CHAPTER 3

WATER RESOURCES DEVELOPMENT

Sector Plan: Chapter 3 Water Resources Development

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WATER RESOURCES DEVELOPMENT

3.1 General Conditions

3.1.1 Climate

Based on the observation data from the meteorological stations in the provinces, the meteorological conditions in NBR may be summarized as shown in Table 3.1.

Data	Nakhon	Mukdahan	Sakon	Kalasin
Data	Phanom		Nakhon	
Mean temperature ()	25.9	26.4	26.1	26.7
Mean relative humidity (%)	74.7	71.8	72.3	70.8
Max. Cloudiness (unit 0-10)	5.6	5.8	5.4	5.7
Mean wind velocity (Knot)	2.0	3.2	2.6	2.8
Mean annual evaporation (mm)	1,433	1,634	1,930	1,715

Table 3.1 Meteorological Conditions in NBR

Source: Meteorological Department

3.1.2 River Basins

The important river basins in NBR are shown on Figure 3.1. The conditions of river basins in each province are summarized as shown on Table 3.2.



Figure 3.1 MaIn River Basins in the NBR

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Province	Major rivers		Stream flow (MCM))	Periods
		Wet season	Dry season	Annual	
Nakhon	Mekong	178,244	41,517	219,761	1962-1994
Phanom	Huai Nam	899	105	1,004	1982-1992
	Songkhram	907	21	928	1962-1994
Mukdahan	Mekong	190,599	42,462	233,060	1962-1994
	Huai Bang Sai	559	27	586	1968-1994
Sakon	Songkhram	1,107	23	1,130	1962-1994
Nakhon	Huai Nam	682	62	747	1982-1992
	Nam Pung	228	29	257	1982-1992
Kalasin	Lam Phan	867	322	1,189	1978-1995
	Lam Pao	1,150	430	1,580	1975-1994
	Nam Yang	579	19	598	1984-1995

Table 3.2 River Basins in Each Province

Source: Royal Irrigation Department

Based on data shown in Figure 3.1 and Table 3.2, the features can be summarized as follows:

(1) The Mekong River and its tributaries

The Mekong River runs through Nakhon Phanom and Mukdahan, and offers ample water resources to these provinces.

(2) The Songkhram River and its tributaries

The Songkhram River runs through Nakhon Phanom and Sakon Nakhon, and causes major floods in the provinces, especially in Nakhon Phanom.

(3) The Chi River and its tributaries

The Chi River runs through Kalasin, and provides a large portion of water to Kalasin for irrigation purpose and residential consumption.

3.1.3 Rainfall

The data on rainfall in NBR is shown in Table 3.3, which reveals that the annual rainfall in NBR is around 1,500 mm. Although this amount is lower than those in other areas of Thailand, judging from its total, it may not exert any detrimental impact on agricultural production or the daily life of people.

However, the unbalanced seasonal rainfall is the most serious problem. Within a year, rainfall in the dry season (from May to October) is only around 10% of the total rainfall in the wet season (from November to next April).

The difference in rainfall between the two seasons has resulted in the different rate of flow in rivers, which is also an indication of this feature.

Table 3.3 Rainfall in NBR

Province	R	ainfall (mm/year)		Period
	Wet season	Dry season	Annual	
Nakhon Phanom	1,672	141	1,813	1961-1995
Mukdahan	1,328	120	1,449	
Sakon Nakhon	1,337	130	1,467	
Kalasin	1,179	117	1,296	

Source: Meteorological Department

3.2 Characteristics of Water Resources in the NBR

3.2.1 Wet Season and Dry Season

As shown in Table 3.2, there exists a significant difference in water resources between the dry season and the wet season in NBR.

Take the Mekong River as an example. Its rate of flow in the wet season is nearly 4 to 5 times higher than that in the dry season.

This feature has resulted in water shortage in many areas of NBR in the dry season, and unfavorably affected agricultural production and the daily life of residents.

3.2.2 Consumption of Water Resources

(1) General

The current consumption of water resources in NBR is shown in Table 3.4.

Province	Available water	Wate	r demand (MCM	/year)	Consumption
	resources	Irrigation	Municipal	Total	rate
	(IVICIVI/year)				
Nakhon Phanom	3,775	76.4	5.2	82	2.2%
Mukdahan	2,041	83.7	2.4	86	4.2%
Sakon Nakhon	3,984	679.1	5.8	685	17.2%
Kalasin	2,183	1,441.6	5.0	1,447	66.3%
Total	11,983	2,280.1	18.4		?

Table 3.4 Current Consumption of Water Resources in NBR

Source: Meteorological Department

Based on Table 3.4, the consumption of water resources in NBR may be briefly characterized as follows:

Water resources are mainly used for agricultural irrigation, industrial production and urban water supply purposes, which only comprise a real small portion, i.e., 0.15% of the total water resources and 0.8% of the total water consumption.

The features of NBR cause this. Agriculture takes a dominant position in the industrial structure of NBR, while urban and industrial development still remain at the initial stage. Its urban population only comprises 15.9% of the total population. Its industrial production only comprises 13.8% of its GDP.

In view of this, it may be expected that the supply of water resources will not become a limiting factor to the economic growth of NBR in the future.

(2) Irrigation

1) General Background

In general, there are considerable fluctuations in wet season rice yields because the rainfall pattern is very variable. Irrigation development can be used as an important measure to improve this situation by supplementary irrigation in the wet season and some dry season irrigation.

2) Irrigation in the Study Area

Existing irrigation projects in the Study Area by province are summarized in Tables 3.5 and 3.6. There are two large-scale projects in Sakon Nakhon, namely, Nam Un Project with storage capacity of 520 MCM and an irrigable area of 185,800 rai, and Nam Phung Dam by EGAT with storage capacity of around 165 MCM for hydropower generation. In Kalasin, there is also one large-scale irrigation project, Lam Pao, with total irrigable area of 314,300 rai and storage capacity of 1,430 MCM.

Province	Number of projects	Storage (MCM)	Irrigated area (Rai)
Nakhon Phanom	153	76.4	116,751
Mukdahan	98	83.7	81,795
Sakon Nakhon	40	679.1	523,530
Kalasin	203	1,441.6	407,493
Total	494	2,280.8	1,129,569

Table 3.5 Water Facility Projects in NBR

Source: Agricultural Statistics of Thailand

Almost all of the water facility projects in NBR are small-sized projects and are intended for agricultural irrigation.

There are 3 large-sized water facility projects in NBR as shown in Table 3.6.

Projects	Location	Storage (MCM)	Irrigated area
Nan Un Dan	Nakhon Phanom	520	185,800
Lan Pao Dan	Kalasin	1340	315.098

Sakon Nakhon

Table 3.6 Large-sized Water Facility Projects in NBR

Source: Agricultural Statistics of Thailand

Nam Phung

These 3 large-sized projects have played important roles in agricultural irrigation and urban water supply in NBR.

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At present the total irrigable area of large-scale projects serve about 37% of the irrigated area in the Study Area, while the irrigated area under the medium-scale projects is 301,541 rai, or 22%, and the irrigated area of small-scale projects is also approximately 22%.

Two large-scale irrigation projects, Nam Un and Lam Pao, comprise a storage dam and associated gravity irrigation systems served by a main canal, a secondary canal and a tertiary canal or on-farm works. For medium-scale projects, most of them are supplied by storage reservoirs but a few are run-off-river projects.

3.3 Issues Concerning Water Resources in NBR

3.3.1 Issues Concerning Water Resources in NBR

Major issues concerning water resources in NBR are inadequate water supply and floods. These issues are explained as follows:

(1) Inadequate f Water Supply

Judging from a macroscopic view, the supply of water resources in NBR is not inadequate. However, NBR has two distinct characteristics which have led to the severe inadequate supply of water resources in certain local areas in NBR during the dry season.

1) Strong Sunshine and Evaporation

A comparison in rainfall and evaporation among the provinces in NBR is shown in Table 3.7. It reveals that with the exception of Nakhon Phanom Province, evaporation is significantly higher than rainfall in the provinces.

Items	Nakhon Phanom	Mukdahan	Sakon Nakhon	Kalasin
Mean annual evaporation	1433	1634	1930	1715
Rainfall (mm)	1813	1449	1417	1296

Source: Meteorological Department

The strong unbalance between evaporation and rainfall has led to dependency of the provinces on irrigation facilities for agricultural water supply.

2) Unbalanced Rate of Flow of the River

As mentioned above, there exist great differences in the flow rate of major rivers in NBR between the wet season and the dry season. In the dry season, as the rate of flow decreases, water shortage may often occur where irrigation facilities are inadequate.

(2) Flood Damage

Flood occurs periodically at the river mouth of the Songkhram River and the areas along the Mekong River at the end of rainy season. But this situation has become more serious recently as deforestation accelerates flooding in the NBR. Flooding occurs due to the large fluctuation and uneven distribution of water flow within the year and the slow flow of river water on flat riverbeds.

Water flow of the Mekong River and the Songkhram River varies severely by season as indicated in Figure 3.2. This has caused both severe loss of water in the rainy season and shortage of water supply in the dry season, while river water flows slowly on flat riverbeds, after leaving mountains and going into valleys or plains. Once floods occur, they cannot discharge water instantly resulting in the rise of water level and the start of inundation of the flood plains.



Figure 3.2 Mean Monthly Discharge

These environmental characteristics also create drought problems owing to inadequate groundwater in the NBR.

There are two distinct groundwater strata in the NBR. The first one is rather shallow and is filled up through infiltration during the first months of the rainy season. It can be reached through a hand-dug well, which has been a common practice for a long time, but this reserve is greatly responsive to drought. Thus, as soon as the rain stops and surface water runs off, shallow groundwater becomes depleted and the wells dry up. The second reserve lies beyond the reach of simple tools or is even isolated by rocks. This deep stratum of water fills up slowly but is, on the other hand, less subject to changes during seasonal drought. In the future, the development of the deep groundwater may partly contribute to be a source of irrigation water for the dry season.

Floods occurred in almost every wet season in the Songkhram Basin in the north part of Nakhon Phanom due to their lack of necessary flood control facilities, which severely affected agricultural production and the normal life of farmers. (Figure 3.3)

3.3.2 Strategies Concerning Water Resources

In view of the issues concerning water resources in NBR mentioned above, the strategy on water resources mainly focuses on the following 3 aspects:

- Watershed Management;
- Water Supply Improvement; and
- Flood control measures for the Songkhram Basin.

(1) Watershed Management

Closely related are the factors of natural environment in the watershed. The change of a certain factor may affect the entire watershed. Therefore, regional planning and comprehensive development should be based on the whole watershed. The watershed management system consists of interrelated aspects as follows:

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Villane	Household	inme	exnenditure	income	inmme	household			Major Iterits Of Mo			
No.	No.	(A)	(B)	(C) = (A) - (B)	0	income	expenditure	Food	electricity	Education	Medical expense	g
-	2	24,500	7,200	17,300	48,000	65,300	31,404	7,200 (23%	5) 2,880 (9%)	5,000 (16%)	(0%)	<u>,1</u>
	4	0		0	10,000	10,000	8,710	4,740 (54%	6) 720 (8%)	(0%)	1,200 (14%)	
2	5	0	2,890	-2,890	145,500	142,610	120,580	18,000 (15%	6) 10,800 (9%)	3,000 (2%)	500 (0%)	ų
	9	55,200	29,430	25,770	42,500	68,270	25,980	19,000 (73%	5) 1,440 (6%)	2,240 (9%)	(0%)	2,7
	7	0	2,010	-2,010	84,750	82,740	32,820	21,600 (66%	5) 3,240 (10%)	4,400 (13%)	500 (2%)	1,28
	8	300	650	-350	37,300	36,950	24,630	19,200 (78%	5) 1,200 (5%)	3,060 (12%)	(0%)	1,17
3	6	23,700	10,470	13,230	0	13,230	13,155	7,200 (55%	5) 1,440 (11%)	(0%)	250 (2%)	, <u>1</u> ,0
	10	41,300	14,890	26,410	61,000	87,410	48,315	36,000 (75%	5) 3,600 (7%)	(0%)	3,500 (7%)	
	12	0	0	0	15,250	15,250	33,680	19,400 (58%	5) 1,680 (5%)	4,900 (15%)	500 (1%)	1,000
4	14	619,000	191,980	427,020	30,000	457,020	78,600	5,400 (7%)	34,200 (44%)	1,320 (2%)	500 (1%)	21,260
	15	421,600	245,340	176,260	3,600	179,860	133,926	41,400 (31%	5) 3,216 (2%)	32,520 (24%)	8,000 (6%)	6,000
	16	0	1,250	-1,250	22,430	21,180	22,080	7,200 (33%	b) 660 (3%)	1,100 (5%)	360 (2%)	2,970
сл	17	174,100	78,060	96,040	3,000	99,040	63,550	28,000 (44%) 4,080 (6%)	4,000 (6%)	1,000 (2%)	750
_	18	33,500	31,178	2,322	83,400	85,722	61,998	28,800 (46%	o) (0%)	680 (1%)	6,500 (10%)	096
,	19	108,000	31,660	76,340	4,000	80,340	22,010	12,000 (55%) 3,000 (14%)	(0%)	500 (2%)	750
	20	0	0	0	32,160	32,160	34,910	28,800 (82%) 2,100 (6%)	(0%)	500 (1%)	2,430
<u></u>	21	169,000	62,160	106,840	21,000	127,840	33,750	14,400 (43%) 960 (3%)	600 (2%)	500 (1%)	5,290
	22	134,380	64,980	69,400	27,000	96,400	85,550	36,000 (42%) 1,200 (1%)	430 (1%)	(0%)	3,750
	23	7,000	11,090	-4,090	90,000	85,910	65,260	29,000 (44%) 16,800 (26%)	1,500 (2%)	500 (1%)	1,650
	24	0	600	-600	19,000	18,400	14,790	11,800 (80%) 1,080 (7%)	1,760 (12%)	30 (0%)	120
7	25	54,050	15,813	38,237	32,400	70,637	34,775	25,200 (72%) 1,335 (4%)	1,100 (3%)	600 (2%)	
	26	27,088	3,468	23,620	10,000	33,620	8,520	600 (7%)	960 (11%)	1,330 (16%)	(%2) 009	2,800
`	27	0	1,690	-1,690	11,440	9,750	10,781	3,800 (35%) 480 (4%)	(0%)	1,900 (18%)	2,100
8	30	47,700	17,275	30,425	33,000	63,425	50,359	10,800 (21%) 1,080 (2%)	20,319 (40%)	(0%)	5,280
	31	6,000	3,051	2,949	36,000	38,949	13,890	6,000 (43%) 1,800 (13%)	(0%)	(0%)	4,090
9	33	153,800	25,800	128,000	47,250	175,250	116,758	43,108 (37%) 8,160 (7%)	12,900 (11%)	6,190 (5%)	6,800
	34	14,000	11,350	2,650	202,000	204,650	107,800	44,000 (41%) 10,800 (10%)	20,000 (19%)	7,200 (7%)	1,800
	35	18,000	9,110	8,890	105,500	114,390	110,495	40,000 (36%) 2,760 (2%)	38,200 (35%)	4,000 (4%)	5,000
10	38	89,522	57,767	31,755	20,500	52,255	46,150	26,500 (57%) 1,380 (3%)	10,900 (24%)	(0%)	4,490
	39	11,520	5,190	6,330	40,200	46,530	41,546	35,516 (85%) 1,560 (4%)	(0%)	(0%)	1,590
Durce	The Social	Suevey										

 Table 7.17
 Expenditure Structure of the Sample Households

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Since the Mekong River, the Chi River, the Songkhram River, and other important rivers do not terminate in NBR, it is impossible to hold an integrated management of their watersheds only in NBR. However, it is necessary for NBR to hold discussions and join hands with its neighboring regions to conduct an integrated management of the major rivers.

(2) Improvement of Water Supply

In order to resolve water shortage in the dry season, measures may be taken as follows:

1) Construction of New Water Storage Facilities

It is necessary to construct new water conservation facilities in Sakon Nakhon Province and Kalasin Province where severe water shortage occurs in the dry season, and these facilities will be used to intercept water resources in the wet season

2) Construction of Pumping Stations

It is necessary to construct new pumping stations along the Mekong River, in order to supply irrigation water in the dry season.

(3) Reasonable Utilization of Water Resources

It is necessary to make reasonable use of water resources, especially in the dry season, taking the following measures:

1) Underlay water channels with concrete materials

According to experiences of other countries, this measure may minimize water leak, and save about 30% of irrigation water.

2) Water user's organizations

It is necessary to make reasonable distribution of irrigation water through water user's organizations in order to save water.

(4) Flood Control Measures for the Songkhram Basin

It is evident that it will be quite difficult to find funds to build large dams along the river in order to control flood disasters in the Songkhram Basin. Thus, it is necessary to find locations in upstream areas, which have favorable natural and social environments, e.g., topographical and geological advantages, less population, and limited flood impact. Cascading projects should be distributed in accordance with the practical situation in order to raise the capacity of the Songkhram River to redistribute and compensate river runoffs in the temporal and spatial dimensions.