Under those provincial irrigation offices, one each for all the provinces and the existing projects O & M offices are established for the different tasks assigned.

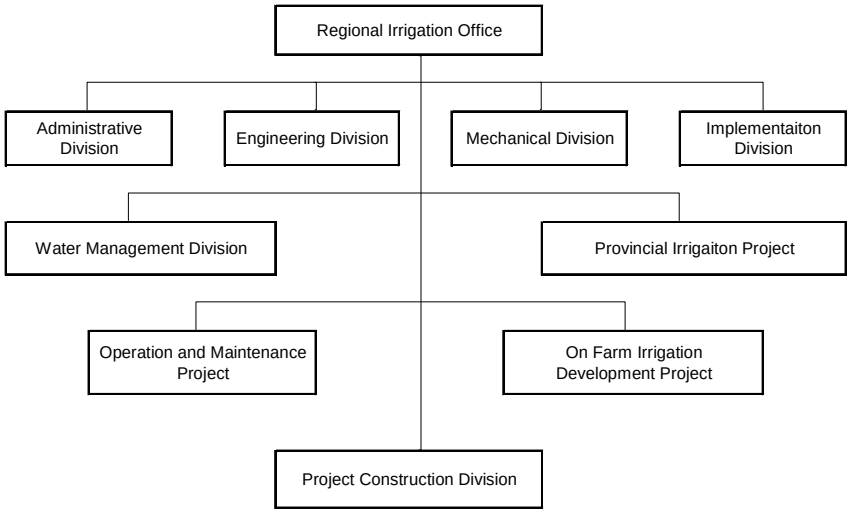


Figure 3.10.3 Organization Chart of RIO

There are four (4) Regional Offices of No. 5, 6, 7 and 8 in the Northeast region, in charge of 19 provinces as allocated for each Regional Office as shown below.

Table3.10.3 Regional Irrigation Office (RIO) in Northeast

RIO	Regional Irrigation Office 5	Regional Irrigation Office 6	Regional Irrigation Office 7	Regional Irrigation Office 8
Location	Udon Thani	Khon Kaen	Ubon Ratchathani	Nakhon Ratchasima
Province	Loei Nong Khai Udon Thani Sakon Nakhon Nong Bua Lam Phu (5 Provinces)	Chaiyaphum Khon Kaen Kalasin Maha Sarakham Roi-et (5 Provinces)	Nakhon Phanom Mukdahan Yasothon Amnat Charoen Ubon Ratchathani (5 Provinces)	Nakhon Ratchasima Buri Ram Surin Sisaket (4 Provinces)

(3) Budget

As of the year 2009, the annual budget of RID was 37,132 Million Baht, of which the investment for project development shared 81 % in the amount of 29,990 Million Baht. After 1997, there observed a tendency that the investment for the new irrigation development has been declined while those for flood control and rehabilitation purposes has been in increasing tendency. Out of the investment nature budget spending by RID in the last three (3) years, the Northeast region shared about 17-20 % (Details on budget are as shown in the Appendix 3.10.3-5).

3.10.4 Roles of National Water Resources Committee and River Basin Committees

(1) NWRC

NWRC is a national level committee established based on the Regulation of Prime Minister's Office (1999). The committee chairman is nominated by the Prime Minister among the Deputy Prime Ministers and a substantial part of the committee members is composed of the Minister of

relevant Ministries, Departments' Director Generals and the chiefs of state enterprises. Originally, the total number of committee member was 26 including representatives from water users, academics and NGOs, but due to the reforming in March 2009, the number was increased to 41 in total including in addition those representatives from provincial government, TAO, communities as well as 9 members from the 25 RBCs nation-wide. The authorities and roles of NWRC are as summarized as follows.

- To submit to the Cabinet for approval policies for development of small, medium and large scale water resources so as to meet the water demands
- To indicate guidelines on water resources development and project plan formulation to the government agencies and state enterprises concerned
- Scrutinizing and approval on project plans, instruction, supervising and monitoring on project implementation and reporting on water quantity and quality
- To solve urgent issues and problems
- Priority setting on water allocation and coordination on water demands by various users as water supply, hydropower generation, industrial and irrigation etc. and reporting to the Cabinet
- To propose to the Cabinet adopting/amending of regulations/laws concerning water resources development, monitoring of water quality and conservation

At the initial stage, the Office of NWRC was established and operated under the Prime Minister's Office, but due to the governmental reform effected in 2002, the Office was transferred to the DWR under MoNRE. The organization of NWRC is as shown in the Appendix 3.10.7.

(2) RBC

During the period of 7th NESDB Plan (1992-1996), a study on 25 basins in the whole country was carried out, and in parallel with the establishment of the NWRC, RBCs were organized gradually one by one. The first RBC was established in 1994 in 3 basins of Pasak, Upper Ping and Lower Ping as pilot RBC for which assistances by WB and ADB were secured. After the establishment of the DWR too, FAO and ADB supported the RBC development and continued the establishment for the remaining basins as well as capacity building activities. At present, there are 25 RBCs in the 25 major basins nation-wide.

RBC is based on the Regulation of Prime Minister's Office on National Water Resources Management 2002, but due to the amendment made in 2007, the composition (Number of committee member and manner of member selection) of the organization has been modified. At present, in most cases, the committee chairmen are assumed by provincial governors and the members are selected from those representatives of regional offices of line agencies, local administration bodies, private companies, NGOs and people of each basin locality. Under the committee, there is an Administrative and Academic Sub Committee and for each sub-water-shed, sub-watershed working group is supposed to be organized. (See Appendix 3.10.8)

Roles and authorities of RBC are as explained below.

1) Formulation of guidelines on water management
2) Endorsement on basin's water management plan
3) Water allocation
4) Monitoring on performances by government agencies concerned
5) Opinion advancement to NWRC on project plans, policies and problems
6) Formulation of water resource management plan within the basin
7) Publications and public relation activities
8) Formulation of action plan in joint with concerned agencies

(3) State of RBC establishment/activities in Northeast region

RBCs status existing in the 3 major basins in Northeast region is as outlined below; (Details in Appendix 3.10.9)

Chi River Basin: Members are 7 provincial governors, government agencies concerned (RID, LDD, DOF, Department of Agricultural Extension (DOAE), OPS-MoNRE, RFD, DWR, DNP, DDPM and EGAT), 3 TAO representatives, 4 irrigation water user group representatives, 2 industrial water user representatives, 2 from commercial/tourism representatives and 1 water expert. In total there are 35 committee members and the DWR Region 4 Office serves as the secretariat function.

Mun River Basin: Members are 6 provincial governors, government agencies concerned (RID, LDD, DOF, DOAE, OPS-MoNRE, RFD, DWR, DNP, DDPM and EGAT), 3 TAO, 4 irrigation, 2 industrial, 2 commercial/tourism and 1 water expert. There are 29 committee members in total and the DWR Region 5 Office assumes the secretariat function.

Khong Basin: Members are 6 provincial governors, government agencies concerned (RID, LDD, DOF, DOAE, OPS-MoNRE, RFD, DWR, DNP, DDPM and EGAT), 3 TAO, 4 irrigation, 2 industrial, 2 commercial/tourism and 1 water expert. There are 28 committee members in total and the DWR Region 3 Office serves as the secretariat function.

Each year, budgets for RBC are allocated by DWR in the amount of 500,000-800,000 Baht (Appendix 3.10.10). However the amount is just sufficient for holding regulatory meetings and some for training and preparation of meeting materials etc. only and almost none of the budget available for activities required for adequate water management. As for concrete activities in action, Case of Chi River Basin Committee is presented in Appendix 3.10.11.

3.10.5 Organizations for Irrigation Development/ Water Management and Their Roles

(1) Roles of central government and regional offices concerning irrigation development process and O & M

The process of project undertaking from planning to implementation differs depending on the scale of the project.

1) Large scale project

In 1996, RID conducted the master plan study on 25 river basins where potential areas for large

and medium scale projects were identified and a plan was formulated to implement them in 10 years period. Provided however in the Northeast region most of the large scale projects were implemented through having foreign assistances in conducting the master plan studies and feasibility level studies. In this case, in principle, the project planning was the responsibility of the Planning
Division of the central office and thereafter project construction office be established when project implementation be finally decided. After the project construction completed, a project O & M Office be established individually for operation and maintenance activities by the O & M office.

2) Medium scale project

For medium scale project, each of the Regional Office coordinates the local issues and applies for project implementation to the central office. The Planning Division of Headquarters prepared (2009) potential medium scale project list by using GIS and based on this list and the confirmation by the beneficiary farmers in the project area, priorities be given and sent to the Headquarters for decision-making. The construction period for the medium scale project is longer than a year and supervision shall be made by the construction division of the Regional office. Post-project O & M is to be done by the provincial irrigation office but due to the limited budget availed, no permanent O & M worker be assigned and provincial staff does the job for 3-4 projects at the same time.

3) Small scale project

Formerly, small scale project was handled mainly by RID, but as per the Decentralization Act 1999, all the facilities constructed were transferred to the local administrative bodies (TAO). With the limited budget available for TAO, new construction of small scale project is seemed hardly possible. As is the case, TAO sends requests through the provincial irrigation office to the Construction Division of RID Regional Office and some proceed to construction depending on the budget availability. Small scale project is to be completed within 1 year for the construction and after the construction the facilities be transferred to TAO for the O & M activities by TAO.

(2) Organizations for irrigation project O & M and water management

There are two (2) major offices under RID in charge of the project O & M. They are project O & M office and the provincial irrigation office. The former is specifically organized for large scale project O & M and the scope of work include reservoir management, operation, water distribution to each main and lateral canal as well as O & M of the project facilities. The organization chart is as shown in the following figure. The overall system is divided into several blocks and be taken care by Water Master of each block. Further, a block is divided into several zones and each zone is responsible by the zone-man assigned. Zone-man is responsible for opening/closing of gates, informing of the irrigation schedule and collection of data on planted area and yield data. In the former time RID used to be responsible for gate operation even at the terminal level, but today the RID staff is not sufficient to do it due to the down-sizing of the organization as caused by administrative reform. Therefore, RID can not help but commission the O & M jobs to the water users group at lateral level, especially for the new O & M project.

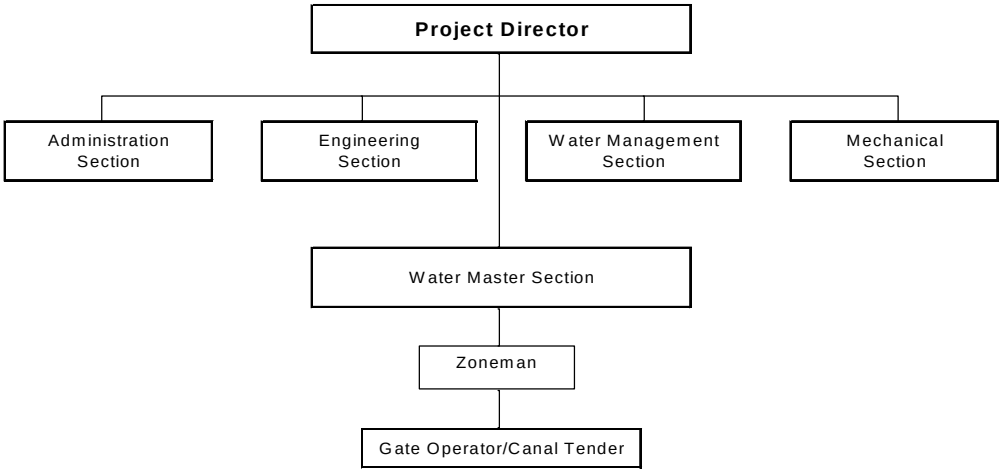


Figure 3.10.4 Organization Chart of Irrigation O&M Project

Provincial Irrigation Office (PIO) is responsible for water management and O & M of the medium scale project. In addition the PIO has to cover planning for small scale irrigation projects and pump irrigation projects and also various coordination works with the other governmental agencies on water related issues and problems at the provincial level.

O & M for the small scale projects are the responsibility of the TAO as previously discussed. However, the PIO has to be responsible for management of water resource like community pond and also the management of natural resources in the community. The provincial office of MoNRE is also related with the management of natural resources and water issues too. This implies that the clearly demarcated mandates on small scale water resource development, conservation and management by different Ministries at the central level are in fact carried out in duplicate at the field level.

Table 3.10.4 Regional Irrigation Offices (RIO) in Northeast

Office	Department	Responsibility	Situation
Provincial Irrigation Office	RID	- Development and management of medium scale irrigation projects	Support small scale
MoNRE Provincial Office/ Water Recourse Unit	MoNRE DWR	- Policy and Plan for integrated water resources management	Construct Water Infra.
Tambon Administrative Organization (TAO)	-	- O&M of small irrigation transferred by RID - Natural/ water resource management in area	SSIP/ Pump Irr. request to RID

3.10.6 Water User Group and Participatory Irrigation Management (PIM)

In line with the international trend to promote the PIM, Thailand is also trying to apply the concept nation-widely. In Thailand, organizing of Water User Group (WUG) itself had been widely progressed during the 1980's. In the organizing process, those WUGs who formed based on lateral's turn-out unit were focused on especially during the on-farm facilities construction. However, it was said that the WUGs functioned merely to do canal cleaning and no much functioning in water management aspect (JBIC's SAPS study on "Irrigation Sector-International Comparison" Dec. 2002). In view of the legal status of organized group/association, those can be

classified into the followings.(see Appendix 3.10.12)

WUG: No status of juristic person
WUA: With juristic person status based on Civil and Commercial Code
WUC: With juristic person status based on Cooperative Act

After the economic crisis in 1997, reforming of irrigation sector was tried to be implemented through the Agricultural Sector Program Loan (ASPL) with having the support by ADB and JBIC. One of the concepts to be applied at the time included the ideas of introducing PIM, strengthening of WUG, service contract and cost sharing. However, the implementation of ASPL was cancelled by the newly started Taksin government and only a part of PIM pilot project was continued. Since then the PIM has been continued by RID to date as one of the RID's important strategies for water management issue.

RID interprets the PIM as the farmers' participation in construction and O & M of the irrigation facilities. The Office of Public Participation Promotion, RID fixed the ideas of 11 activities concerning the O & M in the PIM guideline prepared by RID including the following key issues.

- Establishment of WUG
- Formation of Integrated Water User Group
- Establishment of Joint Management Committee

IWUG is a federation of WUG at the lateral level and responsible for water distribution and O & M within lateral coverage. JMC is considered something like WUG at the project level and this organization is to participate in joint water management with RID consisting of the members from IWUG, TAO and other water user representatives. Under JMC, there should have a meeting on water allocation for each season. At present there are as many as 22 irrigation projects with which JMC have been organized. In the Northeast region, JMCs are existed only for 2 medium scale projects of Huai Sappadoo Irrigation Project and Huai Prasatyai Irrigation Project in Nakhon Ratchasima province. (see Appendix. 3.10.15)

After 1998, it is regulated that when the construction was completed an Agreement to organize WUGs in the project area was to be signed by the parties concerned, and as of the present, 10 % of RID projects(Large and Medium scales) are with WUGs formed already.

Through the modernization of Water Management Project as assisted by JICA, RID ever continued the efforts to organize IWUG at the lateral level and by now as many as 1,360 IWUGs are formed.(Appendix 3.10.14) However, under the said project, a top-down manner was applied in the IWUG formation, and does not function well. Currently, therefore, the IWUG formation is left for the Farmers' own will and intention.

3.11 Legal Aspect of Water resources Management

(1) Water Resources Bill

It was in 2002 that the DWR was established aiming at further promotion of water resources management as one of the core mandates of the Department. However, the special laws/regulations to allow water management to be done with due legal support are yet to be

stipulated. In 1997, the NWRC proposed a Draft Water Law to the parliament but no much progress was seen in the processing. Thereafter, the MoNRE drafted another Draft, passed through 13 times of public hearings with participation of 72 provinces and 3,000 participants and submitted the final Draft to the Cabinet to secure the approval on May 2007. Presently, however, the Draft is still in the position waiting for due debating at the parliament.

At the present condition, the established NWRC and RBCs as well as the roles assigned to DWR are based on the Regulation of the Prime Minister's Office in 1999, and it can be said that the authorities to control the water resources are not clearly demarcated legally.

(2) Existing Laws/Regulations on Irrigation

Existing laws/regulations in Thailand as follows were reviewed on its main points.(For detail, please see the Appendix 3.11.1)

Table 3.11.1 Overview of Laws/Regulations regarding Irrigation

Name of Laws/ Regulations	Final Revised year	Description	Responsible Agency
Canal Maintenance Act, 1902	1902	Conservation of transportation by ships, regulation for securement of non-commercial domestic water, control of construction of water way facilities, management of waste water	MOAC
People's Irrigation Act, 1939	1939	Control of 3 types (Private, People's and Commercial) irrigation facility construction, necessity of project approval, order of suspension of operation in case of spoil of common benefits	MOAC
State Irrigation Act, 1942	2005	Control of construction and O&M by official budget, scope of authority of governmental agencies, regulation for collection of User Fee, (actually, free of charge for agricultural water use and charged for industry and water supply), protection of facilities, and penalty clause	MOAC
Field Dyke and Ditches Act, 1962	1962	Due to increase upland crops, Paddy Bunding and Dyke Act (1941) was amended. As a result, dike construction which can retain 20cm depth inundation became compulsory for landowners.	MOAC
Agricultural Land Consolidation Act, 1974	1991	Land development for production increase and efficient water use, determination of reduction of part of parcel for public facilities and principle of partial cost burden by beneficiaries, specification of power and functions of Central Lands Consolidation Office (CLCO), bringing up for discussion to the Cabinet, determination of land to be consolidated and its proclamation, Additional amendment of LC fund regulation enacted in 1991	MOAC

(3) Laws/Regulations on Water User Group establishment

Relevant laws/regulations are as shown below.

Table 3.11.2 Overview of Laws/Regulations regarding WUG Establish and Decentralization

Name of Laws/Regulations	Final Revised year	Description	Responsible Agency
Cooperative Act, 1999	1999	Clarification of limited liability by shares for development of cooperatives, promotion of growth for improvement of competitive ability, application of concept of single system	MOAC

Name of Laws/Regulations	Final Revised year	Description	Responsible Agency
Civil and Commercial Code	1925	Regulation of association establish: at least 3 members apply for establish and they can obtain juridical personality after the registration (Section s78-109)	
Royal Decree on the Farmer Group 2004	2004	Issuance of Decree following Cooperative ACT, requirements of cooperative establish are at least 30 members and 7 originators (see Section 10). The number of working committee is stipulated 5 to 15.	MOAC
Decentralization Act, 1999	1999	The act stipulates delegation authority from central to PAO and TAO based on Clause 284 of the Constitute in 1997. RID delegated authority of its 10 duties such as small scale irrigation and O&M of canal to local authorities.	All RTG

(Details in Appendix 3.11.2)

(4) Reforming of irrigation sector and amendment of State Irrigation Act

In consideration of the direction of decentralization policy as stipulated in the 1997 Constitution, there is a need for amendment of the State Irrigation Act. The amendment is purposed on the following 4 points. The authorized body/organization has a status of juristic person and through the development by joint management, the body/organization can be graded up to the higher status.

1) Provide WUG with formal authority and responsibility from legal viewpoint
2) Based on the law, WUG can manage the irrigation system and engage in O & M of the facilities
3) WUG is given with authority and flexibility and WUG can manage internal organization matter easier
4) By the above, farmers' participation can be practically realized

The draft amendment has been prepared with having due assistances by FAO and through the workshops arranged and held 2 times in 2007 by RID working group and the seminar to have constructive discussions among the participants including those from outside, and the draft amendment bill (extracted in Appendix 3.11.3) has been prepared already.

3.12 Mekong River Commission and relationship with Neighboring Countries

3.12.1 Hydrological Condition of Northeast Thailand in Lower Mekong Basin

(1) Hydrological Condition of Mekong Basin

Mekong River is originated at Rupsa pass (EL4,975m)[39] in Tibetan Plateau. The River has the length of 4,425 km[40], and drains an area of about 800,000 km^2, and discharging 475 km^3 of water annually. It rises on the Tibetan Plateau as the Lansang and flows south through six (6) countries

[39] In 2007, Dr. Liu Shaochuang expedited the Mekong originates at the foot of Jifu Mountain, at the head of the Gaodepu, longitude 94 40 52 N, latitude 33 45 48 N and altitude 5,200 meters

[40] River length was decided as 4,425 km by Royal Geographical Society (1995), while is reported as 4,909 km by MRC's report (State of Basin Report 2010).

of China's Yunnan province, Myanmar, Laos, Thailand, Cambodia and Vietnam. The river basin are respectively sheared by 170,000 km^2 of China, 200,000 km^2 of Lao, 160,000 km^2 of Cambodia, 180,000 km^2 of Thailand and 70,000 km^2 of Vietnam.

Yunnan Province is known as 'Three Parallel Rivers of Yunnan Protected Areas' in the Hengduan Mountains. In the areas, Mekong river course runs parallel to the Salween River on the west and the Yangtze River in the east.

After leaving China, it flows southeast and forms the border of Myanmar and Laos for about 100 km then turns southwest to form briefly the border of Laos with Thailand. The Mekong then flows east and south into Laos for some 400 km and defines the Laos-Thailand border again for some 850 km as it flows east, turning south, passing through the capital of Laos, Vientiane. The Mun River's confluence with the Mekong occurs right before it crosses into Cambodia, where it receives the Tonle Sap River, flowing by Phnom Penh, the capital of Cambodia. The Mekong slows as it enters Vietnam, where it divides into nine channels of the Mekong Delta, where Ho Chi Minh City lies. The water from the Mekong Delta flows southeast into the South China Sea. The extreme seasonal variations in flow and the presence of rapids and waterfalls in this river have made navigation extremely difficult.

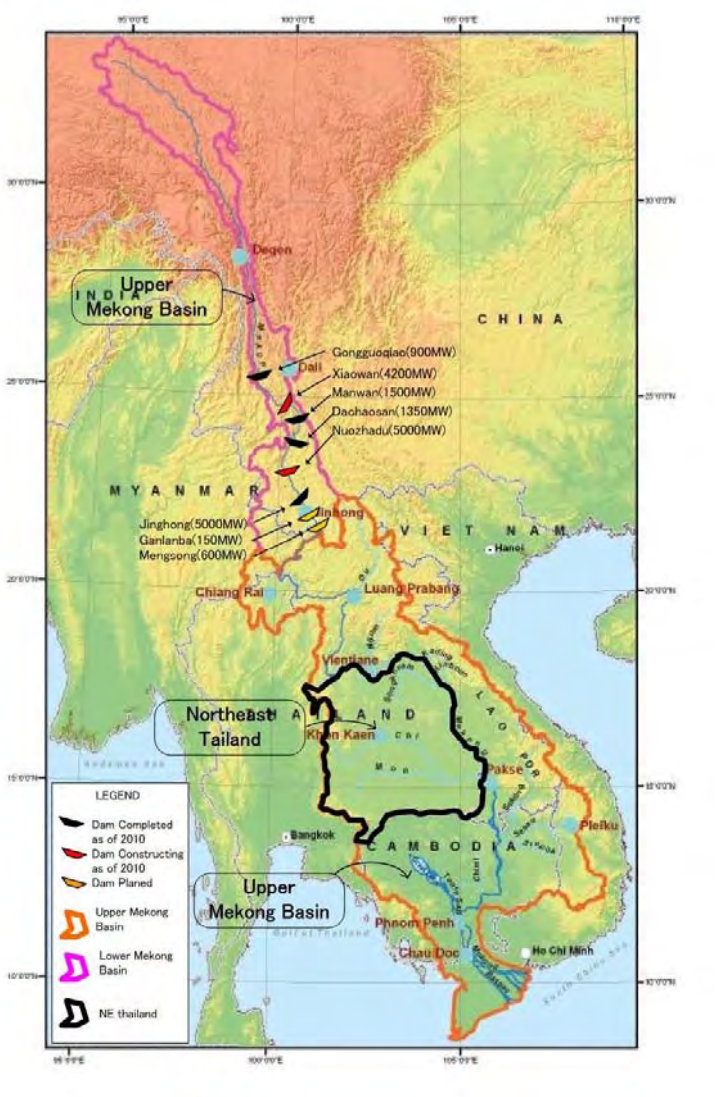


Figure 3.12.1 Great Mekong Basin

The upper area with length of 1,880 km from head water to Laos is called as 'Upper Mekong Basin (165,000 km^2)' and is characterized by huge water power resources estimated as 660 x 10^9 kWh [41]derived by the rich river discharge in Tibetan Plateau and topographic relief. While for the lower reach of 2,545 km after China boundary to South China Sea, it is called as 'Lower Mekong Basin' and featured by low relief topography and many of inhabitants of 60 million. The people are living with the water resource of Mekong through lowland agriculture and inland fisheries. As hydrological units, Northeast Thailand is classified as 'Vientiane and Nongkhai

[41] The elevation at China boundary is about 490 m and relative height from the head water exceeds 4,000 meters.

Pakse Section' among 6 Mekong units[42] divided by features of flow regime, topography and land use pattern. In Table 3.12.1, basin area, water resources potential and irrigation area for six (6) countries are shown.

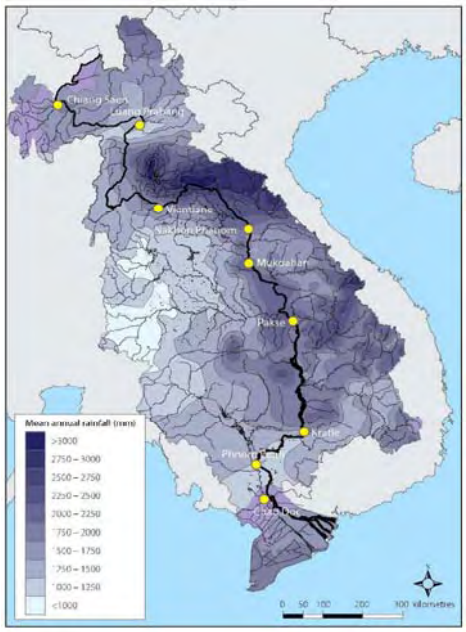
Table 3.12.1 Summary of Water Basin for Mekong Countries

Area	Total	China (Yunnan)	Myanmar	Lao	Thailand	Cambodia	Vietnam
(1) Mekong Basin Area(10^3km^2)	795	165	24	202	184	155	65
(2) Area Rate of Country(%)	(100)	(21)	(3)	(26)	(23)	(19)	(8)
(3) Total Area of Country(10^3km^2)	2332	395	677	237	513	181	239
(4) Basin Area Rate(%)	(34)	(42)	(4)	(85)	(36)	(86)	(20)
(5) Potentail Water Resources(10^9m^3)	475	75	10	166	86	86	52
(6) Water Resourcs Rate of Country(%)	(100)	(16)	(2)	(35)	(18)	(18)	(11)
(7) Runoff Yield (mm)	600	455	417	822	467	555	800
(8) Popualtion- Mekong Basin- (10^6)	71	10	1	5	23	13	19
(9) Population Rate of Country (%)	(100)	(14)	(1)	(7)	(33)	(18)	(26)

Data Source: National Static of each country and MRC report(State of the Basin Report, 2010)

(1) Climate of Mekong Basin

The climate of Lower Mekong Basin is dominated by the Southwest Monsoon, which generates wet and dry seasons of more or less equal length. The monsoon season usually lasts from May until late September or early October. There is usually heavy rainfall especially in the eastern half of the region located nearby Annamite Mountains but less rainfall in Thailand and Cambodia of lower hills. Later in the season, tropical cyclones occur over much of the area so that August and September and even October are the wettest months of the year.



Note: Figure is reproduced from 'State of t Basin Report (MRC, 2010)

Figure 3.12.2 Rainfall in Mekong Basin

The Northeast Monsoon, which sets in towards late October, brings lower temperatures. Rainfall during the months of the Northeast Monsoon is even partially blown by, generally confined to Viet Nam since the rest of the Lower Mekong region lies in the lee of the Annamite Mountains or the Central Highlands.

In the Upper Mekong Basin, Yunnan province has a similar monsoon climate, although there is considerable variation with local topography. The climate varies from tropical and subtropical monsoons in the south of Yunnan, to temperate monsoons in the north as the land rises from a

[42] Mekong basin is classified into 6 hydrological units based on river regime, topography and land use as Upper Mekong Basin(Upper Mekong), Lower Mekong Basin(Chiang Sean-Vientiane and Nong Khai, Vientiane and Nong Khai – Pakse, Pakse – Kratie, Pratie – Phnom Penh, Pratie – Phnom Penh – South China Sea).

mean elevation of 2,500 meters above sea level to 4,000 meters on the Plateau of Tibet.
Depending on the variation in climate, the amount of rainfall is quite different in places, even exceeding 4 times in annual rainfall is shown, such as that the lowest rainfall (less than 1,000 mm in Khorat) is in north east Thailand while heavy rainfall more than 4,000 mm is observed in Laos territory located in west flank of Annamite Mountains as shown in Figure 3.11.2.
Seasonal change is also very clear, and 85% (1,460 mm) is concentrated in the wet season (May to October) in mean annual rainfall of 1,670 mm.

(2) River Flow

The seasonal change of rainfall is reflected on the river flow, thus river level increases as monsoon begins. The maximum level of river is observed during September and October. It turns to decrease on December and reach the minimum level on April.

In Figure 3.12.3, the monthly runoff at the most down stream in Thailand is shown. In the 32 years' records, the maximum runoff was recorded as 42,700 m^3/sec and the minimum runoff was only 1,400 m^3/sec, which indicates 30 times of difference in values between Dry and Wet seasons. The river flow in dry season is largely controlled by the inflow from China (Upper Mekong Basin). This volume of water is called "Yunnan Component" and it plays an important role in the low-flow hydrology of the lower mainstream. Even as far downstream as Kratie, the Yunnan Component[43] makes up almost 30 per cent of the average dry season flow.

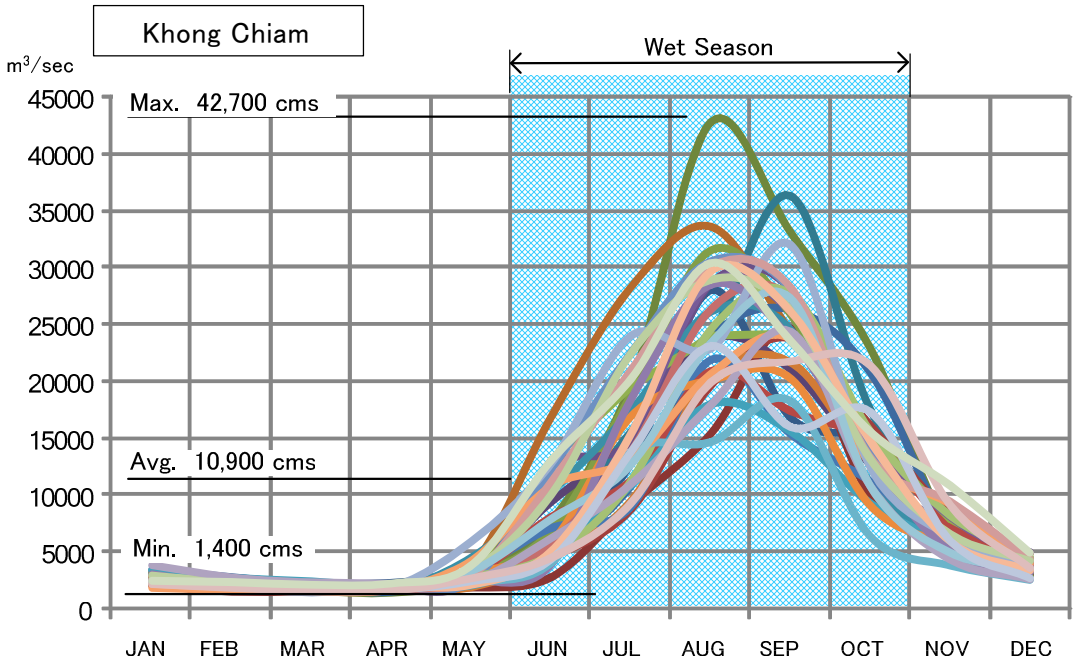


Figure 3.12.3 Monthly Discharge of Mekong River (Khong Chiam)

Mekong river has 475 x $10^9 m^3$ of water resources for all basin area. As for country basis, China-Myanmar(24% of basin area) has 18%(85 x $10^9 m^3$) , Laos-Western area of Annamite

[43] It is called as 'Yunnan component' that derived from the major source of water flowing into the river comes from melting snow on the Tibetan Plateau and necessary flow amount to maintain the low water discharge in dry season.

Mountains (68% of basin area) has 71%(338 x 10^9m^3), and Vietnam(8% of basin area) has 11%(52 x 10^9m^3) of whole water resources, as shown in Table 3.12.1.

Of those, inflow from NER (Khong, Chi and Mun) shares 49 x10^9m^3/sec which is equivalent to 10% of the whole Mekong water. In Table 3.12.2, mean annual flows from right and left bank are shown.

Table 3.12.2 Flow Contribution for Mekong Mainstream

River Reach	Left Bank(%)	Right Bank(%)	Total(%)	Country
China	16		16	China
China-Chiang Sean	1	4	5	China/Myanmar
Chiang Sean-Luang Prabang	6	3	9	Lao/Thailand(NT)
Luang Prabang-Chiankhan	1	2	3	Lao/Thailand(NT)
Chian Khan-Vientiane	0	0	0	Lao/Thailand(NER)
Vientiane-Nong Khai	0	1	1	Lao/Thailand(NER)
Nong Khai-Nakhon Phanom	19	4	24	Lao/Thailand(NER)
Nakhon Phanom-Mukdahan	3	1	4	Lao/Thailand(NER)
Mukdahan-Pakse	5	6	11	Lao/Thailand(NER)-Cambodia
Pakse-Stung Treng	23	3	26	Cambodia
Stung Treng-Kratie	1	0	1	Cambodia
Total	60	24	100	

Note: NT: North Thailand, NER : North East Thailand, shaded part shows inflow from North east Thailand.
Data source: MRC (Overview of the Hydrology of the Mekong Basin, 2005)

(3) Land Cover and Soil Erosion

As for the land cover in Mekong river basin, the actual forest area is not cleared due to the various classification and rapid deforestation rate. However, with the result of statistical data around year 2000(as shown in Table 3.12.3), the forest cover is regarded as about 30% in whole Mekong basin, which is 30 to 60% in China (Yunnan), Myanmar, Laos and Cambodia as preserved area while 10% in Thailand and Vietnam(Mekong delta) as relatively deforested area. Developed areas as NER and Vietnam show the high rate of agriculture area more than 50%[44].

Soil erosion in the Mekong tributaries was studied based on actual observation of suspended material in main channel of Mekong. The rate of 61,210 x 1,000 ton (in average 1989-2003) was observed at Chiang Saen located near Thailand-Myanmar border while the rate of 72,800 x 1,000 ton at Pakse located near the down stream of Thailand-Cambodia border. As the conclusion of the observation and analysis[45], the suspended material is dominant in the inflow water from China territory rather than that of tributaries of Lower Mekong Basin. Especially from NER, the suspended material is limited as low as several thousands tons in a year.

The influence by Manwan dam in Upper Mekong Basin was also suggested in the study that the suspended materials including nutrients decreased by 48%. It regarded not helps to redistribute nutrients within Lower Mekong Basin and act as an obstacle for a protein production for inland fisheries.

[44] According to remote sensing data and analysis, the rate of agriculture area was obtained as 79%, 84% for Thailand and Vietnam (Mekong delta) respectively. By province statistical data, 5 million rai (8 x 10^6 50%) was calculated.

[45] Kakizawa et al (2007)

Table 3.12.3 Forest Area and Farm Area in Mekong Basin

Area	Total	China (Yunnan)	Myanmar	Lao	Thailand	Cambodia	Vietnam
(1) Mekong Basin Area(10^6ha)	80	17	2	20	18	16	7
Forest Area							
(2) Forest Area in Mekong Basin(10^6ha)	27	8	1	11	3	4	0
(3) Rate of Forest Area(%) (2)/(1)	(34)	(48)	(54)	(52)	(14)	(27)	(6)
(4) Covareg Rate by Contory (%) (2)/(2)	(100)	(30)	(5)	(39)	(9)	(16)	(1)
Farm Area							
(5) Farm Area in Mekong Basin(10^6ha)	18	1	0	1	10	2	3
(6) Rate of Farm Area(%) (5)/(1)	(22)	(7)	(4)	(5)	(54)	(15)	(46)
(7) Covareg Rate by Contory (%) (5)/(5)	(100)	(6)	(1)	(6)	(57)	(13)	(17)
Irrigation Area							
(8) Irrigation Area in Mekong Basin(10^6ha)	4	-	-	0	1	1	2
(9) Rate of Irrigation Area (%) (8)/(9)	(22)	-	-	(10)	(14)	(22)	(63)

Data Source: Agriculture statics of each country and MRC Report (Basin deveopment plan, 1999, 2009)

(4) Irrigation

According to the irrigation review summarized by MRC[46], total area of irrigation in Lower Mekong Basin is increasing year by year at rate of 1 to 4%, and was estimated at 4 million ha as of 2009. By country, Cambodia and Laos shares 510,000 ha (22% of total farm area) and 170,000 ha (10%). Thailand and Vietnam has 1,420,000 ha (14%) and 1,730,000 ha (63%) respectively. Among Lower Mekong countries, Vietnam shows the highest rate (more than 60% in farming area), and due to intensive cropping as 2.5 times a year, cumulative irrigation area (i.e. total area of dry, wet and 3rd season) is accounted as large as 3,890,000 ha. Thailand has same area as Vietnam's, but it's cumulative irrigation area is only 1,550,000 ha because of single (wet season) cropping in the most of irrigation area, as shown in Table 3.12.4.

The total area of cumulative irrigation area in Lower Mekong Basin reaches 6,260,000 ha, and 50 x $10^9 m^3$ is obtained as the water consumption, in case 800 mm of crop water requirement is applied. The water for irrigation is thus equivalent to 10% of water resource potential (475 x $10^9 m^3$) of Lower Mekong Basin.

Table 3.12.4 Irrigation Area of Lower Mekong Basin

Area	No. Scheme	Irrigation Area (x 1000 ha)	Wet (x 1000 ha)	Dry (x 1000 ha)	Third (x 1000 ha)	Wet+Dry+Third (x 1000 ha)
Cambodia	2,099	505	274	261	17	551
Laos	2,387	172	172	99	0	271
Tailand	5,710	1,425	1,373	172	0	1,544
Vietnam - Delta -	120	1,728	1,528	663	1,479	3,670
Vietnam - Hightlands-	492	193	143	77	0	220
Vietnam -Total-	612	1,921	1,671	740	1,479	3,890
Total	10,808	4,023	3,490	1,272	1,495	6,257

Data Source: Irrigation Sctor Review (MRC, 2009)

[46] Regional Irrigation Sector Review(Basin Development Plan MRC,2010)

(5) Development Plan of Upper Mekong Basin (Yunnan province)

Since 1970's, China government (Yunnan province) has promoted the hydropower projects in Upper Mekong Basin ('Lansang River' in local name) for the power supply to Guangdong province and other cities. 14 cascade dams in consequence were planned with 22,260 MW of power output (i.e. annual power generation of 109,400 GWh).
Of those, the development of eight (8) dams (refer to Figure 3.12.1) are already well underway, with four (4) dams completed and two currently under construction as shown in Table 3.12.5.

Table 3.12.5 Development Plan of Upper Mekong Basin (14 dams)

Dam/ Power Plant	Basin Area ($km^{2)}$	Full Reservoir Level (m)	Gross Capacity of Reservoir (MCM)	Plant Power Output (MW)	Annual Power Generation (GWh)	Present Status
1 Liutonjiang	83,000	2,174	500	550	3,360	
2 Jiabi	84,000	2,054	320	430	2,650	
3 Wulonglong	85,500	1,964	980	800	4,890	
4 Tuoba	88,000	1,820	5,150	1,640	7,630	
5 Hyangdeng	92,000	1,640	2,290	1,860	8,500	
6 Tiemenkan	93,400	1,472	2,150	1,780	8,270	
7 Gongguoqiao	97,300	1,319	510	900	4,670	Constructed(2008)
8 Xiaowan	113,300	1,240	15,130	4,200	18,540 (19,170)	Under Construction
9 Manwan	114,500	994	920	1,500	7,870	Constructed(1993)
10 Dachaosan	121,000	899	880	1,350	7,090 (5,931)	Constructed(2003)
11 Nuozhadu	144,700	812	24,670	5,000	22,670 (23,700)	Under Construction
12 Jinghong	149,100	602	1,040	1,500	8,470 (7,340)	Constructed(2010)
13 Ganlanba	151,800	533		150	1,010	
14 Mengsong	160,000	519		600	3,740	
Total				22,260	109,360	

Data source: Yunnan Provicial Electric Power Bureau (Brief description of the power industry and development plan in Yunnan 1994) and Mekong Watch (http://mekongwatch.org/env/yunnan/dams)

Four (4) dams, consisting of Manwan dam (1,500MW), Gongguoqiao dam (900MW), Dachaoshan dam (1,350MW) and Jinghong dam (1,500MW); have been constructed by 2010 and are in operation. The two (2) dams of Xiaowan dam (4,200MW) and Nuozhadu (5,000M) is currently under construction. Xiaowan dam is the highest dam in the world with large storage capacity of 15,130 MCM and has impounded since October 2004. Nuozhadu dam is the biggest dam in 14 dams with huge storage capacity of 24,670 MCM. It has also started construction from 2006.

The potential hydrological impacts of the 14 cascade of hydropower dams has been explained by China as the degree of regulation (the proportion of flood season flows transferred to the low-flow season) could be as high as 20 per cent of total flow. Conversely, the downstream countries, specifically Vietnam and Cambodia, apprehend the adverse effect on fishing resources and agriculture productivity and loss of biodiversity caused by significant changes of low-flow regime, changes of seawater/freshwater interface and deterioration of water quality.

3.12.2 Agreement for the Development of the Mekong River Basin

The Governments of the Kingdom of Cambodia, the Lao People's Democratic Republic, the Kingdom of Thailand, and The Socialist Republic of Viet Nam exchanged the Agreement in 1995 for sustainable development, utilization, conservation and management of the Mekong River

Basin water. The contents are as shown in the following page.

As mentioned above, any signatory state has obligation to notify to the MRC about water intake in general. Moreover, it is necessary to have a prior consultation in the following cases:

- Water intake from main stream in dry season
- Water diversion from Mekong river main stream to non-Mekong river basin even in wet season

The process and timing of consultation is still under discussion and has yet to be established among the MRC. Since thirty-three (33) projects implemented so far in riparian countries were mainly development of tributaries, only notification to MRC was sufficient. The first case of notification was for the Study on Kok-Ing-Nan Water Diversion Project. There have been no opposing and claims for holding consultation meeting so far. There was only one case of water diversion from main river by Laos, however, the project was cancelled eventually, which led to no need for consultation meeting.

Based on this agreement, it is judged not necessary to hold a prior consultation for LPC project, Nam Ngum - LPC and KLCM water diversion projects too, since they accompany water diversion from the tributary only. However, the National Mekong Committee of Thailand shall notify to MRC about water diversion projects seven LPC project including water diversion within Thailand. It is essential, therefore, to notify to MRC before water diversion projects are implemented. Furthermore, it is needed to confirm the necessity of prior consultation and if necessary, any proponent should hold a consultation to get approval for implementation.

CHAPTER III. OBJECTIVES AND PRINCIPLES OF COOPERATION

Article 1. Areas of Cooperation

Article 2. Projects, Programs and Planning

Article 3 Protection of the Environment and Ecological Balance

Article 4. Sovereign Equality and Territorial Integrity

Article 5. Reasonable and Equitable Utilization

To utilize the waters of the Mekong River system in a reasonable and equitable manner in their respective territories, pursuant to all relevant factors and circumstances, the Rules for Water Utilization and Inter-basin Diversion provided for under Article 26 and the provisions of A and B below:

A. On tributaries of the Mekong River, including Tonie Sap, intra-basin uses and inter-basin

B. On the mainstream of the Mekong River:

1. During the wet season:
   a) Intra-basin use shall be subject to notification to the Joint Committee.
   b) Inter-basin diversion shall be subject to prior consultation which aims at arriving at an agreement by the Joint Committee.
2. During the dry season:
   a) Intra-basin use shall be subject to prior consultation which aims at arriving at an agreement by the Joint Committee.
   b) Any inter-basin diversion project shall be agreed upon by the Joint Committee through a specific agreement for each project prior to any proposed diversion. However, should there be a surplus quantity of water available in excess of the proposed uses of all parties in any dry season, verified and unanimously confirmed as such by the Joint Committee. an inter-basin diversion of the surplus could be made subject to prior consultation.

Article 6. Maintenance of Flows on the Mainstream

To cooperate in the maintenance of the flows on the mainstream from diversions, storage releases, or other actions of a permanent nature; except in the cases of historically severe droughts and/or floods:

A. Of not less than the acceptable minimum monthly natural flow during each month of the dry season;

B. To enable the acceptable natural reverse flow of the Tonie Sap to take place during the wet season; and,

C. To prevent average daily peak flows greater than what naturally occur on the average during the flood season.

The Joint Committee shall adopt guidelines for the locations and levels of the flows, and monitor and take action necessary for their maintenance as provided in Article 26.

Article 26. Rules for Water Utilization and Inter- Basin Diversions

The Joint Committee shall prepare and propose for approval of the Council, interior Rules for Water Utilization and Inter-Basin Diversions pursuant to Articles 5 and 6, including but not limited to: 1) establishing the time frame for the wet and dry seasons; 2) establishing the location of hydrological stations, and determining and maintaining the flow level requirements at each station; 3) setting out criteria for determining surplus quantities of water during the dry season on the mainstream; 4) improving upon the mechanism to monitor intra-basin use; and, 5) setting up a mechanism to monitor inter-basin diversions from the mainstream.

Article 27. Decisions of the Joint Committee

Decisions of the Joint Committee shall be by unanimous vote except as otherwise provided for in its Rules of Procedures.

Note: The above is extracted from "Agreement on the cooperation for the sustainable development of the Mekong river basin, 5 April 1995"

3.13 Water Resources and Irrigation Development Plans

3.13.1 RID Project Plans

(1) Project plans in the NE Region

RID is one of the major government agencies in charge of water resources development, and has ever implemented a number of project in small, medium and large scales. RID plans to implement, after the fiscal budget year 2010, 18 large scale projects, 465 medium scale projects and 2,930 small scale projects. The following table 3.13.1 shows the number of projects to be implemented scale-wise with some information about total capacity and irrigable areas.

Table 3.13.1 Development Plan of Water Resources and Irrigation in the Northeast (RID)

Project Type	Description	Unit	FY 2010-2011				FT 2012 ~				Total
			LS	MS	SS	Total	LS	MS	SS	Total	
1. Reservoir	No.Proj.		-	5	44	49	4	197	366	567	616
	Total Capacity	mcm	-	64	7	71	611	2,113	354	3,078	3,149
	Irrigable Area	rai	-	40,606	19,460	60,066	412,800	1,633,449	400,974	2,447,223	2,507,289
2. Weir	No.Proj.		-	18	168	186	-	43	647	690	876
	Total Capacity	mcm	-	-	-	-	-	70	23	93	93
	Irrigable Area	rai	-	57,496	89,851	147,347	-	202,964	303,522	506,486	653,833
3. Regulator/ Barrage	No.Proj.		-	7	-	7	-	37	116	153	160
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	109,500	-	109,500	-	565,580	206,612	772,192	881,692
4. Pump Station	No.Proj.		-	5	230	235	-	7	811	818	1,053
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	28,950	340,503	369,453	-	136,092	1,448,470	1,584,562	1,954,015
5. Wetland (Kaemling)	No.Proj.		-	-	1	1	-	126	135	261	262
	Total Capacity	mcm	-	-	2	2	-	612	99	711	713
	Irrigable Area	rai	-	-	1,000	1,000	-	155,527	137,923	293,450	294,450
6. Water Network	No.Proj.		-	3	-	3	4	4	-	8	11
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	13,600	-	13,600	17,900,000	166,405	-	18,066,405	18,080,005
7. Distribution System	No.Proj.		-	11	84	95	-	-	298	298	393
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	65,590	103,891	169,481	-	-	269,689	269,689	439,170
8. Drainage	No.Proj.		-	-	-	-	-	2	-	2	2
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Beneficiary Area	rai	-	-	-	-	-	700	-	700	700
9. Rehabilitation	No.Proj.		-	-	-	-	10	-	-	10	10
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	-	-	-	62,642	-	-	62,642	62,642
10. Other	No.Proj.		-	-	1	1	-	-	29	29	30
	Total Capacity	mcm	-	-	-	-	-	-	-	-	-
	Irrigable Area	rai	-	-	100	100	-	-	14,910	14,910	15,010
Total	No.Proj.		0	49	528	577	18	416	2,402	2,836	3,413
	Total Capacity	mcm	0	64	9	73	611	2,795	476	3,882	3,955
	Irrigable Area	rai	0	315,742	554,805	870,547	18,375,442	2,860,717	2,782,100	24,018,259	24,888,806

Note : LS : Large Scale Project
MS : Medium Scale Project
SS : Small Scale Project

（Hearing from RID）

If all the projects as tabulated be implemented, the total storage capacity will be increased by about 4,000 MCM, the irrigable area by about 4 million ha (24,888,806 rai) and irrigation rate by 54% from current rate of 10.6%. In the table, the irrigable area noted as 17,900,000 rai (2.86 million ha) under the project type No. 6 “Water Network”----Large Scale---Long Term is by “Khong-Loei-Chi-Mun Water Management Diversion Project (KLCM Project) alone, for which

details be discussed in the subsequent sections. Other than the above, those projects which may contribute largely to the expansion of irrigable area is firstly the medium scale irrigation project with which storage be increased by about 2,100 MCM and 261,000 ha (1,633,449 rai) of irrigable area and also irrigation rate be increased to 13.5%. Secondly, it is pumping irrigation project (Small scale) and increases are 1,041 pumping stations and about 286,000 ha (1,789,000 rai) which raise the irrigation rate up to 16.6% in combination with the small scale projects.

(2) Large scale irrigation (reservoir) project

In the "1.Reservoir, L.S" in the above table 3.13.1, the following sub-projects are included.

Table 3.13.2 Large Scale Reservoir Project (RID)

No.	Project Name	Location			Project Scale	Capacity (MCM)	Project Area (Rai)	Note
		Tambon	Amphoe	Changwat				
	Chi Basin							
1	Yang Na Di Dam	Chi Bon	Ban Khwao	Chaiyaphum	Large	70.20	165,300	Long Term
2	Prong Khun Phet Dam	Khok Sa-ad	Nong Bua Rawae	Chaiyaphum	Large	97.00		Long Term
3	Chi Bon Dam	Nong Waeng	Nong Bua Daeng	Chaiyaphum	Large	325.00	35,000	Long Term
	Mun Basin							
1	Lam Dom Yai Reservoir	Dom Prasert	Nam Yuen	Ubon Rachathani	Large	119.10	212,500	Long Term

(3) Wetland (Kaemling) project

"Wetland (Kaemling)" of project type No. 5 is a retarding pond construction project aiming at flood protection purpose and in English called as "Monkey Cheek Project".

(4) Water Network Project

Under the category of "Water Network" of Project Type No. 6 includes the following listed projects.

Table 3.13.3 Water Network Project (RID)

No.	Project Name	Location		Project Scale	Project Area (rai)	Note
		Amphoe	Changwat			
	Khong Basin					
1	Khong-Loei-Chi-Mun Water Management Diversion Project	-	-	Large	100,000	Long Term
2	Nam Un-Nam Kam Water Network Project	-	Sakon Nakhon	medium	60,000	Long Term
	Chi Basin					
1	Khong-Loei-Chi-Mun Water Management Diversion Project	-	-	Large	5,480,000	Long Term
	Mun Basin					
1	Pumping from Lam Takhong Basin to Huai Ban Yang Reservoir	Khueng	Nakhon Rachasima	medium	3,000	FY 2010
2	Nong Yao-Nong Koi Water Network Project	Nong Song Hong	Khon Kaen	medium	600	FY 2011
3	Kut Chap-Kut Mak Kheb Water Network Project	Waeng Yai	Khon Kaen	medium	10,000	FY 2011
4	Khong-Loei-Chi-Mun Water Management Diversion Project	-	-	Large	12,320,000	Long Term
5	Pasak Dam-Lam Takhong Dam Project	-	-	Large	(Domestic)	Long Term
6	Sieo Yai Sub-basin Water Network Project	-	Mahasarakham	medium	37,800	Long Term
7	Thung Kula Rong Hai Water Network Project	-	Roi-et	medium	50,000	Long Term
8	Lam Chiang Krai Sub-basin Network Grid Project	-	Nakhon Rachasima	medium	18,525	Long Term

Of the above table 3.13.3, "Pasak Dam-Lam Takhong Dam Project"---Large Scale No. 5 in Mun basin is to be constructed for the purpose of domestic water supply. Further, all the other large

scale projects are those included in the KLCM project. The KLCM project aims at supplying irrigation water to the most of the possible irrigable area in the NE Region by using the water diverted from the Mekong River. KLCM covers irrigable area of as large as 2,864,000 ha (17,900,000 rai).

(5) Rehabilitation project

Under this category of project type No. 9, the following projects are listed up.

Table 3.13.4 Rehabilitation Project (RID)

No.	Project Name	Location			Project Scale	Project Area (rai)	Note
		Tambon	Amphoe	Changwat			
	Khong Basin						
1	Rehabilitation of Nam Un O&M Project	Rae	Phang Kon	Sakon Nakhon	Large	-	Long Term
2	Rehabilitation of Huai Mong O&M Project	Tha Bo	Tha Bo	Nong Khai	Large	-	Long Term
3	Rehabilitation of Huai Luang O&M Project	Nikom Song Khro	Kut Chap	Udon Thani	Large	-	Long Term
	Chi Basin						
1	Rehabilitation of Nong Wai O&M Project	Nam Prom	Nam Prom	Khon Kaen	Large	-	Long Term
2	Rehabilitation of Phrom-Chern O&M Project	Chum Pae	Chum Pae	Khon Kaen	Large	-	Long Term
	Mun Basin						
1	Rehabilitation of Sieo Yai Basin Development O&M Project	Borabue	Borabue	Mahasarakham	Large		Long Term
2	Rehabilitation of Lam Dom Noi O&M Project	Non Klang	Phibun Mangsahan	Ubon Rachathani	Large		Long Term
3	Rehabilitation of Lam Phra Phloeng O&M Project	Ta Kob	Pak Thongchai	Nakhon Rachasima	Large	18,000	Long Term
4	Rehabilitation of Lam Takong O&M Project	Lat Bua Khao	Si Khieu	Nakhon Rachasima	Large	11,402	Long Term
5	Rehabilitation of Thung Sam Rit O&M Project	Nai Muang	Phimai	Nakhon Rachasima	Large	33,240	Long Term

(6) Outline of Khong-Loei-Chi-Mun (KLCM) project

RID conducted a pre-F/S study for KLCM water diversion project under the "Master Plan for Flood and Water Shortage Problems in Chi- Mun Basin" in 2008. The project is to take Mekong water at the Loei river mouth, Chiang Khan, Loei province to convey the water to Chi and Mun rivers. The project aims at solving water shortage problems and development of irrigation area throughout the NE Region and the newly developed irrigation area reveals at 2.87 Million ha (17.9 Million rai) in total (0.02 Million ha in Khong, 0.88 Million ha in Chi and 1.97 Million ha in Mun basin, respectively). Major dimensions of the project are as shown below. (Project plan map is attached in Annex I, Appendix 3.13.1)

At present, RID is undertaking the Strategic Environmental Assessment (SEA) and the Feasibility Study at the same time and the projects components are currently being discussed/examined through the RID's internal committee assigned for the subject study. The project is of the idea that from the intake to the distribution to the field, water be conveyed by gravity system[47] and the project scale is huge one not comparable any of the past project in Thailand with having as many as 12 lines of long distance tunnel (80 km) and two (2) lines of long main canals of 600-700 km. The project implementation period is tentatively assumed as 10 years but it seems that much longer period might be needed as the project has to clear various pending issues concerning technical, social and environmental aspects prior to the initiation of the project implementation.

[47] As the maximum diversion discharge, 25,731 MCM for 17.9 M. rai in wet season, 7,862 MCM for 14.86 M. rai, 33,595 MCM in total per annum will be diverted from Loei River near confluence with Mekong river which corresponds to about 24.4% of the Mekong river run-off of 137,846 MCM per annum (from Power Point Data of RID).

As one of the target irrigation areas under the subject project, those beneficiary areas by the LPC project being promoted by DWR are included. Therefore, it is necessary to discuss the matter under the examination of SEA including the policy matters and due coordination shall be secured for the implementation of any water diversion project in the NE Region.

KLCM Water Diversion Plan Basic Dimension

（1）Intake Facility：
- River training along Loeir iver up to confluence with Mekong river： 20km in length
- Construction of Diversion Canal : 17km in length
- Diversion Tunnel Diameter 10~12m、Length 80km、12 lines
  1 line for diversion to Lam Phauiang : 79.5km in length
  Other 11lines for diversion to Huai Mo : 80km in length

（2）Irrigation Canal：
- Irrigation Canal（Khon Kaen、Chaiyaphum、Nakhon Ratchasima Route）： 625km
- Irrigation Canal（Khon Kaen、Kalasin、Maha Sarakham、Roi Et、Yasothon、Amnat Charoen、Ubon Ratchathani Route） : 725km

（3）Irrigation System： Irrigation Area 17.9 million rai（2.87 million ha）
Irrigation Area in wet season：17.9 million rai
Irrigation Area in dry season：5~12 million rai

（4）Design Discharge： 1,730 m^3/sec （Mekong river WL (Max) 210.40 m. MSL）
773 m^3/sec （Mekong river WL (Min) 198.93 m. MSL）

（5）Implementation Period：10 years
- Preparatory period（F/S、D/D）： 3 years
- Construction period (6 phases)： 8 years

（6）Total Project Cost： 806,377 million baht（23,717 millionUS$）

3.13.2 Water Resources Related Project Development Plans by DWR and Others

(1) Water resources development project by DWR

DWR is the government agency in charge mainly of survey/study planning and management on water resources, and at the same time the Department covers implementation of small scale water resources rehabilitation project including the followings.

* Conservation of water resources
* Construction of small weirs (Check dam, water source retention and erosion protection) at the upstream basin (Water conservation area and rapids)
* Improvement of water resource facilities
* Construction of water distribution facilities
* Construction of small scale reservoir

DWR's project list planned to be implemented based on the above by 2011 is as follows.

Table 3.13.5 Water Resources Rehabilitation Plan of DWR

Water Sources Rehabilitation Plan, Fiscal Year 2009-2011 by Region and Activity : DWR

Projects	Year 2009-2011		Year 2009		Year 2010		Year 2011		Benefit area	Beneficiary	Storage Capacity
	No.of places	Investment cost (Million Baht)	No.of places	Investment cost (Million Baht)	No.of places	Investment cost (Million Baht)	No.of places	Investment cost (Million Baht)	(Million rai)	(household)	(MCM)
Northeast	**1,189**	**4,887**	**351**	**1,451**	**539**	**1,782**	**299**	**1,653**	**0.530**	**148,837**	**339**
Water source conservation	300	1,291	195	745	48	285	57	261	0.049	34,032	140
Weir strengthen for ecology system	383	84	95	18	268	49	20	17	-	-	-
Improving of water source structure	412	1,893	35	129	186	816	191	948	0.428	103,966	185
Spillway	79	1,316	21	413	33	582	25	321	0.042	7,981	3
Water distribute system	6	60	3	43	1	7	2	10	0.004	1,692	-
Reservoir	9	243	2	103	3	43	4	96	0.008	1,166	11
Whole Country	**6,552**	**14,942**	**1,013**	**4,477**	**2,922**	**5,436**	**2,617**	**5,029**	**2.190**	**359,562**	**835**

Data Source: "Investment Plan on Water Management & Irrigation" Water Development and Management Committee for Water Resources and Irrigation, July 2008 (NESDB)

(2) Outline of Huai Luang-Lam Pao-Chi (LPC) water diversion project

As one of the possibly implemented water diversion projects in the NE Region, there is the LPC project as proposed by DWR.

Brief Description about LPC Water Diversion Project

In Khong river basin, the ratio of unused run-off (26,200 MCM) emptying to Mekong River against the water demand (2,500 MCM) is extremely high as compared with the other basins of Chi and Mun. Due to the topographic condition which does not allow to build large scale dams in its own basin, such huge amount of water is released without chances for proper utilization.

While in Chi basin, an improvement project is being implemented. Lam Pao dam is the one and the storage capacity is to be increased by about 500 MCM through raising up the full water level by 2 m by means of spillway improvement for easier operation during the flood periods. The inflows to Lam Pao reservoir are very fluctuating with about 2 Billion CM in normal year, 3.5-4 Billion CM in flood year and only less than 1 Billion CM in dry year, respectively, causing very difficult reservoir operation in many years. The most difficult operation is in the requirement to fulfill the reservoir at the end of the wet season to secure irrigation water needed for next season, but it is difficult to avail correct operation based on the predicted inflow to be caused by the subsequent rainfall, and in many cases the problem of insufficient storage happen as the result.

Therefore the idea is to effectively utilize the abundant surplus water in Huai Luang, Khong basin by diverting it to Lam Pao reservoir when the storage in Lam Pao would have vacancies at the end of the wet season as said. If this could be materialized, the water to empty to Mekong River without adequate use can be fully utilized in Chi basin together with the additional storage by increased capacity in the existing Lam Pao service areas and newly expanded service areas. In the operation of Lam Pao dam, if such supplementary water source could be secured, a full utilization of storage function including the increased storage capacity can be realized and the operation can be much improved towards flood control and mitigation of water shortage problems at the same time.

The project conveys the surplus water from Huai Luang in Khong basin to Lam Pao reservoir in Chi basin in the later wet season. (Pre-F/S level study completed by RID) (Please see the project

map as attached in Annex I, Appendix 2.2.3)

LPC Water Diversion Plan Basic Dimension

- Annual Water Diversion Quantity from Huai Luang to Lam Pao Reservoir： 930MCM
- Average Annual runoff to Lam Pao Reservoir： 2,070MCM → 3,000MCM
- Average Annual Release from Lam Pao Reservoir：
  Wet season 1,230MCM → 1,300MCM
  Dry season 600MCM → 1,700MCM
  Annum 1,830MCM → 3,000MCM
- Proposed Irrigation Area： 208,000 ha [1.8 million rai（Existing 0.5 million rai、Newly developed 1.3 million rai）]
- Total Project Cost： 31,300 million baht
- Water Cost： 0.63 baht / m^3
- Main Facilities： Middle Huai Luang Barrage
  Water Diversion Canal: L＝42km, Maximum discharge : 100m^3/s
  Luang Pump Station: Total lift head 20m
  Dike construction、Irrigation System、Medium scale dam, etc.
  New outlet facility construction at right bank of Lam Pao Dam

At present, RID is undertaking necessary procedures for surveying the inundation area at the upper reservoir to be created by the existing river mouth barrage and the relevant compensation for land acquisition. After these procedures, pumping irrigation project in and around the reservoir area is scheduled to be implemented. Under the LPC, most of the existing facilities will be fully utilized and those main facilities in need of new construction are only pump station for water diversion and diversion canal in addition to the existing river channels.

(3) Water resources related project development plans by DWR and other agencies

Concerning the basin improvement plans/projects and flood mitigation projects at the community level, several agencies involve in its implementation. Plans to be implemented by 2011 are as shown in the following.

Table 3.13.6 Watershed Area Rehabilitation Plan and Inundation Mitigation Plan

Summary on Watershed Area Rehabilitation Plan and Inundation Mitigation Plan Year 2009-2011 : by Work Unit									
Work plan		Work unit	Cost (million Baht)					Target	
			Total	2009	2010	2011	2012	Total	Unit
1	Watershed area rehabilitation plan		9,883	2,381	3,771	3,731	-	-	
1.1	Weir construction	DWR, DNP, RFD	1,906	372	817	717	-	139,408	places
1.2	Forest revival and ecology improvement	DNP, RFD	1,819	548	608	663	-	1,075,410	rai
1.3	Vetiver growing	DNP, RFD	249	83	85	81	-	148	M no.
1.4	Safety taking care for community in forest	DNP	403	136	128	137	-	-	
1.5	Water and Soil conservation, top soil protection, and land slide	LDD	5,506	1,240	2,133	2,133	-	1,110,000	rai
2	Inundation Protection Plan in community area	DPT	12,226	1,206	2,828	3,998	4,194	-	
Total			22,109	3,567	6,599	7,729	4,194		

Data Source: “Investment Plan on Water Management & Irrigation” Water Development and Management Committee for Water Resources and Irrigation, July 2008 (NESDB)

3.13.3 Potential for Irrigation Area Expansion

(1) Irrigable area expansion by irrigation development projects

Those irrigation development projects planned at present were assessed on its development

potential and the time of implementation so as to grasp the overall potential for irrigation area expansion. As to the time frame for development, three (3) terms were set to classify into different groups as present (2010), short term (2011-2016), medium term (2017-2026) and long term (2027-2040).

* Concerning the large scale project with reservoir, Upper Chi project was classified into short term and the Lam Dom Yai project as medium term based on the progress to date.
* For the medium and small scale projects, the plans as shown in the Table 6.1.1, indicates the potential as a whole. Under the condition that development of large scale project becomes difficult, medium and small scale projects will be more actively implemented. For the medium scale, however, there may be considerable constraints in its implementation due to the difficulties in topographic conditions, social problems and also the natural and environmental conditions. As is the case, the quantity of project implementation has been estimated based on the budget actually disbursed in the recent past for the medium and small scale projects. RID's budget spending for medium and small scale projects in NE Region in recent years is confirmed as about 2,500 Million Baht/year (Appendix 3.10.5), while the development cost per rai at present is estimated at about 15,000-40,000 Baht/rai as shown in (6) of 3.6 of Chapter 3.

  Supposing that there will be no much change in the budget allocated for RID, as large as 30,000 rai /year for each of medium and small scale project will be implemented, while for the case of small scale pumping irrigation scheme, about 60,000 rai/year will be implemented, as estimated.

  In the past, the pace of development of irrigation area by medium scale exceeded that by the small scale but recently due to the difficulties as above noted the development pace by the medium scale would be slowed down to be the same with the small scale.

* Under the present study, the actual irrigation area by the small scale projects shall be assumed to be 20 % (565,000 rai) of the total irrigable area (Table 3.6.1). Judging from the water storage capacity of 991 MCM by small scale projects, possible irrigation area was estimated to be about 600,000 rai, about 20 % of the existing irrigable area.
* In the case of estuary barrage type project, the Huai Nam Kam project and the Huai Luang Estuary barrage project are classified as short term and the Nam Songkhram project as medium term project based on the RID plan. In addition to these, there will be development of 50,000 rai area in the other tributary basins under the long term category.
* Medium scale and small scale pumping irrigation project will be actively implemented in the future. In case of small scale pumping, around 60,000 rai per year will be developed and the allocation to short, medium and long term category was done as per the RID plan.

Table 3.13.7 Potential Project of Irrigation Area Expansion

(Irrigation Area Unit : 1,000rai)

Potential Project	Existing	Short Term ～2016	Medium Term ～2026	Long Term 2027～2040	Total	Remarks
Development Project						
Routine Type Project						
Large Scale Project	2,454	199	213		2,866	
Upper Chi						
Chi Bon Dam		34				
Yang na Dee Dam		165				
Prong Khun Pet Dam						
Lam Dom Yai Dam			213			
Medium Scale Project	1,485	150	300	400	2,335	(*1) 20% of Beneficial Area which almost correspond with total storage of 991MCM (1,500m^3/rai)
Small Scale Project	565 (*1)	150	300	400	1,415	
Estuary Barrage Type Project	(62)	219	276	50	545	
Huai Nam Kam Project		126				
Nam Songram Lower Project			276			
Huai Luang Estuary Barrage		93				
Others				50		
Pump Irrigation (Medium Scale)	1,544	30	60	60	150	
Pump Irrigation (Small Scale)		300	600	600	3,044	
Inter-basin Diversion Project						
LPC Project (Phase I)			100	(1,000)	100	Facilitate to river maintenance flow
KLCM Project				17,900	17,900	80kmx12lines Tunnel + 625km & 725km Canals
Water Grid Project				(800)	(800)	
Medium Scale Water Network		14	166			

* Concerning the inter-basin water diversion scheme, there are four (4) project development plans as explained below.

- LPC project is to be divided into Phase I and Phase II. The initiation of project implementation may be in medium term, as it requires SEA process. Under the Phase I, diversion canal from Huai Luang to Nong Han Kumpawapi will be constructed and irrigation will cover 100,000 rai at around Huai Luang, another 100,000 rai along the diversion canal and 100,000 rai at the upper reach of Lam Pao dam. There has been, however, an irrigation project under the Estuary Barrage project and also the upper reach of Lam Pao dam is included in the RID's medium scale project already. Accordingly, it is planned that the new irrigation area of 100,000 rai of the Huai dam tributary near the diversion canal be included in the medium term. Under the Phase II, as large as 1,000,000 rai will be developed in Chi and Mun basins, but there are some duplications with other project development plans, and the water resource developed is supposed to be used as environmental discharge for river maintenance and etc.
- For KLCM project, RID is currently undertaking the SEA and F/S study. The project plans to develop as large as 2.86 Million new irrigation area including the construction of long and large scale tunnel facilities and open canals. There

will be various difficult issues to clear before the initiation of project implementation, and therefore, the project was classified to the long term category. The project cost, however, was supposed to be incurred in the medium term period.

- DWR proposed to the NWRC 19 Water Network System and after endorsement, the matter was proposed to the Cabinet. The Cabinet approved to proceed to the SEA covering the whole NE Region including F/S and EIA. The beneficiary area is estimated to be 800,000 rai for 180,000 farm families.
- RID planned medium scale Water Network projects as shown in the Tables 3.13.1 and 3.13.3. The plan was divided into either short or medium categories.

(2) Potential of irrigation area expansion by rehabilitation project

Similar to the development project case, the developed area by rehabilitation project is estimated as follows. Also the component of rehabilitation is noted as well.

* RID is currently implementing the improvement of Lam Pao project. The improvement will increase the storage volume by 550 MCM and new expansion of irrigation area by 225,000 rai. New development area is divided into two places, one in the right bank area (50,000 rai of Huai Chiang Song Irrigation Area) and the other on the left bank downstream area (175,000 rai). Considering the construction period for canal systems, the right bank is considered as the short term and the left bank as the medium term.

Table 3.13.8 Potential of Irrigation Area Expansion by Rehabilitation Project

(Irrigation Area Unit : 1,000rai)

Potential Project	Existing	Short Term ～2016	Medium Term ～2026	Long Term 2027～2040	Total	Remarks
Rehabilitation Project						
Large Scale Project		50	175		225	
Lam Pao Dam		50	175			Rehabilitation of Spillway and storage volume 550MCM
Other Large scale project		(120)	(240)	(240)	0	Annualy 1.0%of the existing shall be rehabilitated (Durable period 100yrs)
Medium Scale Project		(75)	(150)	(150)	0	Annualy 1.0%of the existing shall be rehabilitated (Durable period 100yrs)
Small Scale Project		-	-	-		
Facilities Consolidation Project		[Existing weirs in the tributaries will be examined to be removed and/or mergered				Increase maintenance flow in dry season
On-farm	(300)	(55)	(225)	(2,100)	(2,680)	Central Land Consoridation Office, RID

* The existing facilities under the large scale and medium scale projects are to be deteriorated year by year and the functions could be lost finally. In order to maintain the functions, it is necessary to execute rehabilitation projects. For the rehabilitation works, it is estimated that at least 1 % of the existing facilities shall be covered every year, though this will not include any of new development of irrigation area.

* Irrigation areas under the on-farm development project are derived from the data by the Central Land Consolidation Office, RID.

(3) Potential of irrigation area expansion by improvement of water management

In the pre-F/S study for the LPC project, the possibilities to increase the water release in dry season are discussed and examined by improving the dam/reservoir operation. Based on the result, there is a possibility to increase in normal years dry season outflow by 310 MCM for both of Lam Pao and Ubonrat dams. In this case, the irrigation area in the dry season can be increased by about 200,000 rai each (400,000 rai in total).

Table 3.13.9 Potential of Irrigation Area Expansion by Improvement of Water Management

(Irrigation Area Unit : 1,000rai)

Potential Project	Existing	Short Term ～2016	Medium Term ～2026	Long Term 2027～2040	Total	Remarks
Water Management						
Lam Pao Dam		200	[Increase 310MCM (200,000rai) in dry season]		200	By improvement of reservoir operation
Ubolrat (O/M under EGAT)		200	[Increase 310MCM (200,000rai) in dry season]		200	By improvement of reservoir operation
Other Large & Medium Reservoir		(10)	(10)	(10)	0	Increase maintenance flow in dry season by operation improvement

Other than Lam Pao dam and Ubonrat dam, there are several reservoirs with potential to increase the dry season outflow through the possible improvement of reservoir operation, for which further study is recommended.

3.13.4 Direction of Water Resources Development and Management

Khong, Chi and Mun basin has a number of issues on water resource (water-utilization), river flow (flood management), river environment (water quality and salinization) and etc. Each also inherently depends on the local conditions in hydro-meteorology, facility operation and even cultural identification, therefore the basins have difficulties for which there are no easy answers by 'procrustes bed' to develop and manage the water resources. If 'regional environment' is taken into account as basic policy, following items are in general introduced.

- Fostering an environmentally sound water cycle on the basis of basin-tributary and strengthen the management foundation for flood and drought.
- Water resource preservation and soil conservation to attain stable and productive agriculture frameworks.
- Sustainable management for biosphere based on strategy of biological diversity in respective basin-tributary
- Sustainable conservation for regional culture inherited from agrarian society.

Based on above four (4) policies, a valid solution for the issues as above is to be considered with inherent condition of the area. However, the latest data and information are in fact very few, and the integrated management plan is not able to be worked out. In addition, their environmental

risk and interferences have not been studied to the whole river system.

Namely, first need in Project area is collecting and evaluating actual information, including re-arrangement of observatories, re-analysis for tributary's hydrology. As secondary requirement, integrated basin management involving existing water facilities (about 6,000 and more) should be established.

By the activity on integrated basin management, local residents and/or water users have some benefits on the efficiency of water utilization, improvement of water allocation, flood control capacity, river environment, groundwater environment and water resource monitoring. In following sections, water resource evaluation and operation of large scale facility is partially described.

(1) Evaluation of Water Resources

Evaluation of water resources will be conducted with

- Re-arrangement of observatories,
- Establishment of control points,
- Re-build of hydrological database, realignment of river basic information and
- Hydrological models.

a) Re-arrangement of observatories

There are many gauging stations being influenced by the back water of the large barrages in main rivers and weirs in tributaries. It will be necessary to re-select the stations without influence by the back water and with correct rating curve. Instead of the stations, the barrages and weirs is able to be selected for the control points.

b) Establishment of control points

The control points linked to basin water management (river stage, discharge and water quality), has to be established and basic information for 80 tributaries shall be authorized[48]. Because water level and discharge is changed by daily operation of barrages in the main rivers and weirs in tributaries, the control points are selected with consideration of the effect by water operation.

c) Re-build of hydrological database, realignment of river basic information and hydrological models

For the management of flood control and low water management, a numbers of management criteria must be determined by hydrological models with the reliable data arranged in database. Some models were already recommended in existing reports, but verified models with latest observation data has not been established for whole the Northeast Region basins. To clarify the current hydrologic condition and decide the management criteria, at least four(4) types of models are required, as noted below.

[48] Basic information for 80 tributaries is not authorized and their description and figures are also different by reports and organizations respectively.

1) Water balance models for 3 basins to understand water balance in accordance with the future development and management plan,

2) Runoff models for 3 basins to grasp the flood condition for determination of high water level(flood level),

3) Groundwater flow and water quality models for the surface-ground water system to evaluate the salinization from salt layer underneath in accordance with the future development and management plan,

4) Water demand management models as decision support system to evaluate above 1)-3) results and evaluation of management criteria.

(2) Operation of Large Reservoir Dams

As for the operation of Ubonrat, Lam Pao reservoir and middle scale reservoirs[49], following improvement plans are considered.

a) Ubonrat and Lam Pao

The dry season outflow has been increased by the reservoir operation but used mostly for dry season irrigation and as a result the existing dry season runoff in the Chi river is about 1,000 MCM, which is mostly same as the original runoff. It is desirable to increase the dry season runoff to 2,000 MCM at least by the improved reservoir operation. Conversely in wet season, discharge amount shall be decreased in December and April to May and concentrate water use in June to July in accordance with water demand.

b) Medium Scale Reservoir

Reservoirs are designed with very shallow depth of 3 to 5 m, which bring about large water losses by evaporation and seepage from reservoirs. Many existing reservoir dams have not adequate data such as catchments area, reservoir inflow, active capacity, full, high and low water level, H-A and H-V curve, scale of beneficial area, etc. to carry out the proper and effective reservoir operation[50]. In addition, the reservoir capacity is decreasing year by year by sediment

[49] As tributaries in the Khong basin is mostly formed with vast plateau and plain, suitable dam sites with large capacity are limited and only three dams are constructed at present. In the Chi basin, a hydropower dams of Chulabhorn is located at the upstream of Ubonrat dam in the Phong tributary basin and have not influence to control the runoff in the Middle Chi basin. Ubonrat dam is the most important one to mitigate flood and supply irrigation water to the Middle Chi basin. Lam Pao dam is locating at the Lam tributary in the Chi river and the most important one to control the Lam Pao runoff and to supply irrigation water to the Lower Chi and Middle Mun basin. In addition, Lam Pao dam is under improvement to increase the active capacity to 1,530 MCM in order to enlarge the flood control capacity and introduce the diversion water from the Huai Luang wetland. In the Mun, all dams except for Sirindhon dam are constructed at the most upstream tributaries in the Upper Mun basin and their reservoir water has been used mostly for irrigation at the immediate downstream area of dam sites, so that the river runoff flowing down in the Upper and Middle Mun river is considerably decreasing.

[50] As large scale dams are limited by topographical constraints in the Northeast Region, about 300 medium scale dams are constructed and under operation. However, medium dams have been planned and constructed without feasibility study and with short study period. Accordingly, there are existing many dams having inaccurate and unknown dimension for available inflow, active capacity, design outflow capacity, allowable irrigation area, etc. It is necessary accordingly to review the existing dimensions and set up the reasonable and sustainable reservoir operation rule. In addition, some existing dams have possibility to increase the dam height and active capacity.

transport by flood. Some dams have possibility to increase the dam height to increase the reservoir capacity. Accordingly, the inventory survey to check and review the reservoir dam dimensions as mentioned in the above shall be carried out and then reservoir operation guideline to use the reservoir water effectively shall be prepared based on the reservoir operation study.

c) River Maintenance Flow

The water allocation for the river maintenance flow shall be made with the first priority to conserve the environment of the river. In the each tributary and project, the water allocation in the wet and dry season shall be re-studied.

d) Operation of Weir and Barrage

Guideline of Weir Operation

River flow is affected by operation of weir and barrage. Operational guideline shall be prepared for each weir and barrage based on monthly water level.

High water and Low water Management

As the river shapes has been changed by flood and sediment load, the river training works are required to release the flood smoothly at high water, as well as release the small discharge in the dry season at low water. As many retarding ponds are distributed along the Chi and Mun river, the flood and drought mitigation plan by using the retarding ponds shall be proposed.

Fish Pass

Fish cannot migrate in the river and tributaries because the river and tributaries are closed by barrages and weirs, the fish way to release a part of river maintenance flow, with upstream and down stream channels capable for various type of aquatic life, shall be considered.

e) Water Resource Development and Water Diversion

Due to the improvement and effective use of water in wet and dry season, water development and /or water diversion plans from Khong basin and Mekong river shall be carefully discussed with long term vision of the Northeast Region.

Khong Basin

In order to use the rich runoff in the wet season, especially in the peak wet season of August to October and mitigate the flood and drought. The medium scale reservoir dams shall be proposed with consideration of topographical conditions where large scale reservoir dams can not be allowed. While the large scale inundating areas with water depth of 6 to 8 m is extending in the wet season. However, the inundating water is not used yet at present even in the wet season and released to the Mekong river in the dry season. The water utilizing plan in the wet land is the important issues. The water diversions from the wetland are also evaluated with both sides of negative and positive points of view.

Review of Proposed Reservoir Operation

Improvement plan for the reservoir operation as mentioned in the above (3) is originally proposed by ADCA (Agriculture Development Consulting Association in Japan) and has been studied by both of RID and ADCA since 2007. Lam Pao dam is under upgrading works by RID in order to increase the active reservoir capacity of 1,060 MCM to 1,530 MCM and RID is going to carry out more detailed reservoir operation study proposed by ADCA to apply for the actual reservoir operation of Lam Pao after completion of the upgrading works. Because, the wet season outflow is stabilized and the dry season outflow will increase to 900 MCM from the existing 600 MCM in the case of without water diversion and 1,250 MCM with water diversion from Huai Luang wetland. In addition, the dry season outflow of 300 MCM can be increased by the improved reservoir operation of Ubonrat without water diversion.

In the case of improved reservoir operation without water diversion the irrigation area of 800,000 rai in the wet season and 400,000 rai in the dry season could be newly developed in the Middle and Lower Chi basin. In the case of the new operation for Lam Pao with water diversion and Ubonrat without water diversion, the irrigation area of 2.0 million rai in the wet season and 1.0 million rai in the dry season could be developed. The developed new area is extending to the Middle Mun basin by the water diversion from the existing Yasothon Phoanom Phrai barrage in the Lower Chi to the existing Rasi Salai barrage in the Middle Mun with gravity flow[51]. This project will contribute largely for the flood and drought mitigation in the Northeast Region with the water management of two reservoirs with less investment.

3.14 Royal Thai Government's Challenge to Introduce Integrated Water Resources Management (IWRM)

In response to the call as derived from "Dublin Principles" confirmed in the international conference held in 1992 in Dublin, Ireland, in Thailand preparatory works for introducing IWRM had been started at an early date and by now a road map to introduce IWRM has been prepared and implemented to date.

IWRM elements practiced in Thailand can be summarized as follows.

* Important elements in the IWRM implementing process
  - Clear and common interpretation of IWRM concept
  - Awareness on water and sharing of idea that participation in the process is very important
  - Integration of 3 key principles in IWRM (Legal support, institutional framework

[51] There are high possibility to use the large flood plain in the Middle Mun basin for the reservoir by proper control of Rasi Salai reservoir and water diversion from the Yasothon Phanom Phrai barrage to Rasi Salai through the Siaw Yai tributary, which had been studied preliminarily by ADCA (Agriculture Development Consulting Association in Japan) in 2007.If the dry season water is diverted from the Chi river to Rasi Salai reservoir with gravity flow, such water could be supplied to the agricultural area along the tributaries of Siaw Yai, Thap Than, Samran etc. with low pumping head of 10 to 20 m because the back water of Rasi Salai reservoir with the water level of 120 m. can easily enter to downstream of Siaw Yai and Thap Than tributary and then be used for agriculture area lying on the elevation of 135 to 120 m. by pumping system with 10 to 15 m. head. The expected irrigation area will be 1.0 to 1.5 million rai at least depending on available dry season water at Yasothon Phanom Phrai barrage site in the Chi river.

and management tool)
- IWRM institutionalized into government system through highest level endorsement
- Establish water "Champion" to catalyze and pursue the policy and implementation process

* 3 key principles of IWRM

(1) Formation of enabling environment for legal support
- Confirmation of national water vision
- Formulation of national water policy
- Fixation of budgeting for RBCs
- Fixation of water sector budgetary procedure
- Drafted water law

(2) Institutional framework
- Establishment of RBCs
- Foundation of DWR

(3) Management instrument
- Water dialogues
- IWRM training
- River basin plan

In Thailand, IWRM was put into practice with the following processes.

1) The first approach taken in Thailand was to generate consensus. This was because of the necessity to gain support and approval from a wide range of water sector stakeholders (e.g. civil society, academia, government). It was in 1999 that a national dialogue to introduce IWRM to a large group of multidisciplinary stakeholders was held and the participants endorsed IWRM as a useful process and approach for water resources management, and recommended that the government should be aware of and support IWRM principles. The recommendation was submitted to the Cabinet for endorsement through the NWRC.

2) A multi-stakeholders workshop to draft a national water resource vision was conducted in July 1999. The Cabinet endorsed it as the National Water Vision in July 2000.

3) The National Water Vision was translated into a nine-point water policy again through a multi-stakeholder workshop in March 2000 and the Cabinet endorsed it as the National Water Resource Policy in October 2000.

4) Simultaneous to the above, the government approved a proposal to establish three pilot river basin committees (RBCs) proposed by the National Water Resources Committee in April 1999. Since then, more RBCs have been established with financial support from the government. At present there are 25 RBCs in Thailand, one fro each of the 25 major river basins in the country.

5) IWRM training modules wee designed for various stakeholders from the grassroots level to

decision makers. Training programs on IWRM were developed and conducted for the members of RBCs as well as government officials since the establishment of RBCs.

6) A comprehensive and integrated water sector budgetary procedure was discussed, and it was confirmed that the comprehensive budgetary procedure mandates the RBCs to align their budges to the national budgetary procedures and timelines and to consider and endorse the water resources projects in their respective river basins as proposed by the various government agencies prior to submission for budget allocation. The water sector budgetary procedure was submitted to the Cabinet, which then approved the procedure in June 2002.

7) Preparation of river basin plan was launched in 2001 with emphasis on stakeholder participation in the process. The objective was to provide the opportunity for local stakeholders to participate in identifying problems and solutions to water management issues and accordingly formulate basin programs and basin plans with the help of experts and/or consultants who were then engaged to undertake the preparation of all 25 river basins plans. While the plans were not perfect, the process followed provided a concrete opportunity for the experts/consultants and stakeholders to agree on the key components of the plan, and work together as a team. Presently, all projects proposed by all water related agencies now have to engage stakeholders in the project areas through such a public participation process.

8) An institutional reform process with the aim of consolidating water resources related agencies was launched by the government, resulting to the establishment of the Ministry of Natural Resources and Environment (MoNRE) in 2002. The Department of Water Resources (DWR) was also established under MoNRE by pooling technical staff members from five (5) water related agencies. The DWR was designed to function as a regulating agency, with awareness raising and promotion of IWRM concept as one of its activities.

9) In 2004, the DWR commissioned the drafting of a National Water Resources Law with the objective of updating and consolidating fragmented water related laws, policies and guidelines in the country. The drafting process itself was a pioneering process, which started with holding public hearings throughout the country to consult stakeholders on the important provisions that should be integrated in the National Water Resources Law. A team of legal experts then drafted the water law to cover all the identified issues, subjects and provisions. The first draft was presented to various stakeholders through a number of public hearings, and legal team integrated the feed back into a second draft. The final draft has been submitted to the government, and is awaiting government endorsement to the Parliament for consideration and enactment.

All the process as stated above was a part of concrete practice for introducing IWRM as the national system for water management.

The basins where IWRM practices were introduced are Chaophraya river basin, Yom river basin and Bang Pakong river basin for which some information shall be noted hereafter, but there has been no IWRM practice introduced in the river basins in NE Region except some initial activities on the tributary basin level in the middle Chi basin.

What is Integrated Water Resources Management?

The last decade has seen an increasing recognition of the need to protect and sustainably manage our water resources. The international conference on Water and the Environment held in 1992 in Dublin, Ireland, called for new approaches for the assessment, development and management of freshwater resources and produced what is now referred to as the Dublin Principles for sustainable water management.

Dublin Principles for sustainable water management

- Freshwater is a finite and vulnerable resource, essential to sustain life, development, and environment
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels
- Women play a central part in the provision, management and safeguarding of water management and safeguarding of water
- Water has an economic value in all its competing uses and should be recognized as an economic good

Based on the Dublin Principles, the Technical Committee (TEC) of the Global Water Partnership (GWP) defined IWRM as a process towards improved water resources management:

"IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-system."

In addition, the previous five World Water Forums (1977, 2000, 2003, 2007 and 2009), the Millennium Summit (2000), the World Summit on Sustainable Development (2002) and the four Asia Water Forums (2003, 2005, 2007 and 2009), as well as other international and regional forums had reiterated the need for concerted global and regional actions for sustainable water management action. In particular, one of the Ministerial Declarations issued during the World Summit on Sustainable Development in Johannesburg is *"for every country*

Note: The above description is abstracted from "Implementing Integrated Water Resources Management (IWRM): based on Thailand's experience, Dr. Apichart Anukularmphai, President, Thailand Water Resources Association"

3.15 Issues and Policy Direction

To consider the water resource management in the Northeast Region, the issues are classified into three (3) categories of water use (irrigation), the flood management (river improvement), and environment (water quality and damage from salt water). Issues are arranged according to each category as below.

3.15.1 Issues on Water Use

(1) Water Resource Development Amount

The strategy for the water use plan in Thailand is reflected by climate condition which the most of surface water and 85 to 95% of river runoff concentrates in the rainy season, and the surplus water of wet season is stored for the use of the next dry season with various headwaters such as

reservoir, channel storage, pond, etc. Although the water is stored by the various facilities, the most of water resources have been utilized by large dam-reservoirs. In other regions out of the Northeast Region, the rate of the reservoir capacity (active storage capacity) to total runoff of basin (water resources) is high as 80% to 100%[52]. As an instance, Upper Chao Phraya Basin has 2,400 MCM of active capacity which is 95% of the 2,500 MCM of water resources.

According to basin water balance as shown in Appendix 3.15.2, the runoff rate is indicated as 35%, 17% and 13% in Khong, Chi, and Chi-Mun basin respectively. Consequently, it can be recognized as 75 to 87% is lost by water use and evapotranspiration from the basin, Moreover, the rate of developed water to water resource is 5%, 40%, and 21%, respectively for Khong, Chi, and Mun basin.

In the Northeast Region, large number of reservoirs constructed with small scale, middle-scale projects, and the large reservoir of Ubonrat (active storage capacity: 1,760 MCM) and Lam Pao (active storage capacity: 1,060 MCM) have been constructed. However, due to topographical conditions as flat undulation terrain, effective dam reservoir is few, and even if summing up all reservoirs' capacities, active storage capacity is limited as 10,000 MCM.

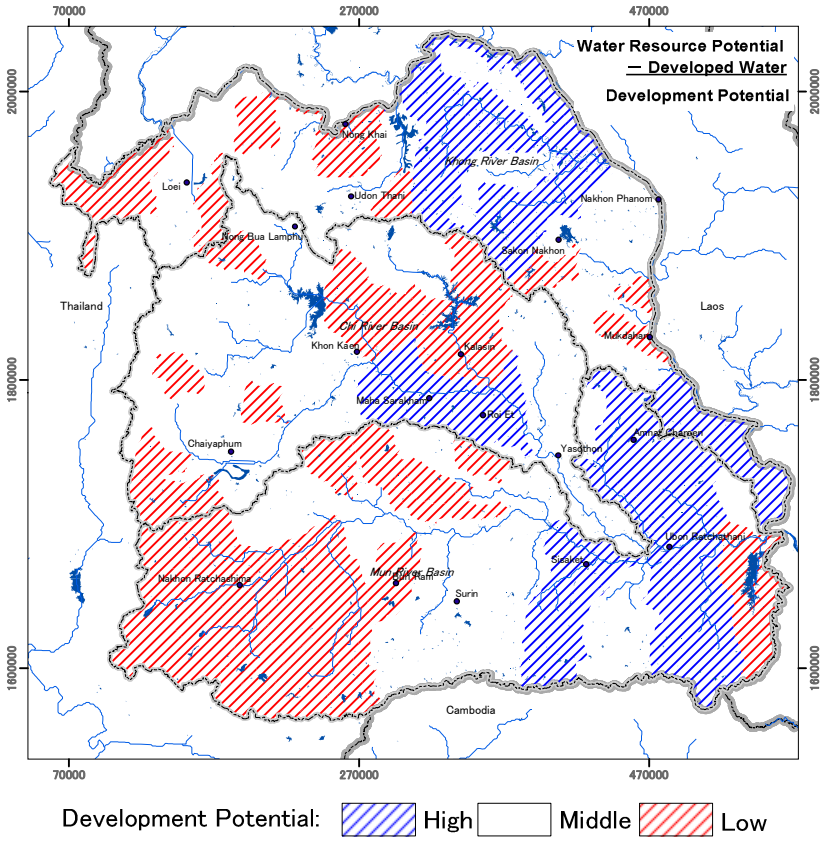


Figure 3.15.1 Water Development Potential

Accordingly, only 15% of the water resources of 65,000 MCM have been developed by the present, 85% of water resources is still lost by evapotranspiration or released to Mekong river.

As for the distribution of development potential, the value subtracting developed amount (existing water use) from water resources, is shown in Figure 3.15.1. As shown in the figure, high potential area for development is restricted to the down stream of three (3) basins, and the drought zone such as Upper Mun, known as occupied by broad rain-fed paddy, have not sufficient potential for the development.

[52] Wet years' runoff records (Aug. to Oct.) is in general applied for the dam plan, consequently most of dam reservoirs are large capacity compared with average years' runoff.

(2) Storage Loss

In the Northeast Region, over 80 % of area is covered by the gentle relief topography so that the dam reservoirs do not store the water effectively. Even tough the reservoir area is large, the shape is inefficient like as pan-shaped with shallow depth. The active depth of reservoir operation therefore is limited such as 7 m of Ubonrat, 6m of Lamb Pao and 3 to 4 m of Middle scale dams. One eighth to one third (1/8 to 1/3) of the active storage (13% to 33%) is annually lost by evaporation and infiltration.

(3) Reservoir Operation

The active reservoir capacity in the Northeast Region is estimated as about 10,000 MCM in total. The water use plan by proper reservoir operation is set up simply as follows.

- Active capacity of 10,000 MCM is filled up to the full water level generally at the end of wet season (October to November) by the ordinary reservoir inflow except for the dry year with less reservoir inflow.
- The carrying over capacity of 2,000 MCM shall be saved for the carrying over capacity at the end of dry season (May) for the supplement irrigation water for the wet season paddy in June to July in next year.
- Accordingly the remaining 6,500 MCM (65%) is available water for the dry season irrigation[53].

The issues on reservoir operation depend on the scale of reservoir as well as their hydrological conditions where reservoirs are placed. Due to topographic condition, their involved issues are also differed respectively. As the operation on largest reservoirs in the Northeast Region, those on Ubonrat and Lam Pao are summarized as below.

a) Review of Reservoir Operation for Ubonrat and Lam Pao

The existing reservoir operation result of Ubonrat and Lam Pao is reviewed approximately as shown in Table 3.15.1.

< Ubonrat Reservoir Operation>

Annual inflow: Inflow in the average year is 2,400 MCM, which decreases to 1,940 MCM in the outflow. Lost water is estimated as large amount of 460 MCM (=2,400-1,940), which is mostly similar value of 400 MCM(=3,960–3,560) in the wet year and 430 MCM(=1,030-600) in the dry year. It is assumed, this large water loss may be taken place by not only evaporation and seepage from the reservoir but also reservoir water use at surrounding area of the reservoir.

The dry season inflow of 230 MCM in the average year increases to 660 MCM in the outflow by the reservoir operation. The increased dry season water is only 430 MCM (660-230), which is clearly small water as compared with large active capacity of 1,760 MCM.

[53] According to the irrigation sector review (MRC, 2009), 2,400MCM/year is reported as irrigation water in dry season and is much different from 6500 MCM/year of discharge amount from dams. It may imply impropriate operation of dams for irrigation demands.

Reservoir Capacity: It is desirable to maintain the dry season water of 1,000 MCM at least corresponding to 60% of the active capacity by improved reservoir operation method. The reservoir capacity at the end of wet season is 1,110 MCM in the average year and 1,560 MCM in the wet year. This capacity is clearly small as compared with the active capacity because the inflow of 460 MCM in the average year is lost by evaporation and water use mentioned in the above and also the wet season outflow of 1,280 MCM seems to be large. It is desirable to minimize the outflow in the wet season to less than 1,000 MCM because the Phong downstream has much wet season runoff.

Over-year Storage: The carrying over capacity at the end of dry season reaches 400 MCM[54] in the average. The proposed carrying over capacity will be 250 to 300 MCM. Large inflow of 1,410 MCM in September in the wet year decreases to 610 MCM by the reservoir operation, while very small inflow of 25 MCM at March increases to 120 MCM by the operation. The reservoir fulfills the flood and drought mitigation effort but more effort could be obtained by the improved operation.

Flood Regulation: With the effort in current operation, outflow discharge in wet season (e.g. 1,410 MCM in September) has decreased 610 MCM, while dry season amount (25 MCM in March) increased 120 MCM. With further improvement in operation process and its monitoring function, the flood control capacity is expandable in the future.

Table 3.15.1 Existing Reservoir Operation Result of Ubonrat and Lam Pao Dam

Items	Ubonrat (Capacity of 1,760)					Lam Pao (Capacity of 1,060)				
	Wet	Dry	Total	Sep	Mar	Wet	Dry	Total	Sep	Mar
1. Average Year										
Reservoir Inflow	2,170	230	2,400	780	25	1,930	140	2,070	660	13
Reservoir Outflow	1,280	660	1,940	260	120	1,240	600	1,840	370	120
Remained Capacity	1,110	400	-	960	590	640	50	-	1,200	630
2. Wet Year										
Reservoir Inflow	3,740	220	3,960	1,410	40	2,630	170	2,800	950	18
Reservoir Outflow	2,530	1,030	3,560	610	190	1,240	800	2,600	650	155
Remained Capacity	1,560	420	-	1,560	800	830	40	-	970	210
3. Dry Year										
Reservoir Inflow	830	200	1,030	340	20	1,330	130	1,460	520	8
Reservoir Outflow	400	420	600	30	50	840	360	1,200	190	85
Remained Capacity	400	170	-	380	160	460	100	-	700	130

< Lam Pao Reservoir Operation >

Lam Pao reservoir operation has similar issues as is Ubonrat operation.

Annual inflow: Annual inflow is 2,070 MCM. However, annual outflow is only 1,840 MCM. The difference (230 MCM =2,070-1,840) is regarded as lost water by evaporation, seepage from the reservoir and water use at the surrounding area of the reservoir. Regulated amount (by deducting the inflow from the outflow).in dry season is estimated as 460 MCM (=600-140) in the average year and 630 MCM (=800-170) in the wet year The amount is not so large as compared with the active capacity of 1,060 MCM..

[54] The amount seems to be large taking into account the irrigation water demand of Nong Wai Project with area of 260,000 rai in June to July in the wet season.

Reservoir Capacity: Reservoir capacity at the end of wet season is 640 MCM in the average year and 830 MCM in the wet year. They seemed to be small as compared with the active capacity of 1,060 MCM.

Over-year Storage: Although the carrying over capacity at the end of dry season reaches 500 MCM in the average, it can decrease by the improved operation.

Flood Regulation: RID has constructed new spillway aiming to rise-up Full Water Level and High Water Level as is FWL increases EL164m (from EL162m) and HWL increases 165.5m(from EL164m). Consequently, active storage capacity of 1,060 MCM increases 1,630 (Gross Storage Capacity: 1,981MCM) and Flood Regulation is strengthen.

b) Issues to be Improved for Reservoir Operation of Two Dams.

Ubonrat and Lam Pao reservoir seems to have sufficient inflow of 2,400 MCM and 2,070 MCM respectively as compared with the active capacity of 1,760 MCM and 1,060 MCM. However, large amount of inflow such as 460 MCM in Ubonrat 230 MCM in Lam Pao is lost by the reservoir losses and reservoir water uses. Further, large wet season outflow such as 1,280 MCM in Ubonrat and 1,240 MCM in Lam Pao is carried out and as a result the reservoir can not fill up the active capacity at the end of wet season and the dry season outflow becomes small naturally. Therefore, the reservoir operation shall be improved so as to reduce the wet season outflow firstly and deficit water by reservoir loss and water uses shall be covered by the water diversion from the other basin. It is very important that the active capacity shall be filled up at the end of the wet season or at the end of December because December has still some runoff in the downstream river and does not require much irrigation water as compared with January to March in the dry season. In addition, the dry season reservoir operation shall be carried out so as to release much outflow in January to March requiring irrigation water and save the outflow in December, April and May, which have still runoff in the river but does not require much irrigation water.

(4) Irrigation

The irrigation area in the Northeast Region is about 7.5 million rai in the wet season and 1.1 million rai in the dry season showing very low irrigation rate of about 15% and only 2% for total farm area of 53.1 million rai. The water resources at each tributary basin and the river flow in the Khong, Chi and Mun basin have been changed by the irrigation water use of those many projects. The beneficial area contributed by those irrigation projects is about 15%, and .out of beneficial area (85% of farm area) has suffered serious water shortage due to in a part excessive water use for the irrigation.

Crop diversification is suggested by government as the surface water and river runoff are limited, it expands the cultivation area of cassava, maize, sugarcane, rubber tree, etc. requiring less irrigation water demand as compared with paddy cultivation. In the existing irrigation area, the water duty will be changed in accordance with crop diversification in future, the water duty shall be reviewed periodically and the water operation for irrigation facility shall be improved.

Existing irrigation area and water use in the dry season is estimated only as 24,000 MCM in

MRC survey. However, 6,500 MCM is obtained from reservoir operation, and there are big difference between 6,500 MCM and 2,400 MCM, so that it is necessary to review the existing reservoir operation.

3.15.2 River Flow Control

The slope of river bed is very gentle as is 1:7,000 at the up-steam of Chi and Mun and 1:50,000 at the middle stream of Mun. If floods occur in the rivers, flow velocity is not so fast, therefore the serious damage such as for human life is few. In Khong basin, the floods are controlled by a seasonal change in Mekong river. It is also gradual change of water level.

As a traditional life, people were living with a flood as a part of life. However in recent year in particular after 1980's as the basin development has been progressing, floods frequently bring down the economical loss. To release the flood damage, effective countermeasure is demanding these days through a facility operations. However, in the projects area, the numbers of type of water facilities, comprising of 21 large-scale and 356 middle-scale reservoirs and 996 pump stations, and they make river flow management difficult.

As the principal of river flow management, the control point is to be settled for observation and flood control. However, the necessary information, such as station networks, evaluation systems, routine analysis and basin-wide guideline have not been prepared yet[55].

3.15.3 River Environment (water quality)

In the Northeast Region, the basin-development has been conducted for the acquiring irrigation water with many plans which include the water-diversion from other basin. In the development planning and water use, the first priority is to be given to the river maintenance water in addition to the possible maximization of water use. In fact, the consideration of river environment is a key for a sustainable development of the basins. Although the river flow has been actually increased by the existing developments, a deterioration of water quality is also reported increasingly year by year by monitoring data[56]. It indicates that the maintenance water is not sufficient to preserve the river water quality, so far.

As well, low water management is an essential for the river environment in dry season. But control points have not been firmly settled yet and data processing, analyzing and planning for low water flow improvement works are still in progress.

3.15.4 Issues on Institutional Aspect of Water Resources Management

In practicing an improved water resource management in the Northeast region, followings are identified as the problem areas.

(1) Lack of laws/regulations on water resource management

The lack of specific law concerning the authorities of related agencies/organizations such as

[55] Measures for flood prevention with telemeter system are now planning and installing in Chi-Mun river.
[56] Arunin S, 1984, Characteristics and management of salt-affected soils in the northeast of Thailand. Food and Fertilizer Technology Center for the Asian and Pacific Region (FFTC Book Series no. 27)

NWRC, RBC and DWR causes always difficulties in practicing water management in the country. For this sake, it is considered necessary for the Minister of MoNRE to take a leadership in doing water management in an integrated manner and to show the political will to secure an endorsement by the Cabinet and to secure approval by the parliament on the drafted Water Law. There is an anxiety, however, that the Draft Law may, depending on the contents, give too much authorities to RBC, which may possibly result in influence-peddling to the local politicians. Therefore, it is considered very necessary to take a transparent process in finalizing the contents of the Draft Law through having public hearings sufficient to integrate opinions from the civil society.

(2) Duplication of roles by RID and DWR and the unclearness

As pointed out the matter concerning the NWRC, roles of RID and DWR duplicate both at the central and regional levels. There happened to be different projects proposed by plural numbers of agencies but the nature of the project is similar and the project locations are same. In principle, the DWR is to limit their role as a regulator without putting emphasis on the project implementation itself. Otherwise, it is afraid that DWR may not function as the secretariat offices for NWRC and RBCs and also the role of regulator in promoting the IWRM nation-widely.

At the RBC level, low profile of RID's participation is observed. This may disturb an efficient and proper function of RBC, as RID is the largest water user in any of the 25 basins in the country. It shall be necessary to have incentives and rules to cause more intensive participation by RID in RBCs.

(3) Insufficient budget allocation for RBC and limited technical capacity

With the budget availed at present, RBC's activities are limited to hold meetings several times a year. It seems impossible to do other needed activities such as activities by working groups in each tributary basin, participatory action program and conducting of learning process. Further, in order to conserve the water resources through equitable water allocation and efficient water use, calculation of water balance and monitoring of river discharge etc. shall be worked out by RBC, for which strengthening of technical capability of RBC is deemed necessary.

(4) Organizing of WUG and expansion of PIM practices

RID intends to materialize PIM through strengthening the related organizations and their roles by means of providing legal status by amending the State Irrigation Act. However, the amendment of the Act alone can not bring the fruitful PIM practice for each of the irrigation system in a day, but it requires day-to-day efforts to strengthen a number of WUGs for each locality. Even in case an efficient water use with less RID staff could be materialized, the quantity of water available and the irrigation area could not always be increased, and therefore, it is considered necessary to include some incentives for farmers to participate in the water management in the process for the organizational strengthening. For example, combinations of rehabilitation and improvement of facilities with PIM program and income raising through crop diversification and value-adding are the ideas so that farmers may really feel the advantages of improvement by PIM.

(5) Water resource management/promotion and control of irrigation development by provincial government and TAOs

Under the trend of accelerating decentralization, development and O & M of small scale irrigation projects have been transferred from RID to TAOs. There are many TAOs who show interest in irrigation development, but it is difficult for them to promote it individually by TAO due to the lack of budget and technical capability. While, provincial governments have much bigger budget and are in the position to receive technical support by the provincial offices of RID and DWR. This suggests that for small scale projects provincial level authorities engage mainly in the management of natural resources, irrigation development and O & M of the existing projects. With this concern, it shall be noted that even small scale if many numbers of project be implemented like pumping irrigation from rivers and community pond project in rain-fed areas, they will affect on the run-off and river discharge for sure and it is necessary to have control system on tributary/basin levels, for which RBC should play the assigned important role.

3.15.5 Potential/tasks on Water Resource/Irrigation Development and Challenges for Improved Water Resource Management

(1) Potential/tasks on water resource/irrigation development

1) Changes in water storage developed and irrigation area

Modern irrigation development in the Northeast Thailand has been progressed stage by stage since the mid of 20th century. It was in 1951 some time after the end of the 2nd world war that RID started pilot projects by means of weir construction and small scale reservoir. At the same time, like Thung Samrit Irrigation Project, there was a project implemented to supply irrigation water through intake weir without storage reservoir upstream. However the effect by irrigation was very limited under the hydrological condition particular to the Northeast Region where river run-off was so fluctuating and unstable.

Entering into 1960's, NESDB formulated "Northeast Region Development Plan (1962-66)" and proposed a large scale reservoir/dam construction and large scale irrigation development plan from a long term development perspective. As the results, those large scale projects as noted below were completed in the 1980's with having technical as well as financial assistances by donors as noted.

*Ubonrattana dam	(2,264 MCM)
*Lam Pao dam	(1,430 MCM, World Bank)
*Sirinthorn dam	(1,966 MCM, OECF, Japan)

Simultaneously, construction of medium scale irrigation facilities was enhanced and the irrigation area of about 160,000 ha (1,000,000 rai) in 1970 was expanded to the double coverage of about 330,000 ha (2,060,000 rai) in the mid 1980's.

Such large scale irrigation projects as implemented in the period from 1960's to mid 1980's were accompanied with large scale reservoir construction. Since then, however, large scale projects

were hardly implemented due mainly to the difficulties in settling the resettlement issues and in finding suitable sites for large scale dam construction. As was the case, instead of large scale project, medium scale projects were regularly planned and implemented to expand the irrigation areas by medium projects to cover as large as 158,000 ha (985,000 rai) during the period from mid 1980's to the year 2005.

While, RID actively implemented the small scale water resource/irrigation development projects since the later part of 1970's focusing on the quick yielding and more number of beneficiaries nation-wide in a shorter period. At the same period, the Department of Energy Development and Planning (DEDP) implemented a number of electric pumping irrigation projects. In Chi and Mun Basins, 20,000 ha (125,000 rai) irrigation area by 79 pump stations in 1982 was expanded to 160,000 ha (1,000,000 rai) by 653 stations in 2000 as confirmed.

As the water resource development within the Northeast region was considered to approach to the marginal area, a new concept development plan of Khong-Chi-Mun Project was formulated and proceeded to its implementation. The project is of huge scale by 3 phases for 42 years implementation period. The beneficiary irrigation area covered as many as 15 provinces with 800,000 ha (5,000,000 rai) and the water source was targeted to the Mekong main stream. The project planning and subsequent implementation were executed during the period of 1992-2000 by DEDP, and as many as 20 large scale weirs and associated pumping facilities were constructed in Chi and Mun basins. The project was, however, faced with suspension due to the economic crisis occurred in 1997 and also to the difficulty in securing water source in dry season from the Mekong mainstream. As was the case, the water source for the project has not been secured to date. Almost all the weir facilities as well as pumping stations as constructed by DEDP under the said project have been transferred to RID owing to the re-organization of government structure in 2002, and the small scale pumping facilities were further transferred to the local administration bodies (TAOs). Of all, RID started to operate as many as 4 weirs on the mid basin of Chi river in an integrated manner and commenced due planning for additional pumping facilities aiming at improved operation and maintenance on such existing facilities. While for the existing weirs in Mun basin, the facilities remain at the status of an independent operation by each individual facility in need of introduction of integrated operation manner.

As of 2010, total reservoir volume and irrigation area by those of water resources and irrigation development in the NE is summarized as shown in the Table 3.15.2 (Detail figures shall be referred to Table 3.5.1).

Table 3.15.2 Water Resource Storage and Irrigation Area in Northeast in 2010

Basin	Large Scale Project		Medium Scale Project		Pump Irrigation Project		Total	
	Storage (MCM)	Irrigation Area (1,000rai)	Storage (MCM)	Irrigation Area (1,000rai)	Storage (MCM)	Irrigation Area (1,000rai)	Storage (MCM)	Irrigation Area (1,000rai)
Khong	984	395	3.15	404	-	479	1,294	1,278
Chi	4,089	1,130	451	305	-	726	4,540	2,161
Mun	3,235	928	910	775	-	339	4,145	2,042
Total	8,308	2,454	1,671	1,484	-	1,544	9,979	5,481

Remark: water storage and irrigation area of small-scale irrigation are excluding

The water resource development and expansion of irrigation area as discussed above shall be shown as in the following graph (Figure 3.15.2, Not including the irrigation area by pumping). As can be seen from the graph clearly, the tendency that the development of storage capacity has been nearing to the end or marginal area (After 1986, especially after 2000). This implies that today it is quite difficult to develop a large scale reservoir as the main facility for water resource development. Problems encountering include the followings:

Firstly, there is no more dam sites technically suitable for large/even medium scale reservoirs, being the most of suitable sites already developed. Secondly, as irrigation area expansion is subject to water resource quantity and there is the same tendency for the expansion of irrigation area.

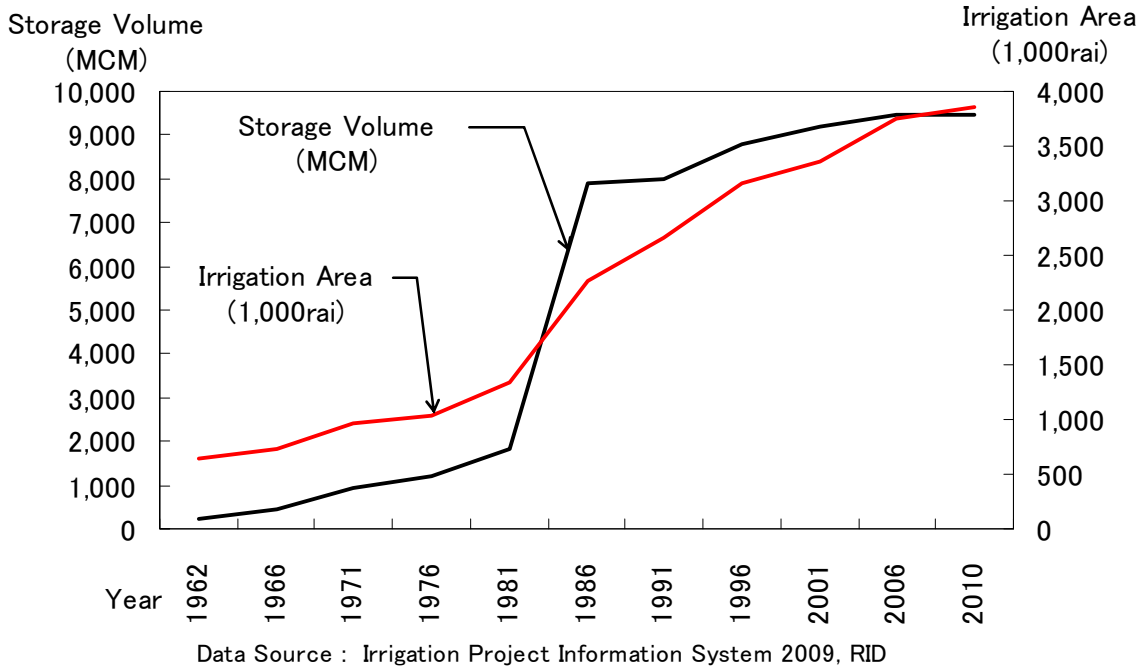


Figure 3.15.2 Changes of Water storage Volume and Irrigation area in Large and Medium Scale Project

2) Balance in water resource volumes and problem areas

A water resource balance study was made for the mean of 30 years period in the Northeast region. The result is as shown in the Table 3.15.3.

By the overall rainfall in the region (1,382 mm in regional average), as much as 228.8 Billion m^3 (No.1) of water appear in the region, of which potential run-off into rivers is mere 64.8 Billion m^3 (No.3). The difference of No.1 and No. 3 (164.0 Billion m^3, No.2) is lost as either evaporation or percolation into the ground before flowing into rivers or used in rain-fed areas.

Of the potential surface run-off of 64.8 Billion m^3, 12.8 Billion m^3 (No.4), 20 % is utilized for irrigation, supply to cities and domestic purposes.

Table 3.15.3 Water Resource Balance in the Northeast Region

No.	Items	Water Volume MCM / year					Remarks
		Khong Basin	Chi Basin	Mun Basin	**Northeast (NE)**	**% (%)**	
-	Basin Area (km^2)	(46,460)	(49,480)	(69,700)	**(165,640)**		
-	Rainfall (mm/year)	(1,593)	(1,279)	(1,314)	**(1,381)**	-	
1	Rainfall Volume	74,000	63,200	91,600	**228,800**	**100**	
2	Evaporation & Seepage (1)	48,400	49,000	66,600	**164,000**	**72**	
3	Potential Surface Runoff	25,600	14,200	25,000	**64,800**	**28 (100)**	Runoff to the channel
4	Developed Water Resource (Present Water Demand)	2,500	4,500	5,800	**12,800**	**[6] (20)**	Irrigation, Domestic Water Use, etc.
5	Unused Runoff (Drained to Mekong river)	23,200	9,400	16,200	**48,800**	**[21] (75)**	Almost discharged during Aug., Sep., Oct. & Nov.
6	Evaporation & Seepage (2)	-100	300	3,000	**3,200**	**[1] (5)**	Mainly from reservoir & river

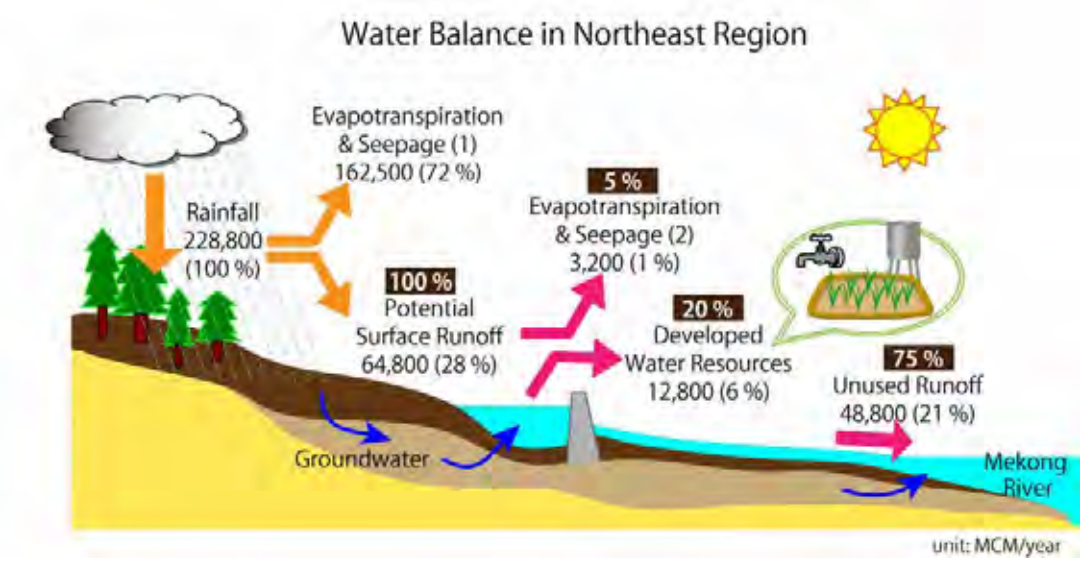


Figure 3.15.3 Water Balance in the Northeast Region

Average Monthly Discharge **Monthly Discharge Distribution**

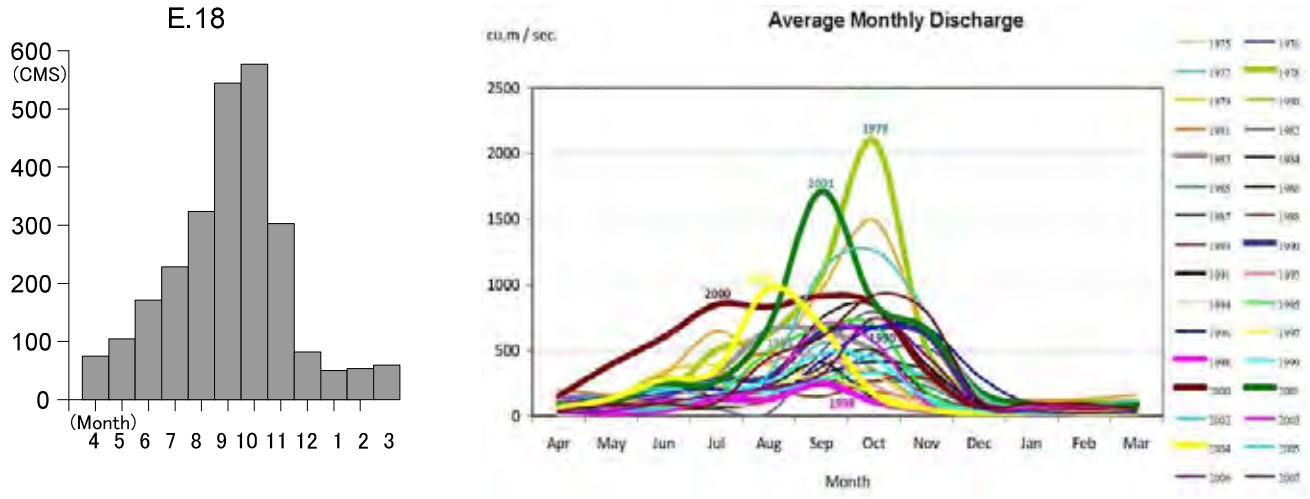


Figure 3.15.4 Water Discharge at E18 st. in Chi river

Of the remaining 80 %, 3.2 Billion m^3 (No.6), 5 % water is lost by evaporation from reservoirs and river channel.

Therefore, the possible water quantity to develop in future is the remaining 48.8 Billion m^3, about 75 % (No. 5). From the hydrograph as shown in the Figure 3.15.4, however, it can be found that the most of the run-off happen in August-November in wet season and finally empties into Mekong River, though there are some minor fluctuations in some years.

The irrigated agriculture in the Northeast is mainly for paddy cropping in the wet season. It requires supplementary irrigation water during May-July when river run-off usually prevails at low level, and further for the dry season cropping it requires more irrigation water per a unit area during January to May when river flow is extremely scarce. Accordingly, the big challenge in developing water resource in the Northeast is in the fact that storage is necessary to utilize the available run-off for irrigation out of the 48.8 Billion m^3 quantity which used to empty into Mekong River during the period of August to November.

Concerning the Table 3.15.3, it is noted that the evaporation and seepage is indicated as minus 100 MCM (No.6). The minus value is due to the inclusion of Mekong water in the water level data as affected by the higher water level in Mekong River.

3) Future potentials for water resource development and expansion of irrigation area

i. Large scale irrigation development accompanied by construction of dam/reservoir

Presently, there is only one on-going irrigation development plan inclusive of construction of large scale dam/reservoir in the Northeast region. The water resource development project in Upper Chi basin is the one and the project includes the following large-medium scale

dam/reservoir plans. For the Chi Bon dam and Yang Na Dee dam, however, a special study on salinity problem is required though EIA study has been completed and secured approval from the National Environmental Board (NEB). Prong Khun Pet reservoir plan is in the status pending approval for EIA and SIA, and further, the issues on land compensation is yet to be compromised. At any rate, there is no definite schedule confirmed for the start of said project implementation.

Table3.15.4 Upper Chi River Dam Construction Plan

No	Project Name	Province	Amphoe	Tambon	Capacity (mcm)	Irrigation area (rai)
1	Chi Bon dam	Chaiyaphum	Nong Bua Dang	Ta Yai	325	34,335
2	Yang Na Dee dam	Chaiyaphum	Ban Kwao	Chi Bon	70	165,300
3	Prong Khun Pet reservoir	Chaiyaphum	Bum Ned Na Ron	Kok Pet Patan	97	
4	Lum Sa Pung reservoir	Chaiyaphum	Nong Bua Dang	Nong Wang	32	24,000
5	Ban Loan Yod Chi reservi	Chaiyaphum	Nong Bua Dang	Nang Dad	26	15,000
6	Klong Cha Roen reservoir	Chaiyaphum	Nong Bua Dang	Nang Dad	12	5,000
7	Lam Jien reservoir	Chaiyaphum	Puk Dee Chum Po	Ban Jieng	50	40,000
8	Pra Ar Jarn Juer reservoir	Chaiyaphum	Sub Yai	Ta Kube	30	
9	Wang Da Lard reservoir	Chaiyaphum	Bum Ned Na Ron	Huai Yai Jiew	25	13,000
10	Chi Long reservoir	Chaiyaphum	Ban Kwao	Pu Ka Land	11	6,000
Total					678.21	302,635

Concerning the future development of large scale irrigation development inclusive of dam/reservoir in the Northeast region, the followings can be pointed out.

Firstly, there is little candidate sites with topographic conditions technically suitable for construction of large-medium scale dam/reservoirs or it can be said that most of the good sites have been already developed. Secondly, the situation becomes very difficult to solve the problems on resettlement, compensation for lands and environmental issues like negative effect on fishes and so on, leaving the possible consensus building among the stakeholders concerned very difficult. Thirdly, the economic viability on the project construction is worsened due to the longer implementation period as caused by required environmental counter-measures and escalation of cost for land compensation.

ii. Possibility/potential of water resource/irrigation development in Khong basin

The development manner of water resource and irrigation as in the Huai Mong project in Khong basin is considered to be possibly applied to the river mouths of other tributaries emptying into Mekong River (21 tributaries in total). Under the Huai Mong project, an estuary barrage was constructed near the confluence with the Mekong River which provided a water source reservoir by using the depressed low land at the back of the barrage. Irrigation areas are extended along the Huai Mong river and around the said reservoir. Irrigation is practiced by pumping for 54,000 rai area in wet season and 25,000 rai in dry season. In case the water available in the reservoir is not enough, additional water can be supplemented by pumping from Mekong River by using the pumping facility as installed at the barrage.

There is a similar project development plan in Huai Luang, Nong Khai too aiming at irrigation coverage for as large as 92,900 rai area (14,864 ha). Further, in Nakhon Phanom, an estuary barrage was constructed at Nam Kan where plan includes additional weir construction at upper-reaches so as to irrigate as large as 165,000 rai area (26,400 ha).

To this end, it shall be noted that in developing the depressed low land/swamps at the back of estuary barrage, careful attention shall be paid on conservation of eco-system including protection of wild fauna and flora as well as of local people's life-style with fishery and food supply. It is necessary to consider carefully about the natural and social environments so as to make up a well-harmonized development plan reasonably acceptable by the people living there.

iii. Medium scale irrigation development

Presently, RID is undertaking a preliminary study on potential of medium scale reservoir development using GIS for possible coordination of GIS with the planning for medium scale dam/reservoir project. According to the Interim Report (September, 2009) of the said study, the maximum development potential of storage capacity and irrigation area by the medium scale projects in the Northeast region are confirmed as shown in the following Table.

Table 3.15.5 Potential of Middle Scale Dam/Irrigation Development

Basin	Number of Project	Storage Capacity (MCM)	Irrigation Area (1,000rai)
Kong Basin	63	348	567
Chi Basin	74	1,620	891
Mun Basin	64	504	370
Total	201	2,472	1,828

Based on the above Table, there remains a development potential of 2.5 Billion m3 water storage by medium scale project in the region which may expand as large as 290,999 ha (1,828,000 rai) additional irrigation area. However, the plan shall be examined further from now on for social/natural environmental aspects, technical soundness as well as the priorities for development etc. and only after those could be cleared favorably the implementation plan can be formulated. Even in the case of medium scale project, similar to the large scale project, technically feasible sites are rather limited, environmental issues are not easily solved and possibilities to cause social conflicts are high especially in solving the compensation for land for those local residents to be resettled. These will be very much time-consuming processes and it is hardly possible to define the probable timing when these medium scale projects can be constructed and operated for actual farming production.

iv. Small scale irrigation development

There are as many as 2,930 SSIP projects planned to be implemented in the Northeast region after 2010. The storage capacity in total is about 485 MCM for irrigation area of about 534,000 ha (3,340,000 rai). In the SSIP projects planned, 1,041 pumping irrigation projects for 1,790,000 rai are included. As the initiation of SSIP projects are based on the requests by farmers, the possibilities to have social problems are very low unlike the large-medium scale projects. SSIP projects are of participatory type as led by beneficiary farmers from the beginning and

considered as one of the important sector in seeking possible development of limited water resource and expansion of irrigation area. Due to the fact that as many as 5,500 SSIP projects have been implemented in the Northeast region already, however, good sites are rather scarce. By now, those existing SSIP projects have been transferred already to each of local administration bodies responding to the policies implemented, but in some cases due to the insufficient budget allocated and the unavailability of technical staff in the local administration bodies, there observed complete absences of adequate O&M for the transferred facilities. It is considered necessary in this concern to establish a system RID can support the technical matters in the O&M of the transferred facilities.

v. Retarding pond construction at flood plains (Monkey cheek-Kaem Ling project)

Construction of retarding ponds is currently under-going in several locations. Though the individual impact as water resource development is not very substantial, the scheme is considered as one of the important development sectors in attaining expansion of irrigation areas steadily. Of those planned, small scale ones are included in the storage volume and irrigation areas under the SSIP category as above mentioned. In future, as many as 126 monkey cheek projects of medium size are planned which covers as large as 612 MCM storage and 24,900 ha (155,500 rai) irrigation area.

vi. Community –level water use in rain-fed area

Of the whole farm land in the Northeast region, 90 % is under rain-fed condition, of which 2/3 is of rain-fed paddy cropping. As discussed in the foregoing, the impact on agricultural production by increased use of water resources by means of farm ponds in rain-fed area is considered importantly substantial. In case of rain-fed paddy in particular, the water use as the supplementary supply for emergency case in May and June (Nursery period) when no rains continue is effective. Also, the farm ponds are important in supplying required irrigation water for fruit trees/vegetable and livestock in promoting self-sufficiency-oriented mixed farming under the “Self Sufficiency Concept” and New Theory farming as suggested by His Majesty the King.

Community ponds exist in many of the local villages. The water in the pond has been used traditionally as the source for agricultural and domestic uses. Recently, however, there are new challenges that the water be used for vegetable production in combination with the improved techniques for higher cash income. In the rain-fed area in Buri Ram province, there is a new project called “Ban Lim Thong and Ban Nong Thong Lim Pilot Project”. Under the project, the flood water flowing down through 1,291 ha project area is caught by 10.9 km collecting canal and stored in 15 farm ponds (132,941 m^3 storage) and used for irrigation and domestic use in the community. The project is practicing a new method of water resource utilization by farm ponds and considered advantageous and applicable in other rain-fed areas in the region.

4) Tasks/challenges in water resource/irrigation development in future

As discussed in the foregoing, construction of new large/medium dams/reservoirs is becoming more difficult and the tasks and challenges for further development can be considered as follows

divided largely into 7 items.

- Improvement in water use efficiency:
    - Heightening of reservoir's full water level
    - Improvement in operation
    - Expansion of irrigation area
    - Improvement of canal facilities and management facilities
- Efficiency improvement by additional distribution canals and on-farm facility
- Re-vitalization of WUG organization and equitable/efficient water distribution by participatory manner in the existing irrigation project area
- Increase of water conservation forest by reforestation (Check dams)
- Increase of water use volume by farm pond and water harvesting in rain-fed areas
- Basin management through introducing IWRM and efficient/sustainable water utilization
- Water diversion from other basins

5) Possibility of water diversion from other basins (Development by inter-basin water Diversion)

The overall Northeast region can be divided into 3 river basins of Khong, Chi and Mun. As can be seen from the Table 3.15.3, there are big differences among the 3 basins between the developed water resource (No.4) and the unused run-off emptying into the Mekong River.

Khong basin is favored with comparatively more rainfall and as many as 21 major tributary rivers directly empty into the Mekong River where the river lengths are mostly short and the floods run-off drain quickly. At the river mouths emptying into Mekong River, there found many inundation areas like retarding ponds due to the high water level in Mekong River and the resultant difficulty in draining the tributary water. This inundation condition usually lasts until the Mekong water level is lowered down to allow the draining from the tributaries.

While in the upper-middle streams in Chi and Mun basins, flood run-off is controlled by operation of large reservoirs so as to avoid the flood damage and drained out from the rivers relatively in short period. The reservoir operation as said is done based on flood forecast and also prediction of rainfall, but in many cases there happened that the inflow into the reservoir after the flood operation is not enough to fulfill the capacity. In the reservoir operation for the purpose of irrigation water storage, the reservoir be filled up at the end of the wet season to secure required water for dry season cropping and the supplementary supply for wet season cropping, but in many cases reservoirs remain with big vacancy due to the insufficient inflow at the end of the previous wet season.

Accordingly, in order to fill up the vacant storage capacity of reservoirs in Chi and Mun basin, surplus water can be diverted from Khong basin where inundation by flood run-off usually continues till the last part of the wet season. By this, the flood water can be converted to irrigation water in the other basins. Comparing the Khong basin with the Chi and Mun basins, the years of flooding and the timing of flood occurrence are not the same, providing some advantageous conditions for possible diversion.

If the reservoirs in Chi and Mun basins be filled up by the diverted water to the desired level at the end of the wet season, the reservoir operation during the flood time can be done more easily without worrying too much for the subsequent rainfall during the ending of the wet season. This will surely contribute to mitigate the usual flood damages in the related areas to a great extent.

Through reviewing the previous studies on possible water diversion, the one from Huai Luang of Khong basin to Lam Pao and Ubonrat reservoirs in Chi basin is considered as one of the high possibilities.

(2) Challenges for water resources management

1) Introduction of integrated water resources management

The water resources development in 20th century in Thailand focused mainly on conversion of rain-fed paddy cropping to irrigated paddy cropping aiming at increase of rice production. Therefore, the developed water resources were used mainly in June and July as supplementary irrigation water for wet season paddy cropping. This is particularly true in the Northeast region where water resources are much smaller when compared with the abundant land resources and the developed water resources were used mostly for supplementary water for paddy cropping. That is, the manner of water management was to satisfy the said requirements, and the water availed in wet season during August to October was stored as much as possible for the use in June-July next year when irrigation water be most needed. As for the dry season where rainfall is almost none, paddy cropping is very limited as the crop water requirement for paddy in dry season is so much, almost double of that in wet season.

Since the end of the 20th century, such tasks and challenges on water resources management as mentioned below have been raised up and it is said that an integrated manner of basin water resources management will be crucially required in attaining the effective use of limited water resources.

During the 1970's, RTG promoted the agricultural policy to encourage farmers to expand production of export-oriented farm produces aiming at earning foreign currencies. Then, during the period, cultivation areas for cassava and sugarcane were rapidly increased. These expansions of farm lands could be made possible by tree cutting and land reclamation by farmers themselves, and the forest coverage ratio in the Northeast region was drastically reduced from higher than 60 % in 1950 to about 30 % in 1973. On the contrary, the farm land covering only 20 % before was expanded to double ration of 40 % in 1973. In parallel with the drastic reduction of forest area, water holding capacity in the region has also been graded down as well. This resulted as the matter of course in increasing the flood discharge and the frequencies of flood occurrence and at the same time considerable reduction of dry season run-off. Due also to the disappearance of forest areas and expansion of inadequate cultivation of fruit trees, more soil erosion has been developed further and caused more sedimentation in rivers, heightening of flood water level in rivers and reduction of storage water volume in the existing reservoirs. All this caused further the changes in rivers flow regime and brought about negative effects on the ecological system for entire flora and fauna in the region.

As is the case, it seems necessary to grasp the latest conditions prevailing so as to avail adequate/correct measures to flood problems and also to secure sustainable water use in the region. This requires firstly Watershed Management and River Flow management to be implemented as soon as possible. There is a great change in monthly water use situation as well to respond to the rapid expansion of industrial areas and urban cities and also the progressing diversification of dry season cropping. Formerly, the water use pattern was rather simple with high concentration in paddy only. On the other hand, it is vitally important to control the floods and increase dry season discharge by reservoir operation to respond to the unusual climate condition occasionally occurred and the reduced water holding capacity as above mentioned. This requires improving operation rules of the existing reservoirs by Water Source Management.

Other than the above, the following categories of management are required to attain the overall basin management by applying the IWRM concept.

*Distribution Management: Canals to meet the weekly demand changes
*On-farm Water Management: On-farm level management by farmers
*Drainage Water Management: Basin-wide and on-farm
*Waste and Sewage Water Management: Waste/pollution control
*Water Quality Management: Salinity control in NE region
*Ground Water Management: Conjunctive use

In view of the above discussion, it is concluded that the introduction of an integrated water resources management in practice including all the relevant aspects of water use, flood control and environmental protection measures is urgently needed in the region.

2) O & M of irrigation facilities and improvement in water use efficiency

Attaining higher efficiency in the use of limited water resource through rehabilitation and improvement of the existing facilities is also an important task in overall water management. Presently, RID is undertaking a number of projects for providing distribution system in the existing medium-small water source facilities where water sources have been built but distribution canals and on-farm facilities were not constructed due to the limit of the budget available at that time. Another case is to improve the water use efficiency by up-grading the distribution facilities through adding concrete lining. Thung Samrit Project had been implemented long time ago and the canal system was of earth canal causing rather low irrigation efficiency under the project. The project was taken up under the ASPL (Agricultural Sector Loan Program) as assisted by ADB and JBIC under which the earth canal was improved by concrete lining. It was confirmed by the project O & M Office in the field survey this time that after the project overall production in the project area was increased by 55 %.

As discussed in the previous section, there is an on-going improvement project for the Lam Pao dam/reservoir for the purpose of improvement of spillway gate. The improvement was required to avail easier gate/reservoir operation during flood times with having higher full storage level by 2 m. By this improvement, the total storage capacity be increased by about 550 MCM and the irrigation area will be expanded from 310,000 rai at present to 535,000 rai after the project improvement.

Improvement in water use efficiency by rehabilitation/improvement of existing facilities as discussed above is considered applicable not only to the large scale projects but also to medium/small scale systems. Especially, there are many numbers of medium/small scale projects which were implemented in haste with the master plan level study without sufficient hydrological studies. Those projects usually have no adequate O & M activities after the construction. As is the case, it is considered necessary to study those projects for possible improvement aiming at attaining higher water use efficiency including mitigation of flood damages too.

3) Issues to be solved for better coordination among agencies concerned for water management

There are several laws and regulations concerning water resources development and management under which plural numbers of government agencies are in charge of their own projects and tasks assigned. In fact, however, problems as noted below appear to be solved at an early date.

*Demarcation of responsibilities by each agency is unclear.
*Rational operation of facilities not materialized.
*Lack of harmonized and effective water management practice

At the same time, it shall be noted that the existing laws and regulations shall be consolidated in an integrated manner into a unified water law.

Through the field survey under the present study, the following problem areas have been identified.

i. Problems at a project level

In the Huai Sam Mo project (A tributary basin water management), as much as 30 MCM per annum is diverted from Huai Prathow Multi-purpose Dam/reservoir in the Chi Part 2 basin to the upper-most reach of Huai Sam Mo. The water release from the dam is after the hydro-power generation and supposed to be used for irrigation for 3,000 rai area in Huai Sam Mo basin. In fact, however, there was only a main canal and water could be used by only limited areas along the main canal. Therefore, the most of the water diverted was not used effectively and emptied into the downstream Chi river. It was then in the year 2006 that DWR initiated a pilot project for tributary basin water management to attain effective use of this diverted water by means of 6 storage ponds in the area.

The problem was due to the lack of information from the implementing body (DEDP). Under the administrative reform in 2003, DEDP was reorganized to be under the Ministry of Energy, and the facilities were transferred to RID but so far the management is not well functioning.

ii. Management on unregulated development of pumping irrigation

In so many locations in Khong, Chi and Mun basins, many numbers of pumping irrigation projects have been implemented and operated by various government agencies including local administration bodies. Pumping system is easy to construct as far as water is available even a little, and to date, there are as many as 1,000 pumping stations existing and being operated. Of all the pumping system, the large scale ones were constructed by DEDP and transferred to RID

by now to be under the RID's management activities. For those small scale ones covering the irrigation area less than 3,000 rai, the facilities were transferred to the local administration body (TAO). However, TAO is not provided with necessary budget for O & M and repairs/maintenance activities are hardly carried out, causing some problems in electric charge collection from farmers.

Planning for pump irrigation projects have been done on individual project basis without taking into account balance of water resources in the overall basin as well as the tributaries. This usually causes water shortage problems in the lower stream areas in the drought periods. As is the case, the quantities of water used for pumping irrigation in each tributary basin are unknown and it is difficult to grasp the development potential in future too. If the unregulated development as above may continue as it was, water shortage problems may happen here and there in so many locations, which surely cause further difficulty in electric charge collection, suggesting the need of better coordination between/among upstream and downstream and various government agencies concerned.

iii. Problems prevailing in and around Nong Han Kumpawapi

The wetland (Swamp) is located at Ban Tamuang, Tambon Wiengkam, Amphoe Kumpawapi in Udon Thani province. The downstream reach is Lam Pao river and empties into the Lam Pao reservoir. The wetland is with 11 small rivers and the catchment area of 36 km2. In 1989, the Khong-Chi-Mun project was approved by RTG and DEDP initiated the construction of Rasi Salai weir in 1992 as the first large scale construction under the project. As to Nong Han Kumpawapi wetland, the weir was constructed as a part of water diversion scheme to Lam Pao together with 112.4 km dyke embankment surrounding the wetland and as many as 14 pumping stations for dual purpose of irrigation and drainage. The main purpose of weir and dyke construction was in creating a storage capacity of about 100 MCM in the wetland as the relay point of water diversion from Mekong River to Lam Pao reservoir. Though originally the wetland was as large as 30,000 rai (Hearing at the site), it was confirmed that the surface water area within the dyke is 22,500 rai. Under the administrative reform in 2003, the DEDP was reorganized and the KCM project was suspended leaving those pending issues as explained below:

*Water diversion from Mekong River not materialized.
*Storage plan in the wetland abandoned.
*Irrigation plan partly implemented but not completed.
*No securing of irrigation water source.

The wetland is filled year by year by sediments as brought by the streams emptying into and is much covered by fast-growing weeds. This makes operation of pumps for irrigation difficult and in dry season water increasing the salinity contents due to the insufficient inflow into the wetland and fishes decline its number as well. On the contrary, the area suffers from poor drainage and frequent flood damages due to the insufficient capacities of drainage facilities as pumps and culverts. Those local people supposed to be beneficiaries under the KCM project were mostly not informed of the KCM project scope from the beginning and due to the suspension of project implementation, people are in the position to encounter only problems but no benefits. The main

cause of this problem is in disappearance of DEDP, the project implementing body due to the administrative reform and lack of follow-up activities by the government to take care the standing problems after the construction.

It was in 2003, almost all the existing facilities as weir, dyke, irrigation facilities and pumping facilities were transferred to RID for its O & M activities. While, DWR is implementing an improvement project as a part of the water management program by dredging around the internal wetland and improvement of drainage condition. However, main facilities are under the RID's control and O & M activities and it seems difficult for DWR to formulate a well-conceived improvement plan, suggesting more closer coordination among the agencies concerned.

iv. Problems on data management

There are many agencies concerned with water resources and they are doing their own activities rather independently and they collect water resource and related data to meet their own requirements. This resulted in preparation of data by plural numbers of agencies even the data are of similar natures. Therefore, it is difficult to judge which data is correct and reliable. These duplications of data preparation cause unnecessary extra cost for the government and further un-uniformed data cause much confusion and needed to be integrated into one system for effective management.

4) Trial for collaborated operation of water resource/irrigation facilities

Chi basin is divided into 3 sub-basins as indicated below:

Upper sub-basin--------Maha Sarakham weir to upper-most
Middle sub-basin-------Maha Sarakham weir to Roi-et weir
Lower sub-basin-------Roi-et weir to the confluence with Mun river

In the middle sub-basin, there are 2 large scale reservoirs of Ubonrat (2,264 MCM, EGAT) and Lam Pao (1,430 MCM present and 1,980 MCM in future). (Ref. Fig. 3.15.1) In the upper sub-basin, Lam Khan Choo (56 MCM) is existing but mostly undeveloped and Upper Chi irrigation project is under planning by RID aiming at implementation at an early date.

Under the reservoir operation for irrigation water supply in Chi basin except the upper sub-basin, irrigation area is divided into 2 parts. One is the areas covered by Nong Wai project and those served by weirs located downstream of Nong Wai for which irrigation manager of Nong Wai project confirms the overall irrigation water requirement and informs the release request on weekly basis to the manager of Ubonrat dam. The other area is served by Lam Pao dam/reservoir and the irrigation water supply is simply for its own beneficiary area. Each of weirs receiving water released as mentioned above is in principle operated to maintain the water level at the upstream side of the weir at a certain level. During the flooding and drought period, RID Headquarter carries out various forecasting and the River Basin Committee with the provincial level working group assess the situation, consult the measures and finally make decisions. At the O & M office of Ubonrat dam/reservoir, EGAT tries to collect necessary information by using their own tele-metering system, while RID does the same at the O & M office at Lam Pao dam. To this end, it can be said that in Chi basin, water management is undertaken in an integrated

manner to some level with grasping the overall basin situation, though remaining the upper sub-basin mostly undeveloped.

While for the Mun basin, in its upstream reaches, there developed Lam Thakong project and Thung Samrit irrigation project with available water sources by Lam Thakong reservoir (314 MCM), Upper Mun reservoir (141MCM), Lam Sae reservoir (275 MCM) and Lam Phra Phlerng reservoir (149 MCM). In the downstream basin of the said reservoirs, there are 5 numbers of large scale weirs (Chumphoung, Ban Kue, Ban Taloung, Rasi Salai and Hua Na) constructed on the Mun river under the KCM project and serving for each of pumping schemes. Due to the cease/suspension of KCM project, however, no water source is secured so far. Operations of weirs are done individually for each demand depending on the Mun river run-off. Even in the drought periods, the measures to be taken are discussed individually for each of weirs by WUG as assisted by RID and the sub-basin working group supported by DWR. This suggests the necessity for improvement of management by introducing an integrated management where paying due attention to the balance between the upstream and downstream based on the correct understanding on the overall basin situation.

Khong basin is composed of as many as 21 tributary basins. At about 5 tributary mouths, management activities are being practiced on estuary barrages, irrigation by pumping and drainages. It is deemed important in Khong basin to intensify further the management activities during the flooding period.

5) Necessity for IWRM (Integrated Water Resources Management) at basin level

In practicing IWRM at basin level, the first and the most important matter is the due collaboration by RID who is in charge of management activities on most of the major water resource and irrigation facilities and DWR who serves as the secretariat to the NWRC and is assigned by RTG to promote IWRM at the policy level. In order to materialize efficient water use and to implement effective counter-measures for mitigation of flood and drought damages, it is inevitable to have the closest cooperation by the said two (2) key agencies, though belonging to different Ministries.

Secondly, acceleration of organizational reinforcement concerning the already established RBCs (River Basin Committee) for Khong, Chi and Mun shall be further enhanced in actual practice so as to promote further development of collaborations among various stakeholders participated.

Thirdly, the tasks to be attained under the said institutional arrangement are noted as follows toward the materialization of integrated/coordinated water management.

- Purpose: Effective use of basin water resource and existing facilities together with environmental conservation
  - Data collection
  - Assessment of situation and identification of problems
  - Counter-measure planning
  - Budget plan
  - Operation manner/maintenance plan

Currently, RID is carrying out a study to formulate a plan for installation of tele-metering system covering overall basins of Chi and Mun. The plan after completed will be implemented to be completed within 2 years time. In the lower-most reach basin of Mun river, there is a tele-metering system already installed and operated and grasping of river flow regime can be availed to some extent. While DWR installed as many as 17 Meteo-hydro-water quality stations in Chi basin and lower Mun basin in 2007 with having a tele-metering system too. All these data/information as said are to be integrated into IWRM practice in the basin, and it is considered necessary to utilize flexibly all these information/data including those to be newly available for the possible basin conservation and sustainable and efficient water resource use in the basin as a whole.

6) Possibility of IWRM application over Khong, Chi and Mun basins with inter-basin water diversion

Through collaborative networking among the Khong, Chi and Mun basins, an integrated management can be conceived with due inter-basin water diversion from one to the others, and the networking is considered worthy to do taking into account the different nature and characters of each basin. As can be seen from the Table 3.15.3, each basin has its own characteristics of water resources and if this could be managed with a unified intention to maximize the efficiency by balancing with each other, it may bring about the following effects.

- Water use efficiency can be improved.
- Equitable access to water resource can be secured.
- River flow friendly to eco-system can be maintained.

CHAPTER 4 NATURAL AND SOCIAL ENVIRONMENTAL ISSUES IN WATER RESOURCE DEVELOPMENT AND MANAGEMENT

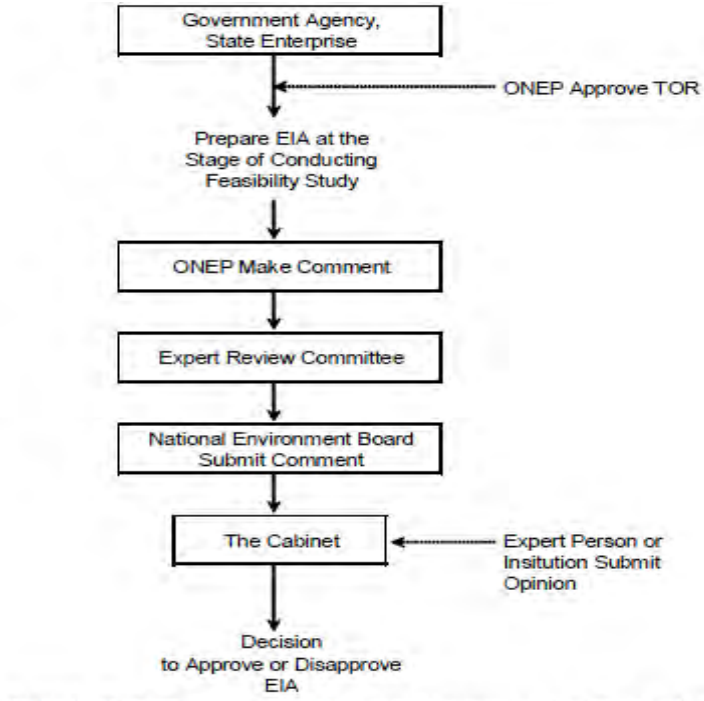
4.1 Environmental and Social Consideration in Thailand

In Thailand, not only agriculture, but also industry and tourism are remarkably developed in the last two decades and the counrty is becoming a middle income country soon. On the other hand, the development caused various problems such as water and air pollutions, increasing harmful waste, decrease of forest area, involuntary resettlment due to large-scale projects and so on. Responding to these situations, the Government of Thailand establsihed various Acts and Guidelins concerning enviornmnetal conservation and revised them occasionally based on the necessity. One of the objectives of the 10th NESDP is "to preserve natural resources and biodiversity, along with safeguarding the quality of the environment to be a secure foundation of national development and livelihood for both current and future generations; to create mechanisms to safeguard national benefit in a fair and sustainable manner." The plan emphasizes the importance of sustainable development to secure a balance between environmental conservation and economic development.

(1) Framework of Environmental Impact Assessment and Trend

The first legal framework of environmental consideration policies in Thailand is "Improvement and Conservation of National Environmental Quality Act"(NEQA) , which was issued in 1975. A part of this act was amended in 1978, and Ministry of Science, Technology and Environment issued an announcement regarding Environmental Impact Assessment (EIA), which regulates scale and type of projects requiring EIA. This announcement has become effective since 1982 and more than 3,000 EIA reports were prepared until 1992 based on this announcement. However, these projects are only mines, factories, sewage-treatment plant and so on, while water resource development and irrigation did not require EIA implementation during the period.

The authorities of National Environmental Board (NEB) was delegated to Ministry of Science, Technology and Environment due to the modification of NEQA in 1992. Moreover, Ministry of the Natural Resources and Environment



ONEPP (2007):Environmental Impact Assessment in Thailand, p.11

Figure 4.1.1 Approval Process for EIA of Governmental Agencies

(MoNRE) was newly established in 2002.

The rules and procedures for evaluation and approval of EIA are stipultated in Article 46 to Article 49 of the NEQA. Following to the principles set by NEB, Office of Natural Resources and Environmental Policy and Planning (ONEPP) confirms the contents of EIA reports and the Expert Review Committee, consisting of experts on concerned fields, examines the EIA reports and approves them. If proponents of projects are gorvenmental agencies or joint projects in collaboration with private companies, it is needed to get approval by the cabinet for those projects in addition to opinions from NEB. Figure 4.1.1 shows the approval process of EIA of governmental projects.

In 2009, "Notification for type and size of projects required EIA" that was established in 1992 became defunct and a new notification regarding "Specification on types and sizes of projects or activities requiring the preparation of Environmental Impact Assessment report and the criteria, procedure, practice and guideline for the preparation of the environmental impact assessmnet reports" was published. Following this notification, concerned irrigation and water resource development projects requiring EIA are as shown in Table 4.1.1 and the list coveing all types of projects requiring EIA is attached to Appendix 4.1.1. water diversion is not included in the project requiring EIA.

Table 4.1.1 Types and Sizes of Projects Requiring EIA report preparation*

Types of Projects/Activities	Sizes
1～31: omitted	Omitted
32. Dam or reservoirs 32.1 Storage volume 32.2 Storage surface area	 100 million m^3 or more, or 15km^2 or more
33. Irrigation	Irrigated area 80,000rai (12,800ha) or more
34. All projects located in the areas classified as a Class 1 watershed area by the Cabinet Resolution	All sizes

*Only projects related to water resource development and irrigation are abstracted from the Notification in 2009

(2) Points of Concern for EIA Implementation for Water Resource Development Projects

According to a responsible person for EIA under MoNRE, it is needed for EIA report preparation to follow three guidelines, namely, 1) Guideline for preparation of the EIA report for dam and reservoir development projects, 2) Guideline for social impact assessment and public involvement, and 3) Health impact assesment guideline. In addition to that, it is needed to anticipate following impacts by the water resrouce development projects:

- Impacts on physical resources: topographic conditions, surface water (quality and quantity), soil and sedimentation, and geology & seismicity;
- Impacts on biological resources: forestry, wildlife, aquatic life and biodiversity (number, species, habitat, distribution, migration, importance and so on);
- Impacts on human use values: water uses, agricultural activities, land use, flood control, fishery, recreation, electricity and transportation; and
- Impacts on quality of life values: resettlement, socio-economy, health and historical

values (histrocial sites, archarlogical sites, tradition and culture and so on)

It is important to integrate various plans for forest conservation, fishery management, public health, tourism development, management of historical monuments and documents, and water development. It is needed to implment continuous monitoring on environmental impacts and it is recommended to focus on following points:

- Forestry situations in the reservoir and upstream
- Change in water quantity and quality in the rservoirs, downstream and irrigation area
- Change of groundwater level
- Salt water dispersion on intrusion
- Change of fish resources
- Change of land use
- Impacts on agricultural production
- Soil erosion and sedimentation
- Change in water uses e.g. agriculture, electricity, flood control and so on
- Impacts on publich health, sanitation, nutrition and so on
- Change of socio-economic status e.g. occupation, income, life patter and so on

Public participation in Thailand has to comply with the “Order for Conducting Participation” issued by the Office of the Prime Minister in June 2005. The Order prescribes criteria and procedures for conducting public hearings (meetings to explain projects to public). They can be summarized as follows:

- Prior to development of government project, responsible agency is required to inform the public and hold public hearings to obtain people’s opinions.
- If the responsible agency does not conduct public hearings and stakeholders request to hold them, the authority has the right to order the agency to satisfy the request.
- Information to be disseminated to public include objective of the project, project description, responsible agency, location, prcoedures and period, outcomes, possible impacts, mitigation measures, estimate cost
- Public hearings is needed to inform the public of the real information.
- Public hearing can be done through survey for opinion, consultation or other approved methods
- Method for public hearing, period, location and other necessary information have to be released to public for their understanding and exchange of opinions.

ONEPP has specified minimum criteria to secure participation as follows:

<u>Project requires Initial Environmental Examination (IEE)</u>

- Project proponent has to at least disseminate information to the public and concerned

agencies, and conduct public hearings at the beginning of the project. All opinions, recommendations will be included in the report. Mitigation measures will be identified and released to the public. During construction, it is required to inform the public of the progress and to obtain their opinions continuously.

Project requires EIA implementation

- At the beginning of the project, it is needed to disseminate project information, scope of EIA study, possible positive and negative impacts to the public and concerned agencies.
- During preparation of draft final report and mitigation measures, it is necessary to explain about mitigation measures to the surrounding people. Public opinions shall be included in EIA reports. After the approval of projects, the information shall be released to the public soon. It is essential to communicate with the people and to obtain their opinions continuously during construction.

In addition to that, RID shall hold a series of public hearings[1] to collect opinions from all stakeholders during feasibility study and EIA study. The agenda, timing, and participants in the public hearings are shown as follows:

Table 4.1.2 Agenda, Timing and Participants in the Public Hearings

Public Hearing	Agenda	Timing	Participants
1st public hearing (provincial level)	Introduction of the proposed project, hearing of the problems in the project area and suggestions for smooth project implementation process from the participants, etc.	After tentative project formulation and submission of Inception Report	Governors, representatives, official agencies at provincial level, district level, local level, and TAO
2nd and 3rd public hearing (local level)	Direct talk to stakeholders about their problems and what kind of project they want	During progress report preparation for 2 to 3 times depending on project scale	Sheriff, Kumnam, TAO, stakeholders in both affected and beneficiary area The meeting may have to separate for many sub-meeting for many areas as small groups like 20-30 participants
4th public hearing (all stakeholders level)	Project finalization	After submission of draft final report to be modified based on the meeting	All stakeholders

RID is supposed to open all kinds of information to secure transparency, and to notice the public hearing to the stakeholders through public relation such as news letters and visit to the project area. For every meeting, RID issues official letters with signature of Director General to the Governor for requesting cooperation from local administration to invite participants as much as possible. When affected people are not satisfied with the proposed project, the project figure can be adjusted following their opinions. Most of the discussion concerned is the impacts of inundated area by reservoir construction. There are some cases that RID shifted initial dam sites to upper or downstream of proposed ones or RID lowers height of dam in order to minimize

[1] It is also called as "Public Participation" in Thailand.

submerged area by the projects.

(3) Social Impact Assessment

Procedures of SIA

- Confirmation of project feature
- Implementation of preliminary social survey
- Recognition of social impact issues
- Initial impact anticipation
- Collection of baseline data to identify community status in the past and present, and without project

Social Impact Assessment (SIA) is considered as a part of EIA, which emphasizes on particular aspects and concern to stakeholders rather than general social impact study. Important aspects to be considered are involuntary resettlement, land acquisition, compensation to vulnerable people. SIA study should be implemented in participatory manner. ONEPP has developed the guideline of procedures of SIA as shown above. Stakeholder analysis, information dissemination, official and unofficial meetings and public hearings are implemented in the process of SIA. In general, large-scale projects require implementation of SIA. In case of Prong Khun Pet dam project, a SIA report in addition to an EIA report was prepared.

Land acquisition is regarded as an important process in irrigation development project implementation. RID has developed the operation manual for land and asset acquisition in compliance with laws and regulations and revises the manual every year. Major concerning laws are the Constitution in 2007, Land Acquisition Act in 1987 and Royal Irrigation Act revised in 1987. There are three categories by RID for land acquisition, namely, 1) case of land owner agree on the land acquisition and compensation, 2) case of land owner disagree on the compensation, 3) case of occupiers have no land title.

1) Case of land owners agree on the land acquisition and compensation

a) Identify the real owner of land

b) Identify compensation cost for land, relocation cost for building, structures and trees

c) Compensation through banking system

2) Case of land owners disagree on the compensation

a) Release of Royal Decree including followings:
   - Memorandum on public participation in compliance with the Constitution
   - Minutes of the meetings with land owners
   - Summary of project information
   - Detail of assets to be acquired
   - Location of area to be acquired
   - If the area to be acquired overlap with government land, coordination document will be attached
   - Preparation of acquisition map

b) Establish of the coordinating committee

c) If landowners agree with compensation rate, the negotiation is complete

d) If landowner disagree with compensation even after negotiation, it is necessary to enforce the Acquisition Act

3) Case of occupiers with no land title compensation will be for houses, short-term crops and lands[2]. Procedures to be taken are as follows:

a) Identification of land to be acquired

b) Specification of area occupied by residents

c) Confirmation of the size, location, owner etc.

d) Establish of compensation committee

e) Establish audit committee to check compensation cost

f) Announcement of residents eligible to compensation for appeal

g) Compensation

(4) Projects which may Seriously Affect Community

Section 67 of the Constitution in 2007 stipulates that governmental agencies or private individual should prepare EIA report prior to implementation of project, which may seriously affect community. This EIA study shall include examination of environmental impacts and health impacts, public hearing, hearing from independent organizations. However, it was not clear which kind of projects/activities correspond to those above and no guideline concerning this matter was established for a while.

In 2009, the government promulgated "Notification of Rule, Procedure, Method and Guidelines for Preparation of the Environmental Impact Assessment Report for the Project or Activity which may Seriously Affect Community with respect to Quality of Environment, Natural Resources and Health". The operation system based on the Section 67 of the Constitution was established by this notification. This notification stipulates that independent organizations examine EIA reports at the final stage. This system is completely different from EIA mechanism mentioned above. In addition, the list of projects/activities that affect community, was finalized by NEB in August 2010, and 11 projects/activities were recognized as those which may "Seriously Affect Community with respect to Quality of Environment, Natural Resources and Health" as shown in the following list. These project/activities require Health Impact Assessment (HIA) report preparation in addition to EIA report formulation. In addition, public hearings and review by independent organizations should be implemented for these 11 projects/activities. Originally, "dam or reservoir", "water diversion", and "irrigation" projects were included in the draft list (18 projects/activities) and "water diversion" and "irrigation" out of them were excluded from the final list.

[2] According to RID (July 2010), if occupiers have no land title, they are paid 80% of compensation rate of that to the official landowners.

Project/Activities requiring HIA and EIA under Article 67 of the Constitution

1. Offshore or coastal landfill of areas larger than 300 rai
2. All types and sizes of mine operations
3. Industrial estate and annexed or extended areas
4. Headstream or middle stream petrochemical productions, of all sizes, or extended size of at least 35 per cent of output
5. Steel or ore mills, with minimum daily output of 5,000 tones
6. Production, modification or disposal of radioactive material in operations of hospital, veterinarian clinics, or research
7. Disposal facilities or crematoriums of waste harmful to human health
8. Airports with runways of 3,000 meters'' minimum length
9. Piers and ports, except small-scale used by locals
10. Dams or reservoirs with minimum capacity of 100-million cubic meters and water surfaces of 15 km^2
11. Power plants, except those fuelled by natural gas or combined cycle power plants that increase output to 3,000 megawatts

(5) Strategic Environmental Assessment

The 10th NESDP and "Environmental Management Plan (2005-2009)" have been formulated in Thailand. Those plans advocate that Strategic Environmental Assessment (SEA), which requires environmental assessment in the decision-making process, should be implemented. The guideline for SEA was prepared in 2009 and it describes necessary procedures for SEA as follows:

Procedures of SEA

1. Screening : Decision whether SEA reporting is required or not
2. Review of secondary data
3. Scoping
   - 3.1 Determining what level of policy, plan, programme or mage project in preparation of SEA reporting
   - 3.2 Determining what approach of sector or area/subarea to be implemented
   - 3.3 Analyzing the statement of problem, objective or target and expected benefits of policy, plan, programme or mega project
   - 3.4 Analyzing the targets of sustainable development and indicators of all four development dimensions of environmental, economic, social and technological concerns by consideration on baseline data in scoping step of SEA process
   - 3.5 Analyzing framework and impact on various dimensions
   - 3.6 Carrying out stakeholder analysis and design all stakeholders to participate in every step of SEA process
   - 3.7 Designing the study plan
   - 3.8 Using information from stakeholders consultation for improving and correcting the scoping and the study plan
4. Collecting additional baseline data
5. Analysis and appraisal
   - Analyzing problems, causes and trend of problem in environmental economic, social and technological dimensions
   - Analyzing direct and indirect impacts and recipients suffering from impacts
   - Analyzing opportunities and limitation in reducing, preventing and solving the problems (external and internal analysis)
   - Developing at least three strategic alternatives in problem solving including no-action alternative
6. Propose alternatives

7. Propose precautionary principle
8. Decision making on development : for this step, decision on development or no-development should be made and reasons supporting the decision have to be clearly documented to inform stakeholders
9. Follow-up and evaluation : plan and responsible authority should be proposed for monitoring and evaluation
10. Improvement : make the improvement of the data of the Step 9 aiming to increase effective and efficiency in implementing SEA

It is stipulated that SEA report should include following contents:

Contents of SEA report

1. Front cover of SEA report
2. Introduction
3. Methodology
4. Analysis of potential and limitation in all dimensions
5. Strategic environmental Assessment
6. Alternatives and recommendations
7. Precautionary principle
8. Public and community participation
9. Appendix

SEA should be implemented for developments causing impacts on policy, plan and programme and for mega projects covering plural provinces. According to NESDB personnel, NESDB is expected to play a role of examination of SEA reports, the system has yet to be established officially, though. According to an ONEPP staff, no SEA report was prepared and examined so far in Thailand, and one SEA study for the project concerning Tachein river basin, which examines plural alternatives, is in progress and it can be a good practice. RID has already prepared the Interim Report of SEA for Khong-Loei-Chi-Mun (KLCM) project, however, it is not regarded as a SEA level study but as an EIA level study by ONEPP, since the report does not mention about discussions in policy and programme level.

4.2 Natural Environment in the Northeast

(1) Surface Water Quality

1) Water Quality Standard

Monitoring of surface water quality in Thailand is under responsibility of Pollution Control Department (PCD), MoNRE. Surface water in Thailand are classified into 5 classes according to suitability for use and water quality as shown below. Detail standard is attached as Appendix 4.2.1.

Table 4.2.1 Surface Water Quality Standard

Class	Suitability for Use	Standard Value
1	Extra clean surface water source - Consumption but requires disinfection and conventional treatment process - Natural breeding of primary organisms - Conservation of ecological system	Naturally
2	Very clean surface water source	DO (Dissolved Oxygen)>6 mg/L,

Class	Suitability for Use	Standard Value
	- Consumption but requires disinfection and conventional treatment before use - Conservation of aquatic organisms - Fisheries - Recreation and water sport	BOD (Biological Oxygen Demand) <1.5 mg/L Fecal Bacteria < 1000 MPN/100ml
3	Medium clean water source - Consumption but requires disinfection and conventional treatment before use - Agriculture	DO>4 mg/L, BOD<2 mg/L, Fecal Bacteria<4000 MPN/100ml
4	Fairly clean - Consumption but requires disinfection and special treatment before use - Industry	DO>2 mg/L, BOD<4 mg/L
5	Waters are not classification in class 1-4 and used of navigation	None

* MPN: Most probable number

2) Surface Water Quality in the Northeast

Water quality data in main rivers in the Northeast are shown below. Most of them are categorized into Class 2 to Class 4. It is not desirable to utilize down-stream of Lam Takhong river and Huai Luang river (at Station 2 and Station 4) as irrigation water according to the water quality standard above. Given that those points where sampling was done are located in the urban areas and the results show high values of BOD, it is thought that those river waters are affected by waste water from houses. In addition to that, there are some accidental cases that industrial effluent from Tapioca production factories and sugar factories without proper treatment to rivers, which give damages to fishery. Provincial offices of DOF and MoNRE complain about the damages above to these factories. Moreover, agricultural effluent including chemical fertilizers and pesticides to rivers cause water quality deterioration.

Table 4.2.2 Water Quality of Major Rivers

Rivers	Water Classification	DO (mg/l)	BOD (mg/l)	TCB (MPN/100ml)	FCB (MPN/100ml)	NH_3(mg/l)
Pong	3	1.5-9.7	0.2-11.4	18-2,200	18-310	0.02-0.72
Chi	3	4.2-2.3	0.6-3	20-13,000	18-3,300	0.03-0.74
Mun	3	3.9-8.8	0.3-5	40-1,600,000	20-1,600,000	0-0.83
Songkhram	3	3.1-8.9	0.5-1.6	1,100-11,000	450-2,200	0.01
Upper Lam Takhong	3	4-7.8	0.6-2.9	40-2,500	20-900	0-0.02
Lower Lam Takhong	4	1.8-4.9	2.4-7.9	1,200-1,600,000	200-1,600,000	0.04-30.46
Lam Pao	2	5.1-7.9	0.8-1.7	68-5,400	18-320	0.18-0.87
Siaw	2	3.6-6.4	1.3-3.1	40-2,400	18-1,300	0-0.49
Loei	3	5.4-12.4	0.1-2.1	180-160,000	180-92,000	0.01
Oon	2	3.3-13	1-2.1	1,300-24,000	780-24,000	0.01
Lam Chi	2	4.5-7.1	1-3	200-5,000	200-5,000	0-0.03
Nong Han	-	3.3-12.5	0.6-8.5	450-24,000	180-24,000	0.01
Huai Luang St. 1*	-	6.3-8.0	1.6-2.6	450-54,000	450-1,100	-
Huai Luang St. 2*	5**	4.9-8.4	7.4-8.5	7,900-22,000	180-11,000	-

Rivers	Water Classification	DO (mg/l)	BOD (mg/l)	TCB (MPN/100ml)	FCB (MPN/100ml)	NH_3(mg/l)
Huai Luang St. 3*	-	4.6-5	1.4-2.2	1,300-24,000	480-2,200	-
Huai Luang St. 4*	4**	6.8-7.6	2.1-3.7	34,000-11,000	180-4,900	-

Source : PCD (2008)

* Source of Huai Luang river is Provincial Office of MoNRE No.9 (2008). Locations of sampling points are as follows, St. 1 : Nong Wua So district, Nong Khai Province, St. 2: Pumping station, Muang Udon Thani district, S Udon Thani Province, 3: Phon Phisai district, Nong Khai Province, St. 4: Phon Phisai district , Nong Khai Province

**Ranked by the JICA study team based on the water quality standard of Thailand

Water quality data of main wetlands in the Northeast are shown below. Most of wetlands water are categorized into Class 3 and better, they can be utilized as irrigation water. However, waters in Bung Laharn, Bung Nok Ngo, Nong Hun Kumpawapi (except center of the lake) and so on have high values of BOD and water in those wetlands are not suitable for agricultural use.

Table 4.2.3 Water Quality of Main Wetlands

Wetlands	DO (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	NO_3-N (mg/l)	Compliance with standard of classification 3
1. Kaeng Lawa	6.17	1.71	ND	0.02	/
2.Kham Chanote	6.63	1.5	ND	0.06	/
3. Bung Klua Bo Khae	6.6	1.9	ND	0.02	/
4. Bung Phu Hee	7.17	1.47	ND	0.02	/
5. Bung Laharn	7.97	2.83	ND	ND	X
6. Nong Waeng Non Hunting area	6.84	2.35	ND	ND	X
7. Nong Chaiwaan	6.82	2.18	ND	0.04	X
8. Nong Kom Koh	5.62	2.08	0.64	0.13	X
9. Bung Nong Khon	4.15	1.45	ND	ND	/
10. Bung Nok Ngo	5.93	2.31	ND	ND	X
11. Nong Pla Koon	5.38	1.86	ND	0.02	/
12. Nong Roong	5.55	1.56	ND	0.03	/
13. Nong Lalerng Keng	4.21	1.68	ND	0.01	/
14. Nong Sam meun	7.43	2.62	ND	ND	X
15. Nong Si	6.7	1.94	ND	0.02	/
16. Nong Han	6.13	1.24	ND	0.04	/
17. Huai Sua ten	5.95	1.24	ND	ND	/
18.Huai Saneng reservoir	6.61	1.81	ND	0.04	/
19. Huai Chorakhemak Non hunting area	6	1.8	ND	0.05	/
20. Huai Talad Non hunting area	6.1	1.66	ND	0.33	/
21. Sanam Bin Non hunting area	5.83	1.47	ND	0.1	/
22. Nong Hun Kumpawapi (at center of water body)	6.20	0.90	<0.2	<0.05	/

Wetlands	DO (mg/l)	BOD (mg/l)	NH_3-N (mg/l)	NO_3-N (mg/l)	Compliance with standard of classification 3
23. Nong Hun Kumpawapi (at Kumpawapi barrage)	3.80	1.40	0.3	0.11	X*
24. Nong Hun Kumpawapi (at Ban Deam Port)	2.20	2.30	<0.2	<0.05	X*

ND: not detected, X: not comply with standard, /: comply with standard

* Ranked by the JICA study team based on the water quality standard of Thailand

Source: Khon Kaen University, December 2009, Survey of Freshwater Wetland Status in Thailand

(2) Forest

Due to the rapid development and exploitation, forest area in the Northeast was sharply decreased from 70,904 km^2 (41.9% of the regional area) in 1961 to 20,984 km^2 (12.4%) in 1998. Recently, it is under the recovery by the plantation and the forest area was increased to 27,701 km^2 (16.5%) in 2008 as shown in Table 4.2.4. Chaiyaphum province, Mukdahan province and Roi Et province have relatively high percentage of forest area, namely, 30%、33%、34% of whole provincial area, respectively. Based on the National Forest Reserve Act (1964), national forest reserves (including national parks and non-hunting area) are allocated, which are 13,948km^2 in the Northeast. Especially, those forest reserves distribute in Roi Et province, Nakhon Ratchasima province and Chaiyaphum province (refer to Annex III-4-3). Broadleaf deciduous forest and needle leaf deciduous are main tree species of those forests. Furthermore, a world heritage, Kaoyai national park partly ranges in Nakhon Ratchasima province.

Table 4.2.4 Trend of Forest Area

Year	Area (km^2)	Ratio to total area (%)
1961	70,904	41.9
1978	31,221	18.5
1988	23,693	14
1998	20,984	12.4
2000	26,526	15.7
2004	28,095	16.6
2005	25,354	15
2006	24,549	14.5
2008	27,701	16.5

Source：RFD

(3) Watershed Classification

There are six types of watershed classification for suitbale land use depending on environment for watershed conservation in Thailand. Watershed which is categorized into Class 1A is needed to be conserved and any development within the area is restricted. On the other hand, development of watershed categorized into Class 3 to Class 5 is not restricted very severely (refer to Table 4.2.5). Area by each watershed class in Khong, Chi and Mun bains is as shown in Table 4.2.6. Since around 90% of three basins is categorized into Class 3 to Class 5, development in the Northeast is not restricted in terms of watershed conservation.

Table 4.2.5 Watershed Classification

Classification	Land use and restriction
1A	Protected forest area, including headwaters of rivers having high elevations and steep slopes. No human activity in this zone is permitted.
1B	Protected forest area, including headwaters of rivers having high elevations and steep slopes. Human activity in this zone is allowed.
2	Higher elevations and steep to very steep slopes but with land forms that erode less easily than classes 1A or 1B, mining along logging with usually be permitted.

Classification	Land use and restriction
3	Upland areas with steep slopes, fruit trees and commercial logging permitted in these areas.
4	Areas of gentle slopes, upland farming acceptable
5	Areas of relatively flat slopes, paddy fields or other agricultural activities permitted with few of no restrictions.

Table 4.2.6 Areas by Watershed Classification in Khong, Chi and Mun Basins

Watershed classification	Khong Basin		Chi basin		Mun Basin		Total Area	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
1A	1,072.49	2.31	4,965.25	10.53	1,353.75	1.98	7,391.48	4.56
1B	3,562.84	7.68	322.26	0.68	296.45	0.43	4,181.55	2.58
2	2,181.33	4.7	1,321.99	2.8	615.8	0.9	4,119.12	2.54
3	2,984.15	6.44	1,457.24	3.09	1,391.53	2.03	5832.92	3.6
4	1,0576.84	22.81	11,815.88	25.06	13,531.28	19.76	35,924	22.18
5	2,5990	56.05	27,262.47	57.83	51,295.1	74.9	104,547.42	64.54
Total	**46,367.50**	**100**	**47,145.08**	**100**	**68,483.91**	**100**	**161,966.49**	**100**

Source: Cabinet resolution on watershed classification and recommendation for land use in Mun and Chi basin, 1988

(4) Saline Soil in the Northeast

Northeast is usually called as the Khorat Plateau and in terms of geology, it contains the Maha Sarakham Formation, which is rich in salt. Salty aquifer, namely, "Maha Sarakham aquifer" ranges widely around middle stream basin of Chi River and the whole basin of Mun River (see Annex III-6-1). Most of soil texture in the region is sandy with high percolation. Groundwater level is generally very shallow. Salt is an inevitable problem in the Northeast, on the other hand, people have adapted themselves to this environmental condition, and salt making and fermented fish production by using the local-made salt have been operated for hundreds of years. The unique natural conditions have formed the foundation of life and culture in the Northeast.

Salt in the Northeast is originated from six salt rocks of the Maha Sarakham form. The area of salt rocks is 50,000km^2, which accounts for one third of whole area of Northeast and has the largest scale in the Southeast Asian countries. It is said that those salt rocks were generated from sun-dried salty lakes in the Mesozoic Era. At present, the salt rock is recognized as a strategic natural resource in Thailand and foreign investors are not allowed to utilize the rock salt[3]. According to MoNRE, scale of rock salt and degree of salinity issues are

Scale of rock salt and degree of salinity issues

- Saline soil : around 28,970km^2
- Damaged area by salinity : around 2,830 km^2
- Rock salt : around 18,000 billion tons
- Mineral deposit of potassium : around 2.5 billion tones
- Thickness of rock salt : around 100m～150m
- Depth of rock salt : around 150m～300m in depth

[3] The rock salt is recognized as an important source producing highly pure sodium chloride in various industries, the number of wells for salt water pumping is sharply increased. Northeast produces around 200 million tons annually,

as shown in right.

The area covered with saline soil accounts for 20% of whole Northeast area and 10% of this area is regarded non-suitable for crop production. Before development, seepage of rainwater was restricted by forests, and groundwater level was kept at deep layer. Moreover, since forest has high water holding capacity and vegetation cover rate in the soil was high, good hydrological balance was sustained for prevention from soil salinization. However, logging of trees initiated in 1950s spoiled the good hydrological balance, as a result, raised the level of salty groundwater and increased infertile area. Furthermore, constructions of weirs and barrages in Mun river basin and Chi river basin brought about poor drainage, which let groundwater level shallower.

The mechanism of soil salinization is as follows[4]: When water balance among rainfall, evaporation, water storage in surface and discharge into rivers is sustained properly, salt dissolved to groundwater does not move to surface. However, once the balance is spoiled, evaporation from surface stimulates raise of salty groundwater. Even though the salinity concentration is low, salt can be finally crystallized in surface. In rainy season, the salt in surface seepages into groundwater. The salty groundwater is raised to surface in dry season again. Therefore, repeat of rainy and dry season stimulates soil salinization.

When ground water level is shallow and the groundwater has high salinity, the possibility of surface salinity can be high. Figure 4.2.1 shows distribution of high TDS (Total Dissolved Solid)[5] and groundwater with shallow level that is less than 5m depth in the Northeast. It corresponds

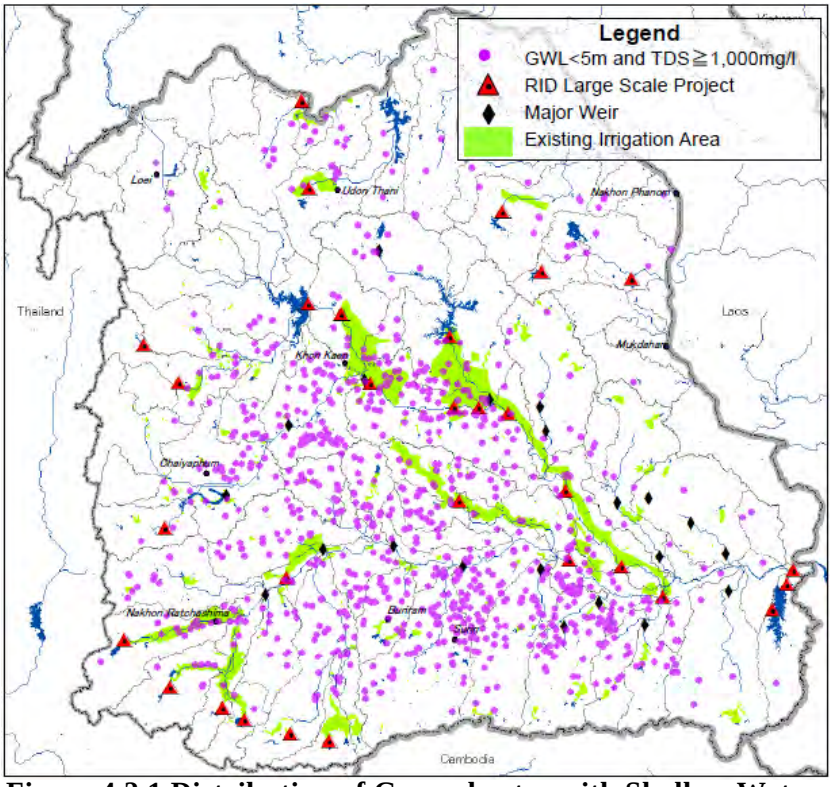


Figure 4.2.1 Distribution of Groundwater with Shallow Water Level and High Salinity, and Existing Irrigated Area

60% and 30% of the produced salt are used for chemical industry and food industry, respectively. Government of Thailand regulates traditional salt making which can cause environmental impacts, however, the attempt is not successful due to lack of alternative industries for households who are engaged in salt making.

[4] The Jigsaw Strategy and Survey of Salt Damage Areas in the Northeastern Part of Thailand(Theme: International Cooperation)

[5] The correlation between TDS and EC can be assumed as follows: TDS (mg/l) = 640 x EC (dS/m) or 6.4 x EC (mS/m). Therefore, more than 1,000 mg/l of TDS value corresponds to 1.56 dS/m or 156.25mS/m. This value is categorized into "slight to moderate" in terms of restriction use for crop according to irrigation water standard of FAO (1994) "Water Quality Guideline for Agriculture" , Table 1 Guidelines for Interpretations of Water Quality For Irrigation.

to distribution of Maha Sarakham aquifer to a considerable extent, which indicates high potential of salinity. However, salinization is caused by interaction of many factors e.g. topographic situations, geological conditions, rainfall, vegetation etc. Actually, not all existing irrigation area has salinity problem issues and situations are various place by place. It can be said only that there is potential of salinity to some extent in this area, therefore, detail study and analysis is needed always prior to irrigation development.

It is the first priority to decrease groundwater level to prevent from salinization, however, it is not easy to do that in the Northeast due to flat land. Gradient of groundwater is very gentle for drainage. Moreover, rainwater percolation rate into the soil is high due to the soil texture as mentioned above, there is a tendency that groundwater level is sustained in shallow level continuously. Therefore, in addition to forestation, various measures such as re-examination of management method of existing facilities, delinking of affected area by salt, improvement of drainage, leaching by rainwater, soil improvement have to be considered. Since it is needed to request collaboration of residents for saline soil recovery taking consideration into both environmental and economic aspects, it is essential to reflect people's opinions in the planning. Especially, in case of water diversion projects, careful examination in multi-direction is necessary.

(5) Wetland

The National Environment Board has established the Wetland Management Sub-Committee in 1993, which is responsible for development of policy and national plan for wetland management and protection, support and monitoring of activities, support of research, and coordination of related agencies. In 2000, the Cabinet endorsed "National List of Wetlands", which including 1) 61 wetland sites of international importance (including Ramsar sites), 2) 48 wetland sites of national importance, 3) 19,295 wetland sites of local importance, 4) 9 wetlands qualified for Ramsar Site nomination[6], and 28 priority wetlands for study, survey, protection and rehabilitation. The standard of wetland classification is attached in Appendix 4.2.2.

Bung Khong Long Non-Hunting Area is only one Ramsar site in the Northeast. 13 wetlands including Nong Han Kumpawapi are listed up as "international importance" and 12 wetlands are categorized into "national importance" in this region. These wetlands including rivers and lakes are utilized for fishery, water supply, irrigation, navigation, residential area, and tourism. Those wetlands are very important for people. A summary of wetland sites international importance in the Northeast is shown in Table 4.2.7. The 13th wetland in the table, namely, Kud Ting reservoir is not listed in "National List of Wetlands" above. However, it is the candidate for the 2nd Ramsar site in the Northeast and the data of Kud Ting reservoir is added to this table. Detail information about fauna and flora in Kud Ting reservoir, Bung Khong Long Non-Hunting Area and Nong Han Kumpawapi is attached in Appendix 4.2.3.

[6] This number includes Bung Khong Long Non-Hunting Area. The wetland was not registered as a Ramsar Site at this moment, it was officially registered as one in 2001.

Table 4.2.7 Wetland sites of "international importance" in the Northeast

Name	Type	Province and Area	Beneficial Use	Biodiversity Characteristics
1.Nong Han	Natural reservoir	Sakon Nakhon, 78,250 rai (12,520ha)	Fishery, community settlement, agricultural purpose, potential for tourism development	Presence of 32 bird species, at least 31 fish species and at least 42 species of plant
2. Nong Han Kumpawapi	Natural reservoir	Udon Thani 28,125 rai (4,500ha)	Fishery and derived products (fermented fish) water supply, agriculture, community settlement, income from handicraft using plant species in the wetland, potential for tourism development	Presence of at least 74 bird species, 39 fish species and 39 species of plants
3.Bung Laharn	Natural reservoir	Chaiyaphum, 18,181 rai (2,909ha)	Community settlement, agricultural purpose	Presence of at least 56 bird species and 25 fish species
4.Bung Khong Long Non Hunting Area	Natural reservoir	Nong Khai 13,837.5 rai (2,214ha)	Fishery, tourism, agriculture, community settlement	Presence of at least 29 bird species and 25 fish species
5.Huai Chorakhemak Non hunting area	Semi natural reservoir	Buri Ram, 3,876 rai (620ha)	Fishery, water supply, 8 community settlements	Presence of at least 11 bird species and 18 fish species
6. Huai Talad Non hunting area	Semi natural reservoir	Buri Ram, 4,476 rai (716ha)	Fishery, agriculture and source of income from plants in the wetland	Presence of at least 30 bird species and 18 fish species
7. Sanam Bin Non hunting area	Semi natural reservoir	Buri Ram, 3,568 rai (571ha)	Water supply, community settlement and tourism	Presence of at least 23 bird species, 14 fish species and 9 plant species
8.Khong River	Internati onal river	Chiang Rai down to Ubon Ratchathani 38,062,500 rai (60,900km^2)	Fishery, navigation, agriculture, community settlement, tourism, cultural practice, water supply	Presence of at least 289 fish species in Thailand
9.Songkhram River	Deep part in the River	Udon Thani, Sakon Nakhon, Nong Khai, Nakhon Phanom 8,125,875 rai (13,000km^2)	Fishery, navigation	Presence of at least 183 fish species
10.Lam Plaimat	River and tree grown in flood area	Buri Ram 11,875 rai (1,900ha)	Source for irrigation water and for fish culture, community settlement	Presence of at least 5 bird species, 37 fish species and 16 plant species
11.Lamdoemyai and Yod Dome Non-Hunting Area	River, flood plain and stream	Ubon Ratchathani	Community settlement, tourism, agricultural area	Presence of at least 188 bird species, 36 fish species
12.Phu Khieo Non-Hunting Area	Flood plain	Chaiyaphum, 975,000 rai (156,000ha)	Tourism	Presence of at least 223 bird species,26 fish species, 28 reptile species and 57 mammal species
13.Kud Ting	Natural reservoir	Nong Khai province	Agriculture, fishery, income from plant grown in the	Presence of at least 100 bird species, 103

Name	Type	Province and Area	Beneficial Use	Biodiversity Characteristics
		16,500 rai (2,640ha)	wetland and fish derived product such as fermented fish, dry fish	fish species, 3 freshwater shrimp species and 59 plant species

(6) Fish Resources

Fishery is a major industry as well as agriculture in the Northeast and it is essential for culture and lives in this region. The numbers of fish species and standing of crop in main rivers in the Northeast are shown in the following table. The situations fluctuate at each season very much and tendency of fluctuation depends on each river. Generally, it can be said that Huai Luang river (Phen District), Lam Se Bok river and Mun river (upstream of Pak Mun dam) are relatively rich in fish resources in terms of variety and volume. Moreover, UNDP and other international agencies supported a fish distribution study of in Songkhram river basin covering 6,330km^2. As a result, distribution of 162 fish species in the river was confirmed and it was revealed that fishery is the most important industry next to rice harvesting for local communities.

Table 4.2.8 Fish species in main rivers in the Northeast[7]

Water Bodies and Locations	Season	Number of Species	Standing Crop of Fish
1. Huai Luang (Huai Luang river mouth)	Cold season	13 species	7 kg/rai
	Hot season	29 species	14.2 kg/rai
	Rainy season	15 species	15.1 kg/rai
2. Huai Luang (Phen district, upstream of proposed Ban Nakham pumping station)	Cold season	22 species	25.7 kg/rai
	Hot season	27 species	33.5 kg/rai
	Rainy season	27 species	9.4 kg/rai
3. Nong Han Kumpawapi	Cold season	10 species	6.3 kg/rai
	Hot season	7 species	1.2 kg/rai
	Rainy season	13 species	1.5 kg/rai
4. Lam Pao Reservoir	Cold season	13 species	7.8 kg/rai
	Hot season	18 species	8.8 kg/rai
	Rainy season	15 species	5.4 kg/rai
5.Lam Pan	Cold season	21 species	8.3 kg/rai
	Hot season	15 species	5.8 kg/rai
	Rainy season	25 species	3.4 kg/rai
6. Lam Pao River downstream of Lam Pao Reservoir	Cold season	25 species	14.9 kg/rai
	Hot season	20 species	5.1 kg/rai
	Rainy season	16 species	5.0 kg/rai
7. Chi River downstream of Maha Sarakham Weir	Cold season	30 species	23.5 kg/rai
	Hot season	13 species	0.7 kg/rai
	Rainy season	15 species	17.7 kg/rai
8. Chi River downstream of Yasothon- Phanom rai Weir	Cold season	28 species	11.9 kg/rai
	Hot season	29 species	12.9 kg/rai
	Rainy season	25 species	5.4 kg/rai
9. Chi River downstream of That Noi Weir	Cold season	36 species	5.6 kg/rai
	Hot season	11 species	1.3 kg/rai
	Rainy season	20 species	7.4 kg/rai
10. Mun River downstream of	Cold season	23 species	3.4 kg/rai

[7] The source is "Additional Environmental Impacts Study and Preparation of Environmental Management Plan for Phase 1 Khong-Chi-Mun Development Project, 2007"

Water Bodies and Locations	Season	Number of Species	Standing Crop of Fish
Talung Weir	Hot season	36 species	12.3 kg/rai
	Rainy season	31 species	12.3 kg/rai
11. Mun River downstream of Rasi Salai Weir	Cold season	28 species	10.5 kg/rai
	Hot season	14 species	1.5 kg/rai
	Rainy season	35 species	10.5 kg/rai
12. Lam Se Bok (Donmotdaeng district) Ubon Ratchathani	Cold season	33 species	16.9 kg/rai
	Hot season	28 species	19.9 kg/rai
	Rainy season	25 species	3.6 kg/rai
13. Mun River upstream of Pak Mun Dam	Cold season	33 species	16.9 kg/rai
	Hot season	28 species	19.9 kg/rai
	Rainy season	25 species	3.6 kg/rai

4.3 Environmental Impacts by Water Resource Development Projects –Case Studies-

Development projects can cause impacts on surrounding environment both negatively and positively. The case studies described in this chapter are those brought about negative impacts on people's livelihood more than positive impacts, even though the objectives of the projects were improvement of living condition. It is important to reflect the feedback from the cases in future development projects to avoid repeating the same mistake. The introduced cases here are (1) Rasi Salai Weir, (2) Pak Mun Dam, (3) Prong Khun Phet Dam and (4) Nong Han Kumpawapi development project, and those project sites are shown in the figure 4.3-1. In case of (3), it has yet to be implemented, however, there are some people who protest against the project.

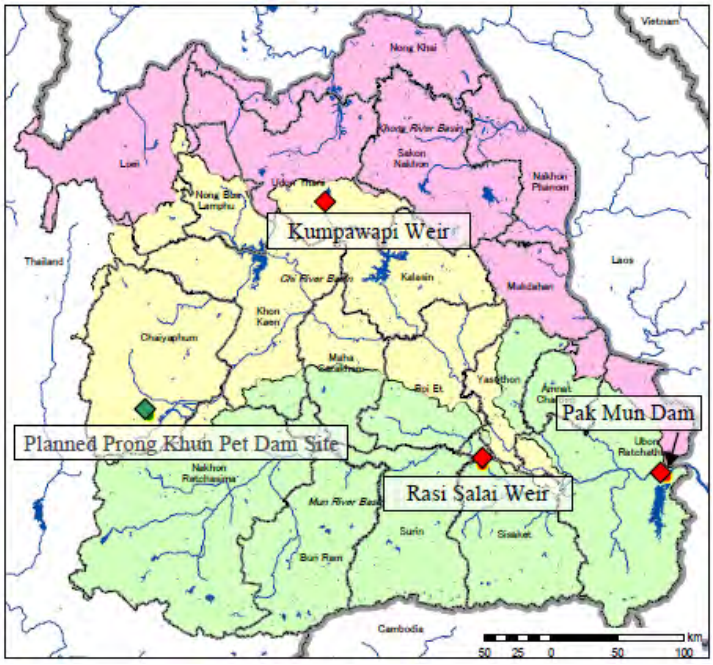


Figure 4.3.1 Location Map of Project Sites cited in the Case Studies

(1) Rasi Salai Weir

The Rasi Salai weir is located on the Mun River in Rasi Salai District, Si Sa Ket Province, 150 km upstream of the Pak Mun Dam. As a component of the KCM Project, the Rasi Salai weir was originally proposed as a rubber dam with an expected irrigation area of 55 km^2 for the purpose of provision of irrigation water for agriculture. Construction of the Rasi Salai weir was started under DEDP in 1992 and it was completed in 1993. The actually constructed weir has much large scale than expected, namely, covering 100 km^2 and has concrete structure against the prior explanation to the communities. The reason for the structural change was not explained to the people.

The Natural Environmental Quality Act (NEQA), requiring an EIA to be carried out on reservoirs and irrigation projects prior to construction was effected in 1992. Therefore, the project was not

required to implement EIA study, which means that project was started without assessment of impacts on the surrounding environment. In addition to that, no compensation to the affected people, who were enforced to resettle to other areas, was implemented. The hasty construction resulted in the various problems and long-standing conflict between the people and governmental side.

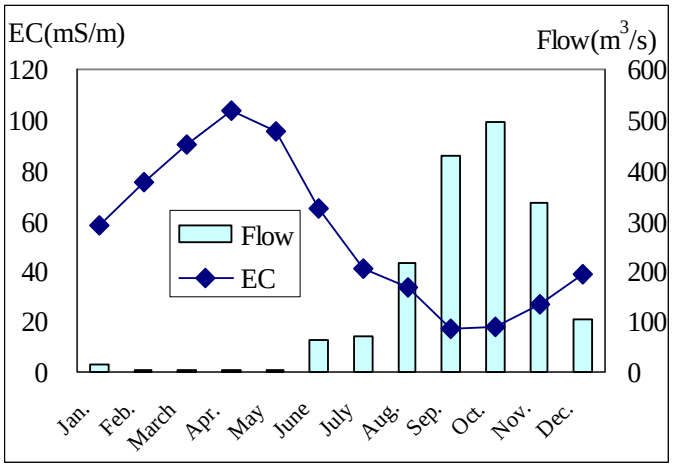


Figure 4.3.2 EC and Flow in Rasi Salai

When the gates were closed, as large as 50,000 rai of wetland area were flooded several months longer than the natural circumstances in the past and many trees died down. According to Wiszniewski (2002)[8], the construction made it difficult for villagers to access to the wetland forest which played a role as food sources and cultivated area. Obstruction to fish migration for spawning by the weir caused decrease of fishery resources. These situations gave server impacts on local economy and household income declined. The original purpose of the project was irrigation, however, it was not achieved due to saline irrigation water from the dam.

A volume of information that the salinity issues was caused by the Rasi Salai weir are available. Unfortunately, most of them do not show quantitative and scientific data e.g. how much degree of salinity. On the other hand, Srisuk et al (2002)[9] describe that groundwater within in Mun River recharges upward due to surface ponding and groundwater disperse its salinity in the surface water based on the analysis by using a hydrogeological model. Surface water shows relatively high saline in dry season in Rasi Salai, the average value of EC in April from 1986 to 2005 is 103mS/m (1.03dS/m) as shown in Figure 4.3.2[10], which is categorized into "Slight to Moderate" in terms of land use restriction[11]. Therefore, there is a possibility that weir construction acted as a trigger of the salinization to some extent.

The affected people protested against the weir persistently and gradually their resistance was becoming a kind of social moving. Based on this situation, the Minister Arthit Ourairat of the Ministry of Science, Technology and Environment ordered the Rasi Salai gates to be temporarily opened in order to conduct two years research in July 2000. In October 2002, RID took over control of the dam from DEDP. In November 2004, a system of regular gates closing for eight

[8] I. Wiszniewski, 2002, The Khong-Chi-Mun Project Implications of Large Scale Dam and Irrigation development on Salinity in Northeast Thailand, Dialogue on River Basin Development and Civil Society in the Mekong Region 8-12 November 2002 Ubon Ratchathani University

[9] Srisuk, Cotanont, T., Naklong, K. and Khachornpipat, A., 2002, International Groundwater Conference "Balancing the Groundwater Budget" Darwin, Northern Territory, Australia May 12-17, Surface Water And Groundwater Interaction in Salinity Areas, Northeast Thailand

[10] MRC, June 2010

[11] According to the standard of FAO (1994) , EC values with less than 0.7dS/m, 0.7-3.0 dS/m and more than 3.0dS/m are categorized into "none" , "slight to moderate" and "severely", respectively, in terms of restriction use for crop.

months per year was begun according to the Cabinet resolution. In 2009, based on the agreement between both parties, it was decided that RID will pay B32,000/rai to the affected people. 1,600 Million Baht (around 85%) for affected area of 58,128rai has been already paid[12].

The proponent also tries to solve the problem and conflict apart from compensation. DEDP requested Khon Kaen University to study the mechanism by using hydro-geological modeling of Rasi Salai Dam's case in 1990s, and the draft final report was submitted to RID regional office 8 in late July 2010 and it is under the revision as of August 2010. In 2009, a coordinating committee was established at central level to solve the issue and there are some sub-committees for rehabilitation, compensation, occupation promotion and operation and so on, respectively. These consist of RID personnel, farmers, district personnel, provincial personnel and so on. As of June 2010, the gates are operated under the control of "operation sub-committee" and the timing to open gates is to be decided based on situations such as discharge through discussions between upper-stream and downstream.

The area has high salinity underground water as people have been engaged in salt making, however, any study on salinity was not implemented in advance. The natural resources e.g. natural forest were not just forests but important food supply sources for the people and this situations were not considered in advance, either. Moreover, another problem, which some people who are not actually affected by the weir demanded for the compensation, complicates the situation further. This case indicates that lack of sufficient survey to grasp people's livelihood and natural conditions, and hasty implementation can result in negative impacts on natural and social environment, even though its project purpose is in enhancement and upgrading of people's living standard.

(2) Pak Mun Dam

This is one of eight international case studies on the performance and the development effectiveness of large dams by the World Commission on Dams (WCD). The Pak Mun Dam hydro power dam was built on the Mun River, 5.5km upstream from its confluence with the Mekong River, in the province of Ubon Ratchathani in 1994. The dam is roller compacted concrete types with a maximum height of 17m and total length of 300m. The reservoir has a surface area of 60 km^2 and the water storage capacity of 225 million m^3. The Electricity Generating Authority of Thailand (EGAT) built and operates the dam as a run-off-river type hydropower plant.

EIA system was not enacted in Thailand before the commencement of the work and only a short period study was implemented. Assessment of project impacts, as well as the ones of dam projects in past, remained focused on inundated areas and resettlement issues. The Environmental planning survey, which was implemented during 1982 to 1983, predicted 241 households as displaced people. Pak Mun project was the first run-off-river type dam, with no reservoir and thus impacts due to flood and resettlement were not assumed to be as serious as those of other big dam projects. There was no study, which predicted that fisheries issues would become problematic during construction or implementation. Any compensation for damage to fishery was

[12] RID Rasi Salai Weir Operation & Maintenance office in June 2010 (an interview result)

not considered to be necessary in advance and this led to a severe conflict on compensation between the people and government after the construction.

265 fish species were recorded in the Mun-Chi watershed before 1994, out of them, 77 species were migratory and 35 species are dependent on habitat associated with rapids flow[13]. The dam is equipped with fish way, however, it did not work well and the migratory fish were prevented to go to the upstream for spawning at the beginning of rainy season. As a result, the amount of fish catch directly upstream of the dam has decreased by 60-80% after the completion (WCD, 2000). The number of households dependent on fisheries in the upstream region declined from 95.6% to 66.7%. Furthermore, loss of access to common property such as forest and grazing land due to the inundation resulted in a damage to people who utilized herbs for sale or medical use. In addition to that, contrary to the expectation, the actual number of households displaced by Pak Mun dam construction was 1,700.

Fishery people demonstrated to a committee that assessed the number and extent of households affected by loss of fisheries income that their "rice and soy sauce" was affected by the construction and operation of Pak Mun dam. The government acknowledged the impact on fisheries and agreed to compensate eligible households at the rate of 90,000 Baht as compensation for loss of income during the three-year construction period. However, mitigation for the long-term loss of fisheries livelihood was not fixed. On the other hand, forests and riverbank planting in dry season were not compensated.

The protest movement was actively pursued day by day, however, the people were criticized by the government and city dwellers that the affected people were moving for compensation. Therefore, the people shifted their policy and stroke out new direction, which demands the dismantlement of the dam for rehabilitation of natural environment. Based on the situations, the government made decision to open the gate for four months (from July to October) in 2003, however, this opening period did not correspond to the fishing season, which generated further protest. In 2008, finally, the local people got a right to determine the time of gate opening. However, it is said that complete solution for adverse impact has yet to be achieved still now.

It is very difficult to estimate social and natural impacts by the project accurately in advance. It seems that the problems in this case were generated from underestimation of the effects and insufficient understanding of social conditions such as source income and living style. Mekong Watch (2009)[14], which is a NGO based in Japan, describes that people, researchers and the government have different standards to estimate values of natural resources. For example, it is difficult for somebody outside to estimate the monetary value of small fish for house consumption and it has low value for the government, it is important for its multi-purpose use and valuable for the people, though. It is thought that governmental side and researchers are requested to pay respect to local standard and culture further.

(3) Prong Khun Pet Dam

Prong Khun Phet dam is one of the projects under the Upper Chi development plan. At initial

[13] World commission on Dams, 2000, Case Study Thailand: Pak Mun Dam and Mekong/Mun River Basins
[14] Mekong Watch, 2009, Impacts on people's lives by "estimation" (in Japanese, the title is translated by the author)

stage, the plan was prepared and studied in 1964. Under the assistance of USBR (United States Bureau of Reclamation), "Preliminary of water resources development in the Northeast basin", namely, a Feasibility Study was implemented in 1971. A project consisting construction of Chi Dam (capacity 1,860 MCM), Chi Diversion dam (capacity 90 MCM) and Chi-long water storage (110 MCM) was proposed. However, this Upper Chi development plan was not implemented for many years. After the suspension for several decades, this dam construction plan was listed up as a short-term project by EC (European Committee) in 1988. The planned water storage capacity and irrigation area of the dam were 96MCM and 100,000rai, respectively. The submerged area was planned as 9,000 rai, which is half covered with forest at present.

Proposed Dam Site in Prong Khun Pet (June, 2010)

Concerning historical background of the area, a hill tribe called as "*Chao Bon*" or "*Nyah Kur*", who belongs to ancient Mon-Khmer people, had stayed in this area since old days. The people were influenced by other ethnic people (Thai) who entered the area and they gradually mixed with Thai people through marriage and were scattered throughout the district. The people stayed as a group in the village name "Bon Bung Khwian", which had around 180 populations in 1979[15]. At present, there are 2-4 "*Chao Bon*" found in every village in Nong Bua Ra-We district and many of them stay in Ban Bung Vien village where is to be submerged by the project. Although the planned project site had been declared as conservation forest (a part of Na Yang Klack Conservation Forest) under the control of RFD in 1982 through the ministerial regulation (No.978, BE2525), Forestry Industry Organization allowed the people to cut timbers in 1988-1989 and the people cultivate crops such as cassava within the forest, leading to forest deterioration.

Due to the forest degradation as mentioned above, RFD allowed RID constructing a dam in that area in 1991. It accompanied land acquisition and involuntary resettlement of around 170 households who stayed there. Since most of the people do not have official land title, they were not the targets to be compensated for the resettlement by RID, even if they have stayed for many years. This situation led to a severe conflict between RID and the affected people including a local NGO that tries to stop the project. Finally, the government made a decision to make payment to the illegal residents at the rate of 8,000Baht/rai and the payment was initiated in 1993 and parts of household compensated have already moved to other area.

In 2007, new constitution was promulgated and the article 67 stipulates that public involvement is necessary. Based on this constitution, RID was requested to implement a study of Social Impact Assessment (SIA). The SIA report has been already submitted to ONEPP and has yet to be

[15] Final Report of Social Impact Assessment of Prong Khun Phet Reserve Project, RID, Feb. 2010 (yet to be approved)

approved at present. In February 2009, the Deputy Prim Minister, who also the chairman of national water resource committee, issued an official letter to establish a sub-committee of Prong Khun Phet project, which consists of around 20 ministries/departments such as ONEPP, DWR, and so on for the project promotion. It seems that the governmental side has a strong willingness to proceed the project soon.

As of June 2010, 90 households out of 170 households still remain in the project site due to the unsatisfactory proposed compensation rate as compared with one in other project areas[16]. Kutrisukhon, T (2002) [17] describes that loss of household income from forest products is estimated around 63,061.13 Baht/year, which is not negligible amount for the people. Some of the people said "if government provides new land and housing in the area near forest and allows us to gather forest things, there is no need for compensation" Some of people to be affected by the submersion make a living by forest products, which accounts for more than 50% of their income source and they do not like to change their conventional life style based on the forest.

Following law, no compensation is needed for illegal residents. In addition to that, forest products are not target to be compensated, people depend on the forest resources for their lives, though. There is a big gap between actual situations and current laws, which complicates the issue more. On the other hand, there is another issue that some persons who have already received the compensation still remain, which makes it difficult to identify those who were actually paid. Probably, it will take long time to solve the issues due to such complicated situation.

(4) Nong Han Kumpawapi Weir

The Nong Han Kumpawapi wetland, which is located in Udon Thani Province, has 24.6km^2 area and receives inflow from 11 streams outside. Its downstream changes the name to Lam Pao river and it finally empties to Lam Pao reservoir. The Kumpawapi weir, 14 pump stations and dike were constructed as a series of components of Lam Pao Diversion Water Plan under the KCM plan from 1991 to 1994 for the purpose of irrigation. Similar to Rasi Salai's case as mentioned above, these construction works implemented in haste without a prior sufficient study.

Nong Han Kumpawapi Wetland (July, 2010)

Especially, in this case, the construction work was half-finished due to shortage of fund, the project caused some adverse effects on natural and social

[16] Construction of operation section, large scale project office (RID) as of late June 2010 (interview by JICA Study Team)

[17] Kutrisukhon, T., 2002, Socio-economic factors affecting forest product dependency from Prong Khun Phet Forest, Changwat Chaiyaphum., M.S. Thesis of Kasetsart University

environment. The weir restricts the water outflow of wetland, consequently, which resulted in waterweed overgrowth, insufficient irrigation water in dry season due to sedimentation, flood in wet season, fishery resource declined in number and diversity, water quality deterioration and so on with few benefits to the people. Although objectives of project was irrigation, conventional rice cultivation in wet season became difficult due to flood and it enforces the people to do that in dry season with paying electric bill for pump irrigation.

Before construction of dike and weir, people could enjoy the diversified natural resources from the wetland such as fish and most of people made a living by fishery. Salt making has been a cottage industry in dry season since 300 years ago and fermented fish by using locally-made salt is a special product in this area. Some people have implemented farming before construction of dike and they cultivated crops in wet season. This traditional life style was spoiled by the project. Of course, there are some positive impacts e.g. use of the dike as a road and as a clear boundary to prevent from stranger's invasion, however, the affected people feel that negative impacts by the project are more than positive impacts for them.

In 2006, a study of Nong Han Kumpawapi wetland and surrounding environment was implemented by Khon Kaen University and a master plan was proposed based on the study[18]. The study recognizes the importance of wetland as food supply and income source for the local communities. For sustainable use of the wetland, the report proposes some countermeasures e.g. weed management by dredging, promotion of aquaculture in the farmlands to reduce fish catch, establish of community rules to conserve the wetland, waste management from the communities, promotion of environmental monitoring and so on.

4.4 Participatory Natural Resource Management

Proper management of natural environment e.g. fish, forest, water and soil is important for their sustainable use. In this section, some cases of natural resource management activities, which are initiated by the local community under the supports of governmental agencies are described. Some lessons learnt through these activities can be utilized and disseminated in other area for natural resource management.

(1) Watershed Management in Huai Sam Mo (HSM) Sub-River Basin

Huai Sam Mo (HSM) Bain is one of 20 sub-basins in Chi river basin. It covers K. Khok Pho Cha district of Khon Kaen province, Consawan district, Kaeng Khlo district, and Phu Khieo district of Chaiyaphum province. HSM covers 455,652 rai that covers 1.47% of the Chi river basin area. HSM was selected as a pilot site for Upper Chi River Basin under the policy of the DWR, MoNRE for integrated natural resource management with local participation of people and good governance in solving water-related problems. The site was selected because 1) it covers more than one province, 2) essential data based for successful research was almost completed, and 3) the topographical feature of basin could be a good representative area of Northeast region.

The sub-basin working group was established in 2006 as a coordinating body for the

[18] Khon Kaen University (Faculty of Environmental Engineering), 2006, Final Report of Study on Management of Nong Han Kumpawapi Wetlands Area

development. Local Administration Organizations were active participants of the development process. HSM has identified five development strategies as follows;

1. Community water resource development
2. Promotion of organic agriculture and income generation activities
3. Institutional Development and Environment Rehabilitation
4. Development of local curriculums, local knowledge study and community rules
5. Promotion of women and youth roles

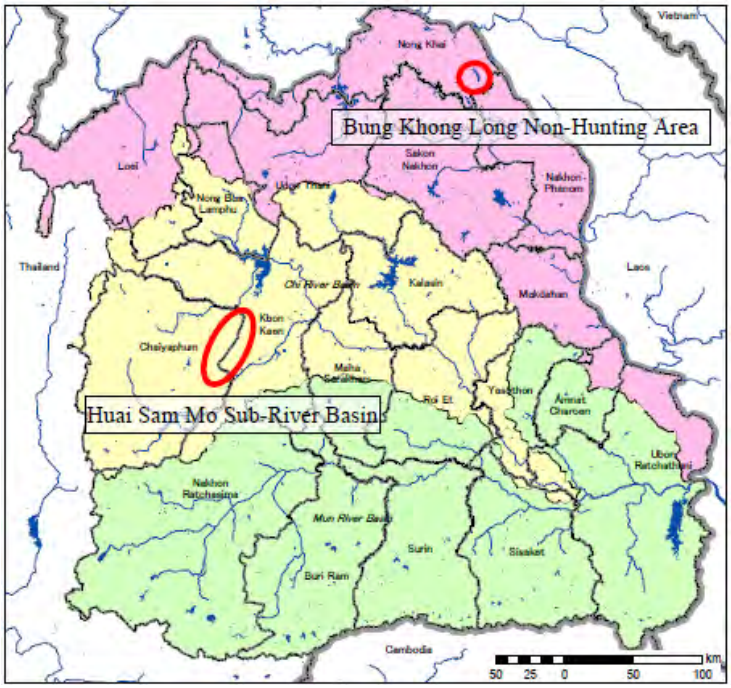


Figure 4.4.1 Location Map of Participatory Conservation area in Case Studies

During 2002-2009, several agencies e.g. MRC-GTZ, World Bank, WWF, Khon Kean University and DWR support HSM to identify its needs and strategies. The following networks were established such as 1) Woman Volunteer Network for River Basin Development, 2) Youth Network for River Basin Development, 3) School Network for Local Course Development and 4) the HSM River Basin Committee. These networks facilitate the five strategies of HSM river basin.

After the establish of sub-basin working group, various research, trainings and capacity building activities have been conducted with the support and participation of local authorities. In 2008, Khon Kean University conducted the multidisciplinary research to identify some common local knowledge/wisdom and suitable local practices in natural resource management in the HSM watershed. And it studied how these local practices can be integrated into watershed action plan and duplicate them to other areas in the watershed. The research team further asked the topic of knowledge that they are interested. Information on soil, water and forest are the first three key elements that people want to know more. Also, the team asked the committee to identify how local people have practiced, whether there are any good practices exist in the watershed.

- Application of organic fertilizer and pesticides

An organic agricultural study center and community owned organic mushroom nursery center were established in October 2006 in Baan Nong Saiwan Tai village in Kaeng Khlo district, Khon Kaen province. Though this organic agricultural study center is still in its early stage of development, its growth is fast and has already demonstrated a prosperous potential. The income from the mushroom selling has been allocated into the community development fund and to organize further learning, making and testing of organic fertilizers and pesticides and different

technique of organic farming. This study center also emphasized the gender balance and provides more opportunities to women for supplementary income generation and more capacity building.

Organic fertilizers and pesticides for rice farming provided by the study center can reduce a large amount of expenses on chemical fertilizers and pesticides for farmers. This program revives some of the traditional ways of understanding nature and of the cultivation practices, and integrates them with the scientific knowledge, which makes the cost for making the organic fertilizers and pesticides low and easy to learn and apply. For instance, the most headache pest – Apple Snail (*Ampullariidae*)—can be collected, decomposed and made into the organic fertilizer. Other example is use of Thai herb—Boraphet (*Tinospora crispa*)—that provides the bitter taste, which is boiled and the liquid is sprayed to the vegetables to chase away the insects. The cumulated rotten fruits can be made as organic fertilizers. And all these materials are easy to find and costless for farmers.

- No-fishing area establishment

This attempt is implemented in Non Kyrum village and Kud Lop village in the HSM. Since the villagers have realized that the fish catch have been declined significantly despite there were a lot of water and ponds in the area, an idea to conserve existing two ponds within wetland as fishery conservation zone was raised. This idea was favored by the people. The rules and regulations on fishery conservation were set through several village committee meetings and village meetings. The signboard of fishing ban was installed near the ponds. Development of fishery conservation zone and control of fishing gear use contributes to enhance fish production and protection of fish species. By having the fishery conservation zone, the fish quantities have increased dramatically. One of[t] reasons for the success is an excellent leadership and another one is that people got together with their own idea and they agreed the location of no-fishing area.

- Forest Conservation

Forest conservation has closed connection with religious practice and forest temple is capable to control deforestation. One monk takes a leading role of this moving at Ponetong temple, Nong Kae village around 30 years ago. At present, the area is expanded to 60 rai and the forest provides people with important place for meditation.

Out of attempts mentioned above, no-fishing areas establish and organic agriculture have achieved successful outcomes, which can be implemented with low budget and with technical easiness in on the community basis. It will take time to get results of forest conservation visible and it is needed to study it continuously. Only several years passed since the sub-river basin committee establishment and concrete activities by the committee is limited. It is expected that the watershed sub-committee apply those successful attempts in HSM sub-basin for duplication.

Collaborative project by Khon Kaen University and New Zeeland had been implemented for the purpose of supporting small scale water resource development in the Northeast from 1978. More than 100 weirs were constructed by this project. Following example was two weirs constructed in the HSM watershed.

- Construction of weir

There is a wetland called as Nong Nok Ngo in Khon Sawan district in Chaiyaphum Province. In the past, during rainy season, people suffered from flood almost every year, while other parts of the Tambon had problem with drought. One member of Tambon council thought construction of new weir in HSM river and canal for the purpose of the flood control and irrigation to paddy field. He read an article about Khon Kaen University-New Zealand Project in newspaper, which supports water resource development in the Northeast. The guy requested the university to construct weirs. The design was based on the guideline prepared by Faculty of Environmental Engineering, Khon Kaen University and scale of weir was designed with people participation. The weir was completed in 1982 with financial support, 300,000 Baht, to buy construction materials by the project. The 2nd weir was constructed with same design but supported by local administration. Both of them are still operated continuously.

The weir constructed in 1982（July, 2010）

(2) Conservation of Bung Khon Long Non-Hunting Area (Ramsar Site)

Bung Khong Long is one of the largest freshwater lakes in the Northeast and it is located on Bung Khong Long district in Nong Khai Province. This lake lies in north-south position with the length of about 13 km and the width of above 2 km with area of 22.1km^2. Bung Khong Long Non-hunting Area support 33 species of wintering migratory water birds and supports a number of endemic species and acts as a vital food source and spawning ground for the important subsistence fishing industry. The Non-Hunting area was registered as one of Ramsar sites in 2001. This is the only one Ramsar site in the Northeast.

At initial stage of registration as Ramsar site, the Ramsar Site project office funded by WWF identified the boundary of the area in collaboration with the surrounding people. Therefore, the specified Ramsar area was accepted by the people and it let people regard this site as their natural resource. Eleven surrounding villages of the lake have each conservation zones within the Non-Hunting Area in 2007, 5-10 rai each in collaboration with the project office and nobody is allowed to enter to the zones through the year. As a result of conservation zone setting, fish seems to be increased in number, which motivated people's awareness. There is a committee for conservation of the site,

Bung Khong Long Lake（June, 2010）

which is chaired by the provincial office and it consists of farmers and TAO personnel. The Non-Hunting Area is under the control of both Royal Forestry Department (RFD) and Ramsar site project office.

Since before registration as Ramsar Site, surrounding people have uses the lake water for paddy field irrigation by using pump. Mobile pumps utilization at the southern part of the lake was also started by 12-15 farmers 3 years ago. The important point for conservation of this area is that the local community can utilize the natural resources e.g. fish and water even after the registration and it can promote people's motivation to conserve the area. Ramsar Convention emphasizes the wise use of wetlands and their resources in addition to conservation, and it does not limit people's access to the wetland. At present, there is no conflict on use of water due to abundant water resources and it is desirable that natural resource management in sustainable manner will be continued.

4.5 Natural Resource Management by Governmental Agencies

There are provincial offices of various ministries and departments in the Northeast. Those implement diverse activities for management natural resource e.g. fishery resource, water, forest. Often these attempts involve public participation. Some examples of them are described as below.

(1) Water Quality Monitoring

MoNRE has provincial offices in the Northeast, major offices in the Region are Khon Kaen, Ubon Ratchathani and Udon Thani. These provincial offices implement a series of water monitoring check regularly e.g. pH, DO, BOD, benthos, Fecal Bacteria and so on in collaboration with the local communities. The people and school students participate as volunteers in the water quality check by using easy equipments provided by the offices. This attempt facilitates people to understand current situation of water quality and promote their awareness of water resource conservation. Khon Kaen Provincial office implements collaborative works with DOF in case of accident e.g. water deterioration caused by waste from factories.

(2) Conservation of Fish Resources

Thai people have a custom or tradition to set fish conservation zone near temples from their religious devotion can be seen in Huai Sam Mo watershed's case. Identified zones as fish conservation are not allowed to enter for fishery, which provide spawning places for fish and promote fish breeding. Some DOF provincial offices in the Northeast facilitate and promote this activity in collaboration with the local communities. There are some villages which have fish conservation zones since around 40 years ago without any assistance from outside. Such existing activity is also strengthened through technical supports by DOF officers. At present, there are 25 fish conservation zones in Mun and Chi river basin according to personnel of DOF Ubon Ratchathani Provincial Office.

(3) Anti-Saline Plantation Project

RFD recognizes saline soil as one of big issues in the Northeast. An attempt to reduce soil salinity was implemented by RFD nation-wide from 1997 to 2002 and the actual implementation in the field were promoted by RFD provincial offices in 18 provinces excluding Roi-et Province in the Northeast (the data of scale and seedling number is not available). RFD provided 3 species of seedlings to the farmers, which are fast-growing and can be sold as raw material of paper within short period. According to the monitoring results, the salinity conditions in soil were not worsened compared with previous ones and it will take long time to assess the impacts of planting on the problematic soil.

(4) Set-up of Community Forest

Nowadays, deforestation is advanced nation-wide in Thailand and one of big issues is encroachment of people to develop more farmland. This situation causes not only forest deterioration but also water shortage and infertile lands. Sometimes, conflicts on forest conservation between people and forest offices were generated. People and private sectors did not have a concept to take responsibility for forest management, since natural resource is under the control of government agencies for many years. Followed by such situations, a new idea, which both governmental organizations and local people get together to solve these problems and to conserve natural resources, was generated. The National Constitution established in 1997 permitted community participation in natural resource management. This principle was developed for sustainable use of forest and the system is called as Community Forest (CF).

The actual project to set up CF was initiated in 3 villages in the Central Region in 1999. In this system, Groups in a villages consisting of more 50 people that have willing to set up a CF should submit a proposal for project establishment and take examination by forest officers to be approved. RFD subsidizes the approved villages/groups for purchase of seedlings, let the people to select desirable tree species and usage, and provides technical training. If a village is approved to set up a CF, people have to mange a CF, e.g. protection forest from degradation, restoring degraded forest back into original condition in collaboration with forest officers. The purposes to set up CFs are various depending on villages, one village wants to get more NTFPs, on the other hand, another village set up a CF to conserve water resource. Many villages in the Northeast established CFs and number of CF projects by region and province from 2000 to 2010 is as shown below:

Table 4.5.1 Number and Area of Community Forest by Region

Region	Number of Villages	Number of Projects	Area (rai)
Northern	2,441	2,336	1,431,366
Northeast	3,909	3,446	967,791
Central	967	868	357,185
Southern	710	705	132,364
Total	**8,027**	**7,355**	**2,888,706**

Source: RFD, as for July, 2010

4.6 Activities of Non-Governmental Organizations in the Northeast

Non-Governmental Organizations in the Northeast initiated their activities in 1970s. NGO has worked with communities to search for alternative development and specific development activities such as health, woman and youth, community right, education and culture and community enterprise at early stage. During 1985 to 1994, adverse effects caused by development projects such as Pak Mun dam, and conflicts between governments and people were elicited. NGOs intervened these problems to advocate conservation of natural resources and human rights, and criticized governmental agencies. Therefore, it cannot be said that the relationship between the government and NGOs was good. However, the government shifted its concept toward NGOs and clearly stated the importance of collaboration with NGOs in the 6th National Economic and Social Development Plan (1986～1990).

At present, there are over 140 NGOs in the Northeast. They are divided into 8 networks dealing with different issues namely alternative agriculture, natural resource and environment, Child, HIV-AIDS, Woman, Human Right, Community Enterprise and Urban Community. List of present NGOs actively working on natural resource management are shown as follows:

Table 4.6.1 NGO working on Natural Resource and Environment in the Northeast

Name of NGO	Activities	Base	Local/ International
Chi River Basin Network	Work with communities on Chi river to study indigenous knowledge and impacts by governmental projects on rural societies such as flood, wetland conservation and so on	Khon Kaen Province	Local
Land and Forest Network	Advocacy of community right in living in forest area in Chaiyaphum province	Chaiyaphum Province	Local
Agricultural Network	Promotion of integrated farm, alternative agriculture and collection of indigenous rice varieties	Maha Sarakham Province	Local
Mineral Network	Promotion of community organization to monitor and realize impact of government policy on mineral mining in Roi-Et province, Loei Province and Udon Thani province	Udon Thani Province	Local
Mun River Network	Work with communities on Mun river to study indigenous knowledge and impacts by governmental projects, forest management and so on	Surin Province	Local
Assembly of the Poor	Help those who affected by development projects and industries such as Pak Mun dam and Prong Khun Pet dam	Bangkok, covering whole Thailand	Local
World Wildlife Fund	Support of Huai Sam Mo, protection of Mekong river and Conservation of the Ramsar site	Bangkok (Main office is located in Switzerland and)	International

4.7 Issues on Environmental Consideration

Past projects that gave impacts on natural and social environment taken as cases above have

something common. Those are 1) insufficient prior study and hasty project implementation, 2) inadequate examination based on scientific data to assess adverse impacts, 3) lack of understanding of social status of affected area e.g. traditional life style, and 4) lack of enough communication with people and information sharing. On the other hand, well-managed cases have common points as follows: 1) these activities satisfy people's demand, 2) the people have an idea that they own natural resources to be managed by themselves, 3) these activities are implemented in small scale with smaller budget in short period, and 4) people's opinions are reflected in the planning process.

Based on the lessons learnt above, it is recommended that careful planning for water resource management is to be done. Regardless of project scale, any project to meet people's needs should be prepared considering natural and social conditions in each area. Even though a large-scale projects requiring land acquisition is proposed, people are not necessarily opponent to the plans. Yang Na Dam project under Upper Chi Development Plan is planned taking consideration into people's request to RID around 40 years ago, who were suffered from drought. This project requires land acquisition, people expressed that positive impact by the project is more than negative impact[19]. However, it is noted that the opinion was advanced by representatives of the village and it is needed to confirm what collective opinions in the village are.

As mentioned before, collaboration between governmental organizations responsible for conservation of natural resources such as soil, water and forest is very limited for integrated management. Therefore, it is desirable to establish a new system to share each lessons learned and experiences for various organizations, to formulate an action plan based on the new system above, and to accomplish their tasks.

4.8 Environmental Consideration in Water Resource Development and Management in Future

Since there are many people who are suffering from water shortage in the Northeast Region still now, some water resource management projects are planned. It is important to optimize lessons and experiences through various cases so far. Environmental consideration for large, medium, and small-scale water resource management projects are as follows:

(1) Environmental Consideration for Large-Scale Water Resource Management with Water Diversion or Trans-Basin

In Thailand, SEA should be implemented prior to developments which can give impacts on policy and programme such as mass transportation, kitchen of the world plan and integrated watershed management, and mega projects covering plural provinces like water diversion. In case of SEA implementation, development site, scale and target area are not determined at initial stage and plural alternatives should be shown and compared in terms of not only technical matter and cost but also environmental impacts. Not only irrigation but also planting and monkey cheek establish can be included as alternatives for water resource management. A proposed image showing this process is as shown in Figure 4.8.1.

[19] Interview to representatives of Yang Na Dee Village (JICA Study Team, 2010 June). EIA report of the project has been approved. However, the possibility of salt damage was pointed by MoNRE and the project is suspended.

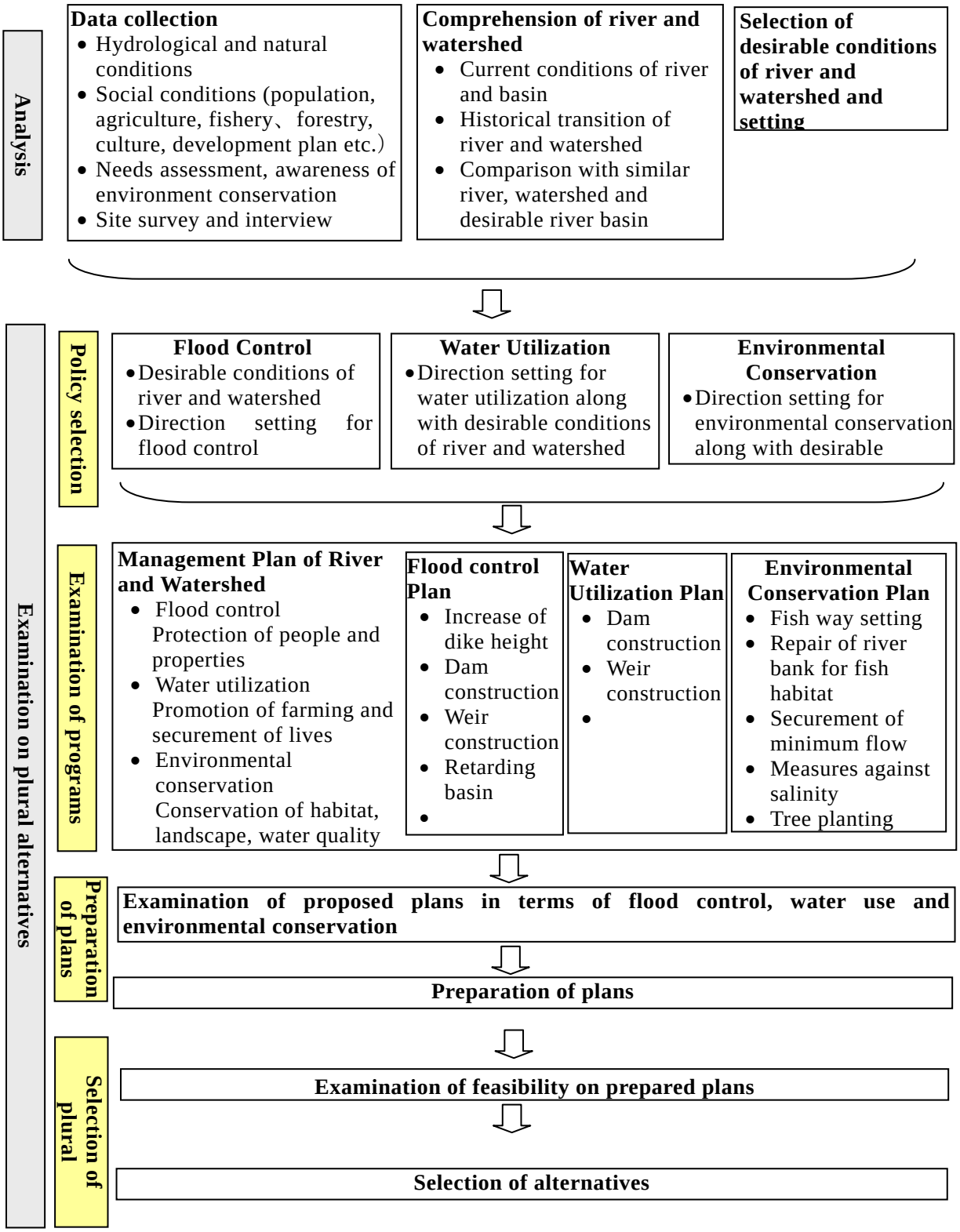


Figure 4.8.1 Proposed process of examination on plural alternatives in SEA

Since large-scale projects have relationship with provincial development plan, not only proponent but also provincial personnel have to be involved in this process. As mentioned in 4.5, there are various activities for natural resource management. Although these factors e.g. soil, water, forest and water interrelate each other, collaborative works among different agencies are very limited. In addition to that, provincial office personnel have no chance to participate in EIA process so far. Therefore, it is desirable to involve not only DWR or RID personnel but also, provincial officers of other agencies who are familiar with local situations. At the same time, participation of representative people and researchers in planning process should be secured. Process of environmental assessment on plans in SEA is proposed as shown in Figurer 4.8.2.

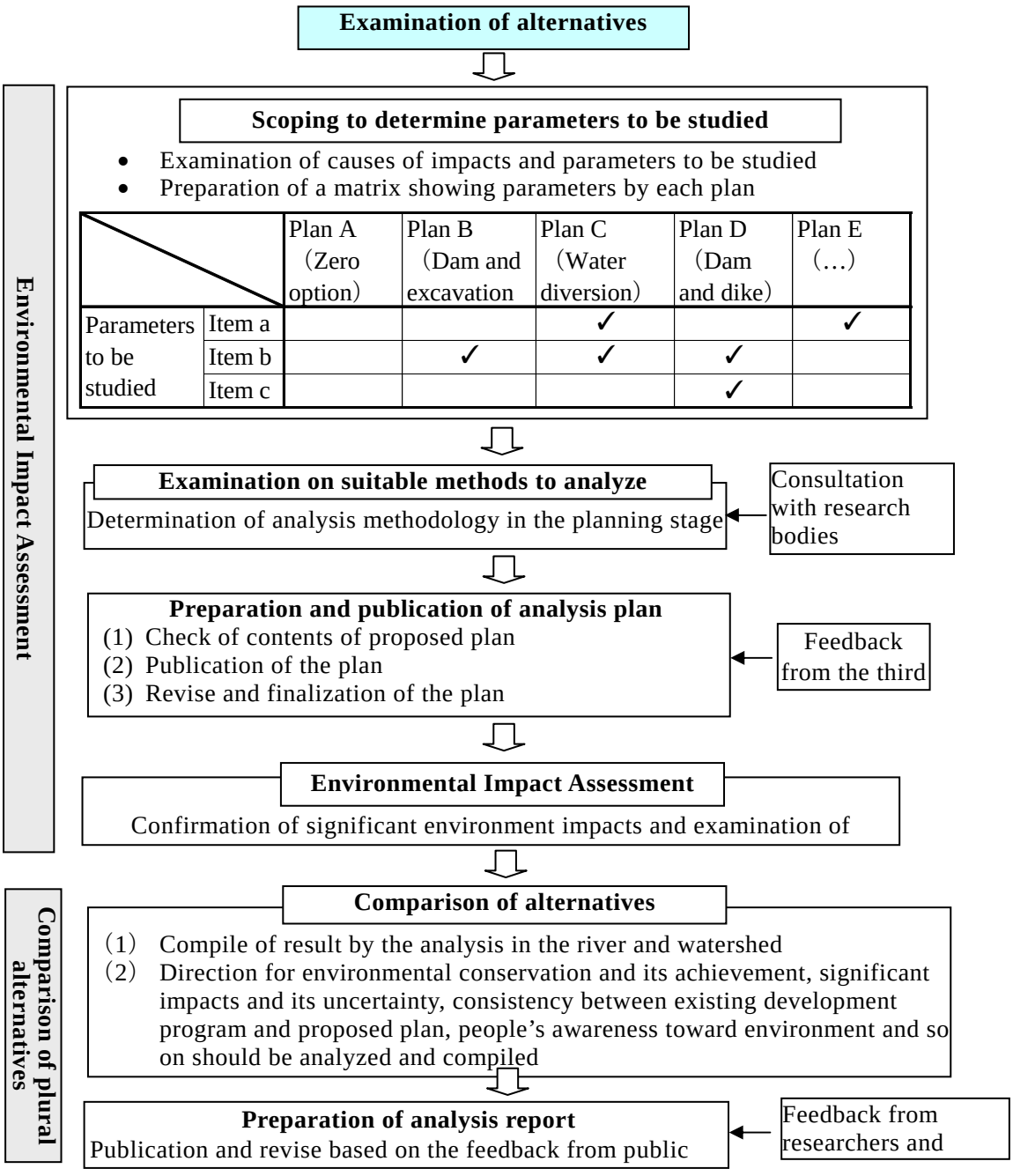


Figure 4.8.2 Proposed EIA process in SEA

(2) Environmental Consideration for Medium-Scale Water Resource Management

This scale of project does not accompany with water diversion and trans-boundary, however, it is needed to implement EIA or IEE. Based on the lessons learnt and experiences through projects in the past, it is important to collect people's opinions from the Scoping stage and to facilitate cooperation among proponent, local communities, and researchers for project implementation.

In case of projects requiring land acquisition or involuntary resettlement, it is recommended to take measures with new twist to minimize affected area and number of people. Especially, if national forest owned by government is submerged by projects, it is recommended to consider that the affected people who depend on forest products and to provide new lands which are accessible for forest resources to them. As described above, irrigation projects in the Northeast have potential to cause salinity. Based on data such as groundwater, topography and rainfall, it is necessary to examine the possibility of salinity issue sufficiently referring to similar cases. In addition to that, fishery is an important industry for the people in the Northeast. Therefore, even though cash income from the fishery seems to be relatively small, there is possibility that it plays an important role as protein source. Therefore, it is proposed to take countermeasures such as fish ladder setting not to prevent fish migration from any projects.

(3) Environmental Consideration for Small-Scale Water Resource Management

It is not needed to implement EIA or IEE for this scale of projects. However, since this is community based water resource management, it is desirable for people to participate in the activities positively. Referring the case of HSM watershed management, it is recommended to request people to prepare plan for water resource management combined with tree planting or organic farming based on their demand. It is also desirable to set rule by people themselves to be easily followed. Governmental agencies and research bodies can support community-based project financially and technically, which can lead to collaborative water resource management in the local level.

CHAPTER 5 REVIEW ON PROJECTS ASSISTED BY GOJ AND OTHER DONORS IN WATER RESOURCE AND AGRICULTURE SECTORS

5.1 Selection of Projects to be Reviewed

5.1.1 Cooperation in Agriculture and Rural Development Sectors

Of the overall development cooperation to Thailand by major donors during the period of 1996-2005, Japan shares an overwhelming majority of 87.9 %. In the agriculture sector, it is even higher at 90.4 %. As to the technical cooperation in the agriculture sector, there had been substantially varieties of cooperation in many fields in the past, but in the recent past, cooperation by GOJ has been rather limited to small scale ones related with Japan-Thai Economic Partnership Agreement (JTEPA). In terms of financial cooperation too, in the past, the yen loan shared about half of the total, though the share by agriculture sector was very limited. Provided, however, that the yen loan extended for irrigation sector projects reached at 5.78 billion yen in total and the amount suggests substantial contribution to some extent when compared with the RID's project budget in average per annum.

5.1.2 Selection of Projects to be Reviewed

(1) Purpose of review on cooperation projects in the past

For Thailand, Japan has been extending a number of cooperation projects in water resource and agriculture sectors to date. Under the technical cooperation category, there have been many success stories in technical transfer as planned on one hand, but there have been some negative results as follows on the other hand.

- Problems on O & M of project facilities
- Too much emphasis on infrastructure and insufficient support for production and marketing aspects
- Project benefits yet to be generated due to delay of on-farm development

It is necessary to learn from the lessons experienced and good practice accomplished, so that the future cooperation may be implemented more effectively. Accordingly, those cooperation projects implemented in Thailand in the past with having due supports by GOJ and other donors shall be reviewed to identify useful suggestions for the directions of cooperation framework focusing on the possible rectifying of regional income disparity.

(2) Selection criteria for projects to be reviewed

In selecting the projects in water resource-agriculture related sectors to be reviewed, a criterion was applied to satisfy the following points.

-Projects implemented in NE Region as the main targets

-Wider coverage of project category (Sector)

-Varieties of cooperation scheme

In addition to the above, some agriculture/rural development projects were selected from which lessons learnt concerning crop diversification and participatory rural development could be extracted. Finally, 17 projects as tabulated below were selected for review.

Project Name	Donor	Scheme	C/P	Area
Water resource development/Irrigation development				
(1) Small Scale Irrigation Program （SSIP）	OECF	Yen Loan	RID	Whole Country （NE Region 49%）
(2) Medium Scale Irrigation Package Project in the Lower Northeast	JICA	F/S	RID	South part of NE
(3) Nong Wai Operation and Maintenance Project (Large Scale Reservoir Irrigation and Land Consolidation Project）	IDA, ADB, KFW	Loan	RID DOAE	Khon Kaen Province, Maha Sarakham Province
(4) Huai Mong Project（Barrage and Pump）	EC, Belgium	Grant	DEDP	Nong Khai Province
(5) Lam Payang Pumipat Project （Water Diversion、Pipeline System、Medium Scale）	RID	Thai Budget	RID	Mukdahan Province, Kalasin Province
(6) Khong- Chi- Mun Project（Large Scale Water Diversion Scheme）	DEDP	Thai Budget	DEDP	Covering most part of NE, especially Mun river basin
(7) Kok-Ing-Nan Water Diversion Project	JICA	Development Survey for Supplementary, F/S and Environmental	RID	North Thai（Kok・Ing・Nan river basins ） and Chao Phraya delta and Bangkok
Basin Water Management/Integrated Water Resource Management (IWRM)				
(1) IWRM in Chao Phraya River Basin	WB	T/A	DWR	Chao Phraya River Basin
(2) IWRM Pilot Project in Yom River Basin	ADB	T/A	DWR	Yom River Basin, one of tributary basin of Chao Phraya River
(3) Introduction of IWRM to Bang Pakong River Basin	FAO ADB	T/A	DWR	East Region
(4) Huai Sam Mo Sub-basin Working Committee and Integrated Water Resource Management Plan	GTZ, WB, MRC, WWF	T/A	DWR	Tributary basin of Chi river, Huai Sam Mo Bain (Southwest of NE region)
(5) Chao Phraya Basin Water Management Strategy	WB	T/A	NESDB, RID, PCD	Chao Phraya River Basin
Irrigation Water Management/O & M/Water Users Association				
(1) Agricultural Sector Program Loan-- Thung Samrit Irrigation Project	JBIC, ADB	Loan	RID	Whole country
(2) Modernization of Water Management System Project	JICA	Technical Cooperation	RID, DOAE	Chao Phraya Delta
Crop Diversification				
(1) Modernization of Water Management System Project	JICA	Technical Cooperation	RID, DOAE	Chao Phraya Delta
(2) Revitalization of Deteriorated Environment in Land Reform Area through Integrated Agriculture Development	JBIC/ JICA	Yen Loan JICA F/S	ALRO	4 Provinces in NE

Rural Development				
(1) Pilot Project for Poverty Alleviation and the Promotion of Food Security in Northeastern Thailand	FAO	T/A	MOAC	3 Provinces of Nakhon Phanom, Maha Sarakham and Sisaket in NE

5.2 Review on and Lessons Learnt from Cooperation Projects in Water Resources/ Irrigation Sector

5.2.1 Water resource development/Irrigation development

(1) Broad-based benefit extension and stabilization of peoples' livelihood through implementation of SSIP: Lessons learnt from SSIP:

Small Scale Irrigation Program (SSIP/RID I-VI, OECF Loan)

1) Project summary

Through 1970's, there still had been political confusions and instable situations prevailing in Indo-china peninsular, and for RTG it was necessary to promote the national economic development with giving higher priorities in securing the internal political stability. Modern irrigation development in Thailand had been initiated since early 1960's where emphasis was placed on large and medium scale water resource development. In addition to this from the early 1970's, such on-farm developments to avail full functions of large scale system constructed were extensively implemented centering mainly in the Central plain.

While, the SSIP focused mainly on the areas where left uncovered by the large and medium scale projects in rural remote areas. The SSIP aimed at securing domestic/livestock feeding/fish raising water as well as irrigation water through providing small scale water source facilities so as to contribute for stabilization of people's life and increasing of agricultural production and resultant promotion of rural development. During the period of 1977-1997, as many as 8,290 SSIP were constructed nation-wide and about half number of 4,063 projects were located in the Northeast Region. From the specific feature of the NE Region, the project-type-wise breakdown of 4,063 projects is shown as follows.

Reservoir	Weir	Regulator	Others	Total
2,389	1,345	16	313	4,063

2) Lessons learnt

i Securing of minimum water source by SSIP especially in dry season in rural remote areas largely contributed to stabilization of people's livelihood.

ii In the areas where were favored with better market situation, vegetable production caused increased income for beneficiary farmers. In this case the SSIP can be evaluated as an economic development type project.

iii Manner of SSIP implementation was improved and intensified as a program loan and contributed to reinforcing of institutional building of the implementing agency too.

iv In the aspects of post project O & M and utilization of project facilities, there observed considerable differences project by project depending on the localities, leaving some rooms for possible improvement. On this aspect, it is considered necessary to pursue further strengthening of institutional set-up with other agri-related agencies especially in reinforcement in the field of farmers' organization and agricultural extension services.

v The initiation of SSIP implementation was by bottom-up system but there had been several cases the project intention could not be fully understood by the farmers, particularly in the NE Region. It is considered necessary that from the initial stage of the project planning farmers' sense of participation should be raised up through activities by extension workers and local staff of RID.

Data source: 1993, SAPS Report, Seasonal Bulletin of OECF (1986/9 No.53), Hearings from RID and Summarizing thereof by the Study Team

JICA Study for Medium Scale Water Resource Development:

Lessons Learnt from the Implementation: F/S on Medium Scale Irrigation Package Project in the Lower Northeast

1) Project summary

The subject F/S study was conducted in the south part of the NE Region at the initial stage of the trend when development of medium scale water resource was high-lighted in Thailand. Under the study, the technical and economic feasibilities for constructing Lam Plai Mat dam/reservoir was positively confirmed, and the major parts of the recommended project were implemented immediately after the study by using the government budget and put in service. At the time of study, stabilization of people's livelihood in the areas bordering with Cambodia was an urgent necessity in the government policy and possible improvement of agricultural productivity by means of extension of irrigated agriculture was badly needed.

Further to mention, the guidelines prepared under the study have been widely used thereafter for the planning and designing of the medium scale irrigation development projects, causing a favorable evaluation on the study that the technical transfer was successfully achieved.

2) Lessons learnt

i. Under the circumstances that suitable site for large scale water resource development was narrowed down, RID tried to implement broad-based implementation of SSIP nation-wide aiming at stabilization of people's livelihood especially in rural remote areas as required by higher priority-given policies. At the same time, RID was in need of possible expansion of medium scale project which has a certain scale merit even not comparable with the large scale one in view of the possible promotion of irrigation development in the country. The scale merit as mentioned is particularly true in the aspect of post project O & M. The subject F/S study was conducted at the initial stage of the said circumstances and therefore considered that the JICA assistance was done quite timely. This resulted in positive utilization of the guideline and the methods applied for

the study in the subsequent studies for a number of medium scale projects by RID and the local consultants. Concerning the O & M (Including rehabilitation) it is judged that the activities shall be further strengthened with having local administration bodies as the main player together with the beneficiary farmers in line with the decentralization policy by RTG.

ii. The JICA F/S was evaluated very useful and timely implemented in view of the fact that the Lam Plai Mat dam project, the core of the study, was implemented immediately after the JICA study by the RTG budget.

iii. The project was to attain irrigation development aiming at alleviation of poverty and rectifying the income disparity in the NE Region where was designated as a special priority-given area under the 5th NESDP. In the soft-nature aspect as stabilization of irrigated agriculture and securing of good market for the produces, the supporting activities by the project implementing agency was not sufficient enough and quantitative grasping of project benefits is difficult. To this end, it shall be noted that establishment of closer cooperation relationship among RID and other agriculture-related Departments under MOAC is necessary.

Data source: 1984 JICA F/S Report and hearings from RID and summarizing by the Study team

(2) Lessons Learnt from Implementation of Large Scale Land Consolidation Project:

Nong Wai Operation and Maintenance Project (IDA, ADB and KFW loan)

1) Project summary

The then UN-ECAFE and RTG took up Nam Phong river, one of the major tributaries of Chi river as a development target to be implemented prior to the others in the Mekong/NE Region and formulated a water resources development plan aiming at hydro-power generation and large scale irrigation development. In line with this move, RID commenced construction of Nong Wai weir in 1965 and in 1966 construction works for the main canals were started. After that, it was during the period of 1975-1979 that on-farm development for the 9,400 ha area on the left bank was implemented with due support by IDA and further it was in 1976-1983 period that another on-farm development project was implemented with having support by ADB for 11,000 ha area on the right bank. While for the 102,000 ha area on the left bank downstream area, KFW supported the on-farm development works together with the construction of extended main canal. This was the on-farm development project to utilize fully the limited but controlled large scale water source in the NE Region and by having an advantage of its geographical location to be in the center of the Region, the project resulted in attaining considerably high agricultural productivity.

2) Lessons learnt

i Recent development observed in Khon Kaen area as the core urban area in NE Region can not be materialized without the basic condition that the area is secured with the large

scale water source controlled. Moreover it can be said that the large scale on-farm developments within a limited time by due supports by international aid institutions have surely contributed to the improvement of productivity in the irrigation beneficiary areas located in and around the city area. As the results, the area centering around Khon Kaen city has captured a reputed position to be a big vegetable production center in the NE Region, enjoying substantial increase of income from dry season cropping and at the same time contributed to the further promotion of the regional economy. (From the initial stage of project implementation, collaboration by RID and DOAE was secured in this project.)

ii In the aspect of farm mechanization which is increasingly needed to be progressed in the recent years, the subject project area is much advanced where broadcasting and use of combine-harvester for harvesting are very popular to data. In the field survey under this study too, there have been repeated requests confirmed directly from the farmers to expand the land consolidation project in the area. This suggests that provision of farm roads is of urgent issue in the NE Region for better access for farm machineries.

iii Technically, it is considered that RID's capability is high enough to manage the issue with the experiences and know-how accumulated to date, but in terms of the financial aspect there have been considerable limitations, leaving rooms to seek possible supports by such international financing institutions like the case of Nog Wai Project.

iv Activities by farmers' organizations are also active and the irrigation loss is reported much less than the other areas. O & M activities by RID also are well-functioned as the core of Chi basin water management to be a good model for the other basins. These can be highly evaluated as a good sample for the other basins in NE Region.

Data source: Project Leaflet by Regional Irrigation Office 6 and hearings from Beneficiary farmers as summarized by the Study team

(3) Khong Basin, Lessons Learnt from Large scale Pumping Irrigation Project

At the Estuary of Tributary Emptying into Mekong River:

Huai Mong Project, Nong Khai Province

1) Project summary

Under the project, an estuary barrage be provided at the river mouth of Mong river to protect the high flood water entering from Mekong main stream and in dry season to store the discharge from Mong river (774 MCM/annum) within the river channel to store for the use for irrigation. The project was implemented about 30 years ago by the DEDP. Through the administrative reform in 2002, the project facilities have been transferred to RID from DEDP.

Of the project area of 61,000 rai area, 54,000 rai is irrigated in wet season and it is 25,000 rai in the dry season. The high ratio of dry season irrigation suggests the abundance of water resources in the project area. The major project facilities are as follows.

-Estuary barrage (4 spans of roller gates)

-Head regulator pump (2.3 m3/s x 4 units) Dual purpose for Irri. & Drain

-Irrigation pump for each of irrigation block (10 stations)

Rice/paddy is the main crop in the project area. Under the project farmers enjoy high unit yield of 700 kg/rai in average. Mechanization is also progressed in the area and plowing and harvesting are 100 % by machineries. For transplanting, broadcasting is predominant in dry season but it is by manual transplanting in wet season due to the necessity/convenience for weed control works.

The O & M activities by farmers' organization and RID are very active and the practices under this project is considered a good example for the other irrigation areas. Presently there is 1 WUA for each block and in total 10 WUAs are doing O & M activities with the 166 WUGs under the WUA. Of the 166 WUGs, IWUG are 4 groups.

2) Lessons learnt

i. Drainage control during flooding times is important at the estuary of the tributaries emptying into Mekong River and it can be said that this type of estuary barrage project is suitable solution in view of the geographical and hydrological features in this particular area. There are several tributaries like Huai Mong on the northern and eastern boundaries of NE Region along the Mekong River, and the similar concept to Huai Mong project is considered applicable to these tributaries estuary areas.

ii. Participation of farmers' organizations in O & M activities is found sustainably common in the area which shows a typical case that securing of sustainable irrigation water supply led voluntary O & M activities by beneficiary farmers.

iii. The pumping equipment under the project had been procured by the grant aid assistance by Belgium Government. After continuous use for a long period, the equipment has been deteriorated in need of renovation. But new procurement today for the Belgium –made equipment and spare-parts is not easy both in locating the original maker and in price. (Hearing from O & M staff, RID). As to the imported pumping equipment and materials as said, there is an idea that these should be domestically produced in future.

Data source: Project Leaflet by Regional Irrigation Office 6 and hearings and summarized by the Study team

(4) Medium Scale irrigation Project by Water Diversion by Pipeline system:

Lam Phayang Pumipat (Water Diversion) Project

1) Project summary

The project was divided into the following 2 phases. Irrigation water supply by means of trans-basin water diversion falls into the phase 2.

Phase 1: Upper Lam Phayang irrigation system (1995)

Irrigation is targeted for 4,600 rai area. The system is gravity flow pipeline system with 72 distribution outlets from the Upper Lam Phayang reservoir (4.0 MCM) constructed at the eastern part of the project area to the beneficiary area.

Phase 2: Huai Phai irrigation system (2009)

At the Huai Bang Sai basin in Mukdahan province, Huai Phai reservoir was constructed for the storage volume of 10 MCM and the part of stored water be diverted to irrigate 12,000 rai Huai Phai irrigation area in the other basin through pipeline system installed in a tunnel. Irrigation water distribution system is by gravity flow pipeline similar to the Upper Lam Phayang project area. The project is at present at the stage of experimental water distribution. The Upper Lam Phayang reservoir serves for the 1,000 rai area in its own basin in Mukdahan province and the rules for water allocation shall be discussed and decided by the beneficiary farmers of both basins and supplied to the irrigation beneficiary areas.

2) Lessons learnt

i This is the typical medium scale irrigation project by applying water diversion concept. Beneficiary areas are located on both basins and the rules on water allocation shall be discussed and decided by beneficiary farmers of both basins, suggesting an important example for the other possible diversion schemes.

ii The project applies gravity flow system by pipeline which is rather rare in the country. O & M is observed functioning well. In case of pipeline water distribution system, there are few water conveyance loss and stealing, resulting in a higher irrigation efficiency. Accordingly, the system is of good example in case of projects which pursue higher efficiency, though requiring further study/examination to apply widely.

iii Ditches after outlet valve are to be provided by the farmers and WUGs are organized one each for an outlet valve with fair O & M activities by farmers. WUGs are expected to be IWUG in near future.

(5) Lessons Learnt from Broad-based Irrigation Development by Large Scale Water Diversion Scheme:

Khong-Chi-Mun Project KCM Project)

1) Project summary

Under the circumstances that possibility to build Pa Mong dam on the Mekong River became scarce year by year, the then RTG changed the idea and put more emphasis on the simpler idea of water intake from the Mekong by pumping at the nearby area of the Pa Mong dam site. In the 1980's RTG put higher priorities in implementing a number of SSIP nation-wide but RTG believed that for the drastic expansion of irrigation area in NE Region, which was an important political challenge to be accomplished at that time, water from Mekong is the best solution with due sustainability and practical potentials. Through the studies conducted, in the late 1980's a "Grand Vision" was presented under the name of KCM Project and assessed by RTG as a systemized strategy for the development of NE Region and duly approved by RTG

in 1989.

The overall project implementation was divided into 3 phases and it was a huge scale development scheme to develop as large as 5 million rai irrigation area over thee 42 years period. Major project components under each phase are as follows.

Phase 1: (9 years: 1992-2000, Irrigation development for 2.323 million rai)
1st step: Improvement of Lam Pao Irrigation facilities
2nd step: Construction of 13 weirs on Chi and Mun rivers (Chi 6 and Mun 7)
Under the 1st and 2nd steps, water resource development within the basins be pursued.
3rd step: To develop 1.616 million rai irrigation area by water diversion from Mekong River
2 pumping stations
3 weirs at Chi river and the tributaries
5 weirs at Mun river and the tributaries
Water diversion canals: 4 lines

Phase 2: (16 years: 2001-2016, Irrigation development for 1.693 million rai)
Construction of pump station at Ban Wieng Kuk, Nog Khai and divert Mekong water to Lam Pao Reservoir. From Lam Pao reservoir 5 lines of canals and 2 pump stations be constructed to divert water to Upper Chi, Upper Mun and Middle Mun.

Phase 3: (17 years: (2014-2033, Irrigation development for 0.964 million rai)
Construction of pump station at Chiang Khan, Loei and divert Mekong water to Upper Mun basin.
Major facilities include 8 lines of diversion canals and 3 hydro-power stations.

After the year 1992, construction of structure/facilities planned to be implemented at the initial stage was started in Chi-Mun basin and it was in 1994 the famous Rasi Salai weir was completed. Huana weir was completed with the construction period of 1992-2000. There had been many other structures constructed during the period, but the KCM Project implementation has been suspended due mainly to the dissolution of DEDP as caused by the administrative reform in 2003. Accordingly, the KCM Project does not perform its planned function to date as explained below.

i) In conceiving the project plan, there was an assumption that water storage by weir construction at the flood plain would not cause resettlement problem for the residents, but in fact, there happened considerable necessities of resettlement and many conflicts occurred between the implementing agency and the local residents. This indicates the case there were problems on accuracy in project planning works.

ii) Water intake by pumping from Mekong River as the source of water resource under the project has not been materialized. Under the circumstances where institutional set-up has not been completed, no endorsement on the subject project implementation had been secured from the LMB riparian countries. Further, there are difficult problems to be

solved technically in water intake from Mekong main stream too.

iii) Policies by RTG for the implementation of the project had not been firmly fixed, and under some governments, policies were to give no priority in the KCM project.

2) Lessons learnt

i. As compared with the project scale which was huge, the finalization process at the project planning was seemed insufficient and/or incomplete. As the result, the participation of RID who was assigned as the main RTG agency for irrigation was extremely limited, leaving essential problem issues in O & M of the constructed facilities/structures.

ii. For utilization of flood plain for storage space, it was necessary to have due careful consideration on the protection of natural environment and social environment for the local residents. However, the project implementation was accelerated in haste due to the necessity by the political background alone, causing many problems/conflicts between the RTG implementing agency and the beneficiary farmers in various localities. This suggests the inevitable importance of people's participation in project planning from the beginning stage for smooth project implementation and sustainable O & M after the construction. Further to mention, there remain considerable problem/pending issues on water quality (Salinity) and natural environment (Negative effects on fishes and eco-system).

iii. During the period of KCM project formulation and implementation, there had been several organizational reforming, merging and dissolution of RTG agencies. It affected on NEA who did the project formulation/planning and DEDP who did the implementation, and there observed some confusion about the responsibilities among agencies affected by the said reforming. This surely brought about negative effects on the subject project as a whole and suggests the necessity that organizational set-up for project planning and implementation and further post-project O & M should be firmly established with due sustainability. Moreover, it shall be noted that there were considerable evils as caused by administrative sectionalism and it seems necessary to have due consideration on adequate institutional set-up so as to secure closer collaboration among the agencies concerned in case of such huge scale project implementation.

iv. Priorities were given in project implementation at the earliest and not in the efforts to obtain people's consent on project implementation through PR activities and sharing of opinions/ideas by local people and RTG agencies. Due to this, the project plan was finalized without reflecting the people's opinion/wishes and further with the dissolution of the implementing agency water source for irrigation supply could not be secured. All this resulted in the absence of necessary efforts in solving the prevailing problems and implementing proper O & M activities for the facilities constructed.

v. DEDP, the project implementation agency, was specialized in the administration of energy development especially of electric power and had some experiences in pumping

irrigation scheme of small/medium scales. For the huge scale irrigation project like KCM project, DEDP's technical capability and staffing both in irrigation technology and O & M would not be sufficient to manage efficiently. This suggests the lack of required collaboration with MOAC and RID.

Data source: Kong-Chi-Mun Development Plan and etc.

(6) Trans-basin by Tunnel Water Diversion: Lessons Learnt from Kok-Ing-Nan Project:

Kok-Ing-Nan Water Diversion Project (JICA Development Survey for Supplementary, F/S and Environmental)

1) Project summary

Under the circumstances Thai national economy attained rapid growth in 1990's, solution of water shortage problems in future in the Chao Phraya delta which held the key role of the national economy became a crucial concern for RTG towards further growth of national economy in sustainable manner and even grading up its development potential. Under the KIN scheme, surplus run-off from Kok river be diverted to Sirikit reservoir to fill the vacant capacity and through converting the wet season surplus water to irrigation water in dry season, the diverted water will cause solution for water shortage as predicted in the Chao Phraya delta. In Thailand, however, there had been no experience in implementing such large scale water diversion scheme and RTG requested JICA to carry out the above-specified study during 1992-1997.

By diverting 2 billion m3 from Kok river, it is possible under the plan to increase additionally 0.8 billion m3 of domestic/industrial and 2 billion m3 of irrigation water and the dry season irrigation area would be increased by 1.2 million rai. Other than the above, the water diverted will contribute to higher power generation efficiency and sustainable economic growth in the Greater Chao Phraya basin as a whole. If in case this diversion scheme could be successfully implemented, considerable project effects could be expected in broader base, but there remain several pending issues to be solved in the aspects of environments both in natural and social and also of project funding before it can be implemented. In terms of the project evaluation, EIRR shows a high rate of 15.8 %, but according to the Final Report, the project is not necessarily feasible and requires EIA assessment on overall scheme level instead of each project level. In the final report as prepared by RTG RID side, it concluded the project to be feasible but it is said that the project could not be implemented mainly due to the economic downturn occurred in 1997 and etc. The project is however included in the long term investment program by RTG even at present.

2) Lessons learnt

i In order to satisfy the increasing water demands as accompanied with national economic growth through overcoming the uneven water resource existence and the seasonal fluctuation in Thailand, the trans-basin water diversion and wider area water management including plural numbers of river basins are considered as an effective

solution under the present situation.

ii Trans-basin water diversion by tunnel will cause considerable impacts on not only the natural environment but also the social environment, and it is necessary to examine the feasibleness of the project by EIA (SEA) at the planning stage.

iii In case of water diversion scheme, understanding on the scheme by the people, water users and local administration officials in the donor basin is very important. Under the diversion scheme, therefore, development benefits to be brought about in the donor basin shall be duly included in the scheme aside from the required compensation plan. Moreover, it is necessary to secure opportunities for opinion advancement in participatory manner through holding sufficient PR activities and public hearings.

iv The planned long distance water diversion canal by tunneling will cause a huge construction cost and the return for the investment would not be sufficient enough if diverted water be used for increased paddy cropping by expanded irrigation area alone. Therefore, the project justification shall be examined through reviewing the long term water demands for irrigation for high value crops, industrial use, city water demand as well as environmental needs.

Data source: Feasibility Study and EIA Study (Final Report) RID 2002

JICA KIN Study Report (Supplementary, F/S and Environmental)

1997 by JICA

5.2.2 Basin Water Management/Integrated Water Resource Management (IWRM)

(1) Case study of IWRM in Chaophraya basin (World Bank)

1) Project summary

The Chaophraya river is the most important river in Thailand as it flows from the northern region down to central region, passing through Bangkok, the capital of Thailand. The river provides water for irrigated areas in the central region, considered to be the rice-bowl of Thailand, and thus carries enormous economic significance in addition to supplying raw water for Bangkok industries and populations. A study to prepare a strategic plan for water management in Chaophraya river recommended the establishment of the Chaophraya River Basin Committee in 1994. A sub-committee was formed to study the formation of Chaophraya RBC in 1995. Due to the rapid industrialization, land conversion, housing development and urbanization, the Chaophraya basin has encountered frequent flooding and water shortages, creating serious concerns about how to manage the basin's water resources more effectively and sustainably.

One of the key points in the study was in the establishment of Chaophraya River Basin Committee (RBC). However, given that the basin is very large with complex socio-economic dimensions, it was recommended to establish three (3) pilot RBCs in three sub-basins of Upper Ping, Lower Ping and Pasak. In 1999, the government received assistance from ADB

for agriculture and water sector management, which included water management in the Upper Ping and Lower Ping sub-basins. At the same time WB assisted Thai government in studying strengthening of water management activities in Pasak sub-basin.

2) Lessons learnt

i Formation/establishment of RBCs in the most important basin in the country

ii By reducing the responsibilities of RBC member and limiting the function of RBC to only three (3) key items as below, the activities became active and the RBC function has been much improved.

* Preparation of basin plans

* Collection of baseline data and maintenance of basin information

* Conducting public relations and awareness raising campaigns

iii Due to the RBC activities falling inactive and not functioning well because of the member composition where more nominated from the government agencies and the meeting/ operation were managed in top-down style, the formation of RBC has been readjusted so that the majority be composed of non-governmental members such as NGOs, academics and more local stakeholders etc. and moreover, working groups were organized in participatory manner. By this readjustment, it was achieved that the stakeholders played more important roles in the process of planning and decision-making.

Data Source: Implementing Integrated Water Resources Management (IWRM): based on Thailand's experience, Dr. Apichart Anukularmphai

(2) Case study in Yom river basin

1) Project summary

The pilot project to introduce IWRM in Yom river basin was implemented in 2008 with having a support by ADB (Pilot and Demonstration Activities Program for Water (PDA). The reasons for selection of Yom basin for the pilot project are as follows.

- The basin has the least extensively developed water resources infrastructure among the major Chaophraya tributaries. It is the only one of the four tributaries of the Chaophraya river that does not have a large control dam upstream. Other medium and small structures are scattered and not interconnected, however there are plans for the development of new water resources infrastructure.

- The basin is subjected to emerging dispute between civil society and promoters of proposed water resources infrastructure projects. Notably there are a number of strong advocacy groups that oppose the proposal of RID to build the Kaeng Sua Teng Dam. These civil society groups have formed a conservation network to protect the forest. In addition there are civil society groups downstream that want action taken to reduce

flooding in Sukhothai. However, although there is potential for water related disputes, there is evidence that these two groups want to have a better dialogue and exchange of opinions with project promoters in order to solve water problems in the basin.

Major points confirmed through the pilot project implementation in Yom basin are as follows.

- Formulation of working group with nominated members selected from key stakeholders
- Control role was assumed by the members from local stakeholders and the Chairman of RBC, Abbot
- Effective technical supports were extended by TWRA expert and universities

2) Lessons learnt

i. Change in attitude and thinking

The process of organizing meetings with real participation from all stakeholders and key line agencies created opportunities for frank exchange and cooperation. Also the creation of the Network of sub-districts located along both banks of the Yom river facilitated the formation of a large group of stakeholders who share similar concerns and ideas, and are committed to addressing priority problems using local knowledge in managing water resources. At the same time, it allowed implementation of activities and projects in a more coherent manner from upstream to downstream.

ii IWRM Training”

Through having common trainings on IWRM with participations by local stakeholders and the government officials concerned, the mutual understanding between them could be much progressed. DWR Region 9 Office is responsible for supporting of working groups and for functioning as the secretariat to RBC and therefore additional training for capacity building of Region 9 staff and required budget allocation are necessary.

iii Data collection and Yom basin Information Center

The activity started with simple data collection leading to the establishment of the Yom Basin Information Center. A three dimensional physical model of the Yom river was constructed with assistance from a lecturer and students from Naresuan University. The Information Center is currently being used as a training facility for various stakeholders on water resources.

iv Flood Warning System

The working group selected 11 locations from the upper Yom to the Lower Yom to install water level measuring devices. To minimize the cost, the pillars of bridges across the Yom river were used as staff gauge for measurement. The measurements were sent through SMS to the Information Center. At the Center then translates the data and be plotted on the longitudinal profile as wee as posted on the website. This is the simple and effective flood warning system with low cost by means of improved management by the stakeholders in the basin.

v Other than the above

In the Yom basin, there some notable activities as networking of sub-districts located along the Yom river, site visit to key existing projects in the basin and youth water quality monitoring volunteers and so forth.

Data Source: Implementing Integrated Water Resources Management (IWRM): based on Thailand's experience, Dr. Apichart Anukularmphai

(3) Introduction of IWRM to Bang Pa Kong river basin

1) Project summary

Bang Pa Kong river basin situates at the Eastern Region, Thailand with having 19,000 km2 of basin area consisting of 9 tributary sub-basins. Though the basin is favored with comparatively rich rainfall, in the dry season the river run-off is quite limited in addition to the topographic condition which allows only small water storage potentials in the basin. The basin has, however, a large irrigation area with considerable extent of aquaculture, one of the major industrial areas and problems on saline water intrusion, causing a difficult condition for practicing proper water management.

Major problem issues in the basin in connection with the water management include the followings.

* Deterioration of eco-system as affected directly by people's way of living
* Insufficient supply of water for life
* Frequently occurred floods
* Water pollution
* Conflicts among various water users constantly occurred as caused by the above problems

It was in 2003 that "Bang Pa Kong Dialogue" was started with due assistance by FAO. The Dialogue aimed at promotion of possible collaboration concerning the basin water management among various stakeholders in the basin. Then "A Pilot and Demonstration Activity" project was launched in 2004 with having financial assistance by ADB. Under the project, capability strengthening of RBC of Bang Pa Kong river (BPRBC) was planned with the objectives of reducing the conflicts in the basin, introduction of adequate water allocation method and also introduction of IWRM.

BPRBC was consisted with the following members and the Committee Chairman was selected from the private sector.

* Representatives from local administration bodies
* Water users
* Local NGOs
* Government officials

* Representatives from private sectors

The positive outcome of the project is considered firstly as the fact that the government sector, civil society and community help each other in pursuing solutions for the problems encountered. Secondly, the committee proposed the manner of water allocation for various users as presented in the draft of water resources law.

2) Lessons learnt

Major points of lessons learned in the practice of IWRM in Bang Pa Kong river basin are as noted as follows.

i Selection of leader is quite important. In case of BPRBC, the key point was in the selection of the committee Chairman from the private sector

ii It is important to level up the capability of RBC members so as to make it possible to fulfill the committee's role in dealing with the complex conflicts on water allocation

iii It is important to clearly define the policies on water management and roles of RBC

iv Linking RBC with the national level central government is important in plan formulation, preparation of adequate action plans and budget aspects

Data Source: Water Champion: Sukontha Aekaraj : Bang Pakong River Basin: Resolving Conflicts Through Dialogue, April 2007, By Ma. Christina Dueñas, Water Knowledge and Communications Coordinator, ADB

(4) Lessons Learnt from IWRM Practice in Tributary Basin: Huai Sam Mo Sub-basin Working Committee and Integrated Water Resource Management Plan

1) Project summary

The Mekong River Commission (MRC) is implementing some IWRM pilot projects in its member countries with having financial assistances by GTZ and WB. One of them is in Huai Sam Mo (HSM) in Upper Chi basin in NE Region. DWR selected this pilot project site and carried out formulation of the sub-basin working group under the Chi river RBC, activities for conservation of basin environment with encouraging the participations by as many as 16 TAOs concerned and the local people and grasping of problem issues and action plan formulation concerning with the water management in the basin.

Applying the participatory manner, 5 strategies as follows were worked out and based on these activities were continued.

- Community water resource development
- Promotion of organic farming and income creation activities
- Organizational development and environmental improvement
- Finding of local wisdom and rules/development of learning text

- Emphasis on roles by women and youths

Through these activities, networks of women groups and youth's groups have been established. Activities include reforestation, fixing of rules on use of community water resource and pilot farm for organic farming and the plan for diverting the surplus water after power generation to the community ponds for which DWR completed the design works and secured the implementation budget by now.

These activities on pilot project in the tributary basin are to be applied to the other 20 tributary basins in Chi basin and under the co-program by WWF and Coca-Cola company for conservation of water resource in Mekong River basin, it has been confirmed that assistances will be extended for these activities for 3 years period under the said program.

2) Lessons learnt

i With having due participation by TAOs and local people, water resource situation as well as the problems in the subject tributary basin were grasped, discussed ways how to solve the problems and practical action plans were formulated by the participants. Through the activities and the process of learning with each other, all the participants deepened the understanding on the water resource situation in the tributary basin. For the successful implementation of IWRM, participation of local people and the process of participation and learning itself is crucially important.

ii DWR is the main actor with having due participation by the local people for the various activities as mentioned, but RID's participation could hardly be confirmed. Also, the assistance/support by the Chi river RBC was found rather limited. In this concern, it is necessary to reinforce the capability of RBC and collaborative relationship between DWR and RID who assume the role of technical supporting to RBC.

iii The DWR Regional Office commissioned a study to KKU-IWRMC for formulation of action plan in participatory manner and examining water resource development and management and a NGO assumed the role of facilitator to the local people. KKU-IWRMC continues their activities as a research subject even after the completion of the commissioned study and also the NGO maintains the close relationship with the local people since then. In order to attain the sustainability of the project, it is expected to have this kind of continuation even after the project termination through active utilization of such local institutes already existing.

Data source: "Three years experience in the pioneer stage in Huai Sam Mo Sub-basin Management Planning" Dec. 2008 and Interviewing During field survey, June 2010

(5) Lessons Learnt from Study/Strategy Planning on Basin Water Management:

Chao Phraya Basin Water Management Strategy (World Bank-JPHRDF TA)

1) Project summary

This Study was conducted during the period of October 1996-October 1997 with having TA by WB and RTG counterpart agencies as NESDB, RID and PCD (Pollution Control Department). The Study worked out water demands projection based on 4 scenarios, proposed the following 11 strategies by 3 different groups and assessed the strategies through conducting water balance analysis.

-Group 1 by new water resource development (Large scale reservoir, water diversion, small and medium scale reservoir and storage at estuary)

-Group2 by water management (Conjunctive use with ground water, re-use of drained water in Bangkok and reducing of loss)

-Group 3 by demand control (Fixing of water right, introducing of water fee and crop diversification)

Based on the above, case studies were made targeting on Mae Taeng/Upper Ping Basin and North Rangsit/Chao Phraya East Bank and proposed to implement the strategies as mentioned above, though the proposed plan has not been implemented to date. The Study also recommended the strategies for an integrated water management for the whole Chao Phraya basin and proposed the following 3 projects to be implemented under Chao Phraya River Basin Organization (CPRBO) to be established.

-Chao Phraya Water Management Project (RID)

-Water Quality Management Project (PCD)

-Flood Management Project (CPRBO/RID)

2) Lessons learnt

i. RTG initiated a study to formulate strategies for basin water management including demand management since 1994 and after the said study sub-basin RBCs as Upper Ping, Lower Ping and Pasak were established in the year 1999. The study by WB was timely and in conformity with the RTG's then policy and direction as justified.

ii. The study covered on many sensitive issues as IMT (Irrigation Management Transfer), water fee collection and fixing of water right and etc., and these issues are considered to be dealt with due careful attention and not to be concluded definitely in such a short period. The issues are to be studied and examined primarily by RTG and the donor side is required in principle to limit its role in assistance in technical matters. In this concern, the Irrigation Sector Reform as assisted by FAO can be considered as a good example where the working group was formed in RID and the ownership was held by Thai side.

iii. The scenario was composed on the pre-condition that agricultural water use would not increase even after 20 years due to the reduction of planted area for paddy in dry season, while in fact 5 crops in 2 years are very popular in Chao Phraya delta today, indicating a big gap in between the prediction and the reality. This showed the correctness of the

viewpoint by TDRI that escalation of crop price is an important factor in estimating the water demand in future. Change of crops to be cultivated could not be determined just by the government policies and target set by the government, but it is very much depending on the prices which are external factors.

iv. As per the opinions from RID officials, there had been some of the content in the study report not agreeable by RID. In order to materialize the new strategies causing considerable change/shifting of government policies, consent by the implementing agencies/relevant government agencies are quite important and it involves a time-consuming processes. It is necessary for all concerned with the study to grasp clearly the position/scope of the assisted study in the overall process or flow to be primarily conducted by Thai side.

Data source: Final Report on Chao Phraya Basin Water Management Strategy (1997) and hearing by the Study Team

5.2.3 Irrigation Water Management/O & M/Water Users Association

(1) Thung Samrit Project under ASPL: Lessons Learnt from Improvement Project:

Agricultural Sector Program Loan: Thung Samrit Irrigation Project

1) Project summary

Thung Samrit Irrigation Project is the first modern large scale irrigation development project implemented in NE Region. The project initiation was in 1940. The project is of the gravity system by using the Mun river run-off in the original plan and put in service for 70 years period by now. Later in recent past the project has been expanded for new area with pumping system. In total the beneficiary area covers as large as 200,000 rai area of which 160,000 rai by gravity and 40,000 rai by pumping. However, the irrigation in dry season is limited to only 5,000 rai area due to the regular water shortage in the river. In wet season, Jasmine Rice is planted for as large as 120,000 rai area while in dry season major crops planted are glutinous rice and vegetables.

Before the ASPL project be implemented, the low efficiency in water use had been the usual problem due to the deterioration of project facilities, inactive O & M activities by farmers' organizations and poor drainage conditions prevailing.

ASPL is the project designed to improve the agricultural sector by using the revolving fund derived from the emergency loan extended to overcome the economic/financial crisis occurred in 1997. The project was provided by the 370 million Baht budget (For Thung Samrit) during the period 2000-2003 and Thung Samrit was one of the various components under the entire ASPL. Through implementing ASPL, the project key word as PIM was extensively popularized in Thailand and resulted in considerable improvement of water distribution efficiency under the project through having concrete lining on the main canal in hard aspect as coupled with the activation of O & M activities by WUA and WUGs in soft nature aspect. Further, drainage facilities had been improved and relevant facilities were

renovated. Policy targets towards farmers' participation under PIM included the followings.

-Strengthening of production capacity of Thai agriculture

-Expansion of export potential of agricultural produces

-Improvement of sector management and governance

In spite of the above, RTG policy direction was altered under the Thaksin government to reduce the borrowings/loan aid from foreign sources, and the implementation of Phase 2 of ASPL (About 50 % of the total) was abandoned in the midway. (The improvement project was continued with having RTG budget.) Concerning the on-farm development portion included under ASPL, budget has been allocated under the currently on-going SP2 program.

2) Lessons learnt

i. The project is appreciated with its good performance in activation of O & M activities by WUA. As per the confirmation made at the RID O & M office, increase of agricultural production was accomplished successfully with the improved water use efficiency which caused 55 % increase of farmers' income in average after the project. This is considered as a good sample of income raising by production increase with improved water management practice.

ii. Through improvement of drainage facilities, flood damages have been lessened. This is the contribution to stabilization of agricultural production and also to the improvement of sustainability of the area.

iii. Being led by the high marketability of Jasmine Rice, farmers' motivation for rice production was stimulated, and this caused active participation and activities for O & M of project facilities by farmers' organization i.e. WUA and WUGs. This suggests that marketability and price of farm produces are important elements for organizing farmers and also that completeness of hard nature facilities is an inevitable pre-condition for improvement and activation of soft nature O & M activities by farmers.

iv. Organizing farmers is an important challenge for any projects which requires a long term, step by step and sustained efforts by the government agencies concerned. In this endeavor to discuss and exchange opinions with the farmers, patience is the key word for success. In this sense, the suspending and/or abandoning of ASPL implementation in its halfway left some problems, though it was caused by major change of the government policy in the financial sector. Further to mention, in the implementation of ASPL, there appeared different ideas/directions on water fee (Beneficiary's burden for recovery of construction cost) between RTG and ADB, co-financing agency, and caused indirectly negative effects on the overall project implementation. This requires coordination among RTG agencies concerned and other related institutions so as to fix the policy on water fee, as it seems that such rehabilitation/improvement nature projects like ASPL will be increasingly important under the prevailing situation.

Data source: ASPL Post Project Evaluation Report, JBIC 2007, Minutes of meeting

Of Project visit prepared by the Study team

(2) Improvement of irrigation efficiency and organizing of WUA:

Modernization of Water Management System Project (JICA Technical Cooperation)

1) Project summary

The agriculture in Chao Phraya delta faced with problems on irrigation water shortage in dry season and the low water use efficiency at the on-farm level. Challenging to improve the water resource use efficiency the RTG requested GOJ to have a technical cooperation project for improvement of practical water management at on-farm level. The project was implemented for the 5 years period from 1999 and the follow-up project for 1.5 years with the counterpart agencies of RID and DOAE. The project target was set to realize "Cultivated area for upland crop in model area be increased and crop diversification be enhanced at the same time through effective use of irrigation water in dry season." As many as 5 outputs were planned divided largely into two parts, one in improvement of irrigation system and the other in expansion of dry season upland cropping area. As to the former, the project has achieved good performance to a certain extent including implementation of water distribution based on irrigation schedule for each lateral canal, establishment of WUA and activities, preparation of handbook for participatory water management system and introduction of U-shape flume for terminal ditch facilities and so on, for which further expansion and dissemination by farmers' initiative could be expected to some extent, but for the latter, the target could not be attained due to the following reasons.

-Soils in the model area was not suited to upland cropping.

-No marketing channel could be secured for farmers.

-No economic incentives for the farmers in the aspects of price, labor input and risks in upland cropping

2) Lessons learnt

i. It is necessary to consolidate systematically the development and present status of WUA including success stories of WUA/IWUA as well as negative results. This will be useful for strengthening and further expansion of WUA activities in future.

ii. Concerning the decision-making support system for water management, RID is recommended to play a leading role among stakeholders to share the common ideas on problems prevailing, consolidating the problems and efficiency improvement.

iii. Restrictive factors in doing dry season upland cropping were not adequately reflected in the project design. In order to formulate a practical project, such information and ideas as possessed by field staff and local stakeholders are necessary to be reflected in the project design. Even in the course of project implementation, the project design should be modified flexibly to meet with the changes caused by external factors.

iv. It is deemed important to formulate the project plan so that the follow up mechanism

could be functioned to discuss among those concerned with the project for the purpose to maintain the project effects and further expand the effects.

Data source: Project Evaluation Report at the Project Termination and Post-Project Evaluation Report (Modernization of Water Management System Project)

5.3 Review on Projects implemented in Agriculture/Rural Development Sectors and Lessons Learnt

5.3.1 Crop diversification

(1) Modernization of Water Management System Project (JICA Technical Coop.)

1) Project summary

The project aimed at increase of farmers' income through establishing sustainable farm management for dry season upland cropping as accompanied by mitigation of water shortage problems in dry season in Chao Phraya delta. The target set was derived from higher priority-given policies as involved in the 8th and 9th National Agricultural Development Plan. While on the other aspect, the RTG policy is to introduce guaranteeing of paddy purchase prices which causes further promotion of rice planting in the dry season in the area. As the result, the cultivation area for upland crop in the model area has been reducing to date with the reasons as explained below.

- The area used to be totally and traditionally a paddy production area and farmers there have no much interest and knowledge on upland cropping.
- Even in the dry season, the area is sufficiently supplied with irrigation water.
- Soils are not suitable for upland cropping and land preparation for upland cropping requires considerable cost and labors.
- Price of paddy is maintained at rather high level, resulting in less incentive for crop diversification.
- Upland cropping requires more intensive care and labor input than paddy.
- Upland cropping holds high risks like insect/disease, price fluctuation, climate and poor drainage.
- Marketing channel and market pricing are not secured sustainably.

2) Lessons learnt

i. When policies are to promote crop diversification, possible integration with the actual needs of the farmers are necessary. In particular, attention shall be paid on the required labor input aspect.

ii. Concerning the risks which farmers become conscious, external factors are more

influential, and project shall be designed in a way the external factors be converted to internal ones.

iii. Creation of markets and marketing channel are important to cause farmers' incentives to challenge crop diversification and it is seemed necessary to include the marketing matter in the project design.

iv. Collaboration with DOAE is important but bridging with private sector is also crucial in attaining success stories.

Data source: Post-project evaluation report on Modernization of Water Management System Project

(2) Revitalization of Deteriorated Environment in Land Reform Area through Integrated Agriculture Development (JICA F/S and Yen Loan)

1) Project summary

After 1960's, the forest area in NE Region had been decreased due to the expansion of farm land by means of reclamation of forest area which was enhanced in line with the then government policy to earn foreign exchange by exporting of cash crops. Later on, the government demarcated the reclaimed land as agricultural land reform area and granted the right to cultivate for the farmers who reclaimed and doing cultivation. Many farmers, however, are in debt owing to the borrowings for purchasing of fertilizer and chemical pesticide/insecticide and also to the one time cash income at the harvesting of cash crop and its price fluctuations. Further, the farmers have to buy vegetables from outside for their consumption as they cultivate only cash crop in mono-culture style. With having these background situations, the subject project of ALRO was launched as a Yen loan project for the ALRO areas in 4 provinces of NE Region (48,000 ha project area with 10,000 beneficiary farm-household) and implemented during the period of 1999-2010.

The project aimed at the followings, among others.

- Consolidation of agricultural infrastructure for lifting up the standard of living of the farmers in ALRO area.
- Conservation of reserved forest area around ALRO area and improvement of environmental condition in ALRO area
- Job-creation through extension of mixed farming

Project development concept was based on the "Sufficiency Economy" concept as suggested by the King of Thailand where development would be progressed step by step as briefly explained below.

- Farmers have to cultivate varieties of crops, raise fishes and keep livestock to satisfy their consumption first.
- Reduce the expenditures for food

- Mitigate/disperse the risks as much as possible
- Sell the surplus produces to gain additional income

The project also supported the sustainably developing learning process for the farmers and community in knowing the problems they faced and to empower them to be able to solve the problems by their own initiative and capability. For this sake, the idea of participatory approach has been applied to every step of the project implementation. The project was composed of the following 5 major components.

- Provision of agricultural infrastructure
- Organizing of farmers
- Extension/expansion of mixed farming
- Environmental conservation
- Development of community market

2) Lessons learnt

i Infrastructure development is a means for improvement of farmers' standard of living and not the objective. Small scale rural infrastructure development is effective in materializing the betterment of farmers' livelihood directly in a short period. This implies that the extension of project effects can be attained through materialization of benefits within the period of project implementation.

ii The project is of integrated rural development, and a synergy effects can be obtained by an organic linkage of hard components with soft components including excavation of farm ponds, extension of organic farming and development of community market and etc.

iii Effective manner of development as proved in the subject project implementation include 1) development suited to the local conditions 2) active utilization of the existing institutions in each locality and 3) positive use of locally available resources.

iv It is possible to level up the sustainability of the project through collaboration with local NGOs, farmers' network and Universities in the area

v Efficiency of cooperation project can be improved with having possible collaboration of various cooperation schemes and with participation of various stakeholders.

Data source: Thailand "Sufficiency Economy" and Sustainable Development, Noda M. 2009, Evaluation on Japanese ODA in Agriculture and Rural Development Sectors (2007, Ministry of Foreign Affairs, Japan), "Civil Engineering Consultants No. 242, 2009, Terminal Evaluation of Project for Revitalization of the deteriorated Environment in the Land Reform Areas through Integrated Agricultural Development Stage I (ALRO, 2007)

5.3.2 Rural Development

(1) Pilot Project for Poverty Alleviation and the Promotion of Food Security in Northeastern Thailand (FAO TA)

1) Project summary

FAO assisted DOAE in implementing a pilot project aiming at poverty alleviation in the NE Region, based on which, FAO is following up the matter through discussion with RTG to implement the "National Strategy for Poverty Alleviation and Promotion of Food Security with Special Emphasis to Northeastern Thailand for 2011-2015. The pilot projects were implemented at 6 communities in 3 provinces of Nakhon Phanom, Maha Sarakham and Sisaket. The outline of the pilot project is as briefed below.

Period:	March 2006-June 2009
Imple. Agency:	DOAE under MOAC
Objective:	Food security and improvement of farmers' living standard
Project purpose:	Raising up of agricultural productivity, self-reliance of Farmers and increase of farm-households' income
Project components:	Multi-sector approach, planning and implementation in Participatory manner based on actual farmers' needs (1 million Baht subsidy per village) (Examples: Food bank, agro-fish processing, improvement of irrigation system, well drilling, reforestation, livestock and community learning center)

Project effects:
- Improvement in agricultural productivity, expansion of irrigation area and crop diversification
- Increase of farm and off-farm incomes
- Reinforcement of group activities by farmers and stabilization of participatory manner
- Through community learning center, knowledge and techniques of farmers were leveled up

2) Lessons learnt

i The roles to be played by academic institutes in identifying the problems farmers face and the solution thereof in PRA approach is very important towards challenging for poverty alleviation and food security.

ii To reach an agreement, people's participation will bring about a common understanding among the various stakeholders and therefore it will promote actual project activities in practice.

iii Village/community is deemed as an inevitable component in tackling the poverty alleviation and food security. Community is a unit to change.

iv With adequate opportunities provided, the community can be an effective body of decision-making.

v It is important to show a common attitude by all villagers to the project ownership concerned. First, concerning the project implementation and then concerning the project achievement and outputs too, the same shall be applied.

vi In any cases, it is preferable to have revolving fund system so as to cover the rest of the villagers to be benefited.

vii Degree of participation and the quality of outputs depend very much on the extent of agricultural extension services and the manner of assistance/supports availed.

viii Supervising and guidance by the government agencies through various levels of committee and various agencies may in reality contribute to smooth undertaking of activities related with poverty alleviation and food security.

ix Agricultural input to be distributed to farmers shall be secured in advance. Delay in delivery/distribution may cause losses and waste and not cause any improvement in the agricultural productivity.

Data source: "National Strategy for Poverty Alleviation and the Promotion of Food Security with Special Emphasis to Northeastern Thailand for 2011-2015" (FAO, 2009)

5.4 Lessons Learnt from Past Projects and Suggestions for Cooperation in Future

The following suggestions can be pointed out from the reviewing as discussed above.

(1) Importance of securing markets and marketing channel for crop diversification

Including the case of Nong Wai large scale irrigation system and SSIP as well, when the projects are favored with advantage in marketing condition, increase of farmers' income has been successfully materialized not only by paddy but also by vegetable production. This is particularly true in the case of Nong Wai project which enjoys the advantage that the project area is located nearby large rural urban area and the position as major vegetable producing area in the NE Region be firmly secured. Another factor for the success is to have an integrated agricultural extension service activity in addition to the completed irrigation facilities. Under the Modernization of Water Management System Project (JICA Technical Cooperation Project), the project target was to promote dry season upland cropping in the paddy field with having RID and DOAE as counterparts, however, the cultivated area for upland crop in dry season could not be increased since markets and marketing channels could not be secured and moreover the price of rice was in high level during the period.

In order to effectively use the limited water resource in dry season, it is preferable to promote the production of non-paddy upland crops, but it is difficult for farmers to switch to non-paddy crops without secured markets and marketing channels even though directions at policy level are firmly confirmed. This implies the necessity to make a project formulation including the marketing aspect from the beginning under the project. Ideas suggested are to

develop and apply further the concept of green/community market like the case of ALRO project or the contract farming with due collaboration with agro-industries is to be expanded as much as possible.

(2) Necessity of Farmers' participation from Planning Stage up to O & M for Effective and Sustainable Irrigation Practice

Concerning the O & M for SSIP projects which have been implemented in many numbers, the levels/qualities practiced depend so much on the localities of each project. For this, it is pointed out that farmers' participation from the very initiative of project planning is important for better understanding of the project and required organizing of farmers. In the large scale irrigation system like Nong Wai Project too, more effective water management has been realized with having high degree of farmers' participation in its O & M activities as reported. In the river basin water management activities too, low cost and effective water resource management can be realized when having active participation by beneficiary farmers in it. This is the lesson learnt from the activities of IWRM practice with people participation in Yom basin.

(3) Stabilized Water Supply and Income Increase are Incentives for Farmers' Participation

Assuming the farmers' participation as necessity for securing project efficiency and sustainability, then what are the factors to stimulate farmers' participation? From the experience in Huai Mong project, it can be pointed out that stable supply of irrigation water is the incentive for farmers' participation and the benefits obtained through effective use of water by farmers' participation in O & M is again the incentive for farmers, making a good cycle.

Preparation of guidelines and due implementation of water distribution program for each lateral canal under the Modernization of Water Management System Project are of important factors, however, it is necessary to make further analysis on different field conditions in different localities and factors to give incentives for farmers' participation.

(4) Important Points to be paid with Due Attention for Mega Projects

Lessons learnt from the Kong-Chi-Mun project indicate that there will remain substantially serious problems on O & M of facilities constructed if the project plan finalization had been done improperly at the planning stage in spite of the mega size of the project. Further to mention, the project plan was finalized without due participation of various stakeholders and the implementation was initiated in haste by political leadership alone, then a number of conflicts have arisen between the RTG implementing agency and the local residents in many localities. To this end, it is noted that due PR, information disclosure by public hearings, people participation and advancing /exchanging of opinions shall be secured for the planning of large/mega scale projects.

In case of water diversion scheme by tunnel like Kok-Ing-Nan project, impacts on natural environments will be great and it is necessary to have environmental impact assessment completed first at the planning stage. In the case of Kong-Chi-Mun project, there have been

many problem issues yet to be solved without having sufficient considerations on natural and social environments before the project implementation started. In the aspect of social environment, the understanding of the project by the people of donor basin and priority-given development projects to be implemented in advance in donor basin are of quite importance. Even the scale of development is much smaller, both donor and recipient basins had due discussion and agreement on the diversion scheme implemented in the case of Lam Phayang Pumipat diversion project.

(5) Collaboration among Ministries/Departments of RTG

In case of Kong-Chi-Mun project, the lack of required collaboration between the project implementing agency and the agriculture-related agencies due to the administrative division/separation caused negative effects on the project performance. In the medium scale irrigation projects too, there are cases collaboration with the agriculture-related agencies have not been secured adequately. It is noted that due collaboration between project implementing agency with the other Ministries/Departments in various fields is inevitable to bring about the planned project effects and performances irrespective to the scale of the projects.

(6) Framework for Encouraging Participation of Stakeholders and Support for Learning Process in Basin Water management

From several case studies concerning the basin water management, it is pointed out what is important are participation of local people, adopting local wisdoms and participatory process itself, and in order to activate the activities of RBC, participation of more stakeholders is the key while government offices and officials take the position to support the stakeholders not assuming any leadership roles. Other effective means include collaboration with the local universities in each locality and active use of NGOs as facilitator.

For the water resource management at the basin level, a linkage from community level up to the national level is necessary and the relevant government agencies should perform a role of technical supporting. Further, considering the limited water resource available in the NE Region, probable occurrence of water-related conflicts can be predicted in future and therefore RBC should be provided with capability in solving the conflicts. From the case of Bang Pakong RBC experience, it is considered that the success is caused by the selection of the RBC committee chairman from the private sector.

When considering possible support for the basin water resource management program from external source, it is deemed necessary to analyze first on various stakeholders including private sector and then on government agencies concerned.

(7) Project Design

In the cooperation projects implemented in the past, there were some cases of errors in the project design itself. Under the Modernization of Water Management System Project which could not achieve the project target, lessons were learnt that it is necessary to modify flexibly the project design even in its midway if the external factors definitely so require. Also, as

pointed out in many of the irrigation projects implemented, collaboration of hard nature component (Facilities construction) with the soft nature component (Extension services, marketing and participatory water management) is so important for the success of the project.

As in the lessons learnt from the FAO's pilot project, delay in supply of input is fatal sometimes in the agricultural practice where cropping schedule is fixed, and the input may be a waste if applied not in time. Accordingly, it is important to grasp fully the farmers' livelihood and their strategies to survive and to formulate the project design in a way to reduce as much as possible such risk factors and restrictive factors.

(8) Roles of Development Partners

For Thailand there would be no donors already and they, any bilateral bodies and international agencies, are in the position of development partners with Thailand today. As is the case, what are the roles to be played by JICA for Thailand in water resource/agriculture sectors?

It is considered that adequate technologies to be introduced for irrigation system would differ depending on the economic as well as social conditions in the country. In Thailand, major part of modern irrigation development had to rely on the assistances by foreign sources in the past, however, most of the irrigation facilities could be constructed by Thai engineers with its own fund today after due developments in technical level and industrial development in the last decades. Under the circumstances, pipeline irrigation (Like Lam Phayang) is an effective means to apply in wider areas in view of the high efficiency in water use, though the idea was too costly in terms of B/C ratio in the past. Further it can be said that pumping equipment (Like Huai Mong project) could be locally manufactured year after year to meet the increasing demand in the country. This will make the needs for foreign assistances limited only in large scale pumping facility and long distance tunnel construction in future, while it is deemed necessary still to have due assistances in the field of soft nature component like water management. To this end, it can be said that technical support in introducing a broad-based water management including several river basins would be quite effective cooperation area to deal with the increasing water demand as caused by economic development in Thailand.

Those areas of assistances/cooperation which require combination of soft and hard nature programs as marketing and new program of project design are considered suitable for JICA who can deal both technical and financial cooperation combined as a program. It is also to be noted in this concern that for Thailand who is about to be a middle income country, creation of new markets and marketing channels are seemed possible with having due collaboration with private sectors.

Aside from the systems/scheme by the RTG, in the rural village, there have been activities by local people applying the local wisdom for possible safety net practices. The followings show merely a part of it. In the areas often hit by flood and drought damages, each community has their own measures, they say.

In the rural areas, people cultivate food grains for their consumption and secured the food safety, and for the needed expenditure in emergency, they sell their livestock to meet the

requirement. In 1997, those immigrant workers lost their jobs in Bangkok due to the negative effect by economic crisis and backed to the rural areas for their living. This shows that the agriculture/rural villages itself sufficiently function as a safety net.

Table 5.4.1 Policies and Measures concerning Safety Net in Agriculture

Activities	Target	Description
Rice Bank	Group	Stockpile of unhusked rice at community level, loan of unhusked rice to members in case of flood, drought and bad harvest
Saving Group	Group	The association is traditional grassroots finance and members can borrow sizable amount of money in turn by reserving fund weekly or monthly. There are cases members shoulder cost for funeral each other.
New Theory Agriculture (Integrated Agriculture)	Individual	Mix farming or integrated agriculture making best use of limited water and land resources by means of ponds, and food supply and risk distribution by crop diversification
Agro-forestry	Individual	Agro-forestry is commonly plantation within forest, however, people plant trees in uplands field in Northeast. After certain period, they can get cash by sale of timbers in the event of an emergency

In view of the above, it can be said that strengthening of communities will result in reinforcing the safety net function since it can cause minimizing the shocks by climate changes, economic downturn and varieties of external negative factors and also earlier recovery from the damages.

CHAPTER 6 DEVELOPMENT SCENARIOS FOR THE NORTHEAST REGION

6.1 Concept of Development Scenarios

For the consideration of long term cooperation framework of Japanese Government in water resources management in the Northeast Region, it is necessary to understand direction of development by Thai Government and to make cooperation frame work in line with such direction. Thai government has prepared 5 years National Economic and Social Development Plan (NESDP) and set development target and investment plan. Currently it is nearly end of 10th NESDP period (2006-2011) and NESDB is preparing final document for the 11th NESDP.

Long term is considered as long as 30 years and the 11th NESDP (2012-2016) is guideline for the short term plan. 11th NESDP includes factors based on vision for 2027, "Green and Happy Society" which was presented in 2008 by NESDB, and situational and gap analysis. In era of uncertainty in rapidly changing world under globalization, however, it is difficult to foreseen long term future and impossible to grasp the change of government policy to adapt to such change in future.

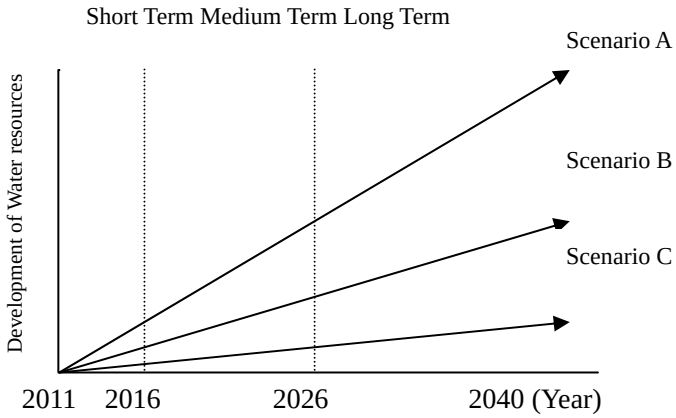


Figure 6.1.1 Concept of Development Scenario

Under such circumstances, scenario planning approach[1] is adopted to guide our analysis and decision making for area of Japanese cooperation framework. By presenting three different development directions as Development Scenarios, implication to cooperation policy in each Scenario and common issues will be drawn. It is noted, therefore, that there is no single most preferable scenario or necessity to create sub-scenario between A, B and C.

Furthermore, water resources development and management option means existing Thai Government plan and policy arranged in short, medium and long term development. Therefore, the Study team does not intend to support or propose to implement these water resources development project and program by presenting in the Scenarios.

[1] Scenario planning is adaptation planning approached developed by Royal Dutch/ Shell in 1970's when they faced oil crisis. "Scenarios; The art of strategic conversations" (Kees van der Heiden, 2005)

6.2 Development Directions for Northeast Region

6.2.1 Roles to be fulfilled by Northeast Region

The 10th NESDP holds up the following four (4) goals under the development strategies for NE Region during the period of 2007-2011.

1) The Region takes a position of key production base for the foods and bio-energy crops.
2) To be a center for food industry and bio-ethanol production
3) To play a role of gateway for trading and tourism among Indochina nations
4) To be one of the major tourism places

In this section, development directions for agriculture and water resources in NE Region shall be discussed taking the first 2 goals as main pillars which are considered closely related with the said sectors. Currently, 11th NESDP is under formulation process, but it has been confirmed that there will be no substantial change in the development directions and basically the same direction as adopted in the 10th plan will be continued for the 11th plan period.

6.2.2 Direction of Agricultural Development

Guideline of 11th NESDP

Current Risk

(1) Parliamentary democracy and government system has been weakened by political conflict
(2) Labour shortage
(3) Aging of rural society and unbalanced social structure
(4) Thai culture is less vital
(5) Decrease of bio-diversity by environmental damage

Principle

(1) Adhere Constitutional monarchy
(2) Put agriculture as basis of economic structure since it is basis of food industry and source of farmers' income
(3) Introduction of up-to-date technology for economic efficiency
(4) Governance based on community and community development
(5) International leadership

6 main points which shall be included in the 11th NESDP

(1) Realization of social justice, solve conflict and rectification of social disparity, and widen access to economic service for the low income
(2) Expand access to knowledge for the nation, realize lifelong education in society
(3) Maintain balance between food and energy crop production, policy implementation in global view
(4) Knowledge base, creative economy development including providing opportunity for innovation of micro and community enterprises
(5) Leadership in ASEAN and development of CLMV countries
(6) Conservation of bio-diversity and natural resources in long term

Source: NESDB seminar on 6th August, 2010 "Guideline of 11th NESDP"

(1) Rice

After grasping the present condition, the problem areas on rice production were discussed in the Chapter 2. It is pointed out that the problem is in its low productivity though the regional farm land shares as much as 40 % of the national total and about half of rice production is derived from the NE Region. In order to be the major production base for rice in the country and to respond to the increasing international food demands (Especially the rice as main staple food of Asia) in the long term perspective as the world No. 1 rice exporting country, however, production increase by 25-35 % in 25 years (Base year: 2007) shall be attained. In case if the productivity of rice in NE Region (Presently 331 kg/rai) could be improved to be the level of the Central Region (589 kg/rai) where irrigation facilities are mostly completed, the overall national production could be increased by 30 % even if the productivities in all the other Regions remain at the present levels.

(2) Cassava and Sugarcane

The NE Region produces cassava by about half of the national total, while 1/3 in case of sugarcane. There expected a little effects on cassava by AFTA but the demand from China who is ranked 1st in importing cassava products from Thailand will be further increased. In case of sugarcane, demands increase is expected owing to the removal of import tariff under AFTA. Both of cassava and sugarcane are materials for bio-ethanol production and the Department of Energy intends to increase the bio-ethanol production from 3.0 Million liters/day at present to 9.0 Million liters/day in 2022. To cope with this target, the national cassava production is needed to be increased by 12.9 Million tons per year when assuming all the ethanol production increase be covered by cassava material. This is the increase by 43 % of the present national total of 30 Million tons. Assuming the no chance for expansion of cassava plantation area and possible increase of ethanol production by using molasses as material, it is deemed necessary to attain increased unit yield by 25-30 %.

For both cassava and sugarcane, yield increase by irrigation is also possible. There are some experiments on-going by means of micro-irrigation, but the applicable areas are rather limited due to the scarcity of water resources and higher production costs to cause lowered competitiveness. Generally speaking, soil improvement by inputs of organic materials and green manure are to be applied for possible yield improvement.

(3) Economic Tree (Para rubber)

As discussed in the Chapter 2, the planted areas for rubber in NE Region are rapidly expanding. This tendency is expected to last for some period with the background that the demands by China for use in tire manufacturing will be further increased. Harvesting of rubber is done periodically throughout a year unlike the other crops like rice and upland crops, and this will bring about cash income for farmers steadily throughout the year and can be a good source of income unless the farm gate price

may fall down drastically. Planting of para-rubber tree is, however, limited only in the areas favored with good rainfall.

(4) Production of high-quality farm produces(GAP/Organic farming)

Improvement of quality of farm produces and processed commodities is an important direction and policy to let Thailand become "Kitchen of the World". This requires to secure such standards and certificates for food safety and quality standards such as GAP and HACCP. Organic farming is recommended from the aspects of possible reduction of production cost and soil improvement. What is important in this concern is how to secure markets for the produces and it seems quite important to develop markets with expansion of contract farming and due participations by private enterprises. Further, there remain rooms for quality improvement in the livestock sector too, and it is very necessary to expand livestock production in the NE Region so as to fulfill increasing demands for organic fertilizers too.

(5) Sufficiency Agriculture (New theory farming) and crop diversification

Under the 5 year agricultural development plan, a target is set to increase the "Self-sufficiency" farmers to 1/4 of the total farm households with the strategy to strengthen the farmers. It is deemed difficult to attain this target by the year 2011 and the same target will be continued for the following years. "Self sufficiency concept" means practicing mixed farming so as to strengthen small scale farmers to be self-reliant where farm ponds be excavated, store the water and use it for vegetables and herbs cropping, fruit tree planting, fish raising and drinking water for animals.

6.2.3 Directions for Water Resource Development and Management

There is no any specific policy/direction on water resource management applicable to the NE region alone, but in the policies included in the 10^{th} development plan, it is noted that all the 25 basins in the country will be covered by IWRM concept/activities by the year 2011. In the NE Region, RBCs have been formed for each of major basins as Khong, Chi and Mun but there have been no substantial activities so far like the other basins in the country. The 5 year agricultural development plan emphasizes the necessity of improved water management and indicates some targets as follows.

*Expansion of irrigation areas
*Efficient use of irrigation system
*Systemization of water resource management
*Mitigation of drought and flood damages with farmers' participation

6.2.4 Environmental Natural Environment and Consideration of Social Impact

Development scenarios are analyses in terms of conservation and impact on ecology and bio-diversity as well as necessary measure for environmental assessment process and public participation.

6.3 Development Scenarios and Options for Water Resource Development/Management for the NE Region

Based on the government policies and the circumstances in and around the NE Region as discussed in the foregoing, 3 scenarios were worked out as development directions for the Region. Water resources development potentials as discussed in the foregoing section was re-arranged in combination with the scenarios as presented in 6.1.4. The terms were set to cover the 11th 5 year NESDB plan for 5 years of 2011-206 as the short term, 10 years of 2017-2026 as the medium term and 15 years of 2027-2042 as the long term, tentatively.

Table 6.3.1 Development Scenarios and Options for Water Resource Development/Management

	Scenario A			Scenario B			Scenario C		
I. Outline of Scenarios	Full development option of irrigation development including large scale water diversion scheme where the NE Region will be developed to be the major production center for foods and bio-energy in Asian Region.			To achieve the economic growth by an agro-industry and improvement of living in rain-fed area. It is mainly targeted effective water use, productivity improvement and crop diversification.			To be expanded the self-sufficiency-oriented mixed farming by using farm pond with development of small scale projects aiming at possible mitigation of drought risks in the rain-fed areas..		
II. Options for Water Resource Deve't/ Management	Short Term	Medium Term	Long Term	Short Term	Medium Term	Long Term	Short Term	Medium Term	Long Term
	～2016	～2026	～2040	～2016	～2026	～2040	～2016	～2026	～2040
1. New Develop.									
Large Scale Irri.	◎	◎							
Medium Scale Irri.	○			○	◎	◎	○		
Small Scale Irri.	○			○	◎	◎	○	◎	◎
Estuary Barrage Type	◎	◎	△	◎		△	◎		△
Pump Irrigation. （Medium scale）	△			△	○	○			
Pump Irrigation. （Small scale）	◎			◎	◎	◎	◎		
Inter-basin water Diversion									
- LPC		○			○				
- KLCM			◎						
- Water Grid			○						
- Water Network	△	○		△	○				
2. Rehabilitation									
Ex. Large Scale Irri.	△	○		△	○		△	○	
Ex. Medium Scale Irri.	△	△	△	◎	◎	◎	△	△	△
Ex. Small Scale Irri.	（Those are included to new development because main components are additional canal construction for existing small scale irrigation facilities）								
Integration & consolidation	(Those are necessary though not included in the government plan. No additional area is increased because of integration of weir.）								
On-farm& Land consolidation	△	○	○	△	◎	◎	△	△	△
3. Rain-fed Farm									
Small Scale Pond	△	○		○	○	○	◎	○	○

	Scenario A			Scenario B			Scenario C		
（Individual）									
Community pond	△	○		◎	○	○	○	○	○
4. Water Management									
Project level	○			○			○		
River basin level IWRM									
- Mun river basin	▬			▬			▬		
- Chi river basin		▬			▬			▬	
- Khong river basin			▬			▬			▬
3 basins IWRM			▪▪▪▪▪▪▪▪▪▪			▪▪▪▪▪▪▪▪▪▪			

Note: For newly developed area: ◎: area more than 200,000 rai,
○: area among 100,000 to 200,000 rai,
△: area less than 100,000 rai,
For rehabilitation and rain-fed farm: △: required budget level is similar with current one,
◎ : required budget level is more than two times of current one,
Small scale farm pond are provided by excavation of earth material at each owner's land and used for individual purpose. This is different from SSIP which has common water source at village level.

6.3.1 Scenario A

(1) Scenario

Under this scenario, the NE Region is targeted to be the main production center of farm produces and bio-ethanol not only in Thailand but also in Asian region. This requires a full development of irrigation infrastructure facilities and improvement of the productivity to cope with the food and energy crisis to happen in future. By this development, living standard of the majority farmers will be greatly improved and by lowering the production cost the region can maintain enough competitiveness.

This is the scenario for full development option of irrigation development including large scale water diversion scheme where the NE Region will be developed to be the major production center for foods and bio-energy in Asian Region.

(2) Expansion of Irrigation areas

Under this scenario, the short term includes the following projects by using the budget as the present level, and as much as 1.062 million rai irrigation area (170,000 ha) will be newly developed.

- Upper Chi project (Large scale, 3 dams)
- 2 estuary barrage type projects (Along Mekong River)
- Medium/Small scale projects including pumping irrigation

Under the medium terms and thereafter the KLCM water diversion project will be started with much investment concentrated. Other than KLCM, therefore, only the following projects be implemented for 10 years for new development of 755,000 rai (120,000 ha).

- Lam Dom Yai Large Scale Project
- Lower Nam Songkhram Project

- Medium Scale Water Network Project

A part of KLCM project will be completed at the end of the medium term and the new irrigation area will be largely increased year by year for a long period. Finally, the overall irrigation area newly developed under the scenario would be as big as 17.95 million rai (2,872,000 ha) area, as the result of such drastic increase.

Not only by the new development project, but also by the rehabilitation project, irrigation areas are planned to be expanded. Lam Pao project will have an increase of irrigation area by 225,000 rai (36,000 ha) through rehabilitation/improvement. Another increase is expected by improvement of reservoir operations. It is estimated 430,000 rai (68,800 ha) area can be expanded for new irrigation area by this manner of improvement.

In view of the above, the overall irrigation area will reach to 26.5 million rai through adding newly developed irrigation area of as big as 20.4 million rai. This will cause the irrigation ratio of about 10% at present to be raised to 46%.

(3) Rehabilitation and Improvement

It is necessary to secure the highest efficiency in using/operating the existing irrigation facilities through rehabilitation of deteriorated portions and improvement in water management practices. However, under this scenario, no priority is placed in these projects. As is the case, the implementation of rehabilitation/improvement project was assured to be carried out with the average budget scale similar to the recent past. The same idea was applied to the case of on-farm development projects too.

(4) Improvement in rain-fed areas

Under the scenario A, irrigation area will be largely expanded in the long term. Therefore, the improvement in rainfed area by construction of farm ponds is estimated at 10,000 ponds a year under the short and medium terms. Construction of community ponds without irrigation canal is also included under the category of improvement in rain-fed areas.

(5) Water Management

In case of scenario A including a large scale trans-basin water diversion scheme, large amount of water be diverted from Khong basin to Chi and Mun basins. This requires an improved water management on the existing facilities in combination with the increased water resources. Otherwise, there might happen to cause more flood damages increased and/or more water-related conflicts. To this end, it can be said that by the time the subject water diversion project be completed even partly, IWRM practice in each of 3 basins in NE Region shall be duly introduced and established to the acceptable level so that the water management system/institutions may function to the changes predicted. This subject is considered as one of the urgent necessities.

(6) Impact on natural environment and consideration of social impact

The scenario involves a huge scale trans-basin water diversion scheme as the core of the project, and it is necessary to clear the SEA procedure. At the SEA process, policies on development direction of NE Region and policies on water management/irrigation development shall be fully discussed and examined and decided through the participatory manner. Trans-basin water diversion project is "a project which will bring about important impacts on communities" and accordingly, there must be many steps / processes of people participations with full transparency to secure consensus among various stakeholders from the beginning of plan formulation to the commencement of project implementation.

Under this scenario, it is necessary to pay fully attentions on the following points.

- Effects on natural environments by excavation of such long distance tunnel as 80 km and large scale trans-boundary water diversion
- Especially the effects on wetlands and social environments for the people living around the wetlands who depend their food sources on the wetlands
- Possibility of salinity damages to be caused by expansion of irrigation area.

Under the project river flows will be considerably increased implying that securing of environmental discharge (Necessity to maintain the eco-system) could be made easier, but there are possibilities to cause large scale flood damages in wide areas if water management be failed. Further, there are possibilities of needs for resettlement of people under the project implementation. In this case, the resettlement plan shall be prepared with due attentions paid on people life and local cultures with sufficient accountability in informing to the people of the full details on the new resettlement area with full transparency.

6.3.2 Scenario B

(1) Scenario

Centering in the existing irrigation areas, more efficient agricultural production shall be attained in the region. Exporting value-added produces will activate the regional economy. At the same time, challenges are to materialize production of high quality vegetables/fruits in rain-fed areas through securing small scale water sources, soil improvement, improvement in farming technologies and sufficient markets. By diversifying the source of incomes, farmers' risks will be dispersed and their quality of life could be leveled up.

Under this scenario, emphasis is placed rather on more efficient agricultural production and value-adding centering in the existing irrigation areas than the expansion of new irrigation area. Improvement in production efficiency as well as high quality products and crop/products diversification shall be sought under this scenario as well. At the same time, promotion of high-quality

vegetable production and livestock industry by using the water resource in rain-fed areas shall be sought.

(2) Expansion of irrigation area

Those large scale projects requiring longer period for securing consensus by local people and having substantial effects on environment are not considered under this scenario and instead of large scale dam/reservoir, substantial number of farm ponds construction shall be planned. While, expansion of irrigation area shall be attained mainly by implementing medium and small scale projects. For short term category, 0.863 million rai (138,000 ha) will be newly developed for irrigation with the following projects with the averaged budget similar to the recent past level.

- 2 estuary barrage type projects
- Medium/Small scale projects
- Pumping irrigation projects

After the end of medium term, main implementing role will be assumed by the local administration bodies (TAOs). Major projects involved will be as follows.

- Small scale projects including the improvement and small pumping along rivers (0.9 million rai)
- Medium scale projects including medium size pumping schemes (0.36 million rai)
- LPC water diversion project to avail water source for increased pumping schemes (0.1 million rai)

In case of LPC project, increased irrigation area except 0.1 million rai is included in the Medium/Small Scale project. LPC is mainly for the improvement of water management for the overall NE basins. Finally the above will contribute to the increase of irrigation area by 3.9 million rai (624,000 ha).

Similar to the Scenario A, Scenario B also includes the expansion of irrigation area by rehabilitation project and improvement in water management, 225,000 rai and 430,000 rai, respectively. As a whole, as large as 4.6 million rai (0.73 million ha) will be developed newly to attain 10.6 million rai irrigation area as the Regional total. This contributes the irrigation ratio of 10% at present to be raised to about 19%.

(3) Rehabilitation and Improvement

Under this scenario, emphasis is placed on infrastructure development towards productivity improvement and diversification by efficient use of irrigation water through improvement of existing systems. For the large scale systems, on-farm development shall be pursued so as to ease farm mechanization and avail improved on-farm facilities for rational water management at on-farm level and desired crop diversification. This direction shall be applied to the medium scale pumping project

after the large scale projects.

There are many cases that adequate project O&M is not practiced for the Medium scale projects due to the insufficiency of RID budget allocated for this activity and also less staffing. Accordingly, measures to be taken are strengthening of WUG and promotion of PIM activities in parallel with the improvement of the existing facilities.

(4) Improvement in rain-fed areas

In case of scenario B where expansion of irrigation area is rather limited as compared with scenario A, it is necessary to implement possible improvement of rain-fed areas by means of farm ponds and etc. For those areas planned for development under large scale project under scenario A, there are necessities to secure water sources by either small scale projects or farm ponds excavation. In the short term perspective, a model of high-value adding agriculture by using farm ponds is necessary to be established, while for the medium term and further future, expansion of farm ponds irrigation shall be implemented mainly by local administration bodies centering on TAOs based on the model established.

(5) Water Management

Under the Scenario B, it is recommended to increase the irrigation area by high water use efficiency pumping scheme. However, if in case the pumping irrigation be expanded with the river-runoff conditions as it is, there would be more water related conflicts among the users especially between upstream users and downstream users. To cope with this, it is considered necessary to divert a part of surplus water from Khong basin to Chi basin by LPC water diversion project. In case that no diversion water project is implemented from the aspect of conservation of natural and social environment, it is important to control the new development of pump irrigation and to manage the water demand allocation of up and downstream. Furthermore, it is necessary to improve the river flow condition by limiting the paddy planting in dry season in the existing irrigation area. Also, it is considered that there are possibilities to improve the O&M condition of the existing medium scale reservoirs mainly in Mun basin. By these improvements, water release in dry season can be increased so that the river flow condition itself in related rivers could be improved as well.

In case if the due water management for the entire basin could be secured in addition to the improvement of O&M and water management at the project level, water allocation for efficient agricultural production could be materialized including the needed water for environmental purpose.

(6) Impact on natural environment and consideration of social impact

Improvement of the existing irrigation systems is mainly focused under this scenario. However, the scenario requires EIA and peoples' participation from the planning stage since it includes new

irrigation development by medium scale project as well as water diversion scheme to improve water balance between the donor basin and recipient basins. LPC project is considered as a water diversion project which requires SEA, and a detailed survey/study on natural environments is very necessary as it includes development of 2 wetlands.

Improvement of river flow regime can be expected and securing of environmental water could be made easier than before with having additional water in dry season by medium scale reservoirs, improvement in reservoir operation and LPC water diversion, possibly causing some positive effects on fishes and etc.

6.3.3 Scenario C

(1) Scenario

Priority is given to the expanded practices of "Sufficiency Economy" under this scenario. Emphasis is to be placed on better management of natural resources in each locality, and based on this concept irrigation development and management shall be undertaken. In the rain-fed areas, self-sufficiency-oriented mixed farming by using farm pond shall be expanded with development of small scale projects aiming at possible mitigation of drought risks.

(2) Expansion of irrigation area

Under the scenario, except the 2 estuary barrage projects for which plans are on-going at present, there will be no large and medium scale development to be implemented after the end of short term. Projects to be implemented further are, therefore, only small scale projects by TAOs and rehabilitation on the existing projects. As is the case, for the entire period, it is estimated that the new irrigation area to be developed will be only 2.224 million rai (0.4 million ha).

(3) Rehabilitation and improvement

For the rehabilitation projects on the deteriorated/damaged facilities, the implementation quantity was estimated based on the budget level at present. The same manner is applied to the case of on-farm development project too.

(4) Improvement in rain-fed areas

Under the scenario C. the target under the 10^{th} agricultural development plan was applied. That is ¼ of the overall farm households shall practice "Sufficiency Economy Concept" farming. To cope with this target, it is necessary to construct about 400,000 farm ponds within the period of short term. In addition, such multi-purpose community ponds (without canal system) at village level shall be included under the category of improvement in rain-fed areas.

(5) Water management

Under the scenario C. there will be no new water created. Therefore, materialization of such water management in the basin as causing allocation of environmental water and needed water for salinity mitigation becomes very necessary. Through water management practice at community level, farmers will have learning opportunities, and through creating networks with other communities in the relevant river basins share common understandings so as to secure required consensus among various stakeholders in the basin.

(6) Impact on natural environment and consideration of social impact

The scenario does not include any new large/medium scale development and therefore there expected no substantial effects on environments by development. While, some improvements by conservation and active use of natural resources at community level could be expected. Provided, however, the scenario does not cause strengthening of agricultural competitiveness in the Region, and therefore, in the long term perspective the region's agriculture will be gradually declined and some negative effects on environment might be brought about due to the increase of abandoned farm lands with the lack of successor farmers and malfunctioning of irrigation facilities due to deterioration.

6.3.4 Further Examination on Scenarios

From the following different aspects' view points, the 3 scenarios as discussed above shall be further studied hereunder. This is, however, not intending to evaluate 3 scenarios to select 1 optimum scenario, but to show approximately differences in its impacts and benefits to be derived from.

(1) Investment amount

The average RID budget in the recent 3 years is 35,500 Million Baht, of which 28,400 million has been allocated for investment purposes. Out of the total investment, 15-20% is allocated for the NE Region with the mean amount of 5,025 Million Baht. When comparing this with the estimated investment amount by each scenario, the scenario A is a huge one equivalent to the overall annual budget of RID. While the scenario B shares about 25% of the RID's annual investment budget which may be possible by allocating more for the NE Region within the normal budget allocation to RID. In case of scenario C. the budget allocated for NE Region will be reduced to a half level in the long terms, where RID's role will be shifted from development to management.

Table 6.3.2 Comparison of Investment Amount by Each scenario

(Unit: Million baht)

		Scenario A	Scenario B	Scenario C
Short Term	Total	34,758	33,003	40,508
	Annual	6,952 /year	6,601 /year	8,102 /year
Medium Term	Total	435,368	86,350	22,950
	Annual	43,537 /year	8,635 /year	2,295 /year

Long Term	Total Annual	466,232 31,082 /year	91,525 6,102 /year	21,775 1,452 /year
Total Investment	Total Annual	936,358 31,212 /year	210,878 7,029 /year	85,233 2,841 /year
Remarks		Almost equal to RID's total annual budget	25% of RID investment budget (5-10% up of NE share)	Half of NE investment excluding Farm Pond shot-term investment

When looking into the breakdown of the investment budget, the KLCM project of large scale water diversion nature shares the most of the total amount. In case of scenario B. as similar to the direction, the investment budget is shared by about half by rehabilitation and improvement projects.

The scenario C shows an equivalent shares by 3 main sectors of development, rehabilitation/ improvement and improvement in rain-fed areas. (Table 6.3.2)

Table 6.3.3 Breakdown of the Investment Budget by Each scenario

		Scenario A	Scenario B	Scenario C
1.Expansion of Irrigation Area (Development)	Amount %	895,708 Mil.B 96 %	89,033 Mil. B 42 %	31,283 Mil.B 37 %
1-1. Large Scale	(%)	(0.5 %)	(- %)	(- %)
1-2. Medium Scale	(%)	(0.7 %)	(38 %)	(19 %)
1-3. Small Scale	(%)	(0.3 %)	(14 %)	(41 %)
1-3. Estuary Barrage Type	(%)	(1.7 %)	(9 %)	(26 %)
1-4. Pump Irrigation	(%)	(0.6 %)	(29 %)	(14 %)
1-5.Inter-basin Diversion	(%)	(96.3 %)	(10 %)	(- %)
2. Rehabilitation and Improvement	Amount %	32,400 Mil.B 3 %	104,100 Mil.B 49 %	28,950 Mil.B 34 %
3. Improvement of Rainfed Area	Amount %	8,250 Mil.B 1 %	17,745 Mil.B 8 %	25,000 % 29 %
Remarks		Almost all is invest for KCLM water diversion.	Half is rehabilitation and improvement	1/3 is investment for farm pond for Sufficiency Economy

(2) Expansion of irrigation area/production increase and food security

In the long term perspectives the irrigation area can be increased as follows under each scenario.

Scenario A 20.4 Million rai (3.3 Million ha)

Scenario B 4.6 Million rai (0.73 Million ha)

Scenario C[#] 2.2 Million rai (0.36 Million ha)

[#] ---- Not including irrigation by farm ponds in rain-fed areas.

As the results, the irrigation ratio shall be increased by percentages as shown below.

Present	Scenario A	Scenario B	Scenario C
10.6 %	46.3 %	18.6 %	14.5 %

The increase of irrigation area is expected to cause following rice production increase.

- Yield increase in wet season (340 kg/rai ➔ 590 kg/rai)

- Expansion of planted area in dry season (30% of expanded irrigation area with 540 kg/rai)

Based on the above conditions each scenario will attain the rice production increase as shown in the following table (Comparison with 2008)

- Scenario A 89%
- Scenario B 30%
- Scenario C 21%

Table 6.3.4 Increasing Irrigation Area and Paddy Production by Each scenario

Items		Current		Scenario A		Scenario B		Scenario C	
Area & Irrigation rate		Area	%	Area	%	Area	%	Area	%
Expansion of Irrigated Area (1,000 rai)	Short	-		1,522	2.7	1,323	2.3	1,279	2.2
	Medium	-		940	1.6	1,711	3.0	485	0.8
	Long	-		17,960	31.5	1,520	2.7	460	0.8
	Total	6,048	10.6	26.370	46.3	10,602	18.6	8,272	14.5
Incremental Paddy Production (1,000 t/year)		Current		Production	% up	Production	% up	Production	% up
	Major	10,378		5,106	49.2	1,139	11.0	556	5.4
	Second	685		3,308	482.9	738	107.7	360	52.6
	Total	11,063		8,414	76.1	1,879	17.0	916	8.3

The estimated production increase in the case of scenario A is equivalent to 25% increase as compared with the national total production and can contribute greatly to the food security issue in the future. For the case of scenario B, to attain 25-30% increase in the NE Regional rice production, it is necessary to secure the average unit yield of 400 kg/rai in the newly developed irrigation areas. This is considered very possible by means of soil improvement and improvement in farming technologies. Under the scenario C. emphasis is placed on food security attainment at the community level, and rice production increase itself will not be given with high priority, considering the present situation that about 40% of the production is being exported to foreign countries.

(3) Number of beneficiaries and impacts on poverty/low income farmers.

The number of beneficiaries by each scenario is as estimated below.

Scenario A 1.6 Million households
Scenario B 1.0 Million households
Scenario C 0.86 Million households

The scenario A will have an overwhelming majority of new beneficiary farmers and expected to bring about benefits centering to the comparatively low income farmers in the presently non-irrigated areas. The scenario B includes 1/3 of the existing irrigation areas under the project, and brings about benefits both for the middle income farmers and also for the poverty/low income farmers in the newly irrigated areas and rain-fed areas even after the project with possible effects on living standard improvement through crop diversification and value-adding. While the scenario C narrows down the target to the improvement in rain-fed areas and can be considered that the investment is focused just on low

income/poverty farmers.

Table 6.3.5 Number of Beneficiary Farmers by Each scenario

	Scenario A			Scenario B			Scenario C		
(1,000 household)	Short	Medium	Long	Short	Medium	Long	Short	Medium	Long
New Irrigation	71	50	1,197	58	102	101	55	20	30
Rehab, Improve	20	53	45	25	188	212	20	45	37
Rain fed	50	100	-	67	100	150	400	100	150
Total	141	203	1,241	149	390	463	475	165	217
	1,585			1,002			857		

(4) Value adding by food processing and bio-ethanol

As to the targets/goals for the NE Region to be the production Center for processed foods and bio-ethanol, the scenario A focuses on upland irrigation development in the following areas.

Cassava : Nakhon Ratchasima, Chaiyaphum, Khon Kaen
Sugarcane: Udon Thani, Khon Kaen, Chaiyaphum

By the above, the plan to treble the production of bio-ethanol by the year 2022 may be possible by delaying the target year by 5 years. Also, value-adding by rice processing can be expected as the rice production will be drastically increased under the projects by scenario A.

Scenario B puts emphasis more on value-adding by food processing and makes it possible to avail sustainable supply of high quality agricultural produces in the existing irrigation areas. In the rainfed areas too, sustainable production and supply of high quality vegetables and etc. can be expected by securing possible water sources in dry season as accompanied by soil improvement. Under the scenario C important points are not in income increase by value-adding, but in safety net factors by mitigation of risks through diversifying the crops and sources of income, which can be made possible by introducing processing and direct marketing of the produces at the community level.

6.3.5 Issues of Each Development Scenario

(1) Scenario A:

- Extension of irrigated agriculture and organizing process of WUG to deal with the rapid expansion of irrigation area.
- Necessity to increase productivity and quality of rice so as to strengthen competitiveness for export
- Necessity to increase productivity of cassava and sugarcane for bio-ethanol and competing land use between food crops and energy crops
- Secure investment for bio-ethanol industry
- Organizational set-up for overall management of large scale water diversion scheme.

- Technical capacity for tunnel construction and complex water management
- Securing of sufficient labor including immigrant farmers and promotion of farm mechanization.
- Equity, information disclosure and public participation

(2) Scenario B:

- Collaboration with private sectors to materialize high value adding
- Food safety and certification and inspection system (traceability)
- Human resource development for farm production and management, roles to be played by local educational institutes.
- Introduction of PIM and cost sharing for water as the economic material for production.
- Strengthening of TAO's capability and budgetary support for improvement of medium/ small scale project facilities.
- Productivity improvement in rainfed areas and coordination among agencies concerned with rural development.

(3) Scenario C:

- Capacity development for TAOs and development funds for small scale infrastructures.
- Activation of NGO and Civil Societies involvement in expansion and strengthening of community activities.
- Dissemination of "Sufficiency Economy Concept" and creation of learning process aiming at increased practices.
- Qualitative improvement of community enterprises and OTOP products and supporting systems.
- Strengthening of TAO's roles and capability in rural development project.
- Incentives for conservation/active use of natural resources in each locality.

In view of the issues to be tackled as state above, a proposal on cooperation program by GOJ shall be considered.

CHAPTER 7 FRAMEWORK FOR ASSISTANCE TO REDUCE REGIONAL DISPARITY IN THE NORTHEAST REGION

7.1 Priority Area of JICA's Cooperation and Proposed Direction to Rectify Regional Disparity

7.1.1 Priority Area of JICA's Cooperation in Thailand

JICA sets priority area of cooperation in Thailand as, 1) Enhancement of Competitiveness for Sustainable Growth, 2) Issues in Maturing Society, and 4) Regional Cooperation. Important key works under each priority area includes, 1) Private- Public Cooperation aside from regional disparity, 2) Environmental Management, and 3) regional cooperation framework of GMS and ASEAN.

7.1.2 Issues in each Development Scenario and Necessity of Cooperation and Assistance

Issues in each development scenario presented in Chapter 6 are summarized in diagram below. Higher priority areas for cooperation and assistance needs of Thai Government are grouped and proposed as approach to rectify regional disparity.

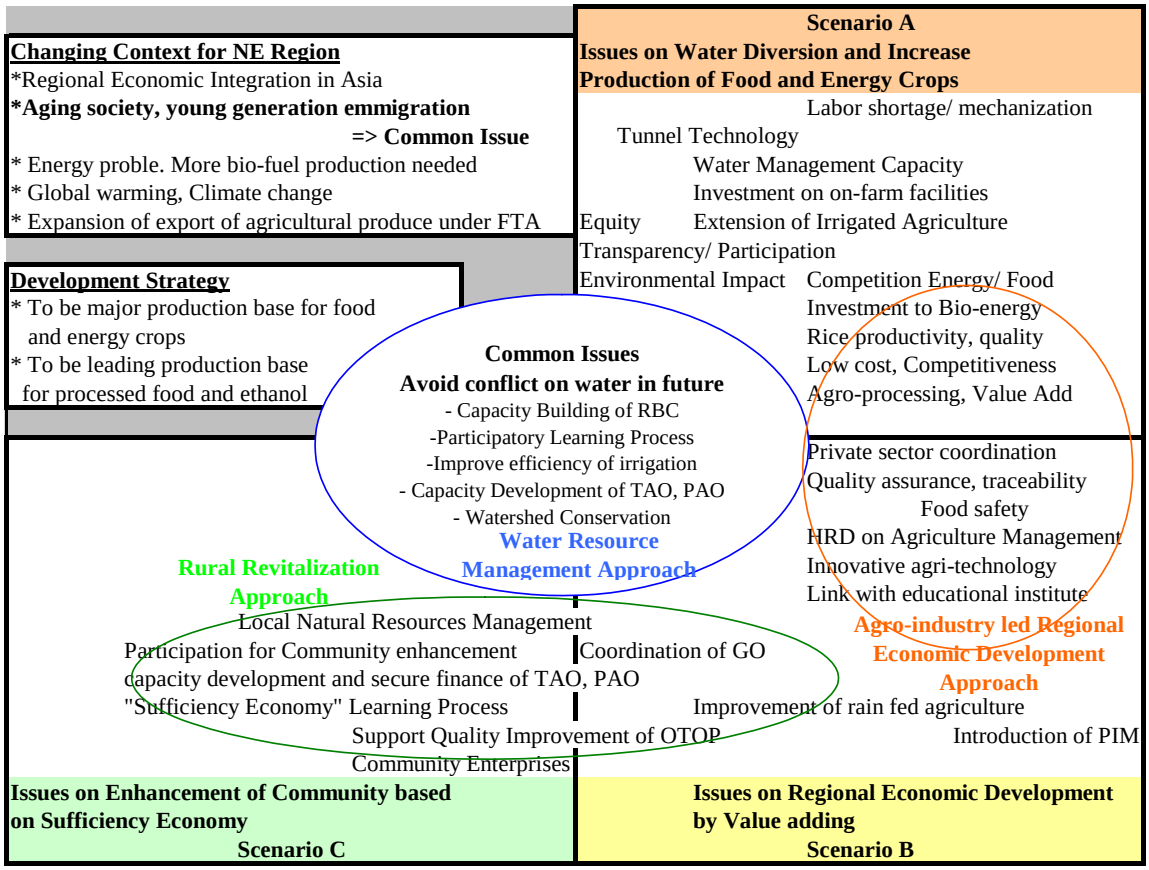


Figure 7.1.1 Issues on Development Scenarios and Cooperation Approaches

7.1.3 Approach to Rectify Regional Disparity

Regional disparity used to be recognized as a major issue of the nation since 1970's. The 4th NESDP (1977-1981) focused on regional development plan under the banner of "Rectifying Regional Disparity", while the succeeding 5th NESDP set "Poverty Reduction" and "Rural Development" as main theme. While poverty ratio is decreased considerably due to continuous rural development effort, regional disparity has not been solved. Though decentralization policy and practice have been preceded, still development is dominated by central government agencies. Issues on local autonomy and development by local initiative shall be improved to achieve the goal of decentralization under the Constitution.

It shall be emphasized that single project or program cannot solve regional disparity problem, rather it can be achieved as the result of continuous development effort of local people, who are main actors of local development initiatives

With this concept in mind, approaches to reduce regional disparity are proposed as follows;

(1) "Water Resources Management" approach

When considering medium and long term development, resources base for sustainable development shall be considered. In case of the Northeast region, industry to be developed may be related to agriculture and water resources is most important resource among others. Not only for agriculture, but for agro-industry and other industries, water is very important. Growing population in the city and town increase demand for water consumption and conflict over water allocation may happen in future.

As analyzed in Chapter 3, potential of water development is already marginal level and problem shall be solved through management of water resources, otherwise a need to divert water from other basin.

Thai government sets institutional framework for integrated water resources management at river basin level by establish RBC and through stakeholder participation. In actual situation, however, there are no activities conduced after set-up of RBC except only limited areas of pilot projects. Moreover, poor coordination among RID, who is the largest water user and operator of irrigation facilities and DWR, who plays role of controller and promoter of river basin management, is the major issue.

It is also necessary to develop incentive mechanism for local participation of people and local administration, to enhance capacity of technical staff of RBC for hydraulic model development as tool for basin management. Moreover, capacity development of RBC to promote participatory process of all stakeholders is important.

Related JICA's priority area: Competitiveness for Sustainable Growth, Regional Cooperation

Related Development Scenario: Scenario A, B, C

Strategy for River Basin Integrated Water Resources Management:

1) Capacity development of RBC

2) Participatory planning and water management activities at sub-basin level, and provision of learning process
3) Small and Medium scale irrigation development and improvement by PAO and TAO
4) Efficient use of irrigation water
5) Coordination between RID and DWR for technical development and support system
6) Introduction of IWRM Model to neighboring countries and networking (forum)

At Mekong Summit in April, 2010, IWRM was agreed as approach to be taken by all the countries. Thailand is expected to be a good model for others.

(2) " Regional Economic Development through Agro-industry" approach

Along with the national development strategy for the Region as to be "Production base of food and bio-fuel crop", "Center for food industry and Bio-ethanol" and "Gateway to Indochina", it is proposed to enhance large number local Micro and Small Medium Enterprises (M&SME) on food industry, which has 60% share of establishments in the Northeast region. In order to revitalize local economy directly related to enhancing livelihood of local people, it is preferable to support M&SME in enhancing management capacity and improvement of quality of product, but not to invite small number of Giant Company in Agro-industry to the Northeast region.

By developing domestic market in the Region and export to Indochina and China with new production development suitable for those countries, such local food industries will be promoted and expand employment.

Supply of raw materials, i.e. agricultural produce, shall be stabilized and quality of those shall be improved through support for farmers. In turn, value added to agricultural produce gives higher income to farmers.

This regional economic development approach takes geographical advantage of the Region and large production base of agricultural produce. It shall be noted that support on M & SMEs capacity building on quality management and assurance as well as crop management capacity of farmers cannot be achieved in short period, but improvement can be realized through competition in market principle.

Issues of development in this approach are linkage of advanced enterprises and local M & SMEs, and establishment of support system for S&SME and farmers.

Related JICA's priority area: Competitiveness for Sustainable Growth, Regional Cooperation

Related Development Scenario: Scenario A, B

Strategy for Agro-industry and regional economy development:

1) Inviting advanced (Japanese) private enterprise (food and agro-processing) and link with local M & SMEs
2) Develop R&D center for food by Linking Private Sector – Public – Academic Institution
3) Local product development and marketing through cooperation of agriculture,

manufacturing and commercial sector

4) Advance technology for agriculture management and HRD of next generation
5) Develop and disseminate model of demand driven agriculture-rural development/ PPP

(3) "Revitalization of Rural Community" approach

Eventually, agriculture and rural development has been implemented for poverty alleviation, however, countermeasures targeting poverty group is becoming more important rather than production increase given that poverty group mainly include elderly households and landless or small holder farmers. However, since these measures are generally implemented in the welfare policy, this matter is not discussed here. It is necessary to take countermeasures to organize suitable environment which enables farmers to make living by agriculture and to live good lives, so that it is possible to avoid probable depopulation in the future. Especially, in the rain fed areas with insufficient water resources, it is recommended to promote community strengthening and self-sufficient mixed farming based on "sufficiency economy concept" to increase tolerance against external shocks such as economic crisis and climate change, and to promote sustainable development, since Northeastern people still regard mutual help of family and community as important part of life, and participate in social events and group activities in the community. In addition, it is desirable to promote economic activation by means of regional sources such as processing, marketing of surplus foods. The rural revitalization approach aims at liable community formulation, where people can make living, after they work away from home for a period of time of life. It is necessary to establish structures for support of community.

Half of the poor, defined by the official poverty line, are concentrated in the Northeast region and, 80% of which reside in rural area. Farm household income is relatively low. Therefore, approach to target the poor and low income households would be proposed. Assistance method may be two different ways i.e., one is direct assistance to the poor as "welfare approach" and another is community strengthening.

Poverty population reduced rapidly from 50% to around 10% over 20 years. Revitalization of rural area might be more important than poverty reduction in long term perspective. Aging of rural population and farmers, it is important issue to find way to make living in rural area by income from agriculture and sustaining environment in rural area. Otherwise, rural community in Thailand may face the same depopulation problem in future and numbers of remote communities might disappear.

Related JICA's priority area: Maturing Society Issue, Competitiveness for Sustainable Growth,

Related Development Scenario: Scenario B, C (rainfed area)

Strategy for Rural Revitalization:

1) Sufficiency agriculture (integrated agriculture) and organic agriculture promotion, promotion of crop diversification through farmer market development
2) Development of community enterprises with market development for employment creation and income generation

3) Cooperation mechanism of PAO, TAO, colleges, government agencies, NGOs with communities
4) Linkage of research and development in agriculture
5) Local economic promotion utilizing local resources, local knowledge and local culture (e.g. Green Tourism)
6) Development of next generation and provision of learning process

All these strategies are mentioned in the NESDP and Agricultural Development Plan. It is necessary to support local initiative to development by central government. Major issue is that integrated approach is difficult to be implemented due to vertically compartmentalized bureaucracy of central government agencies. Japanese cooperation is expected to play facilitation role to derive local people's initiatives by overcoming such bureaucracy. It is also expected to share Japanese experience of rural community development such as livelihood improvement movement, road-side station, farmers market as well as "One Village One Product".

7.2 Proposed Flagship Program for each Approach

Above three approaches are not alternatives and can be combined for application. Flagship program proposed below is the same. JICA's cooperation budget to Thailand, which is to be middle income country, become shrinking and area of cooperation also become limited. Therefore, it may be difficult to implement large scale integrated development project. On the other hand, it should be said that outcome is limited for small scale single agency's cooperation program. Above mentioned approaches are not only for single government agency but involvement of multi stakeholders are necessary for implementation.

Therefore, joint implementation of "Flagship Program" with RTG is proposed. JICA plays facilitator and coordinator role among participating multiple government agencies, local governments, colleges, private sector, NGOs and local community and expand and develop activities by utilizing various JICA's cooperation schemes.

Following flowchart attached as Figure 7.1.2 shows proposed approaches for reduction of disparity and draft core programmes resulting from development scenarios. The development scenarios show the development direction by the Government of Thailand aiming at reduction of disparity. The proposed water resource development and management options are organized based on the plan prepared by the government. Issues toward each development scenario are also needs for support, which the Government of Japan can support. Based on the concept that the reduction of disparity is one of outputs of voluntary and sustainable development by the people in the area, capacity developments are proposed as three (3) approaches to reduce disparity in response to each issue. Those three approaches have relation with plural development scenarios and proposed core programmes correspond to three approaches above.

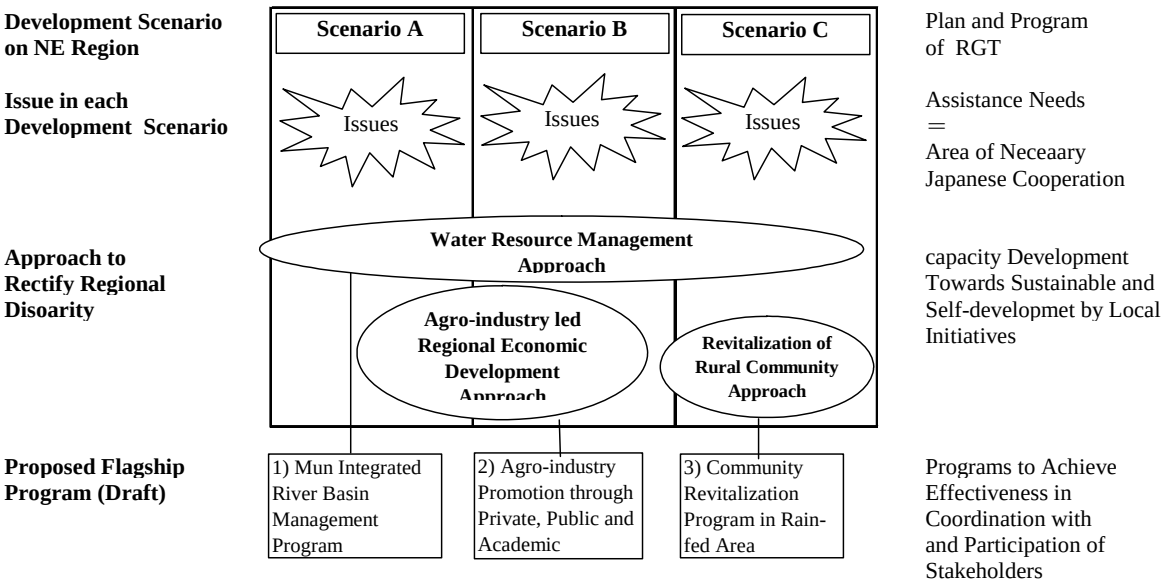


Figure 7.1.2 Flow of Proposed Flagship Programs based on Development Scenarios and Approaches

7.2.1 Integrated River Basin Management program (Draft)

(1) Necessity of Flagship Program

The current situation of water resources development in the Northeast Region can be outlined briefly as follows.

- Almost no potential for further development by large scale project
- Some more potential of development by medium and small scale projects
- The above implies that potential for new development is rather low.

Also, there is a tendency that the quantity of usable water will decline year by year due to the reduced storage volume as caused by sediments in the existing reservoirs, increased irrigation losses by the deterioration of irrigation facilities and the restrictions derived from salinity accumulation and etc.

In view of the above, it can be said that RTG shall give higher priorities in tackling the problems in materializing the following measures.

- Introducing IWRM practices for improved water management
- To avail equitable and sustainable water use by IWRM manner
- The above is urgently needed to adequately utilize the limited and reducing water resources

(2) Scope of IWRM program

1) Selection of basin for pilot program

The Northeast Region is divided into three (3) major basins of Khong, Chi and Mun and there already established three (3) RBCs, one each for each basin. It is considered adequate basically to formulate an IWRM program with each basin as a basic unit to be implemented by each of RBC as a core of the management body. In the Northeast Region there have to be three RBCs effectively functioning in future, one each for each basin, but with the following reasons, IWRM practice should be first implemented/strengthened in Mun basin.

- Of the three basins, the balance of water volume between upstream and lower stream is the worst in Mun basin and the water resource is insufficient in the upstream basin.
- There have been many water use facilities constructed in Mun basin both in upstream and lower stream reaches, leaving no room for further development. However, there is no coordination by and between the upstream and lower stream and each of major facilities are operated independently.
- While in Chi basin, comparatively better management/operation is being practiced with having large scale reservoirs in its middle and lower stream reaches. Further, a large scale water resource development project with reservoir is currently on-going in the upstream basin, implying the pending situation in terms of facilities development.
- Khong basin is favored with comparatively abundant water resources and in the lower stream basin, further water resources development projects are to be implemented.

Moreover, the Mun basin is the main production area of value-added jasmine rice for export, while the basin includes relatively poor provinces such as Buri Ram, Surin and Sisaket. Therefore, it is expected that the program can improve farm household income and revitalize the rural economy. Furthermore, the basin has issues such as negative impacts on natural environment caused by the past projects and therefore, the IWRM program is expected to solve those problems. In practicing the IWRM program, there are several important elements such as participations by civil society and stakeholders, learning process, capacity building for RBC who is the core management body and formulation of IWRM basin plan. DWR, RID, Provincial offices and TAOs will play a main role as implementation agencies. Collaboration and coordination among such related agencies (RID and DWR in particular) are quite important and it is deemed essentially important to create good examples through attaining due coordination at the program implementation level in addition to the political will at the higher policy level.

2) Approach for IWRM

In practicing the IWRM program, there are several important elements such as participations by civil society and stakeholders, learning process, capacity building for RBC who is the core management body and formulation of IWRM basin plan.

① Participations by civil society and stakeholders and learning process

Stakeholders are people living in the basin, farmers, industrial water users, local government and

central government etc. All the stakeholders have to participate in solving the water related problems under RBC. Learning in participatory manner is also important through planning for water allocation and other activities for studies on IWRM concept and water environment in each locality.

- A forum shall be arranged to discuss water related problems and consider the options to solve the problem.
- Participatory survey on water resource situation and problem issues in the tributary basin and communities concerned.
- Participation in formulation of action plan for water resource conservation/management at the tributary basin level and community level
- Improvement of farming practices aiming at higher water use efficiency in irrigable areas and pilot project for crop diversification
- Continuation of learning process at local people level by networking of IWRM practice group

② Capacity building of RBC

Under the RBC, working groups for each tributary basin and technical working group are to be organized. In case of Mun river basin RBC, groups have been organized and existing, but there have been no substantial activities by them. Capacity building takes time and there must be medium-long process to be completed, and it is considered necessary to provide following support to RBC under the short term perspective.

- Strengthening of management bodies with RBC as the core: Support system for RBC and roles by each organization shall be clarified together with the institutional set-up and flows of program implementation
- Holding of workshop and forum: Direction of IWRM plan be clearly confirmed, the concept be disseminated extensively in the related areas and due understanding on RBC and support to RBC be secured.
- Organizing of technical working group: DWR is responsible for technical and financial support to RBC by the government, but support by RID is inevitable as RID engages in O & M of the most major water related facilities. It is necessary to demarcate clearly the roles/responsibilities by RID and DWR, and also to rationalize the institutional set-up for promotion of IWRM. For this sake, the technical working group shall be composed of permanent staff both from DWR and RID as key members and stakeholders with having necessary supports by the consultants/academics.
- Preparation of survey plan, basin plan and program: The technical working group will carry out problem identification and solution of problem issues in the basin, prepare basin plan and basin program in participatory manner with the stakeholders and propose these to RBC. RBC considers the proposals and confirms for implementation with due endorsement/consent by stakeholders.

③ Formulation of IWRM plan for the basin

The subject plan is a road map showing the investment schedule in future for multi-purpose and medium/long term water management project including various sectors such as irrigation, urban water supply, rural water supply, flood control, hydropower generation, drainage, water quality and environment. Therefore, the plan shall be prepared in conformity with the existing national level plans and/or integrated or intensified with them.

3) Components of cooperation to IWRM program

The cooperation to support the implementation of IWRM program can be largely divided into two (2) different levels. One is to take a role of facilitation of participatory activities and learning process at the community and tributary basin levels. The other is a technical assistance to RBC and the technical working group at the basin level.

Concerning the activities at the community and tributary basin level, there have been several pilot projects implemented in some basins including Chi basin, and therefore, it is deemed possible that Thai side can manage the implementation with the cooperation by the external facilitators available in Thailand (Though budgeting is of uncertain factor). While for the RBC, due technical assistance is considered necessary in supporting activities for RBC and in organizing the technical group sub-committee and the supporting to the activities by the technical group.

In principle, RBC is the organization to implement the management plan formulated and the assistance is for the strengthening of the RBC and in their implementation activities. The technical working group is to formulate basin plan, to survey management plan, to assess the performance and to prepare various plans/programs, then, the assistances required is to support the group's activities technically and from the viewpoint of policies. For further details in concrete activities, the followings can be considered.

① Support of RBC

Table 7.2.1 Support of RBC

Component	Major Activities
Capacity Building of RBC	・ Set-up RBC office ・ Formulate and set TOR for Support group ・ Establish sustainable activity by RBC ・ Share of information and Public Relation ・ Management and O&M fee system be developed ・ Set direction of River Basin Management Plan, etc
Water Quality Monitoring, control	・ Monitoring of Water Quality of surface, rain and ground water ・ Water resources assessment including environmental discharge
Conservation of forest area in proposed	・ Zoning, Conversation Forest in Watershed ・ Conservation of water ・ Coordination with other forest conservation plan, etc.
Water Quality / Pollution Control	・ Water quality control and strategy for pollution control ・ Develop river and lake water quality classification ・ Proposal for controlling water quality

Component	Major Activities
Water Use Management	・ Water allocation ・ Water use saving ・ Ground water use
Flood Management	・ Flood Mitigation ・ Early Warning System,

② Support to technical working group

The technical working group is composed of the members by DWR, RID, local stakeholders and consultants and be responsible for preparation of basin plan and management programs. The group may be necessary to be further divided into sub-groups such as survey, planning and information management etc. and the supports is to be rendered in the form of joining in such activities by sub-groups. The contents of supporting activities are assumed as shown in the Table 7.2.2.

Table 7.2.2 Contents of Support for Technical Working Group

Component	Major Activities
Basin Study (By Tributary from Up to down stream)	・ Re-assessment of metrological/ hydrological monitor point ・ Conduct situational survey on agriculture and irrigation ・ Inventory survey of water facilities and diagnosis ・ Review of socio-economic condition (Tribe, Land holding, industry, use of natural resources) ・ Review of Environmental Study (Salinity problem, Water Quality, Relocation, Land acquisition)
Evaluation and Plan	・ Confirm potential water quantity and quality of surface and ground water(Basin-wise Water Balance Model and Evaluation) ・ Set Water allocation of irrigation, domestic, industry and others ・ Set Environmental maintenance flow of tributary ・ Flood Control ・ Propose priority plan including Water Diversion from other tributary, Conjunctive use ・ Study on Water Balance, Environmental aspect of proposed project ・ Evaluation and proposal on development, operation and maintenance of facilities ・ Support on Design, Environmental Assessment, F/S, Financial Plan, etc.

(3) Priority-given Development and Improvement Plans under Management Plan

Priority-given development and improvement plans proposed hereunder shall be finalized through river basin assessment and evaluation to be conducted by the technical working group. Proposed items listed here are just potential scopes for rehabilitation and improvement as assumed based on the findings under the present study.

① Assessment of Water Resources

- Re-arrangement of observatories : Calibration and adjustment of rating curve, re-select the gauging stations、

- Large and medium scale reservoirs: Adjustment of H－V curve
- Establishment of control points (discharge, water quality): Setting the control points in the basin and sub-basins under unified concept
- Basic information of water resources (water source, river flow, water quality): Re-build of hydrological database, realignment of basic river information and formulation of hydrological models as follows;
  - Water balance models
  - Runoff models
  - Groundwater flow and water quality models
  - Water demand and allocation management models

② Review of the reservoir operation

- Review of the operation rule of the large scale reservoir and increase of water release in dry season
- Review of possibilities to increase dam height, to dredge and to modify operation rule for increment of water release in dry season by the medium scale reservoir

③ Review of operation and structure of the Barrages and weirs

- Provision of operation guideline for barrages and weirs
- Integration of weirs constructed in the tributary and installation of movable gate
- Securing the fish way

④ Improvement of efficiency in water utilization(especially in irrigation）

- Improvement of irrigation efficiency by rehabilitation of facilities
- Equitable irrigation water distribution through crop diversification and suitable land use planning

⑤ Planning to mitigate flood problem and facilitate environmental conservation

⑥ Planning of sewage treatment facilities（municipal sewage treatment plant, rural community sewage treatment plant）

(4) Related Projects to be implemented after the formulation of Integrated River Basin Management Plan

Priority projects under the integrated river basin management plan may include the followings, which might be possible cooperation projects for ODA loan and technical cooperation;

- Rehabilitation and improvement of medium scale irrigation facilities
- Consolidation of the existing weirs on tributary
- Construction of fish ladder
- Construction of facilities for water quality improvement

Promotion of crop diversification, value adding to the crops, watershed conservation activities and so on along with IWRM will be implemented. Participatory Irrigation Management (PIM) is to be promoted in Thailand so as to transfer the activities for irrigation management from RID to Water Users along with implementation of rehabilitation and improvement works.

It is necessary to exchange information and data with SEA study for water sector in the Northeast region for water diversion/ water grid plan, which is approved for implementation by DWR.

Moreover, it is necessary to conduct SEA on water sector in the Northeast Region according to guideline, when RTG consider water diversion projects for implementation. Integrated river basin management plan can provide basic information of each river basin for SEA.

Experience of Flagship Program and lessons learned are expected to be shared with other RBCs in Thailand as well as other country in Mekong Region.

To this end, the cooperation framework for Water Management Approach is proposed for short, medium and long terms as shown in Figure 7.2.1.

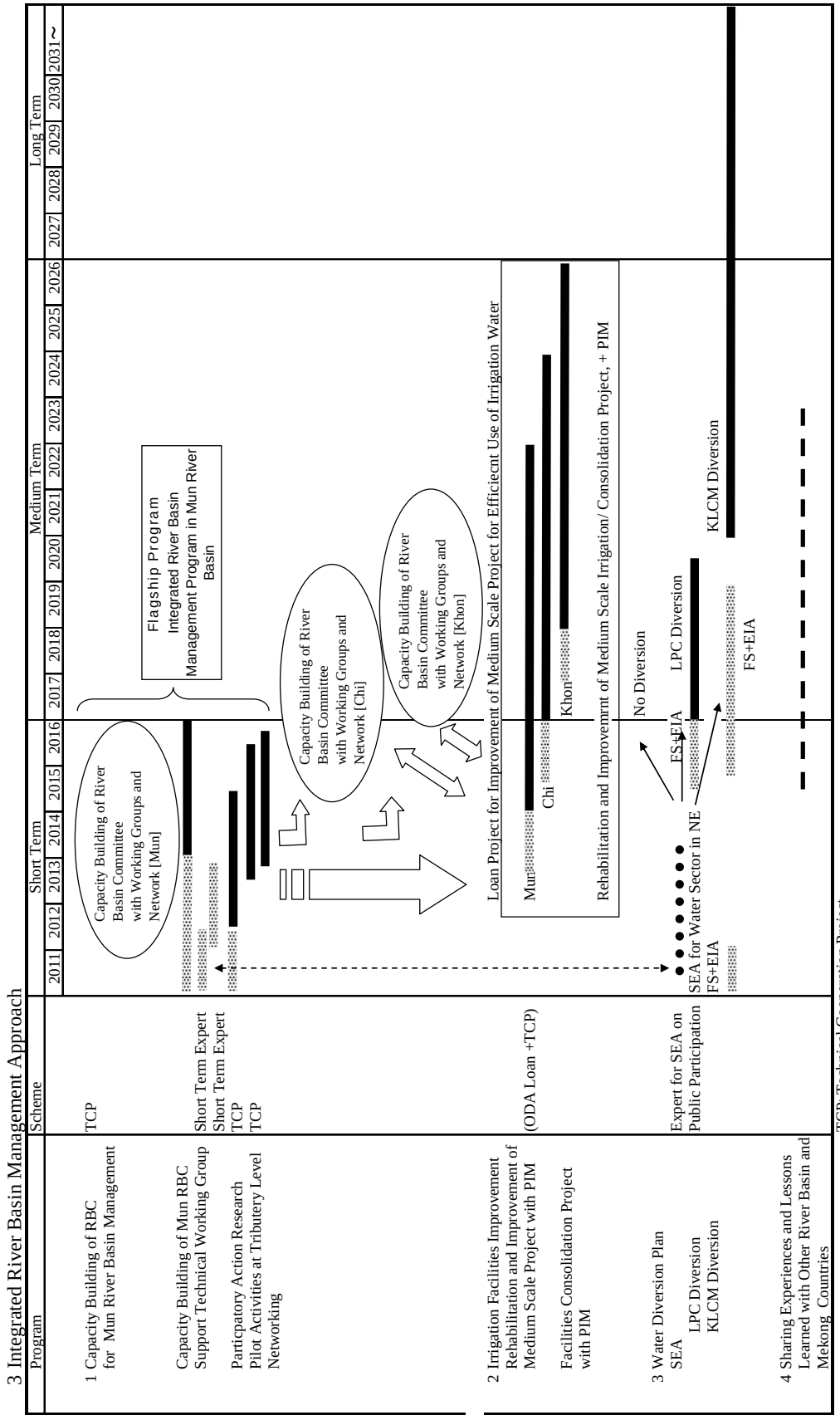


Figure 7.2.1 Proposed Cooperation Framework for Water Management Approach

7.2.2 Agro-industry Promotion through Private, Public and Academic Cooperation (Draft)

(1) Necessity of Flagship Program

Aiming at reducing regional disparity, promotion of agro-industry will be proposed for regional economic development and creating employment opportunity. Linkage with agriculture sector, product development attractive to consumer and marketing is necessary. Demand driven agriculture development needs private sector's involvement in terms of crop diversification. Proposed project contents are as follows;

(2) Proposed Flagship Program

Target area shall be in completed large scale irrigation, with stable agriculture production, and good reputation. Khon Kaen, Kalasin, Udon Thani, and Nakhon Ratchasima are proposed. Proposed activates are as follows;

1) Develop R&D center for food by Linking Private Sector – Public – Academic Institution
2) Inviting advanced (Japanese) private enterprise (food and agro-processing) and link with local M & SMEs
3) Local product development and marketing through cooperation of agriculture, manufacturing and commercial sector
4) Advance technology for agriculture management and HRD of next generation

7.2.3 Community Revitalization Program in Rain-fed Area (Draft)

(1) Necessity of Flagship Program

Livelihood improvement of farm household in rainfed area needs different approach from irrigated area. Expansion of cultivation area and improvement of productivity are major focus in irrigated area. It is important, on the other hand in rainfed area, to have better farm income with low input together with reduction and diversifying risk of drought and flood.

H.M King's "Sufficiency Economy" concept provide rational for such approach in community development and agricultural development. Government agencies apply this concept to agricultural promotion and community development. However, different government agencies conduct activities without coordination in the same area which has less effective and no synergy effect.

In the Agricultural Development Plan (2006-2011), target number of farmer who practice agriculture based on sufficiency economy concept is as many as 1/4 of total farm household. In case of the Northeast, about 400 thousand household is the target number.

Japanese ODA loan assisted "Project for Revitalization of Deteriorated Environment in the Land Reform Area through Integrated Agricultural Development" implemented by ALRO (called ALRO project or PRO-IAD) has developed Model of providing farm ponds and promote integrated agriculture through learning center. Furthermore, Model includes development of Green Market (non-toxic, organic farmer market) which support extension of organic agriculture

(see Appendix 1.18). Such Model can be widely applicable to the rural community in the Northeast.

In the short term, the Program formulate consortium of stakeholders and promote Sufficiency Agriculture by application of the Model. At the same time, it is important to provide learning process and capacity development of communities in order to obtain capacity of problem solving by local people to cope with future issues such as aging society.

For capacity development of local people, it is necessary not only to have capability development of the RTG implementing agencies and trainings for leaders and next generation, but also to have local people practicing trial and errors process by themselves and expand further their practices with having concrete achievements. For this sake, it is necessary to have a framework which may support the local peoples' initiatives by adequate combination of various schemes.

(2) Proposed Flagship Program

Short-term:

Flagship program will be implemented at local level with multi stakeholders. One expert will be attached to Program Coordinating Unit in central government agency (NESDB or MOAC-OPS) and coordinate with other Japanese input like expert dispatched to different agencies (ALRO, LDD, DOAE, CPD, CDD and OSMEP and etc.), JOCV, SV and Training scheme to carry out the Flagship Program. Best practice, lessons learned and Model from the other project implemented shall be fully utilized and updated.

1) Revitalization of rural community based on Sufficiency Economy

- Farmer-to-Farmer extension on Sufficiency Agriculture (integrated agriculture) together with promotion of crop diversification through Green and Community Market. (Construction of farm ponds for Sufficiency Economy by PAO, TAO included)
- Supporting TAO as Focal Point of the Community Enterprise development and marketing.

  Local employment and income-raising will be created (coordination with SVA)

2) Support learning process and initiative of local people for self-reliance

- Participatory planning at village level and provision of learning process (FAO poverty alleviation model)
- Provide support mechanism for local people's initiatives (Japan NGO grant)

3) Preparation fro Future

- Development of next generation leader (JOCV and training)

Mid-term:

In the medium term, input from Japan shall be knowledge base such as sharing Japanese experience, and linking with scientific researchers, assuming that coordination among stakeholders are established.

- Local Economic revitalization utilizing local resource, local wisdom and local culture (OTOP, Green Tourism, etc.) (Campaign and Contest)
- Continue to support local initiative by participation and coordination among TAO, colleges, government agencies, NGO and Community
- Trial on new form of agriculture (low labor intensive agriculture for aged, high quality and profitable agriculture, hydroponics etc) based on collaboration of research and government agencies.

CHAPTER 8 RECOMMENDATIONS

Recommendations were prepared by the Study Team for JICA's further consideration based on the understanding/knowledge and lessons learnt as obtained through the subject study. The recommendations include proposal to JICA for further examining on the following points in addition to the scope of study that "Directions on cooperation framework in medium/long term perspective for rectifying the regional disparity in the Northeast Region (Mainly in water resource management and agriculture sectors) shall be worked out." as indicated in the Chapter 7. The recommendations consist of three different modes, i.e., 1) issues to be paid attention for implementation of proposed programs/projects, 2) need for consideration of wider view of regional cooperation framework which is beyond the scope of this study, and 3) consideration on changing relationship and cooperation manner between Japan and Thailand.

8.1 Important Points to be paid Attention for Implementation of Programs/Projects toward Rectifying of Regional Disparity in the Northeast Region

Approaches and cooperation framework/programs (Draft) toward rectifying the income gap/disparity in the Northeast Region have been presented in the foregoing, however, it is difficult to expect anyone of the programs and projects, though successfully implemented, can cause considerably remarkable effects in narrowing the gap or rectifying the disparity existing between the Northeast Region and Bangkok and the vicinity as well as the Central Region.

However, it is considered that facilitating the needed capacity development for the RTG's central as well as local administration bodies who are responsible for supporting the self-motivating challenges of local people aiming at sustainable development in each locality so as to materialize locally-specific happy and rich way of life, though the disparity would remain as it was in terms of income/economy. This concept of development was proposed as the approach to rectifying the regional disparity.

Important points to be paid with due attention in implementing any concrete projects shall be discussed as the followings.

(1) Fostering Good Governance through Program/Project Implementation (Public Participation and Information Disclosure)

Development in the Northeast Region in the past especially in the recent past used to be initiated by political wills rather than the wish of local people. Some parts of Northeastern people are getting better-off due to such large scale development projects and economic development policies. On the other hand, it is said that many people have been marginalized and flipped off from development process and rather got worsen by development. There are several such cases in water resources development projects as confirmed by the study team from information collected and through field visit.

In case if JICA would provide assistances in capacity development of Thai Government agencies and activities led by local people's initiatives, public participation from planning stage and information disclosure shall be paid with special attention by JICA for implementation of

cooperation projects with the relevant Government agencies.

JICA is recommended to support concrete planning process and implementation with people's participation. Practical approach to create occasions and atmosphere where Thai Government agencies can realize the importance of participation from planning stage, transparency and equity, is preferable so as to make direct approach to avail participation as pre-condition for financial and technical cooperation.

(2) Necessity to Formulate Project with Multi-Agencies and to Eradicate Sectionalism

As mentioned in the proposed flagship program, effective management of programs and/or projects requires integrated approach to meet local people's needs. In order to achieve it, program to cooperate among different government agencies shall be necessary.

Though several development programs with multi-stakeholder cooperation are already introduced, it is not easy to do so, since there is no incentive for a government agency to work together by sharing ordinary budget with the others. Therefore, it is considered that external special fund can facilitate the due collaboration as incentives to work together.

JICA shall play such facilitation role to formulate multi-agencies program aside from ordinary single agency's request and proposal. According to the policy on ODA to support middle income countries, JICA's budget to Thailand is declining. Therefore, it is considered necessary to take a new approach to achieve development goal with the limited budget. For the same reason, cooperation with private sector in demand driven sustainable development is recommended as a cooperation scheme suitable to Thailand as a middle income country.

8.2 Cross border/Regional Cooperation

(1) Regional Cooperation Partnership in the Era of Borderless Economy

Regional economy is rapidly growing and expanding through infrastructure development as well as under Free Trade Agreement regime. Then, movement of goods, people, money across the border is so voluminous and it is to be taken into account in development of local area. In case of the Northeast Thailand, the current position and future trend on the Region in Asia shall be analyzed, and long-term perspective including surrounding countries and wider regional view shall be considered in order to conceive future cooperation framework of JICA. In that sense, this study has a limitation in its scope of work, and further study shall be considered to deal with such big issues.

This study is focusing on narrowing the regional disparity between the Northeast and Bangkok. However, on the other aspect, the economic disparity between the Northeast and neighboring countries, Lao PDR and Cambodia, is also distinguished. Under borderless economy, investment in agriculture for water and agricultural infrastructure development may be necessary to consider. Since Lao PDR and Cambodia has limitation in investment due to country risk as a single country, investment environment may be improved by combining with Thailand as one region. To do so, JICA is suggested to transform country assistance to regional assistance policy in this particular region. With cooperation to be implemented with Thai Government agencies as partner,

JICA can extend its cooperation to surrounding countries. Such new style of partnership might be suitable to Thailand who is becoming to middle income country.

(2) Preparation for Future Water / Food Crisis with Climate Change

In the long term perspective, as forecasted by many researches, demand on food and water in the world become increasing, and when combined with climate changes impact, food and water crisis may surely occur in the world. Infrastructure on water and agriculture can not be developed over night. It shall be prepared for future with 30 to 50 years long -term perspective.

This study results show the fact that water resource in the Northeast region is almost fully developed and little margin remains. With wider view of regions including neighboring countries, however, unbalance of water resources and land resources is prominent. Considering the future water and food crisis possibility, it may be necessary to consider trans-boundary water diversion scheme for implementation together with due trans-boundary environmental management. It shall be implemented through appropriate process based on prior consent for agreement among MRC countries. Lower Mekong countries can cooperate in development for common future, and Japan shall play an important role in technical and financial cooperation within GMS cooperation framework.

8.3 Sharing of Japanese Experience with Thailand on Issues of Maturing Society

(1) Aging Society, Shortage of Next Generation Farmers and Depopulation

According to the study results, agriculture sector in the Northeast region is facing labor shortage problem currently, and issues of aging society and depopulation in rural society are high lighted. Although countermeasures to the issue are not proposed here, aside from community revitalization and making agriculture more profitable and attractive for next generation, practical actions shall be taken at national level as well as local level at the soonest. Japan has experienced the same issues. Therefore it is proposed to share such experience and lessons learned with Thai Government and local community level so as to prepare policy and local actions to cope with agrarian community under aging era.

(2) Towards Self-Governance at Local Level

Local to local exchange program between two countries is suggested in order to foster local people’s initiative for development with support by local government. Capacity building of local administration is necessary but the local administration alone is not enough for local development. Local economic development in partnership with private sector and effort of local community for self-governing is also important.

Toward self-governing of development by local initiative, financial issue is important. Under decentralization reform, role of small rural infrastructure development has been transferred to PAO and TAO but without budget support. Therefore, development is still mainly done by central government budget to date. Financial support system such as issuing local government bond, direct finance to local government by foreign loan may be necessary to be considered in future.