

CHAPTER 8. CONCLUSION AND RECOMMENDATION

8.1 Conclusion

The Master Plan of flood damage mitigation in the Chao Phraya River Basin has been formulated in accordance with the concept of the "Monkey Cheek" for preservation of the present retarding effect and also with the introduction of suitable flood mitigation measures putting more emphasis on flood mitigation in the lower central plain from Chainat with the target year of 2018 (refer to Fig. 8.1.1). To realize the Master Plan, several project components for urgent implementation have been selected. For some of the project components, their feasibility have been examined and confirmed and, for the others, further studies have been undertaken.

In this JICA Study, it is concluded that flood mitigation, in the context of the Master Plan, is essential for the development of the basin and the country as a whole, and the implementation of selected project components is the most effective to attain the objectives.

8.2 Recommendation

8.2.1 Arrangement for Project Implementation

(1) Justification of the Master Plan

The Master Plan of comprehensive flood mitigation in the Chao Phraya River basin has been formulated, as outlined in Fig. 8.1.1. Since the realization of the Master Plan is essential for the future development of the basin and the whole country as well, it should be justified as a part of the Thai National Development Plan.

(2) Strengthening of the Present Organization and Setup of a River Basin Committee

The Master Plan is composed of several project components, most of which will be undertaken by agencies concerned within their scopes of responsibility. For the realization of the Master Plan, however, it is recommended that the present organization be strengthened to successfully implement the project components.

For coordination to realize the Master Plan, it is indispensable to promptly set up a River Basin Committee as proposed in the Water Resources Act that is presently under consideration on the national level. Thus, it is also recommended that the setup of the River Basin Committee be expedited.

In case that the prompt setting up of the River Basin Committee is difficult under the current movement to restructure the existing organization, it is considered to set up an ad-hoc committee to coordinate the flood mitigation works, referring to the current function of agencies concerned. Therefore, it is

suggested to set up an ad-hoc committee as a tentative solution to cope with the flood mitigation issues caused by lack of coordination.

(3) Selection of Alternatives

In the Master Plan, alternative measures (Alternative 1, 2-1 and 2-2) have been proposed to assure the safety level of protection for urban areas in the downstream, especially Pathum Thani, Nontaburi and Bangkok. Since it has been difficult to select the most suitable alternative due to significant issues involved, it is recommended that further discussions be made as early as possible to select the most acceptable for all concerned. In the discussion for realization of the study results, it is necessary for all concerned in the Thai side to recognize that further study shall be done before construction of diversion channel. Also, social and environmental assessment for the heightening of flood barrier in Bangkok shall be conducted in detail before construction. (For the study on flood diversion channel, Alternative 2-2, refer to Vol. 3, Supporting Report, Sector VI, Flood Mitigation Plan.)

(4) Implementation of Priority Projects

In the framework of the Master Plan, four (4) priority projects have been selected: modification of reservoir operation rule, land use control and guidance, institution and organization, and river improvement. For these project components, the following considerations have been made:

(a) Modification of Reservoir Operation Rule

Modification of the reservoir operation rule for flood mitigation is technically feasible and economically viable. However, as to implementation, it is necessary to obtain the understanding and agreement of agencies concerned as well as the people affected through further consultations. After that, it is recommended that the operation rule agreed upon be promoted to the next stage of project implementation.

(b) Land Use Control and Guidance

Land use control and guidance, which is one of the core measures for preservation of the present retarding effect in the context of the Master Plan, is to be promoted by agencies concerned in cooperation with the people concerned based on the flood risk map prepared in this Study. To successfully implement the project components, it is recommended that understanding and agreement among agencies and people concerned be obtained, and arrangements to strengthen the current institutional setup should be taken.

(c) Institution and Organization

As confirmed through the Master Plan study, a River Basin Committee is indispensable for the comprehensive and basin-wide realization of flood mitigation. As the project component of institution and

organization in the feasibility study stage, further study on the river basin committee has been made focusing on the functions and responsibilities of the Committee. To support and execute the functions, establishment of the Office of the River Basin Committee has also been proposed together with its organizational composition. In this connection, preparation for the set up of the Office of the River Basin Committee should be made in advance of the establishment of the Committee.

(d) River Improvement

As the only one selected structural project component, feasibility study on river improvement works was made, and it has been confirmed that river improvement is technically feasible and economically viable. Therefore, it is recommended that the river improvement works should be forwarded to the next stage of project implementation with organizational and financial arrangements.

(5) Review of Urban Protection Plan undertaken by PWD

The flood protection plan in this JICA Study for major urban areas along the Chao Phraya River was based on the plan prepared by PWD to assure the safety level that corresponds to the water level of 100-year return period. Since the water level of 100-year return period was obtained through statistical analysis of the present river basin conditions, it is necessary to modify the water level considering the future basin development. In this connection, the design water level should be reviewed based on the results of this JICA Study, which provide the necessary information.

8.2.2 Further Study in the Next Stage

(1) Study on the Other Project Components for Nonstructural Measures

Among the project components for nonstructural measures proposed in the Master Plan, further studies have been made covering three components: modification of reservoir operation rule, land use and guidance, and institution and organization. As for the other components such as flood forecasting system and flood insurance, which are also essential for the realization of flood mitigation in the Chao Phraya River Basin, further studies should be undertaken in the next stage.

(2) Consideration of the Study on Kok-Ing-Nan Diversion Project

As one of the essential related projects on this flood mitigation study, the study on Kok-Ing-Nan diversion which affects the modification of reservoir operation rule, is ongoing, and the Master Plan of the flood mitigation study was formulated based on the information so far conducted on the Kok-Ing-Nan study. Since the study on Kok-Ing-Nan is still on the progress, it may be necessary to adjust the Master Plan considering the final results of the Kok-Ing-Nan study in the next stage.

(3) Study on Flood Mitigation in Agricultural Areas

As the measures for flood mitigation in agricultural areas, river improvement works and drainage system and distribution system improvement have been proposed. The process of system improvement has been introduced in the Master Plan study, and only the river improvement works have been covered in the feasibility study. To mitigate the flood damage in agricultural areas, however, it is also necessary to promote the distribution and drainage system improvement in parallel with the implementation of river improvement works. Thus, it is recommended that a further study on these system improvement works should be undertaken as early as possible.

(4) Collection of More Information for Further Study

The Study had covered a wide area of the Chao Phraya River Basin, but information on the area has been incomprehensive. The study has been conducted based on the limited information that was available. Since information on hydrology and hydraulics as well as flood damage are essential to enhance the accuracy of the study analysis, more data and information should be arranged for further study, through organizational arrangement.

Tables



Table 2.2.1 AREA AND ADMINISTRATIVE DIVISIONS BY REGIONS (1996)

Region	Area in sq.km	Changwat	Amphoc	King Amphoc	Tambon	Village
Whole Kingdom	513,115.2	76	787	81	7,404	66,604
Bangkok Metropolis	1,565.2	1	38	-	151	727
Bankok Vicinity	7,758.2	6	65	2	459	3,328
Central Region	16,593.4	6	56	2	613	4,822
Eastern Region	36,502.5	8	55	8	521	4,379
Western Region	43,047.1	6	48	3	488	3,973
Nothern Region	169,644.3	17	169	14	1,562	13,962
Northeastern Region	168,854.3	19	258	41	2,675	28,257
Southern Region	70,715.2	14	136	11	1,086	7,883

Source : Statistical Handbook 1996, National Statistical Office, Office of Prime Minister

Table 2.2.2 POPULATION PROJECTION BY REGION AND CHANGWAT COVERING THE STUDY AREA

Region and Changwat	Population		Annual Average Increase Rate(%) 2000-2005	Population Share (%) vs. Whole Kingdom	
	2000	2005		2000	2005
(1) Study Area					
Bangkok Metropolis	7,637,000	8,375,000	1.86	12.2	12.9
Bangkok Vicinity					
Samut Prakan	1,037,857	1,160,740	2.26	1.7	1.8
Pathum Thani	574,355	642,360	2.26	0.9	1.0
Samut Sakhon	442,670	495,083	2.26	0.7	0.8
Nakhon Pathom	866,741	969,364	2.26	1.4	1.5
Nonthaburi	798,294	892,813	2.26	1.3	1.4
Sub Total	3,719,917	4,160,360	2.26	6.0	6.4
Central Region					
Saraburi	537,937	541,596	0.14	0.9	0.8
Sing Buri	241,225	242,866	0.14	0.4	0.4
Chai Nat	372,884	375,421	0.14	0.6	0.6
Ang Thong	274,225	276,091	0.14	0.4	0.4
Lop Buri	760,604	765,778	0.14	1.2	1.2
P.N.Si Ayutthaya	733,379	738,368	0.14	1.2	1.1
Sub Total	2,920,254	2,940,120	0.14	4.7	4.5
Western Region					
Suphan Buri	872,524	900,471	0.63	1.4	1.4
Eastern Region					
Chachoengsao	634,656	667,928	1.03	1.0	1.0
Nakhon Nayok	257,131	270,612	1.03	0.4	0.4
Sub Total	891,787	938,540	1.03	1.4	1.4
Nothern Region					
Chiang Mai	1,458,052	1,464,327	0.09	2.3	2.3
Lampang	778,363	779,593	0.03	1.2	1.2
Uttaradit	460,895	461,273	0.02	0.7	0.7
Mae Hong Sou	174,420	176,449	0.23	0.3	0.3
Phrae	513,133	514,620	0.06	0.8	0.8
Lamphun	435,535	436,903	0.06	0.7	0.7
Nan	442,873	444,263	0.06	0.7	0.7
Phayao	504,858	506,443	0.06	0.8	0.8
Nakhon Sawan	110,538	110,538	0.00	0.2	0.2
Phitsanulok	806,835	810,722	0.10	1.3	1.2
Kamphaeng Phet	683,709	685,520	0.05	1.1	1.1
Uthai Thani	309,455	309,750	0.02	0.5	0.5
Sukhothai	593,029	593,536	0.02	1.0	0.9
Tak	357,084	358,442	0.08	0.6	0.6
Phichit	582,649	583,925	0.04	0.9	0.9
Phetchabun	924,990	927,895	0.06	1.5	1.4
Sub Total	9,136,418	9,164,199	0.06	14.6	14.1
Total of Study Area	25,177,900	26,478,690	1.01	40.3	40.7
(2) Other than Study Area	37,227,100	38,555,310	0.70	59.7	59.3
Whole Kingdom	62,405,000	65,034,000	0.83	100.0	100.0

Source : Population Projection for Thailand 1990-2020, Human Resources Division, NESDB

Table 2.2.3 POPULATION CENSUS BY REGION AND CHANGWAT, AND
1995 REGISTRATION POPULATION COVERING THE STUDY AREA

Region, Changwat	Registration Population in 1995				Number of Household		Person per House
	Urban	%	Rural	%	1995	1995	Hold
(1) Study Area							
Bangkok Metropolis	5,570,743	100	0	0.0	5,570,743	100	1,661,311 3.4
Bangkok Vivinity							
Samut Prakan	154,681	16.7	771,429	83.3	926,110	100	308,545 3.0
Pathum Thani	70,471	13.4	453,780	86.6	524,251	100	217,223 2.4
Samut Sakhon	104,970	26.9	285,729	73.1	390,699	100	132,055 3.0
Nakhon Pathom	92,013	12.6	638,063	87.4	730,076	100	188,980 3.9
Nonthaburi	454,502	60.2	300,125	39.8	754,627	100	284,207 2.7
Sub Total	876,637	26.4	2,449,126	73.6	3,325,763	100	1,131,010 2.9
Central Region							
Saraburi	127,061	22.3	443,622	77.7	570,683	100	151,749 3.8
Sing Buri	21,475	9.6	201,265	90.4	222,740	100	54,719 4.1
Chai Nat	20,153	5.8	330,165	94.2	350,318	100	86,031 4.1
Ang Thong	23,071	8.1	263,318	91.9	286,389	100	66,416 4.3
Lop Buri	44,487	6.0	696,339	94.0	740,826	100	194,314 3.8
P. N. Si Ayutthaya	71,362	10.1	635,140	89.9	706,502	100	176,041 4.0
Sub Total	307,609	10.7	2,569,849	89.3	2,877,458	100	729,270 3.9
Western Region							
Kanchanaburi	54,410	7.3	690,525	92.7	744,935	100	195,862 3.8
Rachaburi	84,638	10.6	713,438	89.4	798,076	100	186,764 4.3
Samut Songkhram	42,313	20.4	164,666	79.6	206,979	100	46,477 4.5
Suphan Buri	41,830	5.0	798,682	95.0	840,512	100	192,650 4.4
Sub Total	223,191	8.6	2,367,311	91.4	2,590,502	100	621,753 4.2
Eastern Region							
Chachoengsao	51,798	8.5	557,443	91.5	609,241	100	153,956 4.0
Nakhon Nayok	17,841	7.5	219,304	92.5	237,145	100	56,854 4.2
Sub Total	69,639	8.2	776,747	91.8	846,386	100	210,810 4.0
North Eastern Region							
Loei	23,629	3.8	597,915	96.2	621,544	100	139,915 4.4
Nothern Region							
Chiang Mai	167,945	10.8	1,384,821	89.2	1,552,766	100	484,674 3.2
Chiang Rai	45,477	3.6	1,203,851	96.4	1,249,328	100	349,008 3.6
Lampang	69,261	8.6	733,930	91.4	803,191	100	218,100 3.7
Uttaradit	43,084	9.0	433,913	91.0	476,997	100	117,435 4.1
Mae Hong Son	843	0.4	212,085	99.6	212,928	100	55,350 3.8
Phrae	21,062	4.3	472,443	95.7	493,505	100	134,355 3.7
Lamphun	14,160	3.5	390,806	96.5	404,966	100	122,113 3.3
Nan	22,821	4.8	450,294	95.2	473,115	100	115,979 4.1
Phayao	21,828	4.2	495,429	95.8	517,257	100	144,332 3.6
Nakhon Sawan	143,613	12.9	973,190	87.1	1,116,803	100	286,041 3.9
Phitsanulok	88,442	10.4	758,188	89.6	846,630	100	217,113 3.9
Kamphaeng Phet	28,263	3.8	714,120	96.2	742,383	100	183,361 4.0
Uthai Thani	19,527	6.0	305,203	94.0	324,730	100	84,967 3.8
Sukhothai	38,798	6.3	574,519	93.7	613,317	100	154,514 4.0
Tak	47,923	10.6	402,230	89.4	450,153	100	116,608 3.9
Phichit	57,935	9.8	534,190	90.2	592,125	100	136,327 4.3
Phetchabun	42,716	4.2	983,421	95.8	1,026,137	100	244,428 4.2
Sub Total	873,698	7.3	11,022,633	92.7	11,896,331	100	3,164,705 3.8
Study Area Total	7,740,156	30.5	17,617,037	69.5	25,357,193	100	7,089,756 3.6
(2) Other than Study Area	3,117,945	9.1	30,985,244	90.9	34,103,189	100	7,607,329 4.5
Whole Kingdom	10,858,101	18.3	48,602,281	81.7	59,460,382	100	14,697,085 4.0

Source: Thailand Population Census, 1980, 1990 Population and Housing Census, National Statistical Office.
Statistical Handbook of Thailand, 1996, National Statistical Office.

Table 2.2.4 PER CAPITA GROSS REGIONAL AND PROVINCIAL PRODUCT AT CURRENT MARKET PRICES COVERING THE STUDY AREA (BY REGION AND CHANGWAT)

Unit:Baht								
Current Market Prices								
Region and Changwat	1989	1990	1991	1992	1993	1994	Ratio vs. Whole Kingdom	Annual Average Growth rate(%)
(1) Study Area								
Bangkok Metropolis	111,906	139,978	152,194	167,549	187,312	203,650	3.3	12.7
Bangkok Vicinity								
Samut Prakan	134,896	162,275	162,510	161,815	169,426	173,006	2.8	5.1
Pathum Thani	102,792	118,389	153,584	191,196	211,824	245,555	4.0	19.0
Samut Sakhon	68,528	80,878	119,196	170,037	211,947	248,216	4.0	29.4
Nakhon Pathom	33,729	34,648	44,248	56,741	65,045	80,978	1.3	19.1
Nonthaburi	55,681	61,810	64,366	63,908	66,532	66,958	1.1	3.8
Average	79,125	91,600	108,781	128,739	144,955	162,943	2.7	15.5
Central Region								
Saraburi	55,676	66,046	80,021	77,947	89,969	103,550	1.7	13.2
Sing Buri	22,704	21,317	24,679	27,189	29,825	33,675	0.5	8.2
Chai Nat	25,049	23,138	27,075	29,201	28,022	33,322	0.5	5.9
Ang Thong	21,680	22,807	26,544	27,535	29,874	33,556	0.5	9.1
Lop Buri	20,543	21,229	24,859	27,623	28,588	34,301	0.6	10.8
P.N.Si Ayutthaya	22,070	25,204	36,085	47,286	57,344	75,067	1.2	27.7
Average	27,954	29,957	36,544	39,464	43,937	52,245	0.9	13.3
Western Region								
Kanchanaburi	38,037	39,831	42,843	44,201	43,751	48,740	0.8	5.1
Rachaburi	28,065	30,039	37,146	43,502	45,603	41,622	0.7	8.2
Samut Songkhram	19,766	23,540	25,346	29,100	30,979	35,325	0.6	12.3
Suphan Buri	22,361	21,268	226,684	30,912	32,004	35,584	0.6	9.7
Average	27,057	28,670	83,005	36,929	38,084	40,318	0.7	8.3
Eastern Region								
Chachoengsao	45,850	45,818	51,880	57,066	65,689	77,784	1.3	11.2
Nakhon Nayok	23,406	23,873	30,245	31,567	33,101	37,573	0.6	9.9
Average	34,628	34,846	41,063	44,317	49,395	57,679	0.9	10.7
Northeastern								
Loei	15,808	16,166	18,823	19,961	18,879	23,256	0.4	8.0
Northern Region								
Chiang Mai	25,644	30,860	34,328	36,193	41,019	45,514	0.7	12.2
Chaiyari	15,611	17,128	19,200	20,550	23,211	25,206	0.4	10.1
Lampang	21,564	25,526	28,848	32,098	33,259	36,500	0.6	11.1
Utaradit	19,883	21,231	24,290	24,829	24,694	28,948	0.5	7.8
Mae Hong Son	15,901	17,977	18,395	23,036	22,401	25,686	0.4	10.1
Phrae	13,472	14,628	16,524	18,730	19,292	21,985	0.4	10.3
Lamphun	15,685	19,118	25,238	38,910	50,915	60,988	1.0	31.2
Nan	13,719	15,241	16,768	18,267	19,892	22,019	0.4	9.9
Phayao	12,919	14,953	16,348	17,842	21,101	23,698	0.4	12.9
Nakhon Sawan	20,068	20,587	23,743	26,877	28,077	31,359	0.5	9.3
Phitsanulok	18,578	18,774	21,375	25,209	26,386	29,046	0.5	9.3
Kamphaeng Phet	22,753	23,991	26,884	29,666	26,898	30,078	0.5	5.7
Uthai Thani	18,138	18,822	22,871	24,970	25,794	30,031	0.5	10.6
Sukhothai	17,447	18,472	19,807	22,267	13,136	25,247	0.4	7.7
Tak	21,555	22,347	25,685	29,204	29,326	33,359	0.5	9.1
Phichit	15,959	16,078	18,478	20,464	20,182	22,675	0.4	7.3
Phetchabun	15,023	15,595	17,142	19,654	19,973	22,839	0.4	8.7
Average	18,995	20,708	23,495	26,798	27,847	32,199	0.5	11.1
Average of Study Area	32,569	36,377	47,896	48,142	52,535	59,636	1.0	12.9
Whole Kingdom	33,633	39,149	44,313	49,435	54,544	61,335	1.0	12.8

Source: Gross Domestic Products & Gross Regional Products, NESDB.

Table 2.2.5 GROSS REGIONAL AND PROVINCIAL PRODUCT AT CURRENT MARKET PRICES
COVERING THE STUDY AREA (BY REGION AND CHANGWAT)

Region and Changwat	Unit: million Baht						Share in 1994(%)	Annual Average Growth rate(%)
	Current Market Prices							
	1989	1990	1991	1992	1993	1994		
(1) Study Area								
Bangkok Metropolis	700,072	867,563	966,280	1,088,234	1,242,917	1,380,343	38.3	14.5
Bangkok Vicinity								
Samut Prakan	105,623	131,605	135,208	138,190	148,587	155,706	4.3	8.1
Pathum Thani	42,927	51,380	68,652	88,141	100,828	120,322	3.3	22.9
Samut Sakhon	22,614	27,337	41,361	60,703	77,997	93,825	2.6	32.9
Nakhon Pathom	20,575	22,972	30,177	39,832	47,028	60,167	1.7	23.9
Nonthaburi	32,963	37,395	40,100	41,029	43,978	45,531	1.3	6.7
Sub Total	224,702	270,689	315,498	367,895	418,418	475,551	13.2	16.2
Central Region								
Saraburi	28,135	33,685	41,131	40,377	46,964	54,260	1.5	14.0
Sing Buri	5,086	4,924	5,720	6,362	7,008	7,947	0.2	9.3
Chai Nat	8,642	8,307	9,774	10,599	10,227	12,195	0.3	7.1
Ang Thong	5,832	5,925	7,008	7,324	7,976	8,993	0.2	9.0
Lop Buri	14,791	15,391	18,147	20,303	21,126	25,486	0.7	11.5
Phra Nakhon Si Ayutthaya	14,544	17,743	25,548	33,714	41,058	54,173	1.5	30.1
Sub Total	77,030	86,025	107,328	118,679	134,359	163,054	4.5	16.2
Western Region								
Kanchanaburi	25,561	25,571	27,805	28,952	28,919	32,558	0.9	5.0
Rachaburi	19,645	22,109	27,637	32,713	34,613	41,624	1.2	16.2
Samut Songkhram	4,012	4,496	4,917	5,674	6,103	7,030	0.2	11.9
Suphan Buri	18,179	16,972	21,534	25,193	26,308	29,570	0.8	10.2
Sub Total	67,397	69,148	81,893	92,532	95,943	110,782	3.1	10.5
Eastern Region								
Chachoengsao	24,667	26,071	29,364	32,556	38,165	45,427	1.3	13.0
Nakhon Nayok	4,986	5,443	6,987	7,386	7,845	9,017	0.3	12.6
Sub-Total	29,653	31,514	36,351	39,942	46,010	54,444	1.5	12.9
Northeastern Region								
Loei	8,378	8,746	10,023	11,039	10,553	13,116	0.4	9.4
Nothern Region								
Chiang Mai	34,239	42,957	48,828	51,104	58,288	65,084	1.8	13.7
Chiang Rai	15,689	18,344	20,717	22,318	25,369	27,701	0.8	12.0
Lampang	16,152	18,973	21,578	24,170	25,010	27,849	0.8	11.5
Uttaradit	8,927	9,512	10,865	11,248	11,256	13,229	0.4	8.2
Mae Hong Son	2,640	2,912	3,017	3,801	3,741	4,341	0.1	10.5
Phrae	6,520	7,196	8,180	9,328	9,685	11,080	0.3	11.2
Lamphun	6,367	7,972	10,600	16,459	21,639	26,103	0.7	32.6
Nan	5,940	6,462	7,151	7,854	8,613	9,578	0.3	10.0
Phayao	6,354	7,222	7,961	8,743	10,403	11,754	0.3	13.1
Nakhon Sawan	21,332	21,802	25,334	28,866	30,351	34,118	0.9	9.8
Phitsanulok	14,175	14,475	16,608	19,713	20,766	23,005	0.6	10.2
Kamphaeng Phet	14,653	15,738	17,744	19,698	17,994	20,226	0.6	6.7
Uthai Thani	5,369	5,647	6,907	7,566	7,841	9,199	0.3	11.4
Sukhothai	10,119	10,529	11,369	12,870	13,442	14,744	0.4	7.8
Tak	7,264	7,620	8,768	10,105	10,206	11,676	0.3	10.0
Phichit	8,666	9,004	10,421	11,603	11,504	13,015	0.4	8.5
Phetchabun	13,916	13,833	15,308	17,669	18,075	20,783	0.6	8.4
Sub Total	198,322	220,198	251,356	283,115	304,183	343,485	9.5	11.6
Total of Study Area	1,305,554	1,553,883	1,768,729	2,001,436	2,252,383	2,540,775	70.6	14.2
(2) Other than Study Area	551,439	632,142	738,299	825,722	911,531	1,060,131	29.4	14.0
Whole Kingdom	1,856,993	2,186,025	2,507,028	2,827,158	3,163,914	3,600,906	100.0	14.2

Source: Gross Domestic Products & Gross Regional Products, NESDB.

Table 2.2.6 PROJECTION OF GROSS DOMESTIC PRODUCTS (GDP) AT CURRENT PRICES

	1994	1995	1996	1997	1998	1999	2000	2001
GDP (million baht)	3,634,848	4,202,835	4,533,000	4,786,848	4,810,782	5,267,807	5,873,604	6,490,333
Real Growth Rate (%)	8.9	8.8	5.7	-0.4	-8.5	2.5	3.5	5.5
Inflation Rate (%)	5.1	5.8	5.9	6.0	9.0	7.0	8.0	5.0

Note : NESDB, Sept.1997, Nov.1998, and JICA

Table 2.2.7 BUDGET EXPENDITURES APPROPRIATION BY PROGRAMME STRUCTURE

Programme structure	Unit : Millions Bhat					Percentage of total		
	Budget expenditures					1993	1994	1995
	1993	1994	1995	1995	1995			
Total	560,000.0	625,000.0	715,000.0	715,000.0	100	100	100	100
Agricultural	48,737.1	59,019.1	68,247.8	68,247.8	8.7	9.4	9.5	9.5
Industry and mining	1,943.4	2,091.3	2,221.5	2,221.5	0.3	0.3	0.3	0.3
Transportation and communication	46,933.2	52,265.2	62,934.1	62,934.1	8.4	8.4	8.8	8.8
Commerce and tourism	5,776.7	4,654.8	5,336.1	5,336.1	1	0.7	0.7	0.7
Science, technology, energy and environment	7,288.3	9,816.0	10,374.8	10,374.8	1.3	1.6	1.5	1.5
Education	109,701.9	124,459.9	137,641.4	137,641.4	19.6	20.0	19.3	19.3
Public health	36,549.6	44,335.0	52,372.7	52,372.7	6.5	7.1	7.3	7.3
Social services	60,012.5	74,611.3	87,909.6	87,909.6	10.7	11.9	12.3	12.3
Maintenance of national security	88,960.2	95,046.2	99,732.4	99,732.4	15.9	15.2	13.9	13.9
Maintenance of internal peace and order	25,383.8	30,017.7	32,153.7	32,153.7	4.6	4.8	4.5	4.5
General services	65,865.3	70,172.7	111,345.1	111,345.1	11.8	11.2	15.6	15.6
Debt services	62,848.8	58,512.8	44,730.8	44,730.8	11.2	9.4	6.3	6.3

Source : The Bureau of the Budget, Office of the Prime Minister.
Statistical Yearbook Thailand 1995

Table 2.3.1 (1/2) MAIN IRRIGATION FACILITIES OF RIVERS AND CANALS IN CHAO
PHRAYA RIVER BASIN
(IN DOWNSTREAM)

Water Course	Name of Structure	Location (Province)	Structural Features					Retention Level (m MSL)	Flood Level (m MSL)		Design Flow (m ³ /s)
			Type	Number	Width (m)	Height (m)	Sill Elevation (m MSL)		Upper	Lower	
Yom River	Mae Yom Weir	Phrae	Fixed Weir & Rubber Dan	5	68.80	3.50	+178.00	+181.50	+183.75	+183.00	3,000
Nan River	Phitsanulok Diversion Weir (Naresuan Dam)	Phitsanulok	Movable Radial Gate	5	12.50	7.60	+40.20	+47.80	+50.35	+49.75	1,600
Thap Salao River	Thap Salao Diversion Weir	Uthai Thani	Fixed Weir	6 2 2	8.0 9.9 3.0	3.00	+71.00	+74.00	+77.25	+76.40	700
Yom to Nan River (Curtain Canal)	Control Regulator	Phitsanulok	Radial Gate	2	6.0	4.00	+33.975	/1	+37.675	+36.750	85
Yom to Nan River (DR 15.8 Canal)	Control Regulator No. 1	Phitsanulok	/1	/1	/1	/1	/1	/1	/1	/1	60
	Control Regulator No. 2	Phitsanulok	/1	/1	/1	/1	/1	/1	/1	/1	60

Note: /1 Data not available yet.

Table 2.3.1 (2/2) MAIN IRRIGATION FACILITIES OF RIVERS AND CANALS IN CHAO PHRAYA RIVER BASIN (IN UPPER AND MIDDLE STREAM)

Water Course	Name of Structure	Location (Province)	Structural Features				Full Supply Level (m MSL)		Flood Level (m MSL)		Design Flow (m ³ /s)
			Gate			Sill Elevation (m MSL)	Upper	Lower	Upper	Lower	
			Type	Number	Width (m)						
Chao Phraya River	Chao Phraya Dam (Barrage)	Chai Nat	Radial Gate	16	12.50	+9.00	+16.50	+7.50	+18.50	+16.00	3,300.0
			Miter Gate	1	14.00	+9.00					
Suphan River	Phonlatap Head Regulator	Chai Nat	Slide Gate	4	6.50	+7.50	+16.50	+13.90	+19.40	+15.86	320.0
	Ban Thabot Regulator	Chai Nat	Radial Gate	4	6.00	+8.75	+13.50	+9.80	+13.73	+13.68	318.0
	Sam Chook Regulator	Suphan Buri	Slide Gate	2	12.50	+2.50	+9.15	+6.30	+9.52	+9.31	318.0
	Pho Phraya Regulator	Suphan Buri	Slide Gate	2	12.50	+0.20	+6.00	+0.75	+5.91	+5.82	318.0
Noi River	Borommathat Head Regulator	Cai Nat	Radial Gate	4	6.00	+9.60	+16.00	+15.10	+18.24	+16.20	260.0
	Channasut Regulator	Sing Buri	Radial Gate	4	6.00	+5.72	+11.60	+9.73	+11.84	+11.40	260.0
	Yang Mani Regulator	Sing Buri	Radial Gate	4	6.00	+2.32	+7.74	+6.16	+7.74	+7.30	260.0
	Phak Hai Regulator	Ayutthaya	Radial Gate	3	6.00	+2.00	+3.50	+3.30	+3.50	+3.30	150.0
Chai Nat-Pasak Canal	Manorom Head Regulator	Chai Nat	Radial Gate	6	6.00	+12.80	+16.472	+16.142	+20.00	+16.142	210.0
	Chongkae Regulator	Chai Nat	Radial Gate	6	6.00	+9.50	+13.390	+13.150	-	-	207.0
	Koke kathiem Regulator	Lop Buri	Radial Gate	4	6.00	+6.29	+10.79	+10.59	-	-	174.1
	Reong Rand Regulator	Saraburi	Radial Gate	3	6.00	+3.97	+8.53	+8.27	+9.810	+9.810	131.0
Chai Nat-Ayutthaya Canal	Maharaj Head Regulator	Chai Nat	Radial Gate	3	4.00	+11.60	+16.00	+15.50	+18.00	-	75.0
Makamthao-Uthong Canal	Makamthao-Uthong Head Regulator	Chai Nat	Slide Gate	6	1.75	+13.75	+16.10	+15.95	-	-	35.0
Pasak River	Rama VI Barrage	Saraburi	Slide Gate	6	12.50	+0.10	+7.50	-	+9.81	-	Unknown

Table 2.4.1 AGRICULTURAL MAIN PRODUCTS IN CHAO PHRAYA RIVER BASIN

(Unit : ha)

Province	Farm Land	Rainy Season Crops (1994/95) June - December										Dry Season Crops (1992) January - May							
		Major Rice			Maize		Sugar Corn		Mungbean		Sorghum		Secan Rice			Cassava			
		Harvested Area (ha)	(%)	Production (tons)	yield (ton/ha)	Harvested Area (ha)	(%)	Harvested Area (ha)	(%)	Harvested Area (ha)	(%)	Harvested Area (ha)	(%)	Harvested Area (ha)	(%)	Production (tons)	yield (ton/ha)	Harvested Area (ha)	(%)
	21,128,193	8,295,107	39%	18,160,715	2.2	1,351,349	6%	922,705	4%	334,996	2%	167,238	1%	700,671	3%	2,881,528	4.1	1,450,699	7%
Northern (Mountain area)																			
1 Chiang Mai	210,051	83,068	40%	276,762	3.3	4,658	2%	522	0%	368	0%	0	0%	4,253	2%	15,501	3.6	59	0%
2 Lamphun	86,942	23,611	27%	73,976	3.1	1,416	2%	0	0%	137	0%	0	0%	1,550	2%	6,852	4.4	0	0%
3 Lampang	178,638	68,490	38%	208,303	3.0	3,539	2%	6,764	4%	435	0%	0	0%	801	0%	2,229	2.8	953	1%
4 Phayao	153,624	72,727	47%	208,991	2.9	28,462	19%	0	0%	1,410	1%	0	0%	146	0%	439	3.0	565	0%
5 Phue	101,485	34,928	34%	104,256	3.0	13,783	14%	4,025	4%	1,277	1%	0	0%	112	0%	268	0	0	0%
6 Nan	140,129	26,970	19%	79,242	2.9	39,535	28%	0	0%	15,042	11%	0	0%	629	0%	1,813	2.9	457	0%
7 Tak	151,725	34,995	23%	90,958	2.6	54,107	36%	1,114	1%	6,691	4%	39	0%	1,113	1%	4,377	3.9	386	0%
Sub-total	1,022,594	344,790	34%	1,042,488	3.0	145,500	14%	12,425	1%	25,360	2%	39	0%	8,604	1%	31,479	3.7	2,420	0%
Northern (Hilly Area)																			
8 Sukhothai	299,360	116,111	39%	268,213	2.3	12,377	4%	24,898	8%	42,158	14%	18	0%	6,491	2%	27,021	4.2	0	0%
9 Utharadit	195,074	70,800	36%	213,659	3.0	16,093	8%	14,402	7%	5,512	3%	277	0%	10,693	5%	46,915	4.4	222	0%
10 Phitsanulok	418,064	177,286	43%	486,279	2.7	35,507	8%	8,114	2%	16,348	4%	0	0%	37,004	9%	177,495	4.8	41,981	10%
11 Kamphaeng Phet	458,437	186,445	41%	563,395	3.0	47,589	10%	68,969	15%	28,769	6%	1,125	0%	29,232	6%	127,279	4.4	56,617	12%
12 Phichit	344,256	196,688	57%	483,205	2.5	14,236	4%	3,694	1%	11,646	3%	250	0%	41,601	12%	194,279	4.7	1,923	1%
13 Phetchaburi	109,814	49,932	45%	133,804	2.7	5,553	5%	6,769	6%	209	0%	0	0%	12,968	12%	52,626	4.1	2,469	2%
14 Nakhon Sewan	651,437	289,510	44%	740,238	2.6	91,242	14%	52,989	8%	27,887	4%	56,024	9%	26,344	4%	122,416	4.6	17,172	3%
15 Ithai Thazi	214,576	73,279	34%	162,683	2.2	40,968	19%	17,628	8%	13,006	6%	2,569	1%	2,157	1%	10,525	4.9	24,606	11%
Sub-total	2,691,018	1,160,751	43%	3,051,496	2.6	263,565	10%	197,463	7%	145,335	5%	60,263	2%	166,546	6%	758,556	4.6	144,990	5%
Central Plain																			
16 Chai Nat	180,325	130,201	72%	473,762	3.6	3,132	2%	5,859	3%	5,111	3%	285	0%	26,146	14%	114,827	4.4	9,973	0%
17 Sing Buri	73,822	51,789	70%	182,595.0	3.5	0	0%	5,597	8%	2,408	3%	0	0%	6,287	9%	28,649	4.6	0	0%
18 Lop Buri	401,684	143,606	36%	309,034.0	2.2	128,004	32%	39,168	10%	17,704	4%	65,161	16%	1,633	0%	6,147	3.8	14,121	4%
19 Suphan Buri	371,407	142,392	38%	529,579.0	3.7	14,137	4%	92,567	25%	601	0%	1,217	0%	75,091	20%	332,674	4.4	6,883	2%
20 Ang Thong	79,418	55,128	69%	153,433.0	2.8	0	0%	3,234	4%	3,541	4%	0	0%	5,264	7%	23,261	4.4	0	0%
21 Aurthaya	188,277	140,153	74%	352,019.0	2.5	0	0%	0	0%	2,035	1%	0	0%	34,250	18%	138,142	4.0	0	0%
22 Saraburi	189,658	62,640	33%	164,285.0	2.6	47,453	25%	6,252	3%	5,367	3%	4,904	3%	4,228	2%	15,487	3.7	2,988	2%
23 Nakhon Pathom	139,425	51,872	37%	231,354.0	4.5	0	0%	17,777	13%	0	0%	0	0%	50,840	36%	224,645	4.4	0	0%
24 Nonthaburi	27,542	18,065	66%	88,647.0	4.9	0	0%	0	0%	0	0%	0	0%	25,766	94%	110,723	4.3	0	0%
25 Pathum Thani	110,374	47,389	43%	200,363.0	4.2	0	0%	0	0%	0	0%	0	0%	37,061	34%	176,270	4.8	0	0%
26 Samut Sakho	37,372	5,894	16%	20,150.0	3.4	0	0%	0	0%	0	0%	0	0%	5,293	14%	21,594	4.1	0	0%
27 Bangkok Metropolitan	41,493	22,826	55%	81,868.0	3.6	0	0%	0	0%	0	0%	0	0%	7,514	18%	24,552	3.3	0	0%
28 Samut Prakan	33,368	9,465	28%	35,267.0	3.7	0	0%	0	0%	0	0%	0	0%	6,543	20%	27,479	4.2	0	0%
Sub-total	1,874,265	881,440	47%	2,822,356	3.2	192,726	10%	170,454	9%	36,767	2%	71,567	4%	285,916	15%	1,244,450	4.4	33,967	2%
Total in the Study Area	5,587,878	2,386,980	43%	6,916,340	2.9	601,792	11%	380,342	7%	207,461	4%	131,870	2%	461,065	8%	2,034,485	4.4	181,376	3%

(Source : Crop Year 1994/95)

Table 2.4.2 AGRICULTURAL LAND USE IN CHAO PHRAYA RIVER BASIN (1992 YEAR)

(Unit : ha)

Province	Area	Forest Area	Farm holding land										Total	Other		
			Paddy Land	Under Field (rops)	Under fruit tree and tree crops	Under vegetable and flowers	Grass Land	Housing Area	Idle land	Other						
Total	51,311,502	13,495,067	26%	11,013,699	52%	5,247,202	25%	3,335,915	1,410,276	119,954	553,848	531,151	185,349	21,128,193	41%	16,688,242
Northern (Mountain area)																
1 Chiang Mai	2,010,706	1,456,445	72%	108,332	52%	35,223	17%	40,664	12,983	228	10,374	1,212	1,034	210,051	10%	344,210
2 Lamphun	450,588	225,962	50%	44,793	52%	5,768	7%	25,137	4,371	0	5,152	1,720	2	86,942	19%	137,684
3 Lampang	1,253,396	820,621	65%	90,841	51%	53,874	30%	11,585	2,077	0	8,824	11,051	386	178,638	14%	254,137
4 Phayao	633,506	253,086	40%	91,757	60%	39,964	26%	11,234	3,296	92	5,428	1,755	99	153,624	24%	226,795
5 Phrae	653,860	245,883	38%	44,419	44%	40,823	40%	9,115	202	0	5,008	1,917	0	101,485	16%	306,492
6 Nan	1,147,207	488,432	43%	37,830	27%	78,022	56%	13,668	1,015	0	6,234	2,468	892	140,129	12%	518,646
7 Tak	1,639,601	1,213,350	74%	42,610	28%	85,610	57%	0	13,333	1,204	0	6,207	1,697	150,662	9%	275,390
Sub-total	7,788,864	4,703,779	60%	460,582	45%	339,284	33%	111,403	37,277	1,524	41,020	26,330	4,110	1,021,531	13%	2,063,554
Northern (Hilly Area)																
8 Sakonkhai	659,609	227,548	34%	160,496	54%	107,887	36%	13,898	1,405	0	10,579	2,490	2,604	299,360	45%	132,702
9 Udonrath	783,859	304,943	39%	84,310	43%	73,866	38%	25,132	1,832	0	6,327	3,027	581	195,074	25%	283,841
10 Phitsanulok	1,081,585	246,152	23%	254,472	61%	127,072	30%	15,478	1,575	1,090	12,991	4,901	486	418,064	39%	417,369
11 Kamphaeng Phet	860,741	211,994	25%	215,159	47%	206,802	45%	15,940	1,172	1,558	13,195	1,678	2,932	458,437	53%	190,310
12 Phichit	453,101	0	0%	280,848	82%	43,015	12%	9,869	389	236	8,963	789	147	344,256	76%	108,845
13 Phetchaburi	622,514	220,237	35%	54,385	50%	31,927	29%	15,450	737	975	5,145	887	310	109,814	18%	292,462
14 Nakhon Sawan	959,768	70,103	7%	383,550	59%	223,700	34%	19,291	5,929	3,403	12,898	1,468	1,198	651,437	68%	238,228
15 Ithai Thani	673,025	265,143	39%	100,683	47%	87,881	41%	11,263	1,936	2,478	6,440	2,849	1,047	214,576	32%	193,305
Sub-total	6,094,202	1,546,120	25%	1,533,903	57%	902,150	34%	126,321	14,975	9,740	76,538	18,089	9,305	2,691,018	44%	1,857,062
Central Plains																
16 Chai Nat	246,975	698	0%	151,319	84%	16,944	9%	5,120	197	229	4,247	2,026	242	180,325	73%	65,952
17 Sing Buri	82,248	0	0%	61,681	84%	5,873	8%	3,649	164	62	1,962	279	152	73,872	90%	8,426
18 Lop Buri	619,975	20,521	3%	155,604	39%	220,680	55%	8,401	1,158	3,200	6,493	1,576	4,572	401,644	65%	197,770
19 Suphan Buri	535,801	59,815	11%	219,357	59%	118,754	32%	11,661	2,458	3,018	11,762	2,619	1,779	371,407	69%	104,579
20 Ang Thong	96,837	0	0%	64,274	81%	1,751	2%	6,758	1,562	0	3,576	0	1,498	79,418	82%	17,419
21 Aurthaya	255,664	0	0%	174,041	92%	0	0%	5,547	172	81	6,232	1,020	1,284	188,377	74%	67,287
22 Saraburi	357,649	6,672	2%	87,111	46%	69,957	37%	12,580	284	11,995	6,019	651	1,062	189,658	53%	161,318
23 Nakhon Pathom	216,833	0	0%	78,607	56%	26,815	19%	13,895	6,142	0	6,998	2,405	4,564	139,425	64%	77,407
24 Nonthaburi	62,230	0	0%	20,065	73%	0	0%	4,939	1,016	0	971	228	323	27,542	44%	34,688
25 Pathum Thani	152,586	0	0%	73,350	66%	0	0%	28,678	939	923	3,078	717	2,689	110,374	72%	42,212
26 Samut Sakhon	87,235	0	0%	18,121	48%	0	0%	14,314	1,660	0	1,287	121	1,869	37,372	43%	49,863
27 Bangkok																
Metropolis	156,522	0	0%	27,903	67%	330	1%	7,948	3,334	0	873	358	746	41,493	27%	115,029
28 Samut Prakan	100,409	0	0%	15,920	48%	0	0%	8,755	0	0	1,635	0	7,058	33,368	33%	67,041
Sub-total	2,970,964	87,706	3%	1,147,353	61%	461,104	25%	132,245	19,086	19,508	55,133	12,000	27,838	1,874,265	63%	1,008,991
Total in the Study Area	16,854,029	6,337,607	38%	3,141,837	56%	1,702,537	30%	369,969	71,339	30,770	172,691	56,442	41,249	5,586,814	33%	4,929,608

(Source : Crop Year 1994/95)

Table 2.4.3 RICE CULTIVATION IN CHAO PHRAYA RIVER BASIN

(Unit : ha)

Province	Farm Land (1992)	Paddy Field (1992)	Major Rice (1994)		Second Rice (1992)		Irrigated Paddy Field		Farm holding	
			Harvested Area	(%)	Harvested Area	(%)		(%)	No. of Farm	Farm Size
Total	21,128,193	11,013,699	8,295,107	75%	700,671	6%	4,589,677	42%	5,148,815	4.1
Northern (Mountain area)										
1 Chiang Mai	210,051	108,332	83,068	77%	4,253	4%	202,464	187%	141,015	1.5
2 Lamphun	86,942	44,793	23,611	53%	1,550	3%	60,429	135%	54,912	1.6
3 Lampang	178,638	90,841	68,490	75%	801	1%	61,746	68%	99,365	1.8
4 Phayao	153,624	91,757	72,727	79%	146	0%	37,354	41%	63,794	2.4
5 Phrae	101,485	44,419	34,929	79%	112	0%	66,192	149%	57,634	1.8
6 Nan	140,129	37,830	26,970	71%	629	2%	38,407	102%	63,015	2.2
7 Tak	151,725	42,610	34,995	82%	1,113	3%	25,256	59%	43,521	3.5
Sub-total	1,022,594	460,582	344,790	75%	8,604	2%	491,848	107%	523,256	2.0
Northern (Hilly Area)										
8 Sukhothai	299,360	160,496	116,111	72%	6,491	4%	44,483	28%	70,403	4.3
9 Utharadit	195,074	84,310	70,800	84%	10,693	13%	16,654	20%	52,779	3.7
10 Phitsanulok	418,064	254,472	177,986	70%	37,040	15%	71,588	28%	83,341	5.0
11 Kamphaeng Phet	458,437	215,159	186,445	87%	29,252	14%	74,048	34%	74,133	6.2
12 Phichit	344,256	280,848	196,688	70%	41,601	15%	147,296	52%	54,388	6.3
13 Phetchaburi	109,814	54,385	49,932	92%	12,968	24%	77,742	143%	31,543	3.5
14 Nakhon Sawan	651,437	383,550	289,510	75%	26,344	7%	150,666	39%	107,683	6.0
15 Ithai Thani	214,576	100,683	73,279	73%	2,157	2%	94,400	94%	39,655	5.4
Sub-total	2,691,018	1,533,903	1,160,751	76%	166,546	11%	676,877	44%	513,925	5.2
Central Plains										
16 Chai Nat	180,325	151,319	130,201	86%	26,146	17%	140,009	93%	37,444	4.8
17 Sing Buri	73,822	61,681	51,789.0	84%	6,287	10%	67,840	110%	18,577	4.0
18 Lop Buri	401,684	155,604	143,606.0	92%	1,633	1%	105,779	68%	62,986	6.4
19 Suphan Buri	371,407	219,357	142,392.0	65%	75,091	34%	278,512	127%	69,663	5.3
20 Ang Thong	79,418	64,274	55,128.0	86%	5,264	8%	81,178	126%	21,865	3.6
21 Aurthaya	188,377	174,041	140,153.0	81%	34,250	20%	197,571	114%	35,243	5.3
22 Saraburi	189,658	87,111	62,640.0	72%	4,228	5%	58,632	67%	32,946	5.8
23 Nakhon Pathom	139,425	78,607	51,872.0	66%	50,840	65%	142,318	181%	37,180	3.8
24 Nonthaburi	27,542	20,065	18,085.0	90%	15,766	79%	36,766	183%	9,253	3.0
25 Pathum Thani	110,374	73,350	47,389.0	65%	37,061	51%	110,958	151%	19,240	5.7
26 Samut Sakhon	37,372	18,121	5,894.0	33%	5,293	29%	37,696	208%	11,719	3.2
27 Bangkoks Metropolis	41,493	27,903	22,826.0	82%	7,514	27%	74,864	268%	11,322	3.7
28 Samut Prakan	33,368	15,920	9,465.0	59%	6,543	41%	60,528	380%	7,946	4.2
Sub-total	1,874,265	1,147,353	881,440	77%	275,916	24%	1,392,651	121%	375,384	5.0
Total in the Study Area	5,587,878	3,141,837	2,386,980	76%	451,065	14%	2,561,376	82%	1,412,565	4.0

(Source : Crop Year 1994/95)

Table 2.4.4 MUTUAL RELATIONSHIP BETWEEN RICE YIELD AND INUNDATION

Growth Stage of Paddy	Condition of Inundation	Type of Water	Inundation Period and Yield Reduction (%)			
			2 days	4days	7days	More Than 7 days
Booting Stage	Submergence	Clean Water	10	20	30	35
		Dirty Water	20	50	85	90-100
Heading Stage	Inundate without Ear Portion	Clean Water	10	30	65	90-100
		Dirty Water	70	80	85	90-100
Flowering Stage	Submergence	Clean Water	25	45	80	90-100
		Dirty Water	30	80	90	90-100
Milk-Ripe Stage	Submergence	Clean Water	15	25	30	70
		Dirty Water	5	20	30	30
Yellow-Ripe Stage	Submergence	Clean Water	0	15	20	20
		Dirt Water				

Source : RID Regional Office VII

Table 2.4.5 DEEPWATER AND FLOATING RICE AREAS IN 1992/1993 BY WATER DEPTH

No.	Provinces	Cultivated Area (ha)		Total
		Water Depth < 100 cm	Water Depth > 100 cm	
1	Ayutthaya	33,328	64,123	97,451
2	Nakorn Sawan	59,527	11,593	71,120
3	Phichit	52,136	13,859	65,995
4	Nakorn Nayok	17,686	25,875	43,561
5	Ang Thong	12,326	29,037	41,363
6	Lop Buri	12,793	21,325	34,118
7	Phitsanulok	21,049	8,598	29,647
8	Prachin Buri	5,796	16,243	22,039
9	Chaiyaphoom	2,887	18,986	21,873
10	Shing Buri	9,856	8,917	18,773
11	Ratcha Buri	9,989	3,943	13,932
12	Suphan Buri	7,778	2,456	10,234
13	Sara Buri	4,336	5,278	9,614
14	Chai Nat	4,114	1,917	6,031
15	Nakorn Pathom	3,403	1,233	4,636
16	Uthai Thani	3,369	383	3,752
17	Nongkai	492	3,072	3,564
18	Khon Kaen	327	2,846	3,173
19	Petcha Buri	1,661	1,001	2,662
20	Udon Thani	10	622	632
	Total	262,863	241,307	504,170

Source : Prachin Buri Rice Research Center

* 1/ Estimated Area = No. of families x Ave. cultivated Area/family.

Table 2.4.6 AREA UNDER FLOATING RICE BY IRRIGATION PROJECT

unit : ha

	Total Area (average)			Floating Rice Area			%	1996/97
	1974-86	1987-91	1992-96	1976	1986/87	1995/96		
Region 7	361,955	372,440	364,215	86,537	104,246	67,120	18	58,485
Don Chedi	22,519	21,556	20,238	720	2,304	1,044	5	1,034
Pho Phraya	42,839	25,713	43,884	13,270	2,562	832	2	758
Boromnathat	58,153	57,287	54,648	4,259	4,327	4,033	7	5,766
Chanasutr	73,672	64,066	54,752	6,838	13,913	10,236	19	9,480
Yangmanee	30,490	29,557	28,964	11,802	22,116	21,792	75	18,918
Phak Hai	31,318	30,429	22,280	28,896	31,896	17,024	76	14,848
Bang Bal	16,088	21,130	15,933	8,848	16,497	11,760	74	7,680
Chao Chet B.Y.	27,630	35,821	35,044	11,904	10,632	400	1	0
Phraya Ban Lu	18,350	45,445	50,628	0	0	0	0	0
Phra Phimon	16,194	31,262	33,485	0	0	0	0	0
Phasi Charoen	24,702	10,175	4,359	0	0	0	0	0
Region 8	466,499	424,325	384,130	93,282	124,076	106,091	28	55,508
Khao Kaeo			0	0	0	0		0
Manorom/K.K.	37,222	40,087	40,742	640	0	0	0	0
Chong Kaeo	36,887	37,761	37,849	6,224	6,258	13,120	35	3,385
Khok Katiem	32,456	31,654	32,890	15,268	17,928	15,430	47	16,656
Roeng Rang	28,407	27,137	25,841	3,195	10,597	8,684	34	6,666
Maharaj	73,782	74,785	70,315	35,544	30,331	35,536	51	19,046
Nakhon Luang	42,085	34,786	33,109	20,089	22,060	22,962	69	7,563
Pasak Tai	37,199	32,280	32,337	5,048	4,160	0	0	0
Rangsit Nua	58,310	39,404	22,940	3,764	5,739	1,864	8	2,192
Rangsit Tai	67,915	68,407	65,238	231	0	0	0	0
Khlong Dan	52,236	38,024	22,870	3,280	27,003	8,495	37	0
Total	828,454	796,764	748,345	179,819	228,322	173,211	23	113,993

Table 2.4.7 LIST OF LARGE AND MEDIUM SCALE IRRIGATION PROJECTS

<u>Reg. Office No.</u>	<u>No. of Project</u>	<u>Irrigable Area (ha)</u>	<u>No. of Res. Proj.</u>	<u>Total Cross Storage (MCM)</u>	
(Region No. 1)					
Ping	36	182,600	17	624.4	
(Region No. 2)					
Wang	8	25,872	5	125.7	
Yom	10	41,200	2	20.4	
Nan	23	19,424	7	16.1	
Sub-Total	(41)	(86,496)	(14)	(162.2)	
(Region No. 3)					
Ping	19	72,832	2	13,463.40	
Yom	10	254,440	2	4.8	
Nan*	26	170,496	4	9,062.30	
Upper Pasak	3	8,256	1	18.7	
Sub-Total	(58)	(277,024)	(9)	(22,549.2)	
(Region No. 7)					
Sakae Krang	7	44,800	1	160	
Suphan River	5	170,240	0	0	The Greater Chao Phraya Project
Noi River	4	197,600	0	0	
Bang Ban	1	21,920	0	0	
West Bank	4	209,600	0	0	
Outside of G. Chao Phraya	4	21,200	3	243.1	
Sub-Total	(25)	(665,360)	(4)	(403.1)	
Region No. 8					
Chainat-Pasak Canal	8	139,785	0	0	
Chainat-Ayutthaya Canal	1	67,520	0	0	
South Pasak	2	108,800	0	0	
Nakhon Luang	1	35,200	0	0	
Chiangrak-Khlong Dan	2	132,000	0	0	
East Bank of Chainat- Ayutthaya Canal	8	4,496	7	24.8	
Upper Pasak River	9	25,560	4	17.5	
Sub-Total	(31)	(513,361)	(11)	(42.3)	
(Region No. 9)					
Chiangrak-Khlong Dan	1	81,600	0	0	
Total	192	1,806,441	55	23,781.20	

N.B * Including 4 projects in Phitsanulok Project (Phase I) (total irrigable 111,153 ha)

Table 2.5.1 MAJOR FLOOD EVENTS

Year	Maximum Discharge at Nakhon Sawan (C.2) (m ³ /s)	Maximum Discharge at Chainat (C.13) (m ³ /s)	Maximum Water Level at Ayutthaya (S.5) (m ³ /s)	Maximum Water Level at Memorial Bridge (C.4) * (m MSL)
1942	n.a.	n.a.	5.15	2.27
1978	3,540	3,770	4.60	1.99
1980	4,350	3,800	4.70	1.92
1983	2,290	3,290	4.54	2.04
1995	4,820	4,550	5.00	2.20
1996	3,100	3,250	4.38	2.12

* : After adjustment

TABLE 2.5.2 SUMMARY OF FLOODING CONDITIONS

Area	Geographical Features	Land Use	Flooding Condition In 1995	Cause of Flooding	Flood Damage in 1995
Upper Central Plain (Upstream of Nakhon Sawan)	Valley plain between hilly areas with gentle slope in the east and west.	Main land use: Paddy (Traditional varieties are dominant, but HYV is applied in Phitsanulok Irrigation Area protected by dikes) Major urban area: Utradit, Phitsanulok, Sukhothai, Phichit	Inundation Area: 5,000 km ² Depth: 0.5 to 3 m Duration: 2 to 3 month (in some depression areas continued more than 3 months up to January next year)	<ul style="list-style-type: none"> • Overtopping of Yom and Nan rivers • Inland flood • Overland flow from upstream • Flash flood from upper mountainous area 	<p>Agricultural Damage More than 50% of Phitsanulok project was protected. 180,000 ha of paddy field was damaged.</p> <p>Urban Area Damage Sukho Thai, Phitsanulok, Phichit are seriously damaged.</p> <p>Infrastructure Roads, bridges, irrigation facilities including regulators and canal embankment were damaged.</p>
Nakhon Sawan Area (between Nakhon Sawan and Chainat)	Narrow valley plain with number of isolated mountains	Main land use: Paddy (Traditional varieties are dominant) Major urban area: Nakhon Sawan, Uthai Thani	Inundation Area: 500 km ² Depth: 0.5 to 3 m Duration: 1 to 2 month	<ul style="list-style-type: none"> • Overtopping of Chao Phraya River • Overtopping of Sakae Krang River caused by back water from Chao Phraya River • Inland flood • Overland flow from upstream 	<p>Agricultural Damage Paddy fields of 160,000 ha and 10,000 ha were damaged in Nakhon Sawan and Uthai Thani respectively.</p> <p>Urban Area Damage Nakhon Sawan and Uthai Thani were severely damaged.</p> <p>Infrastructure Damage Roads were damaged</p>
Higher Delta in Lower Central Plain (between Chainat and Ayutthaya)	Natural levees and back marshes are well developed.	Main land use: Paddy (HYV is dominant but floating rice and deep water rice are dominant in habitually inundated area) Major urban area: Chainat, Sin Buri, Anghthong, Ayutthaya, Supan Buri, Lop Buri	Inundation Area: 4,600 km ² Depth: 0.5 to 4 m Duration: 2 to 3 month (in some depression areas continued more than 3 months up to January next year)	<ul style="list-style-type: none"> • Overtopping and dike breaches along Chao Phraya, Nan, Lopburi, Tha Chin, Pasak rivers • Inland flood • Overland flow from upstream 	<p>Agricultural Damage Total 190,000 ha of paddy field including 50,000 ha in Maharat Project Area was damaged.</p> <p>Urban Area Damage Chainat, Sin Buri, Anghthong, Ayutthaya and Suphan Buri are severely damaged.</p> <p>Infrastructure Damage Roads, bridges, irrigation facilities including regulators and canal embankments are damaged</p>
Lower Delta in Lower Central Plain (downstream of Ayutthaya)	Very flat	Main land use: Paddy (HYV rice) is main but urban areas are expanding rapidly Major urban area: Bangkok, Pathum Thani, Nonthaburi, Samut Prakan	Inundation Area: 4,700 km ² Depth: 0.5 to 2 m Duration: 2 to 3 month	<ul style="list-style-type: none"> • Overtopping of Chao Phraya and Tha Chin rivers • Dike breach • Inland flood • Overland flow from upstream 	<p>Agricultural Damage 40,000 ha of paddy field and 10,000 ha of other crop fields were damaged.</p> <p>Urban Area Damage Pathum Thani, Nonthaburi, Samut Prakan are damaged.</p> <p>Infrastructure Damage Roads, irrigation facilities including regulators and canal embankments are damaged</p>

Table 2.6.1 LIST OF PREVIOUS PLANS FOR FLOOD MITIGATION AND DRAINAGE WORKS

Study/Project on Flood Control	Contents	Agency	Year
Greater Bangkok Plan	Two perimeter canals on the east and west side of the city, Zoning to give high level of protection (Polder system), Short cut of Chao Phraya river	Lidchfield, Whiting , Bowne & Ass. Adams Howared and Greeley	1960
Camp, Dresser Mckee Plan	Polder system of 460 km ² with size of polder ranging from 11 to 100 km ²	Camp, Dresser Mckee	1968
City Core Project	Protection of an area of 86 km ² on the east bank of the Chao Phraya River : Major protection barrier by 100-y protection and Expected land subsidence in 5 years	Nedeco and Land Marin/Span	1984
Master Plan for Eastern Suburban-Bangkok	A polder system with pumps, diversion gates, and retention ponds for the mastar plan area of 500 km ²	JICA	1985
The RID-Plan	Protection of a large area on the west side of the Chao Phraya.The system constited of the construction of dikes enclosing the area between the Chao Phraya River and Tah Chin River	RID	1985
Study on Tawee Wattana by AIT	Proteciton of the western side of the Chao Phraya River to the Tha Chin River for 500 km ² . Polder dikes were proposed in line with the 1985 RID Plan	AIT	1985
Alternative Flood Control Schemes	By-pass channel with a 500 m ³ /s capacity along the east bank of the Chao Phraya river from Ban Mai to the sea, construction of dikes from Bangsia to river mouth and dredging from Pakkret to the estuary	AIT	1985
Chao Phraya 2	Construction of diversion Channel, eastern boundary dike, control structure at Bangsai and sea barrier structure	AIT and Austrarian Consultant	1986
Master Plan for Flood Protection and Drainage of Thonburi and Samut Prakan	Flood protection of a study area of 432 km ² on the west side of the Chao Phraya river: Construction of new or raising of existing flood barriers around the study area and construction or rehabilitation of tegulators and flood gates in the klongs.	Nedeco and Span co, ltd.	1987
F/S for the Lower Chao Phraya West Bank Area Development Project	Sustainable development of RID West Bank projects and protection of the area by dike and drainage improvement	Team, AAC, Sanyu and AIT	1992
Chao Phraya Flood Management Review	Identificaton of high priority flood management projects for on-going and planned flood management initiatives and preparation of a conceptual program for basin-wide flood management.	AIT, DHI and ACRES	1996
M/P for the flood protection and Drainage system in Eastern sub-Urban Bangkok	Proteciton of the 650 km ² of BMA area between the Chao Phraya river in the west and King's dike in the east by improving the existing barriers along the Chao Phraya River and Kings's dike through the establishment of the design crest elevation.	Nedeco, Span co., ltd. and WDC co., ltd.	1997

Table 2.6.2 MAJOR FEATURES OF THE PREVIOUS PLANS FOR FLOOD MITIGATION AND DRAINAGE WORKS

Project	Organization	Year	Main Scheme	Return period of flood	Target Year	Design Discharge	Design Water Level (m)	Crest Height, Freeboard (m)	Flood studied (year)
Greater Bangkok Plan	Litchfield, et al	1960							
Camp, Dresser, McKee Plan	Camp, Dresser and McKee	1968							
City Core Project	NEDECO, Land Marine / Span	1984		100 year			+2.27 MSL (Memorial Brdg)		1942, 1980, 1983
Master plan for Eastern Suburban	JICA for BMA	1985	Pump, Drainage system	100 year	2000	1500	+1.9~+2.2MSL		
Bangkok Flood Control Management	BPLC for NESDB	1985		100 year			+2.1 MSL (Memorial Brdg)		
RID Plan	RID	1985					+2.2 MSL (Memorial Brdg)		1983, 1978, 1980, 1983
Tawee Wattana Study	AIT for BMA	1985		100 year					
Alternative Flood Control Schemes	AIT for NESDB	1985	Greenbelt by-pass Loop-cut Sea barrier, Dike and Pump	10 year (rural) 100 year (urban)			+2.2 MSL (Memorial Brdg)	0.5 (FB)	1983
Chao Phraya 2	TAC, AIT for BMA	1986		100 year	2001	3600 (Bangsai)	+2.2~+4.0 MSL	n.a.	1986
Master plan for Flood Protection and Drainage in Thonburi and Samut Prakan	NEDECO, Span for BMA	1987	Pump, Drainage system	100 year	2000, 2016	n.a. (1942 flood = 75 year r.p. = 3000m ³ /s)	+1.2~+2.3 MSL	0.3 (FB)	1983
Flood Control Bangkok and Vicinity	Sverdrup for BMA	1988	Selection of former schemes	n.a.	1990	n.a.	n.a.	n.a.	n.a.
Lower Chao Phraya West Bank Area Development project	Team, AIT etc. for RID/AWB	1992	Dike for rural areas Flood Protection Dike Drainage System	10-25 year for rural area 100 year and 5 year (urban)	2006		+2.4MSL (Not Thaburi) +4MSL (Bangsai) +1.90~2.75MSL (Bangkok Port-Non Thaburi)	0.50 (FB) 0.50(FB) + 0.20(Land Subsidence)	n.a. n.a.
ESUB	NEDECO for BMA	1996			2016	Approx. 3500			n.a.
Chao Phraya Flood Management	AIT for NESDB/WB	1996	Flood Management	Less than 10 years (rural)					mainly 1995

Table 2.6.3 ON GOING FLOOD PROTECTION WORKS BY BMA

Crest Elevation of Flood Barrier Under Construction (El. m)		
	NEDECO	BMA Final
Kh. Bang Khen to Krungthon Br.	3.10 - 3.20	3.00
Krungthon Br. to Memorial Br.	3.00	2.80
Memorial Br. to Taksin Br.	2.90	2.75
Taskin Br. to Rama IX Br.	2.80	
Rama IX Br. to Wat Yothin Paradiit	2.60	

Discharge of Existing Pump	(m ³ /s)
Core City and Eastern Sub-Urban	452.22
Tomburi (West Bank)	239.80
Total	692.02

Table 2.6.4 SUMMARY OF FLOOD PROTECTION STUDIES FOR SEVEN PROVINCES

Location	Municipality, Sanitary District	Area (km ²)	Population	Pump Cap- acity (m ³ /s)	Dike Eleva- tion (MSL)	Freeboard (m)	Return Period		Construction Cost (M. B)	Implemen- tation Year	Remarks	
							Drainage	Dike				
Nakhon Sawan	Province											
P. Capital	Nakhon Sawan	28.0	109,708									
F/S Area	7-Area	136.3	-	-	-	-	-	-	4,835.60	1998-2009		
	Nakhon Sawan	124.8	145,510	-	29.0	1.0	5	100	4,394.00	1998-2009	& Vicinity	
	Chumsaeng Muni.	2.4	11,690	-	-	-	-	-	90.00	2003-2004	Nan River	
	Lat Yao SD	1.6	-	-	-	-	-	-	69.00	2003-2004	Far from the River	
	Kao Leio SD	1.5	-	-	-	-	-	-	48.30	2003-2004	Ping River	
	Krok Phra SD	2.8	-	-	-	-	-	-	48.70	2003-2004	Chao Phraya River	
	Phayuha Khiri SD	1.8	-	-	-	-	-	-	48.60	2003-2004	Chao Phraya River	
	Banphot Phisani SD	1.5	-	-	-	-	-	-	137.00	2006-2007	Ping River	
D/D Area	Nakhon Sawan	21.0	103,400	115.5	29.0	1.0	5	100	1,687.00	1998-2002	Area No.1	
Chainat	Province											
P. Capital	Chainat	6.1	15,872									
F/S Area	2-Aree	88.8	39,989	12.2								
	Chainat	56.5	35,300	-	20.2-18.1	0.43-0.37	5	100				
	Watsing Muni.	32.3	4,689	-	-	-	-	-				
D/D Area	5-Area	19.6	29,012	5.0			5	100				
	Chainat	4.0	16,131	1.1					82.01			
	Ban Klauay	7.2	4,498	1.1					54.17		Chainat	
	Tha Chai	3.1	2,589	1.1					63.53		Chainat	
	Had Tha Sao	3.3	1,772	0.7					56.92		Chainat	
	Watsing Muni.	2.0	4,022	1.0					62.43			
Sing Buri	Province											
P. Capital	Sing Buri	7.8	21,232									
F/S Area	2-Area	26.7	-	21.5			5	100	3,229.74	1998-2009		
	Sing Buri	14.9	-	15.7	13.3	0.5			2,009.76	1998-2009		
	In Buri SD	7.3	-	3.4	-	-			754.83	1999-2009		
	Phrom Buri SD	4.5	-	2.4	-	-			465.15	2002-2009		
D/D Area	Sing Buri / 4-SA	11.1	-	14.5	13.3	0.5	5	100	1,144.00	1998-2009	SA= Sub-area	
Ang Thong	Province											
P. Capital	Ang Thong	6.2	11,662									
F/S Area	2-Area	50.8	-	-								
	Ang Thong	24.0	-	-	9.0	0.2	5	100	2,378.80	1999-2006		
	Pantok Muni.	26.9	17,368	25.5	-	-	5		2,176.11	2001-2008		
D/D Area	Ang Thong	7.0	-	24.0	9.0					1999-		
Ayuthaya	Province											
P. Capital	Ayuthaya	14.0	70,623									
F/S Area	Ayuthaya	37.0	76,576	75.5	6.5	0.5	5	100	1,564.00			
D/D Area	2-Area	18.4	64,228	39.5	6.5	0.5	5	100	591.91	1999-2002		
	Ko Muang	13.0	53,200	27.5	-	-	-	-	419.39	1999-2001	to Phu Kao Thong	
	Ayothaya	5.4	11,028	12.0	-	-	-	-	172.52	2001-2002		
Pathum Thani	Province											
P. Capital	Pathum Thani	7.1	14,680									
F/S Area	3-Area	119.3	-	49.5	3.9	0.6	5	100	3,133.89	1999-2005	L. Sub:0.2 m	
	Pathum Thani	8.8	-	16.5	-	-	-	-	434.79	1999-2000	West Bank	
	Bang Pho Thai	71.1	-	51.0	-	-	-	-	1,472.88	2003-2005	West Bank	
	Bang Luang	39.5	-	51.0	-	-	-	-	1,226.22	2000-2002	East Bank	
Nonthaburi	Province											
P. Capital	Nonthaburi	38.9	251,468									
F/S Area	2-Area						0.3	5	100		1998-2006	L. Sub.:0.2 m
	West Bank	150.0	237,000	94.5	2.85-3.35							
	East Bank	-	-	139.5	2.85-3.00							

Note: Return Period : Unit = year, SD= Sanitary District, M.B= Million Bahts, L. Sub. = Land Subsidence

Table 2.6.5 Disbursements for Flood Protection and Drainage,
Regional Office 3,7,and 8

(million Baht)

	1995 Regular	1996 Additional	Emergency	Total	(Total)
Region 3	170.8	-	-	170.8	67.3
Region 7	153.2	662	19.9	835.1	147.1
Region 8	381	156	49.8	586.8	19.3
Equipment	-	125.6	7.5	133.1	-
Total	705	943.6	77.2	1,725.80	233.6

Source: RID

Table 2.6.6 CHARACTERISTICS OF BARRAGE KM. 205 AND BARRAGE KM. 345

Item	Barrage km. 205	Barrage km. 345
River around Headwork Area	T. Phra Ngam A. Phrom Buri C. Sing Buri	T.Nam Song A. Phayuha Khiri C. Nakhon Sawan
Elevation of River Bank (m. MSL)	9-10	21-22
Elevation of River Bed (m. MSL)	-1	12.5
River Width (m)	150	200
Headwork Area		
Width of Diversion Canal (m)		
Upstream/Downstream at Barrage Site	215/235	410/305
Flow Control Structure		
No. of Control Gates	12	20
Width of Control Gate	12.5	20
Sill Level (m. MSL)	-1	12.5
Level of Upper Edge of Sluice Gate when Closing (m. MSL)	10	22
Level of Lower Edge of Sluice Gate when Closing (m. MSL)	13	23
Drainage Capacity (m ³ /s)	4120	4564
Level of Roadway Bridge Surface	15.3	26.9
Width of Roadway Bridge	6	6
Max. Storage Level (m. MSL)	12.03	21.72
Storage Level (Dry/Rainy Season) (m. MSL)	9.00/8.00	21.00/20.00
Min. Downstream Water Level (m. MSL)	1.15	15.5
Max. Downstream Water Level (m. MSL)	11.9	21.5
Max. Flow (50 years return period (m ³ /s))	4120	4560
Designed Flow for Downstream Demand (m ³ /s)	80	200
Navigation Lock (number)	1	1
Width (m)	14	14
Length of Lock Chamber (m)	165	135
Downstream Sill Level (m)	-3	11
Fish Ladder (Number)	2	2
Width (m)	4	4
Slope	1:10	1:10
Hydropower Plant		
Type of Turbine	pit turbine	pit turbine
Designed Head (m)	6	4
Designed Flow (m ³ /s)	160	440
Installed Capacity (MW)	8.05	14.76
Average Hydropower (million units/year)	47.15	98.6
Closure Dam		
Crest Level (m. MSL)	13.5	22.8
Width of Road on the Crest (m)	6	6

Table 2.7.1 HISTORICAL CHANGES IN CHAO PHRAYA RIVER BASIN

Year	General Features of the Basin	Characteristics of River Basin						Population		Major Hydro-logical Event	Construction of Major Facilities
		Forest Area	Flood Protection Area*1	Cultivated Area	Urban development*2	Bangkok	River Basin				
before 1950	The basin was in a comparatively undeveloped state the forests in the upstream were largely untouched	166,000 km ²	2,230 km ²	0.7 mil. ha	51 km ²						
1950 to 1970	Basin Development had been promoted converting the forest area to agricultural land		5,700 km ²	1.7 mil. ha	100 km ²	2.25 million in 1960	13.47 million in 1960			Construction of Chat-nat Dam (1957) and Bhumibol dam	
1970 to 1980	Agriculture development had been promoted through construction of irrigation facilities and ring levee had been constructed to protect paddy field from flood		12,900 km ²		200 km ²	4.23 million in 1975	17.51 million in 1970			Construction of Sirikit dam and Kiu Lom dam (1972)	
1980 to 1990	Protection works for paddy field from flood had been implemented and area of traditional paddy like floating rice had been converted to high yield crops	106,000 km ²	12,900 km ²	3.5 mil. ha	389 km ²	5.72 million in 1988	22.70 million in 1980		1983 Flood, 1986/87 Drought, 1987/88 Drought	Construction of Kho Laem Dam and King's dike (1984)	
to present	Urbanization as well as industrial development has been promoted	92,000 km ²	14,400 km ²		528 km ²	5.57 million in 1993	27.42 million in 1990		1992/93 Drouht 1995 Flood, 1996 Flood		

*1 : Northern and Central Regions of Thailand (Source : Chao Phraya Flood Management Review)

*2 : Bangkok area only (Source : Chao Phraya Flood Management Review)

Table 2.7.2 TYPICAL LAND USE OF CHAO PHRAYA RIVER BASIN

Unit: 1,000 km² and 1,000 farmers

	Total Area	Forest Area	Agricultural Land				Total Area	o. of Farmer	Other Are
			Paddy Fields	Upland Crops	Other Areas				
Whole State	513	135 (26%)	110	100	14	221(43%)	5,149	167 (33%)	
Chao Phraya Basin	168	63 (38%)	31	21	3	55(33%)	1,413	49 (27%)	

Table 2.7.3 AGRICULTURAL LAND USE IN CHAO PHRAYA RIVER BASIN (1992 YEAR)

(Unit: ba)

Province	Area	Forest Area	Farm holding land									Others
			Paddy Land	Under Field (crops)	Under fruit tree and tree crops	Under vegetable and flowers	Grass Land	Housing Area	Idle land	Other	Total	
Highlands												
1 Chiang Mai	2,010,706	1,456,445	108,332	35,223	40,664	12,983	228	10,374	1,212	1,014	210,051	344,210
2 Lamphun	450,588	225,962	44,793	5,768	25,137	4,371	0	5,152	1,720	2	86,942	137,684
3 Lampang	1,253,396	820,621	90,841	53,874	11,585	2,077	0	8,824	11,051	386	178,638	254,137
4 Phayao	633,506	253,086	91,757	39,964	11,234	3,296	92	5,428	1,755	99	153,624	226,795
5 Phrae	653,860	245,883	44,419	40,823	9,115	702	0	5,001	1,917	0	101,485	306,491
6 Nan	1,147,207	488,432	37,830	78,072	13,668	1,015	0	6,234	2,468	892	140,129	518,646
7 Tak	1,639,601	1,213,350	42,610	85,610	0	13,333	1,204	0	6,207	1,697	150,662	275,590
8 Phetchabun	622,514	220,237	54,385	31,927	15,450	737	975	5,145	887	310	109,814	292,461
Sub-total (%)	100.0%	58.5%	6.1%	4.4%	1.5%	0.5%	0.0%	0.5%	0.3%	0.1%	13.5%	28.0%
Upper Central Plain												
9 Sukhothai	659,609	227,548	160,496	107,887	13,898	1,405	0	10,579	2,490	2,604	299,360	132,702
10 Uttaradit	782,859	304,943	84,310	73,866	25,132	1,832	0	6,327	3,027	541	195,074	283,841
11 Phitsanulok	1,041,585	246,152	254,472	127,072	15,478	1,525	1,090	12,991	4,901	486	418,064	417,369
12 Kamphaeng Phet	860,741	211,994	215,159	206,802	15,940	1,172	1,558	13,195	1,678	2,932	458,417	190,310
13 Phichit	453,101	0	280,848	43,013	9,869	389	236	8,963	789	147	344,256	108,845
14 Nakhon Sawan	959,768	70,103	383,550	223,700	19,291	5,929	3,403	12,398	1,464	1,198	651,437	238,228
15 Uthai Thani	673,025	265,143	100,683	87,881	11,263	1,936	2,478	6,440	2,849	1,047	214,576	193,305
Sub-total (%)	100.0%	24.2%	27.0%	15.9%	2.0%	0.3%	0.2%	1.3%	0.3%	0.2%	47.2%	28.6%
Lower Central Plain												
16 Chai Nat	246,975	698	151,319	16,944	5,120	197	229	4,247	2,026	242	180,325	65,952
17 Sing Buri	82,248	0	61,681	5,873	3,649	164	62	1,962	279	152	73,822	8,426
18 Lop Buri	619,975	20,521	155,604	220,680	8,401	1,158	3,200	6,693	1,576	4,572	401,684	197,770
19 Suphan Buri	535,801	59,815	219,357	118,754	11,661	2,458	3,018	11,762	2,619	1,779	371,407	104,579
20 Ang Thong	96,837	0	64,274	1,751	6,758	1,562	0	3,576	0	1,498	79,418	17,419
21 Angthang	255,664	0	174,041	0	5,547	172	81	6,232	1,020	1,284	188,377	67,287
22 Saraburi	357,649	6,472	87,111	69,957	12,580	284	11,995	6,019	651	1,062	189,658	161,318
23 Nakhon Pathom	216,833	0	78,607	26,815	13,895	6,142	0	6,998	2,405	4,564	139,425	77,407
24 Nonthaburi	62,230	0	20,065	0	4,939	1,016	0	971	228	323	27,542	34,648
25 Pathum Thani	152,586	0	73,350	0	28,678	939	923	3,078	717	2,689	110,374	42,212
26 Samut Sakhon	87,235	0	18,121	0	14,314	1,660	0	1,287	121	1,869	37,372	49,863
27 Bangkok Metropolitan	156,522	0	27,903	330	7,948	3,334	0	873	358	746	41,493	115,029
28 Samut Prakan	100,409	0	15,920	0	8,755	0	0	1,635	0	7,058	33,368	67,041
Sub-total (%)	100.0%	3.0%	38.6%	15.5%	4.5%	0.6%	0.7%	1.9%	0.4%	0.9%	63.1%	34.0%
Total in the Study Area	16,854,029	6,337,607	3,141,837	1,702,537	369,969	71,339	30,770	172,691	56,442	41,249	5,586,814	4,929,608
Total (%) in the Study Area	100.0%	37.6%	18.6%	10.1%	2.2%	0.4%	0.2%	1.0%	0.3%	0.2%	33.1%	29.2%
Whole Kingdom	51,311,502	13,495,067	11,013,699	5,247,203	3,335,915	1,410,276	119,954	553,848	531,151	185,349	21,128,193	16,688,242
Whole Kingdom (%)	100.0%	26.3%	21.3%	10.2%	6.5%	2.7%	0.2%	1.1%	1.0%	0.4%	41.2%	32.5%

Source: Crop Year 1994/95

Table 2.7.4 THE PRESENT LAND USE IN URBAN AREA

(Year 1993)					
	Residential Area (low to high density)	Factory and Warehouse mixed with Residential	Public, Educational, Religious and Park	Agricultural and Vacant	Total
Area (km ²)	390.9	28.1	63.3	1,095.0	1,577.3
Share (%)	24.8	1.8	4.0	69.4	100

Table 2.7.5 LIST OF URBAN LAND USE PLANNING MAPS FROM DTCP

S.N.	City	Province	Year	Scale (reciprocal)
1	Ang Thong	Ang Thong	1988	15,000
2	Bangkok	Bangkok Metropolis	1992	75,000
3	Chachoengsao	Chachoengsao	1987	20,000
4	Chai Nat	Chai Nat	1989	20,000
5	Kratum Baen	Samut Sakhon	1990	20,000
6	Lop Buri	Lop Buri	-	-
7	Nakhon Nayok	Nakhon Nayok	1996	-
8	Nakhon Sawan	Nakhon Sawan	1990	20,000
9	Phetchabun	Phetchabun	1990	20,000
10	Phitsanulok	Phitsanulok	1989	20,000
11	Prachin Buri	Nakhon Nayok	1988	20,000
12	Samut Sakhon	Samut Sakhon	1987	20,000
13	Sara Buri	Sara Buri	1996	-
14	Sing Buri	Sing Buri	1988	20,000
15	Sukhothai	Sukhothai	1989	20,000
16	Uthai Thani	Uthai Thani	1996	-

Table 2.7.6 PRESENT & FUTURE PROJECTION
OF LADUSE IN THE FLOODPLAIN

Landuse Type	Upper Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Urban	3.9%	206	1.6%	270	2.1%	461	3.5%
Rice	-1.0%	9,544	72.6%	8,921	67.9%	7,794	59.3%
Fruits & Trees	3.3%	1,195	9.1%	1,500	11.4%	2,361	18.0%
Vegetables & Flowers	5.3%	206	1.6%	297	2.3%	614	4.7%
Field Crops	-0.3%	1,386	10.6%	1,360	10.4%	1,308	10.0%
Forest	0.0%	202	1.5%	202	1.5%	202	1.5%
Others	0.0%	400	3.0%	400	3.0%	400	3.0%
Total		13,139	100.0%	13,139	100.0%	13,139	100.0%

Landuse Type	Nakhon Sawan Area						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Urban	3.9%	43	3.1%	56	4.1%	95	7.0%
Rice	-1.2%	890	65.1%	818	59.8%	691	50.6%
Fruits & Trees	2.1%	271	19.8%	313	22.9%	419	30.7%
Vegetables & Flowers	1.6%	41	3.0%	46	3.4%	58	4.2%
Field Crops	-2.9%	40	3.0%	33	2.4%	22	1.6%
Forest	0.0%	17	1.2%	17	1.2%	17	1.2%
Others	0.0%	64	4.7%	64	4.7%	64	4.7%
Total		1,367	100.0%	1,367	100.0%	1,367	100.0%

Landuse Type	Higher Delta in Lower Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Urban	3.8%	185	1.7%	239	2.2%	403	3.7%
Rice	-0.4%	9,133	83.4%	8,859	80.9%	8,336	76.1%
Fruits & Trees	2.9%	669	6.1%	817	7.5%	1,217	11.1%
Vegetables & Flowers	2.4%	165	1.5%	195	1.8%	270	2.5%
Field Crops	-2.2%	299	2.7%	256	2.3%	188	1.7%
Forest	0.0%	12	0.1%	12	0.1%	12	0.1%
Others	0.4%	492	4.5%	504	4.6%	530	4.8%
Total		10,955	100.0%	10,955	100.0%	10,955	100.0%

Landuse Type	Lower Delta in Lower Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Urban	3.7%	1,348	14.1%	1,734	18.1%	2,868	30.0%
Rice	-2.1%	5,411	56.5%	4,653	48.6%	3,441	35.9%
Fruits & Trees	1.1%	1,251	13.1%	1,354	14.1%	1,584	16.5%
Vegetables & Flowers	0.6%	74	0.8%	78	0.8%	85	0.9%
Field Crops	-3.8%	405	4.2%	308	3.2%	178	1.9%
Forest	0.0%	0	0.0%	0	0.0%	0	0.0%
Others	1.3%	1,086	11.3%	1,188	12.4%	1,420	14.8%
Total		9,576	100.0%	9,576	100.0%	9,576	100.0%

Landuse Type	Total (4 Basins)						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Urban	3.7%	1,782	5.1%	2,299	6.6%	3,827	10.9%
Rice	-1.0%	24,978	71.3%	23,251	66.4%	20,262	57.8%
Fruits & Trees	2.4%	3,387	9.7%	3,983	11.4%	5,581	15.9%
Vegetables & Flowers	3.6%	488	1.4%	616	1.8%	1,027	2.9%
Field Crops	-1.1%	2,130	6.1%	1,957	5.6%	1,696	4.8%
Forest	0.0%	230	0.7%	230	0.7%	230	0.7%
Others	0.8%	2,042	5.8%	2,156	6.2%	2,414	6.9%
Total		35,037	100.0%	35,037	100.0%	35,037	100.0%

Table 2.7.7 PROJECTION OF FUTURE LANDUSE
IN RICE CULTIVATION IN THE FLOOD PLAIN

Landuse Type	Upper Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Rice	-1.0%	9,544	100.0%	8,614	100.0%	7,794	100.0%
1) HYV	3.7%	1,466	15.4%	1,887	21.9%	3,129	40.1%
2) General	-2.6%	8,078	84.6%	6,727	78.1%	4,665	59.9%
3) Deep Water	0.0%	0	0.0%	0	0.0%	0	0.0%
4) Floating	0.0%	0	0.0%	0	0.0%	0	0.0%

Landuse Type	Nakhon Sawan Area						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Rice	-1.2%	890	100.0%	814	100.0%	691	100.0%
1) HYV	0.0%	301	33.8%	301	36.9%	301	43.5%
2) General	-1.9%	589	66.2%	513	63.1%	390	56.5%
3) Deep Water	0.0%	0	0.0%	0	0.0%	0	0.0%
4) Floating	0.0%	0	0.0%	0	0.0%	0	0.0%

Landuse Type	Higher Delta in Lower Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Rice	-0.4%	9,133	100.0%	8,684	100.0%	8,336	100.0%
1) HYV	0.3%	6,038	70.5%	6,183	71.2%	6,703	80.4%
2) General	0.0%	0	0.0%	0	0.0%	0	0.0%
3) Deep Water	-3.0%	2,539	16.5%	2,051	23.6%	1,339	16.1%
4) Floating	-3.0%	556	13.0%	449	5.2%	293	3.5%

Landuse Type	Lower Delta in Lower Central Plain						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Rice	-2.1%	5,411	100.0%	4,653	100.0%	3,441	100.0%
1) HYV	-2.1%	5,308	98.1%	4,570	98.2%	3,387	98.4%
2) General	0.0%	0	0.0%	0	0.0%	0	0.0%
3) Deep Water	0.0%	0	0.0%	0	0.0%	0	0.0%
4) Floating	-3.0%	103	1.9%	83	1.8%	54	1.6%

Landuse Type	TOTAL (4 BASINS)						
	Annual Growth (%)	Present (1998)		Future (2005)		Future (2018)	
		Area (sq. km)	Share (%)	Area (sq. km)	Share (%)	Area (sq. km)	Share (%)
Rice	-1.0%	24,978	100.0%	22,765	100.0%	20,262	100.0%
1) HYV	0.1%	13,113	52.5%	12,941	56.8%	13,520	66.7%
2) General	-2.5%	8,667	34.7%	7,240	31.8%	5,055	24.9%
3) Deep Water	-3.0%	2,539	10.2%	2,051	9.0%	1,339	6.6%
4) Floating	-3.0%	659	2.6%	532	2.3%	348	1.7%

Table 2.7.8 CHANGE OF FOREST AREA IN THAILAND
IN THE PAST 32 YEARS (1961-1993)

Year	Forest Area in Thailand		
	km2	Rai	%
1961	273,628.50	171,017,812.50	53.33
1973	221,725.00	138,578,125.00	43.21
1976	198,417.00	124,010,625.00	38.67
1978	175,224.00	109,515,000.00	34.15
1982	156,600.00	97,875,000.00	30.52
1985	150,866.00	94,291,349.00	09.40
1988	143,803.00	89,877,182.00	28.03
1989	143,417.00	89,635,625.00	27.95
1991	136,698.00	85,436,284.00	26.64
1993	133,521.00	83,450,623.00	26.02

Table 2.7.9 AREA UNDER FLOATING RICE BY IRRIGATION PROJECT

Unit : ha

Location	Total Area			Floating Rice Area			
	1974 - 86	1987 - 91	1992 - 96	1976	1986/87	1995/96	1996/97
Region 7	361,955	372,440	364,215	86,537	104,246	67,120	58,485
Don Chedi	22,519	21,556	20,238	720	2,304	1,044	1,034
Pho Phraya	42,839	25,713	43,884	13,270	2,562	832	758
Borommthat	58,153	57,287	54,648	4,259	4,327	4,033	5,766
Chanasutr	73,762	64,066	54,752	6,838	13,913	10,236	9,480
Yangmancee	30,490	29,557	28,964	11,802	22,116	21,792	18,918
Phak Hai	31,318	30,429	22,280	28,896	31,896	17,024	14,848
Bang Bal	16,088	21,130	15,933	8,848	16,497	11,760	7,680
Chao Chet B.Y.	27,630	35,821	35,044	11,904	10,632	400	0
Phraya Ban Lu	18,350	45,445	50,628	0	0	0	0
Phra Phimon	16,194	31,262	33,485	0	0	0	0
Phasi Charoen	24,702	10,175	4,359	0	0	0	0
Region 8	466,499	424,325	384,130	93,282	124,076	106,091	55,508
Khao Kaeo				0	0	0	0
Manorom/K.K.	37,222	40,087	40,742	640	0	0	0
Chong Kaeo	37,887	37,761	37,849	6,224	6,258	13,120	3,385
Khok Katiem	32,456	31,654	32,890	15,268	17,928	15,430	16,656
Roeng Rang	28,407	27,137	25,841	3,195	10,597	8,684	6,666
Maharaj	73,782	74,785	70,315	35,544	30,331	35,536	19,046
Nakhon Luang	42,085	34,786	33,109	20,089	22,060	22,962	7,563
Pasak Tai	37,199	32,280	32,337	5,048	4,160	0	0
Rangsit Nua	58,310	39,404	22,940	3,764	5,739	1,864	2,192
Rangsit Tai	67,915	68,407	65,238	231	0	0	0
Khlung Dan	52,236	38,024	22,870	3,280	27,003	8,495	0
Total	828,454	796,764	748,345	179,819	228,322	173,211	113,993

Table 2.9.1 MAJOR LAWS AND REGULATIONS

Laws and Regulations	Year Established
Constitution of Thailand	1932
Civil and Commercial Code of Thailand	1932
Act on Conservation of Public Water Supply Canal	1913
Act on Conservation of Canal	1902
People Irrigation Act	1939
State Irrigation Act	1942
Dikes and Ditches Act	1962
Grand Water Act	1978
Electricity Generating Authority of Thailand Act	1968
Improvement and Conservation of National Environmental Quality Act	1975

Table 2.9.2 ORGANIZATIONS FOR THE RIVER MANAGEMENT IN THAILAND

ACTIVITIES	ORGANIZATION		M.A.C				OPM	MOI				MOC			Min		MSTE	MOD	MPH	BMA
	RID	ALRO	DF	RFD	EGAT	LAD	DPW	GARD	MWA	PWA	MD	HD	PAT	DW	DMR	NEA	NEB	H&D	DOH	DDS
DATA COLLECTION & RESEARCH	Flood Control	0			0	0														
	Irrigation	0			0											0				
	Hydropower				0											0				
	Navigation									0								0		
	Water Supply							0	0						0				0	
PLAN & DESIGN	Environmental Control	0		0													0			
	Flood Control	0																		0
	Irrigation	0														0				
	Hydropower				0											0				
	Navigation																	0		
CONSTRUCTION	Water Supply	0																		
	Environmental Control	0															0			
	Flood Control	0																		0
	Irrigation	0														0				
	Hydropower				0											0				
OPERATION & MAINTENANCE	Navigation																			
	Water Supply																			
	Environmental Control	0																		0
	Flood Control	0																		0
	Irrigation	0														0				

Note: 0 Major Organization 0 Minor Organization

Table 2.9.3 ORGANIZATIONS FOR THE RIVER MANAGEMENT FOR
CHAO PHRAYA RIVER BASIN

ORGANIZATION	Hydrological Observation & Analysis	Flood Forecasting	Flood Fighting	River Improvement & Water Flow control of Mainstream	Drainage Works
Royal Irrigation Department	○	○	○	○	○
Meteorological Department	○	○			
Electricity Generating Administration	○	○			
Bangkok Metropolitan Administration	○		○	○	○
Harbour Department	○				
Port Authority of Thailand	○				
Local Administration Department			○		
Department Public Works					○
Provincial government			○		○

Note : ○ Major Activity

○ Minor Activity

Table 2.10.1(1/2) NOTIFICATION FOR EIA (1/2)

List of Projects or Activities (1/2)		
items	types of projects or activities	size
1	dam or reservoir	storage volume 100,000,000 cubic meter or more or storage surface area 15 square kilometers or more
2	irrigation	irrigated area 80,000 rais (12,800 hectares) or more
3	commercial airport	all sizes
4	hotel or resort facilities located in areas adjacent to rivers, coastal areas, lakes or beaches or in the vicinity of national parks or historical parks	80 rooms or more
5	mass transit system under the Mass Transit System and Expressway Act or project as the same characteristic or mass transit which use rail	all sizes
6	mining as defined by the Mineral Act	all sizes
7	industrial estate as defined by the Industrial Authority of Thailand Act or projects with similar feature	all sizes
8	commercial port	with capacity for vessels of 500 gross tons or more
9	thermal power plant	capacity of 10 MW. or more
10	Industries (1) petro chemical industry	using raw materials which is produced from oil refinery and/or natural gas separation with production capacity of 100 tons/day or more
	(2) oil refinery	all sizes
	(3) natural gas separation or processing	all sizes
	(4) chlor-alkaline industry requiring sodium chrolide (NaCl)as raw material for production of sodium carbonate (Na2CO2), sodium hydroxide (NaOH), hydro chrolic acid (HCl), chlorine (Cl2), sodium hypo-chrolide (NaOCl) and beaching powder	production capacity of each or combined products of 100 tons/day or more
	(5) irons and/or steel industry	production capacity of 100 tons/day or more (production capacity shall be calculated by using furnaces capacity of ton/day multiply by 24 hours)
	(6) cement industry	all sizes
	(7) smelting industry other than iron and steel	production capacity 50 tons/day or more
	(8) pulp industry	production capacity 50 tons/day or more
11	all types of projects located in the areas where it has been approved by the Cabinet to be watershed area as class 1B*	all sizes

Table 2.10.1(2/2) NOTIFICATION FOR EIA (2/2)

List of Projects or Activities (2/2)		
items	types of projects or activities	size
1	coastal reclamation	all sizes
2	building in areas adjacent to rivers, coastal areas, lakes or beaches or in the vicinity of national parks or historical park	1) height of 23 meters or more, or, 2) total floor area or any floor area in the building is 10,000 square meters or more
3	residential condominium as defined by the Condominium Act	80 units or more
4	land allocation for residential or commercial purpose	500 land plots or more or total developed area exceed 100 rais (16 hectares)
5	hospital which located 1) in area adjacent to rivers, coastal areas, lakes or beaches 2) in area other than (a)	1) in-patient's bed of 30 beds or more 2) in-patient's bed of 60 beds or more
6	pesticide industry or industry producing active ingredient by chemical process	all sizes
7	chemical fertilizers industry using chemical process in production	all sizes
8	highway or road as defined by the Highway Act, passing through following areas 1) wildlife sanctuaries and wildlife non-hunting areas as defined by the Wildlife Conservation and Protection Act 2) National Park as defined by the National Park Act 3) watershed area classified as Class 2 by the Cabinet Resolution 4) mangrove forests designated as the National Forest Reserve 5) coastal area within 50 meters from the maximum sea level	all projects with equivalents to or above the minimum standard of rural highway including roadbed expansion

Table 2.10.2 WATERSHED CLASSIFICATION FOR ENVIRONMENTAL PROBLEM

Classes of Watersheds (prepared by Ministry of Science, Technology and Environment)			
Class	Description	Measures to be Followed	
WSC1	Class 1A	areas of protection forest and head water source areas, usually at higher elevation with very steep slopes.	should remain in permanent forest cover
	Class 1B	areas of similar physical features and environment to 1A but portions of the area have been cleared for agricultural use or occupied by villages	require social conservation protection measures and where possible should be replanted to forest or maintained in permanent agro-forestry
WSC2	Class 2	areas of protection and/or commercial forests, usually at higher elevations with steep to very steep slopes. Landforms are less erosive than WSC 1A or 1B.	may be used for grazing or certain crops with soil protection measures
WSC3	Class 3	areas of uplands with steep slopes and less erosive landforms	may be used for commercial forests, grazing, fruit trees, or certain agricultural crops with need for soil conservation measures
WSC4	Class 4	areas of gently sloping lands suitable for raw crops, fruit trees, and grazing	moderate soil conservation measures are needed
WSC5	Class 5	gentle to flat areas used by paddy field or other agricultural uses	few restrictions needed Classes of Watersheds (prepared by Ministry of Science, Technology and Environment)

Table 2.11.1 GENERAL FEATURES OF STORAGE DAMS IN CHAO PHRAYA RIVER BASIN

LARGE SCALE DAMS

Name of Dam	Bhumibol	Sirikit	Mae Ngat	Mae Kuang	Kiu Lom	Mae Chang	Krasieo	Pasak	Kaeng Sua Ten	Kwae Noi	Mae Wong	Kiu Kho Ma	Mae Khan	Nam Kheok
Purpose	I, P, F	I, P, F	I	I	I	I	I	I, P	I, F, P	I	I	I, S	I, F	I
Under operation by	EGAT	EGAT	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
Name of River	Ping	Nan	Ping	Ping	Wang	Ping	Chao Phraya	Pasak	Yom	Kwae Noi	Salac Krang	Wang	Mae Khan	Nam Kheok
Drainage area (km ²)	26,386	13,130	1,281	569	2,700	426	1,200	12,929	3,583	4,254	612	1,275	1,085	854
Active storage volume (million m ³)	9,662	6,660	255	249	106	30	201	772	1,125	733	250	192	165	345
- ditto - (mm)	366	508	199	438	39	70	168	60	314	172	409	150	152	404
Existing/under constructing/proposed	E	E	E	E	E	E	E	E	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

MEDIUM SCALE DAMS

Name of Dam	Mae Tub	Mae Yao	Mae Arb	Mae Prik	Mae Kam	Khlong Khang	Huai Head	Khlong Tron	Nam Haeng	Huai Mae Khon	Huai Mae Kon	Khlong Khayang	Khlong Prai	Nam Lat	Khlong Khlung	Mae Song
Purpose	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Under operation by	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
River	Ping	Wang	Wang	Wang	Yom	Yom	Nan	Nan	Nan	Ping	Ping	Ping	Ping	Ping	Ping	Yom
Drainage area (km ²)	126	35	35	45	59.2	28	40	265	277	34	44	20	51	74	95	305
Active storage volume (million m ³)	39	3.2	7.5	3.8	9.6	9.5	2.7	52	10.2	3.7	4.85	4.6	13	15	18	53.2
- ditto - (mm)	309	91	214	84	162	339	58	196	37	109	110	230	254.9	202.7	189.5	174
Existing/under constructing/proposed	E	E	E	E	E	E	E	E	E	P	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

SMALL SCALE DAMS

Name of Dam	Mae Tang	Huai Mae Song	Huai Ta Pac	Mae Moc	Wang Daeng	Mae Sai	Huai Suang	Mae Khong	Mae Khanaeng	Huai Nam Klung	Khlong Chomphu	Mae Chaery	Khlong Pho	Huai Nam Dung	Huai Kan Yao
Purpose	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Under operation by	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
River	Yom	Yom	Yom	Yom	Yom	Yom	Yom	Yom	Nan	Nan	Nan	Nan	Sakae Krung	Sakae Krung	Huai Kan Yao
Drainage area (km ²)	120	60	287	728	179	177	47	70	229	148.2	364	18	376	45	65
Active storage volume (million m ³)	28.1	11.4	58	80	12	24.3	5.6	7.7	62	12.4	43	4.3	67.5	5	5
- ditto - (mm)	234	190	202	110	67	137	119	110	271	84	118	239	180	111	77
Existing/under constructing/proposed	P	F	P	P	P	P	P	P	P	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

Table 2.11.2 PRINCIPLE FEATURES OF EXISTING/PROPOSED LARGE DAM

Project Name	(unit)	Bhambel	Sihik	Mas Ngt	Mae Kung	Kin Lom	Mae Chang	Thap Sabao	Pank	Kang	Kwae Noi	Mae Wong	Kin Kho	Mae Khan
Purpose		E.P.F	E.P.F	I	I	I	I	I	I.P.P	I.P.P	E.P.P	I	E.S	E.F
Under operation by		EGAT	EGAT	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
Location		A.Mae Ngt C	A.Tha Phic	A.Mae Ngt C	A.Mae Kung C	A.Mae Kung C	A.Mae Kung C	A.Lom Sak	A.Saban	A.Lom Sak	A.Mae Ngt C	A.Lom Sak	A.Mae Ngt C	A.Mae Khan
Local Community		Phu	Umsai	C.Chang Mai	C.Chang Mai	C.Chang Mai	C.Chang Mai	Umsai	Umsai	Umsai	Umsai	Umsai	Umsai	Umsai
River		Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu	Phu
Latitude		17-14-31	17-14-08	18-03-41	18-03-33	18-03-33	18-03-33	18-03-14	18-03-14	18-03-14	18-03-14	18-03-14	18-03-14	18-03-14
Longitude		99-52-31	99-52-15	99-52-15	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11	99-52-11
Hydrology														
Drainage area	(ha)	26,386	13,130	1,281	569	2,700	426	534	12,929	3,583	4,254	615	1,275	1,085
Annual inflow	(MCM)	5,256	5,600	289	306	308	54.3	202	2,100	933	1,449	221	265	181
	(mm)	195.2	427.5	221.9	362.0	217.8	190.5	378.3	162.4	260.4	340.5	361.1	207.8	166.8
Reservoir														
Max. water level	(m M.S.L.)	260.0	166.0	400.0	385.0	285.0	354.0	150.0	41.3	261.0	130.0	207.5	352.0	381.5
Normal water level	(m M.S.L.)	260.0	162.0	396.0	385.0	285.0	352.0	157.0	231.0	231.0	231.0	204.5	352.0	380.0
Min. water level	(m M.S.L.)	213.0	123.0	360.0	350.0	263.0	340.0	142.0	32.5	210.0	90.0	180.0	328.8	328.8
power operation														
Integration														
Storage														
max. water level	(MCM)	13,482	10,508	325	263	112	109	191	785	1,175	769	250	192	75
normal water level	(MCM)	9,310	265	263	112	112	109	160	13	50	36	20	12	4
min. water level	(MCM)	3,800	2,850	23	14	4	4	8	772	1,125	733	230	180	71
Active storage volume	(MCM)	9,663	6,660	255	249	106	30	152	597	314	172.3	375.8	141.1	152.1
	(mm)	366.3	508.4	199.1	437.6	39.3	70.4	284.7	148.8	65.0	40.5	17.6	13.0	13.0
Surface area	(km ²)	316.0	260.0	16.0	12.0	16.0	12.3	19.0	148.8	65.0	40.5	17.6	13.0	13.0
Dam														
Type		Gravity arch	Barrel	Barrel	Barrel	Gravity	Barrel	Barrel	Barrel	Concrete	Barrel	Barrel	Barrel	Barrel
Height	(m)	154.0	113.6	59.0	61.0	24.5	40.0	26.8	46.2	83.0	80.0	57.0	47.0	65.0
Crest elevation	(m M.S.L.)	261.0	169.0	404.0	400.0	286.5	356.0	151.0	70.8	263.7	135.0	211.0	385.0	385.0
Crest length	(m)	485.0	800.0											
Spillway														
Type		Tunnel type	2 Tunnel											
Crest elevation	(m M.S.L.)	242.9	130.5	353.8			347.0							380.0
Control gate		Radial Gate	Radial Gate											
Design flood peak inflow	(m ³ /s)	11.0	11.8	3,174	1,470	2,900	1,056		2,997	5,600	5,600	1,770		
Design flood volume	(MCM)	17.4	17.4	251	251	251	251		3,097	3,300	7,046			
Max. discharge capacity	(m ³ /s)	6,000	7,670	4,483	4,483	4,483	4,483							
Intake structure														
Intake gate		Fixed Wheel	Fixed Wheel											
Gate size		4.2m(w)* 6.7m(h)*	6.0m(w)* 8.5m(h)*											
Base elevation of inlet		201.0	185.75											
Power station														
Installed capacity		70MW	123MW	133MW										
Discharge of power outlet														
- At max. head	(m ³ /s)	75.8	184.3											
- At nor. head	(m ³ /s)	69.5	175.0											
- At min. head	(m ³ /s)	61.6	156.0											
Predicted Annual Energy	(GWh)	1,560	1,200						47	94	150			

Note: I = Irrigation, P = Power Generation, F = Flood Control Source: RID

Table 2.11.3 DAM RESERVOIR VOLUME IN THE CHAO PHARAYA RIVER BASIN

River Basin	Drainage Area of River Basin	Number of Dam Reservoirs in	Total Dam Redervoir Volume (MCM)	Total Dam Redervoir Volume/Drainage
Ping	39,880	5 (13)	10,268 (10,853)	257.4 (272.1)
Yom	23,550	2(12)	13 (248)	0.6 (10.5)
Wang	11,240	4 (5)	123 (313)	10.9 (27.8)
Nan	31,830	4 (9)	6,693 (7,482)	210.3 (235.1)
Pask	18,200	0 (1)	0 (875)	0 (43.0)
Chao Phraya	16,200	16 (45)	17,298 (19,989)	106.7(123.3)

Note: value in parentheses is total value of exiting and proposed dam reservoirs

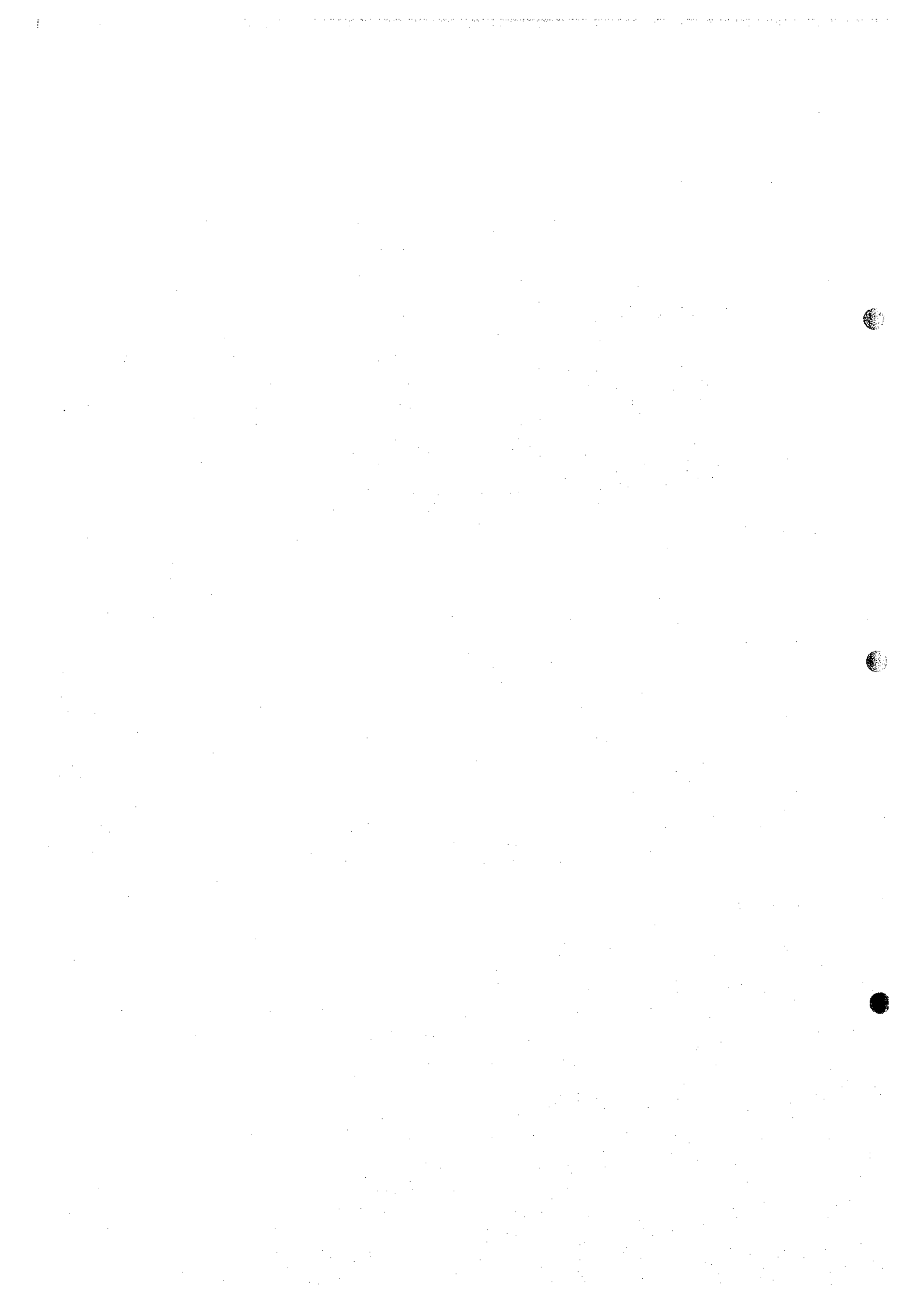


Table 3.4.1 FLOOD AND OTHER DAMAGES ON AFRICULTURE (1984-1993)

		Damaged Area (Hai)										
		Rice	Corn	Ground-nuts	Mung-bean	Soy-cane	Sugar cane	Cassava	Other	Vegetable	Fruit	Total
1983/84	Drought	219,203	902,613	12,047	19,053	11,994	496,158	97,871	20,094	9,910	1,475	1,790,418
	Flood	3,985,614	74,545	8,945	45,041	5,623	83,153	89,903	66,666	74,452	65,757	4,499,699
	Other	212	47	-	-	-	-	-	-	-	5	264
	Total	4,205,029	977,205	20,992	64,094	17,617	579,311	187,774	86,760	84,362	67,237	6,290,381
1984/85	Drought	1,252,661	794,638	24,779	40,141	21,236	8,409	376	29,891	363	-	2,172,494
	Flood	660,838	87,115	324	13,961	21,271	-	304	3,296	15,588	2,171	804,868
	Other	180	168,969	-	-	-	-	-	-	-	-	169,149
	Total	1,913,679	1,050,722	25,103	54,102	42,507	8,409	680	33,187	15,951	2,171	3,146,511
1985/86	Drought	419,506	468,230	5,930	2,548	1,181	88,322	545	3,124	261	171	989,818
	Flood	320,848	51,751	2,295	78,581	43,090	8,384	7,294	33,932	9,134	3,001	558,310
	Other	73	-	-	-	295	-	-	-	100	3,276	3,744
	Total	740,427	519,981	8,225	81,129	44,566	96,706	7,839	37,056	9,495	6,448	1,551,872
1986/87	Drought	4,100,984	1,948,240	25,561	23,038	5,947	4,464	22,261	91,047	267	-	6,221,809
	Flood	732,354	44,808	14,330	4,478	28,105	9,067	3,141	17,355	9,300	11,789	874,727
	Other	4,076	-	-	-	-	-	-	-	-	20	4,096
	Total	4,837,414	1,993,048	39,891	27,516	34,052	13,531	25,402	108,402	9,567	11,809	7,100,632
1987/88	Drought	5,388,361	3,024,444	61,480	23,343	466,185	130,309	163,557	2,197,495	42,254	194	11,497,622
	Flood	1,546,351	42,138	8,863	58,448	20,429	68	12,751	83,929	21,180	8,209	1,802,366
	Other	-	-	-	-	-	-	-	-	-	0	0
	Total	6,934,712	3,066,582	70,343	81,791	486,614	130,377	176,308	2,281,424	63,434	8,403	13,299,988
1988/89	Drought	2,259,166	201,609	1,873	6,411	576	-	-	50,685	1,130	-	2,521,450
	Flood	2,777,727	133,755	1,454	94,167	55,752	34,229	76,742	162,029	74,811	256,611	3,667,277
	Other	-	-	-	-	444	-	-	341	-	1,649	2,434
	Total	5,036,893	335,364	3,327	100,578	56,772	34,229	76,742	213,055	75,941	258,260	6,191,161
1989/90	Drought	2,301,832	784,617	7,646	37,941	21,385	11,026	13,770	169,648	7,582	10,748	3,366,195
	Flood	380,703	23,018	811	481	180,246	-	-	11,440	791	265	597,755
	Other	290,014	695	125	12,990	8,191	-	-	49,094	30,223	790,994	1,182,326
	Total	2,972,549	808,330	8,582	51,412	209,822	11,026	13,770	230,182	38,596	802,007	5,146,276
1990/91	Drought	2,981,355	1,713,762	6,257	29,035	84,645	55,010	9,024	171,022	8,297	23,261	5,081,668
	Flood	4,891,219	53,085	4,833	170	22,954	7,336	63,896	109,125	28,205	145,196	5,326,019
	Other	6,711,556	615	32	-	8,219	-	-	1,674	2,272	1,504	6,725,872
	Total	14,584,130	1,767,462	11,122	29,205	115,818	62,346	72,920	281,821	38,774	169,961	17,133,559
1991/92	Drought	1,326,506	1,592,610	22,694	21,593	336,096	164,739	35,771	189,853	8,876	1,316	3,700,054
	Flood	4,224,995	80,428	2,032	9,011	9,059	3,719	43,185	147,569	10,992	18,489	4,549,479
	Other	34,424	54	9	160	308	-	-	1,495	6,274	1,381	44,105
	Total	5,585,925	1,673,092	24,735	30,764	345,463	168,458	78,956	338,917	26,142	21,186	8,293,638
1992/93	Drought	4,612,249	491,758	16,482	25,641	339,748	160,112	73,929	750,727	9,790	224,951	6,705,387
	Flood	1,561,912	44,618	2,952	27,028	19,990	11,716	-	203,799	29,358	72,113	1,973,486
	Other	1,382,361	3,029	-	-	18,445	-	30	1,263	103	18,296	1,423,527
	Total	7,556,522	539,405	19,434	52,669	378,183	171,828	73,959	955,789	39,251	315,360	10,102,400

Table 3.4.2 RICE CULTIVATION AREA DAMAGE BY FLOOD (1/2)

Region/ Province	Year									
	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
North-Eastern										(rai)
Nakhon Phanom	394	19,764	3,899	-	18,650	-	-	144,481	173,772	
Sakon Nakhon	3,059	33,624	-	9,987	46,504	-	13,826	158,436	87,205	
Nong Khai	49,794	-	3,707	3,020	2,615	3,896	4,438	84,312	72,368	17,068
Udon Thani	12,880	19,388	1,968	12,797	55,049	15,046	27,640	144,860	15,909	53,033
Nong Bua Lam Phu*										
Loei	-	-	-	-	3,596	710	1,756	173	4,332	-
Mukdahan	-	-	-	-	-	-	-	3,612	19,490	-
Yasothon	50,257	-	6,643	-	-	-	23,436	89,087	131,276	33,473
Ubon Ratchathani	36,690	52,081	7,120	-	40,534	636	7,841	62,141	155,120	31,241
Amnat Charoen*										
Kalasin	21,406	1,029	-	16,513	12,599	-	1,200	108,044	125,320	5,373
Khon Kaen	1,965	-	-	646	25,450	49,538	979	85,610	185,610	-
Maha Sarakham	40,268	-	766	-	-	-	1,953	26,138	231,435	-
Roi Et	177,262	-	31,560	-	8,436	-	38,844	156,507	325,070	63,937
Buri Ram	126,337	-	-	45,969	2,414	-	-	16,708	179,047	20,197
Si Sa Ket	107,001	38,004	565	-	33,108	-	-	22,075	99,939	62,731
Surin	68,994	21,532	-	2,608	-	-	3,951	1,940	118,435	32,716
Chaiyaphum	-	5,875	40,880	-	43,657	28,015	-	135,730	219,881	-
Nakhon Ratchasima	302,514	143	-	1,577	181,498	6,292	-	184,667	166,597	-
Northern										
Nakhon Sawan	238,979	-	41,987	-	29,033	235,158	-	9,322	143,165	112,612
Phetchabun	1,358	43,116	19,846	-	135,741	-	1,805	14,146	413,071	23,470
Uthai Thani	129,376	-	-	314	71,278	109,959	-	16,250	-	32,150
Kamphaeng Phet	106,293	-	1,774	14,686	2,707	136,494	4,653	-	158,911	92,873
Tak	4,811	181	805	-	-	19,683	-	-	4,733	9,431
Phichit	1,018	2,524	1,847	-	26,936	-	51,376	-	570,384	-
Phitsanulok	4,740	1,432	23,119	-	31,002	7,925	48,199	12,603	253,187	135,902
Nan	-	2,715	2,777	283	-	-	40	121	-	-
Phrae	-	-	-	-	-	-	-	-	-	10
Lampang	-	-	-	-	762	-	-	-	-	388
Sukhothai	17,319	454	12,714	32,195	47,657	47,707	47,048	14,565	10,193	75,496
Uttaradit	-	-	-	-	3,671	-	25,581	19,498	9,132	29,260
Chiang Mai	29,637	-	-	5,864	67,226	4,639	16,839	6,196	20,306	6,524
Chiang Rai	-	74,207	44,313	2,133	65,879	20,397	23,248	56,430	59,030	369
Mae Hong Son	119	859	2,804	1,027	4,229	-	519	-	3,383	-
Lamphun	334	-	-	192	8,226	-	-	-	893	5,916
Phayao	924	4,041	-	-	29,992	1,818	-	28,729	-	38,636

Table 3.4.2 RICE CULTIVATION AREA DAMAGE BY FLOOD (2/2)

Region/ Province	Year									
	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Central Plain										
Lop Buri	34,377	-	44,428	-	149,769	8,063	523	136,240	54,276	-
Saraburi	31,406	-	4,750	30,561	11,197	747	-	187,740	-	7,811
Chai Nat	30,240	-	-	-	29,042	84,864	12,023	13,100	-	21,124
Nakhon Nayok	105,629	-	1,398	14,056	-	31,527	806	440,805	70,209	-
Nakhon Pathom	41,796	-	-	3,119	-	7,806	-	-	-	5,133
Nonthaburi	8,674	-	-	-	-	-	-	194	-	-
Pathum Thani	164,135	-	-	1,331	715	13,313	-	247,297	-	-
Ayutthaya	222,522	-	-	-	406	13,115	-	468,634	-	1,965
Sing Buri	9,556	-	-	-	55,842	15,396	-	49,625	-	2,284
Suphan Buri	402,448	-	-	37,784	25,167	329,546	-	330,197	-	61,324
Ang Thong	110,138	-	-	-	10,224	78,138	2,457	191,160	-	6,363
Bangkok Metropolis	191,996	-	554	-	-	3,442	-	161,695	105	-
Kanchanaburi	36,474	-	7,434	13,978	-	49,387	-	24,910	2,591	14,340
Prachuap Khiri Khan	569	-	-	-	384	-	-	-	2,802	760
Phetchaburi	3,843	-	9,896	-	-	-	16,578	-	4,057	22,127
Ratchaburi	234	-	1,886	6,204	-	12,106	3,144	1,267	204	-
Chachoengsao	358,242	-	-	46,614	-	54,210	-	431,651	27,455	-
Prachin Buri	406,021	-	-	233,999	-	67,011	-	569,751	62,205	-
Sa Kaeo*	-	-	-	-	-	-	-	-	-	-
Samut Sakhon	11,290	-	431	-	-	357	-	-	-	-
Samut Prakan	59,844	-	-	-	-	-	-	-	-	114
Samut Songkhram	-	-	977	-	-	-	-	-	-	25
Chon Buri	107,384	-	-	-	-	17,136	-	25,905	9,342	47,905
Rayong	28,643	-	-	-	135	12,668	-	795	-	3,808
Chanthaburi	3,546	-	-	719	-	100	-	3,150	3,550	-
Trat	-	-	-	305	-	-	-	-	-	-
Southern Region										
Chumphon	-	1,072	-	4,106	1,200	25,309	-	-	10,100	552
Nakhon Si Thammar	12,776	274,964	-	6,603	119,540	681,658	-	-	-	347,348
Phatthakung	-	24,940	-	22,191	-	85,688	-	4,507	-	-
Songkhla	14,771	-	-	50,455	29,040	261,732	-	-	3,650	89,743
Surat Thani	-	9,828	-	16,246	13,273	117,409	-	-	-	23,204
Krabi	-	-	-	577	-	813	-	-	-	-
Trang	-	13,814	-	21,539	757	27,456	-	-	2,309	-
Phangnga	218	-	-	1,131	190	-	-	-	-	-
Phuket	1,350	-	-	250	-	-	-	-	-	-
Ranong	-	-	-	-	118	31	-	-	-	-
Satun	-	-	-	2,970	-	4,850	-	-	5,079	440
Narathiwat	-	10,243	-	26,919	24,343	15,595	-	-	3,495	1,846
Pattani	53,763	-	-	36,888	54,941	52,066	-	-	2,172	19,285
Yala	-	5,008	-	3,998	21,619	18,275	-	215	4,200	1,605

Table 3.4.3 VALUE OF ASSETS

(Household) thousand Baht

	average/ building	average/ assets
Whole Kingdom	228	85
Bangkok Metro	674	211

Source: NSO (1994)

(Commerce) thousand Baht

	average/ building	average/ assets
Whole Kingdom/ Small	1,218	569
Whole Kingdom/ Large	7,829	5,999
Bangkok Metro/ Small	1,540	687
Bangkok Metro/ Large	1,540	8,127

Source: NSO (1994); Inflation rate (1993-1998) of 1.361 has been applied

(Industry) thousand Baht

	average/ building	average/ assets
Whole Kingdom/ Small	4,088	5,495
Whole Kingdom/ Large	24,550	75,288
Bangkok Metro/ Small	7,394	9,516
Bangkok Metro/ Large	27,158	91,888

Source: NSO (1992); Inflation rate (1991-1998) of 1.463 has been applied

(Other Establishments) thousand Baht

	average/ building	average/ assets
Whole Kingdom	105,403	141,689
Bangkok Metro	89,649	120,512

NOTE 1: All values are in 1998 Price Level

NOTE 2: 'Whole kingdom' does not include 'Bangkok Metro'.

NOTE 3: 'Bangkok Metro' is the area of Bangkok, Nonthaburi, Pathumthani, Samutprakan and Samutsakon.

NOTE 4: Definition of 'Small' and 'Large' group follows that in NSO's reports concerned.

NOTE 5: Asset values of other establishments are averages in the interview result.

NOTE 6: Conversion Rate to economic value is set at 0.96

Table 3.4.4 FLOOD DAMAGE RATE AND FARM GATE PRICE OF AGRICULTURAL PRODUCTS

(1) Flood Damage Rate

Variety	Inundation Depth (m)				Unit: %
	x < 0.3	0.3 < x < 0.5	0.5 < x < 1.0	1.0 < x < 1.5	
High Yielding Variety (HYV)	0	50	71	100	100
Traditional Variety	0	0	51	71	100
Deep Water Rice	0	0	51	71	100
Inundation Depth (m)					
Floating Rice	0	6	18	30	42
					54
					60

Flood Damage Rate of Other Crops

Variety	Inundation Depth (m)		Note	Unit: %
	x < 0.5	0.5 < x < 1.0		
Field Crops	100	100	maize, soy, bean, peanut, sugarcane	
Vegetables	100	100	other plants except field crops and fruits	
Fruits	25	28		50

Source: Flood mitigation manual (Ministry of Construction, Japan)

(2) Economic Farm Gate Price in 1998 Price Level

Rice	Unit: Baht/ha	
Variety	Price	
High Yielding Variety (HYV)	16,400	
Traditional Variety	8,600	
Deep Water Rice	13,000	
Floating Rice	8,600	

Other Crops	Unit: Baht/ha	
Group	Price	Note
Field Crops	9,000	maize, soy, bean, peanut, sugarcane
Vegetables	64,200	other plants except field crops and fruits
Fruits	50,900	

Source: Kok Ing Nan Water Diversion Projects (JICA, 1997)

Agricultural Statistics of Thailand (1994/1995)

Farm Price Index (Bank of Thailand, 1997)

Price Index 1997/1995 of 172.75/166.97 has been applied

Kok Ing Nan Water Diversion Projects (JICA, 1997)

Agricultural Statistics of Thailand (1994/1995)

Farm Price Index (Bank of Thailand, 1997)

Price Index 1997/1995 of 172.75/166.97 has been applied

Table 3.4.5 DAMAGE RATE IN PRIVATE SECTOR

(1) Below Floor Level

(unit: %)

Inundation Depth (m)	House/Building	Assets
$0 \leq x < 0.5$	0	0
$0.5 \leq x$	3	0

(2) Above Floor Level

(unit: %)

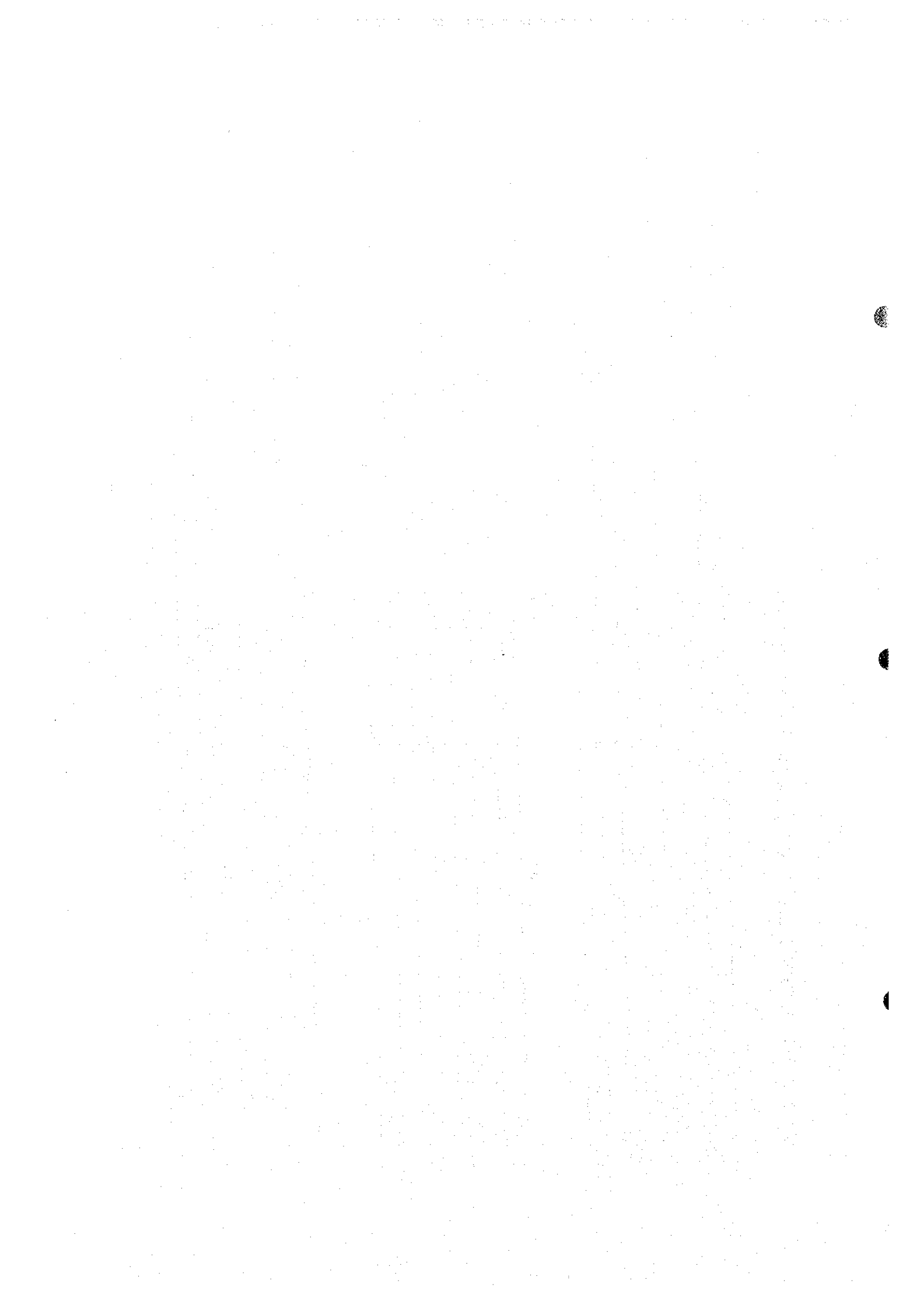
Inundation Depth (m)	House/Building	Assets
$0 \leq x < 0.5$	3	1
$0.5 \leq x < 1.0$	5	8
$1.0 \leq x < 1.5$	7	13
$1.5 \leq x < 2.0$	8	17
$2.0 \leq x$	9	19

Table 3.4.6: ESTIMATION RESULTS OF REPRESENTATIVE FLOODS

1983									
REGION	HOUSES	COMMERCE	INDUSTRIAL	AGRICULTURE	PUBLIC	OTHERS	(mil. Baht)		
							TOTAL	PUBLIC	OTHERS
UPPER CENTRAL PLAIN	774	2570	3642	750	675	310	8720		
NAKHON SAWAN	104	375	963	84	75	35	1635		
HIGHER DELTA	1402	3435	8647	818	736	338	15375		
LOWER DELTA	23921	9764	10333	884	796	366	46065		
TOTAL	26201	16143	23584	253	2283	1048	71796		
TOTAL (%)	36	22	33	4	3	1	100		

1995									
REGION	HOUSES	COMMERCE	INDUSTRIAL	AGRICULTURE	PUBLIC	OTHERS	(mil. Baht)		
							TOTAL	PUBLIC	OTHERS
UPPER CENTRAL PLAIN	1903	4050	5439	959	670	295	13316		
NAKHON SAWAN	550	1194	2377	186	130	57	4495		
HIGHER DELTA	2214	7044	8968	1595	1114	491	21428		
LOWER DELTA	5524	7279	19234	721	504	222	33484		
TOTAL	10192	19567	36018	3461	2418	1066	72723		
TOTAL (%)	14	27	50	5	3	1	100		

1996									
REGION	HOUSES	COMMERCE	INDUSTRIAL	AGRICULTURE	PUBLIC	OTHERS	(mil. Baht)		
							TOTAL	PUBLIC	OTHERS
UPPER CENTRAL PLAIN	1026	1704	2491	526	324	160	6231		
NAKHON SAWAN	205	502	1089	104	64	32	1995		
HIGHER DELTA	1131	2964	4107	992	610	301	8227		
LOWER DELTA	1590	3063	8808	241	148	73	13924		
TOTAL	3953	8233	16494	1864	1146	565	32256		
TOTAL (%)	12	26	51	6	4	2	100		



**Table 4.2.1 THE TARGET COMPLETION YEAR OF CURRENTLY
RELATED DEVELOPMENT PROJECTS**

Sector	Project	Target Year
Flood Mitigation Plan	Chao Phraya Flood Management Review	2016
	Flood Protection and Drainage in Eastern Suburban	2006 for Flood Protection and 2016 for Drainage
	Flood Protection of 7 towns in Chao Phraya Basin	2016
	National Flood Protection Master Plan	2016
Water Resources Development, etc.	Chao Phraya Basin Water Management Strategy	2006, 2016, 2026
	Kok-Ing-Nan Water Diversion Project	2016
	Bangkok Environmental Improvement Program	2011

Table 4.2.2 EXISTING AND PLANNED DRAINAGE PUMP CAPACITY FROM URBAN AREAS
-CHAO PHRAYA RIVER-

Province	Protection Area			Pump Capacity (m ³ /s)			S. Capacity (m ³ /s/km ²)	Population Density	Remarks
	Name	km ²	Population	Existing	Planned	Total			
Sukhothai	Sukhothai	3.5	21,712	0.3**	1.7*	2	0.70	6,203	
	Sawankalok	6.5	19,345	None	5*	5	0.70	2,976	
Phitsanulok	Phitsanulok	18.3	78,469	None	13*	13	0.70	4,297	
Phichit	Phichit	12.0	24,832	None	8*	8	0.65	2,069	
	Taphan Hin	5.2	22,066	None	4*	4	0.70	4,243	
	Bang Mun Nak	2.5	10,258	None	2*	2	0.70	4,103	
Nakhon Sawan	Nakhon Sawan	124.8	145,510	3.0**	131.7	134.7	1.08	1,166	
	Chumsaeng	2.4	11,690	None	2*	2	0.70	4,871	
	Krok Phra	2.8	-	None	2*	2	0.70	-	
	Phayuha Khiri	1.8	-	None	1*	1	0.70	-	
Chainat	Chainat	56.5	35,300	None	15*	15	0.26	625	
	Watsing	32.3	4,689	None	6*	6	0.20	145	
Sing Buri	Sing Buri	14.9	21,232	0.3**	15.7	16	1.07	-	
	In Buri	7.3	-	None	3.0	3	0.41	-	
	Phrom Buri	4.5	-	None	2.0	2	0.44	-	
Ang Thong	Ang Thong	24.0	11,662	None	29.0	29	1.21	-	
	Panomok	26.9	17,368	None	26.0	26	0.97	647	
Ayuthaya	Ayuthaya	37.0	76,576	None	76.0	76	2.05	2,070	
Pathum Thani	Pathum Thani	8.8	14,680	None	17.0	17	1.94	-	
	Bang Pho Thai	71.1	-	None	51.0	51	0.72	-	
	Bang Luang	39.5	-	None	51.0	51	1.29	-	
Nonthaburi	East Bank	89.0	390,335	None	140.0	140	1.57	4,386	
	West Bank	150.0	237,000	None	95.0	95	0.63	1,580	
Bangkok	East Bank	650.0	-	452.2	101.0	553	0.85	-	
	West Bank	240.0	-	221.8	70.0	292	1.29	-	
Samut Prakan	East Bank	236.0	-	18.0	0.0	18	-	-	Drained to the Sea
	West Bank	124.0	-	55#	0	55	0.28	-	#12m ³ /s pumps under const. are included
	West Bank	124.0	-	12.0	0	12	-	-	Drained to the Sea
Total (Chao Phraya River)				791.6	868.1	1,659	-	-	-#16m ³ /s pumps under const. are included

-THA CHIN RIVER-

Province	Protection Area			Pump Capacity (m ³ /s)			S. Capacity (m ³ /s/km ²)	Population Density	Remarks
	Name	km ²	Population	Existing	Planned	Total			
Supanburi	Supanburi	9.0	27,788	None	6*	6	0.70	3,084	
	Songpeenong	10.4	12,848	None	5*	5	0.50	1,235	
Samutsakorn	Samutsakorn	10.3	54,335	0.1*	7.2*	7.3	0.70	5,275	
	Katumban	2.2	14,677	None	1.5*	1.5	0.70	6,671	
	Aomnoy	30.0	29,882	None	15*	15.0	0.50	996	
Total (Tha Chin River)				0.1	34.7	35	-	-	

-PASAK RIVER-

Province	Protection Area			Pump Capacity (m ³ /s)			S. Capacity (m ³ /s/km ²)	Population Density	Remarks
	Name	km ²	Population	Existing	Planned	Total			
Saraburi	Saraburi	20.1	57,410	None	14*	14	0.70	2,856	
	Phaphuttabat	29.6	36,021	None	15*	15	0.50	1,217	
	Nongkha	5.0	8,769	None	3*	3	0.62	1,754	
	Keangkoy	4.1	13,648	None	3*	3	0.70	3,329	
Total (Pasak River)				0.1	34.7	35	-	-	

Note: S. Capacity = Specific Capacity, Population Density = Capita per square kilometer, * = Pump capacity estimated from Specific capacity
- Population density Curve, ** = Pump capacity estimated from pump's diameter

Table 4.2.3 SIMULATION CASE FOR IDENTIFICATION OF INFLUENCE OF FUTURE DEVELOPMENT

Case	Basin Condition						Simulation Results (1995 Flood)				Remarks	
	Present Condition	Urban Development	Change of Agricultural Cultivation	Land Subsidence	Dam Existing Planned	Loop Cut	Flood Discharge at Nakhon Sawan (m ³ /s)	Flood Discharge at Bang Sai (m ³ /s)	Water Level at Samsen (C.12) (MSL+m)	Water Level at Memorial Bridge (C.4) (MSL+m)		Total Inundation Volume (billion m ³)
Reappearance of Present Condition	○						4,600	4,150	2.32	2.20	15.9	
Influence by Urban Development (Providing Ring Levee with Drainage Pump)		○			○		4,430	4,070	2.80	2.57	16.0	
Influence by Change of Agricultural Cultivation (in combination with Urban Development)		○	○		○		4,430	4,070	2.81	2.57	16.1	
Influence by Land Subsidence (in combination with Urban Development and Change of Agricultural Cultivation)		○	○	○	○		4,430	4,070	2.81	2.56	16.2	
Influence by Construction of Dam (in combination with Urban Development and Change of Agricultural Cultivation)		○	○	○	⊙		4,110	4,000	2.77	2.53	14.7	
Influence by Construction of Loop Cut (in combination with Urban Development, Change of Agricultural Cultivation and Construction of Dam)		○	○	○	⊙	○	4,110	3,980	2.62	2.45	14.1	Future Basin Condition
Influence by Large Scale of Agricultural Development (in combination with Urban Development)		○	○		○		4,430	4,570	3.13	2.83	15.9	

⊙ : Actual outflow is applied for Baumipol Dam, but Sirikit Dam outflow is assumed to be regulated with a conduit newly added after the 1995 flood according to the current operation rule, resulting in no spillage.

Table 4.4.1 CUSTOMIZED IEE PARAMETERS

	Changes expected in	Diversion Channel	Retarding Basin	River Training
Physical Resources	Surface water Quantities (hydrology)	X	X	
	Surface water Quality	X	X	
	Ground water	X	X	
	Soil Fertility	X	X	
	Geology / Seismology			
	Sediments and Erosion	X	X	
	Climate			
Ecological Resources	Agriculture	X	X	
	Fisheries	X	X	
	Aquatic Biology	X	X	X
	Wildlife (Terrestrial Fauna)	X	X	
	Forests			
	Reservoir Ecology			
Human Use Values	Water Supply	X	X	
	Aquaculture			
	Navigation	X	X	X
	Flood Control			
	Mineral Development			
	Highways/ Railways	X	X	
	Land Uses	X	X	
Quality of Life Values	Socio-Economics	X	X	
	Resettlement	X	X	
	Public Health	X	X	
	Nutrition			
	Recreation and Aesthetics			X
	Archaeology and Historical Treasures	X	X	

Note: X is parameter to be examined.

Table 5.3.1 EFFECTIVENESS OF MEASURES WHEN SOLELY APPLIED

Type	Alternative Measures	Discharge at Nakhon Sawan ¹ in 1995 Flood (m ³ /s)	Discharge at Bang Sai in 1995 Flood (m ³ /s)	Water Level at Samsen (C.12) in 1995 Flood (m. MSL)	Water Level at Mem. Bridge (C.4) in 1995 Flood (m. MSL)	Total Inundation Volume in 1995 (billion m ³)	Flood Damage in 1995 (mil. Baht)	Decrease of Damage in 1995 (mil. Baht)	Cost ² (mil. Baht)	Decrease of Damages in 1995 by Cost	
Non-structure	Future Basin Condition in 2018 (Without Project)	4,110	3,980	2.62	2.45	14.1	143,535	-	-	-	
	Modification of Dam Operation Rule	Case1: Flood Control Capacity of 4,400 mil. m ³	4,020	3,960	2.59	2.43	13.7	132,829	10,706	minimum	infinite
		Case2: Flood Control Capacity of 6,700 mil. m ³	3,890	3,950	2.58	2.42	13.4	125,467	18,068	185 ³	97.66
		Case3: Flood Control Capacity of 9,100 mil. m ³	3,870	3,920	2.57	2.41	13.1	112,987	30,548	1,855 ³	16.49
	River Improvement from Nan and Yom to Pathum Thani	Case1: 2-year Return Period	4,250	4,570	2.97	2.97	13.2	540,234	-396,699	10,430	-38.03
		Case1: 3-year Return Period	4,290	5,200	3.33	3.33	13.9	1,543,899	-1,400,364	15,240	-91.89
		Case3: 5-year Return Period	4,350	5,400	3.46	3.46	13.7	2,034,769	-1,891,234	21,710	-87.11
	River Improvement from Chainat to Pathum Thani	Case1: 5-year Return Period	4,110	4,350	3.01	2.52	13.8	398,755	-255,220	3,490	-73.13
		Case2: 10-year Return Period	4,110	4,690	3.11	2.67	13.9	874,567	-731,032	4,170	-175.31
		Case3: 25-year Return Period	4,110	4,860	3.12	2.75	14.3	1,093,588	-950,053	4,850	-195.89
Pasak-Raphipat-Sea Diversion	Case1: Q= 500 m ³ /s	4,110	3,750	2.47	2.33	13.5	89,651	53,884	19,100	2.82	
	Case2: Q= 1,000 m ³ /s	4,110	3,450	2.39	2.32	13.4	53,465	90,651	32,000	2.83	
	Case3: Q= 1,500 m ³ /s	4,110	3,320	2.39	2.32	13.3	52,258	91,538	45,000	2.03	
Chainat-Pasak-Raphipat-Sea Diversion	Case1: Q= 500 m ³ /s	4,110	3,790	2.51	2.35	12.9	98,527	45,008	33,000	1.36	
	Case2: Q= 1,000 m ³ /s	4,110	3,540	2.38	2.24	11.9	46,397	97,138	60,000	1.62	
	Case3: Q= 1,500 m ³ /s	4,110	3,170	2.18	2.13	10.9	43,049	100,486	88,000	1.14	
Ayuthaya-East-Sea Diversion	Case1: Q= 500 m ³ /s	4,110	3,550	2.38	2.31	13.7	51,543	91,992	19,700	4.67	
	Case2: Q= 1,000 m ³ /s	4,110	3,140	2.23	2.19	13.4	45,559	95,100	31,400	5.06	
	Case3: Q= 1,500 m ³ /s	4,110	2,670	2.10	2.10	13.3	41,254	101,414	49,000	2.07	

*1: C.2 Station

*2: Financial Capital Cost (exclusive of price contingency)

*3: Net Present Value of Annual Financial Cost

Table 5.3.2 SIMULATION RESULT FOR TYPICAL RIVER TRAINING
IN 1995 FLOOD

Case	Maximum Discharge (m ³ /s)		Maximum Water Level in Bangkok*
	Nakhon Sawan C.2	Bang Sai	
Full Confinement in River	4,850	6,420	3.87
20 cm Dike Heightening	4,110	4,180	2.70

*:RID Samsen Station C.12

Table 5.3.3 DIKE HEIGHTENING COST FOR BANGKOK

Heightening Height (m)	Cost (Million Baht)	Running Cost (mil.Baht/year)
0.1	128	3
0.3	261	5
0.5	359	6
1.0	946	16
2.0	2,059	34

Table 5.3.4 DISTRIBUTION OF INUNDATION WATER IN PADDY FIELD

YEAR	VOLUME (mil.m ³)	DAMAGE (mil.Bhat)	Minimum DAMAGE (mil.Bhat)	DAMAGE REDUCED (mil.Bhat)	RATE (%)
1952	3,040	1,621	687	934	57.6
1953	2,774	1,447	365	1,082	74.8
1954	4,932	3,033	2,979	54	1.8
1955	3,054	1,643	705	938	57.1
1956	4,169	2,589	2,055	534	20.6
1957	5,501	4,089	3,668	421	10.3
1958	2,988	1,590	624	966	60.7
1959	5,488	4,080	3,653	427	10.5
1960	2,525	1,318	201	1,117	84.8
1961	3,485	1,727	1,227	500	29.0
1962	5,592	4,076	3,779	297	7.3
1963	4,149	3,189	2,031	1,158	36.3
1964	5,751	4,043	3,972	71	1.8
1965	2,250	861	61	800	92.9
1966	3,778	2,161	1,581	580	26.8
1967	2,542	1,247	210	1,037	83.2
1968	1,335	300	0	300	100.0
1969	3,944	2,137	1,783	354	16.6
1970	4,407	2,362	2,343	19	0.8
1971	2,878	1,545	491	1,054	68.2
1972	3,040	1,950	687	1,263	64.8
1973	3,039	720	687	33	4.6
1974	3,169	2,062	844	1,218	59.1
1975	5,167	3,458	3,264	194	5.6
1976	3,784	2,083	1,589	494	23.7
1977	2,446	1,104	161	943	85.4
1978	6,123	4,630	4,421	209	4.5
1979	1,860	0	0	0	-
1980	5,432	3,593	3,585	8	0.2
1981	2,860	635	469	166	26.1
1982	2,300	894	86	808	90.3
1983	5,415	4,825	3,564	1,261	26.1
1984	1,906	223	0	223	100.0
1985	3,174	1,551	850	701	45.2
1986	1,813	0	0	0	-
1987	3,270	1,615	966	649	40.2
1988	3,684	2,015	1,468	547	27.1
1989	2,216	1,125	44	1,081	96.1
1990	3,061	1,824	713	1,111	60.9
1991	1,926	0	0	0	-
1992	2,617	1,362	247	1,115	81.8
1993	1,590	0	0	0	-
1994	3,230	1,546	918	628	40.6
1995	6,659	5,851	5,277	574	9.8
1996	4,379	3,751	2,309	1,442	38.4
AVERAGE	3,528	2,042	1,435	607	29.7

Table 5.3.5 EFFECTIVENESS OF DRAINAGE CHANNEL IMPROVEMENT

(1) East Bank

Case	Decrease of Inundation Volume			Decrease of Inundation Duration			Decrease of Flood Damage			Cost (mil. Baht)	Ratio of Decreased Damage by Cost
	Average Vol. *1 (mil. m3)	Decreased Vol. (mil. m3)	Rate of Decrease (%)	Average Duration *2 (day)	Decreased Period (day)	(%)	Average Damage (mil. baht)	Decreased Damage (mil. Baht)	(%)		
Future Basin Condition	663	-	-	100	-	-	7,076	-	-	-	-
Case A-1	468	195	29	77	23	23	5,387	1,690	24	4,040	0.418
Case A-2	380	283	43	50	50	50	3,810	3,266	46	12,230	0.267
Case A-3	327	336	51	32	68	68	2,819	4,258	60	20,580	0.207
Case B-1	569	94	14	95	5	5	5,245	1,832	26	3,020	0.607
Case B-2	550	113	17	90	10	10	4,598	2,478	35	5,840	0.424
Case B-3	534	129	20	85	15	15	4,336	2,741	39	8,860	0.309

* 1 : Average inundation volume for three years, 1983, 1995 and 1996

* 2 : Average inundation period of three points for three years, 1983, 1995 and 1996

(2) West Bank

Case	Decrease of Inundation Volume			Decrease of Inundation Duration *			Decrease of Flood Damage *			Cost (mil. Baht)	Ratio of Decreased Damage by Cost
	Average Vol. *1 (mil. m3)	Decreased Vol. (mil. m3)	Rate of Decrease (%)	Average Duration *2 (day)	Decreased Period (day)	(%)	Average Damage (mil. baht)	Decreased Damage (mil. Baht)	(%)		
Future Basin Condition	726	-	-	120	-	-	7,437	-	-	-	-
Case A-1	303	423	58	56	64	53	3,045	4,391	59	10,400	0.422
Case A-2	197	529	73	29	91	76	1,925	5,512	74	24,500	0.225
Case A-3	147	579	80	13	107	89	1,357	6,079	82	38,280	0.159
Case B-1	474	252	35	83	37	31	5,181	2,256	30	3,100	0.728
Case B-2	442	284	39	79	41	34	4,603	2,834	38	5,900	0.480
Case B-3	413	313	43	75	45	38	3,909	3,528	47	9,020	0.391

* 1 : Average inundation volume for three years, 1983, 1995 and 1996

* 2 : Average inundation period of three points for three years, 1983, 1995 and 1996

Table 5.4.1 MAJOR ISSUES AND POINT TO SELECT SUITABLE MEASURES

Area divided	Contents of Major Flood Issue	Features of Flood Condition	Major points to select suitable measures	Conceivable Measures	
				Non-structural Measures	Structural Measures
Higher Central Plain	Damage to urban area	Protection works for urban area will not bring about severe influence to downstream.	To follow the protection works for urban area by PWD.	Flood plain management/ watershed management/ Institution and Organization/ Modification of Reservoir Operation Rule	Ring levee with drainage pump by PWD
	Damage to agricultural area	Protection for agricultural area may cause adverse influence to downstream.	To seek for measures to mitigate flood damage to agricultural area but not to cause the adverse influence to downstream.	- do -	River Training
	Damage to urban area	Protection works for urban area will not bring about severe influence to downstream.	To follow the protection works for urban area by PWD.	- do -	- do -
Nakon Swan Area	Damage to agricultural area	Protection for agricultural area may cause adverse influence to downstream.	To seek for measures to mitigate flood damage to agricultural area but not to cause the adverse influence to downstream.	- do -	River Training
	Damage to urban area	Protection works for urban area will not bring about severe influence to downstream.	To control and guide the change of land use condition. / To follow the protection works for urban area by PWD.	- do -	Ring levee with drainage pump by PWD
	Damage to agricultural area/ Change of land use/ Reservation of retarding effect	Protection for agricultural area may cause adverse influence to downstream. / Change of land use results in increase of flood damage and reduction of natural retarding effect.	To control and guide the change of land use condition. / To seek for measures to mitigate the flood damage in paddy field maintaining the natural retarding effect.	- do -	River Training and natural retarding basin with damage mitigation in agricultural area and diversion (Ayuthaya-E Bank-Sea route)
Lower delta in lower Central Plain	Damage to urban area/ expansion of urban area	Protection works for urban area will bring about severe influence to downstream, Bangkok/ Expansion of urban area will result in increase of flood damage.	To seek the measures to cope with the adverse influence. / To control and guide the change of land use condition.	Control of ground water extraction in addition to the above non-structural measures	Ring levee with drainage pump by PWD/ Diversion Channel/ other option (Heightening)
	Damage to agricultural area/ Change of land use/ Reservation of retarding effect	Protection for agricultural area may cause adverse influence to downstream. / Change of land use results in increase of flood damage and reduction of natural retarding effect.	To control and guide the change of land use condition. / To seek measures to mitigate flood damage in paddy field maintaining the natural retarding effect.	Control of ground water extraction in addition to the above non-structural measures	Natural retarding basin with damage mitigation in agricultural areas and Diversion (Ayuthaya-E Bank-Sea route)

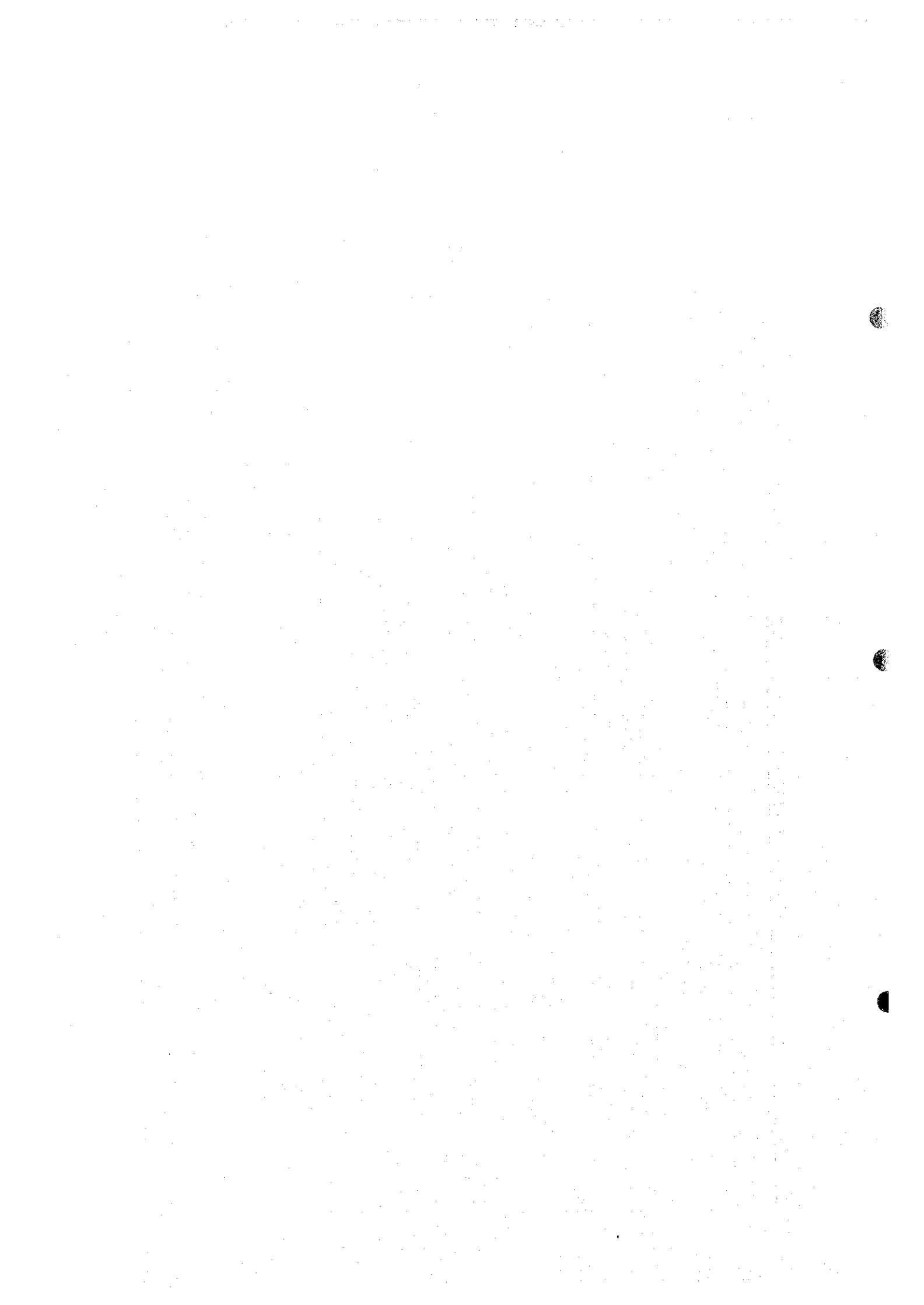


Table 6.1.1 EFFECTIVENESS OF THE DIVERSION FOR AGRICULTURAL AREA

Diversion Route	Ayutthaya-East-Sea
Flow Capacity	300 m ³ /s
Financial Initial Cost (million baht)	11,525
Financial O/M Cost (million baht/year)	106
Economic Initial Cost (million baht)	9,230
Economic O/M Cost (million baht/year)	101
Benefit (million baht/year)	314
Net Present Value (12% discount rate)	-2,840
B/C (12% discount rate)	0.16
EIRR (%)	0.68

Table 6.1.2 COST COMPARISON BETWEEN CHAINAT-PASAK-SEA DIVERSION AND RIVER IMPROVEMENT

	Chainat-Pasak-Sea Diversion	River Improvement
Required Capacity	800 m ³ /s	10-year
Equipment and Financial Cost (exclusive of O&M cost) (million baht)	26,000	1,425

Table 6.1.3 COMPARISON OF OPTION TO MITIGATE FLOOD DAMAGE

Option	Safety Level		Description	Advantage and Disadvantage
	Bangkok	Pathum Thani and Nontha Buri		
(1) To maintain the present condition of Pathum Thani and Nontha Buri	125-year return period	2-3 year return period	Suspension of planned protection works by PWD	From technical, economical and environmental point of view, there may be no issues. From social point of view, inhabitants in urban areas, Pathum Thani and Nonthaburi, will not accept to maintain the present safety level in the future. The option can not cope with the situation to enhance the protection level of agricultural area in the upstream in the future.
(2) To enhance the safety level up to the allowable level	100	5	The safety level of Bangkok can be enhanced more than 100-year return period by loop cut at port. Therefore there is a room to enhance the safety level of Pathum Thani and Nontha Buri for that part.	From technical, economical and environmental point of view, there may be no issues. From social point of view, inhabitants in urban areas, Pathum Thani and Nonthaburi, will not accept to maintain the present safety level in the future. The option can not cope with the situation to enhance the protection level of agricultural area in the upstream in the future.
(3) To lower the safety level at Bangkok	50	7	The safety level of Bangkok will be reduced to 50-year return period for example, while those of Pathum Thani and Nontha Buri be enhanced to 7 year return period for example.	From technical, economical and environmental point of view, there may be no issues From social point of view, inhabitants in urban areas, Pathum Thani and Nonthaburi, will not accept to maintain the present safety level in the future. The option can not cope with the situation to enhance the protection level of agricultural area in the upstream in the future.
(4) To narrow the protection area of Pathum Thani and Nontha Buri	100	100, and 2-3	The protection area of Pathum Thani and Nontha Buri is narrowed down to the extent, in which adverse influence to Bangkok is not severe.	From technical, economical and environmental point of view, there may be no issues. From social point of view, inhabitants in urban areas may oppose delineation of protected and not protected areas in the same municipality level in the future. The option can not cope with the situation to enhance the protection level of agricultural area in the upstream in the future.
(5) To heighten the flood barrier at Bangkok	100	100	To further heighten the flood barrier at Bangkok from ongoing project.	From the technical and economical point of view, the works will not involve serious issues. From environmental and social points of view, this option will cause serious issues. The option can not cope with the situation to enhance the protection level of agricultural area in the upstream in the future.
(6) To provide diversion channel	100	100	To provide diversion channel to absorb the adverse influence.	From the technical point of view, the works will not involve serious issues. From the environmental point of view, issues derived from the option will be solved. From economical point of view, this works will require a huge burden to the country. From social point of view, this option will cause issues for land acquisition and house evacuation. This option can be used for enhancement of the safety level of agricultural areas.

Table 6.1.4 REQUIRED CAPACITY OF AYUTTHAYA-EAST-SEA DIVERSION

Capacity of AES Diversion (m ³ /s)	Combination of Applicable Measures			Discharge at Nakhon Sawan* ¹ in 1995 (m ³ /s)	Discharge at Bang Sai in 1995 (m ³ /s)	Water Level at Samsen (C.12) in 1995 (m MSL)	Water Level at Memorial Bridge (C.4) in 1995 (m MSL)	Total Inundation Volume in 1995 (billion m ³)
	Dam	Retarding	River Improvement					
800 m ³ /s	14,600 mil. M3	5,600 km ²	10yr (Chainat to Pathum Thani)	3,820	3,230	2.26	2.20	12.4
1,100 m ³ /s	14,600 mil. M3	5,600 km ²	25yr (Chainat to Pathum Thani)	3,820	3,490	2.32	2.18	11.6

Note : The required capacity has been estimated so that the water levels at Samsen and the Memorial Bridge could be lowered below the actual levels in 1995, namely 2.32 and 2.20 m MSL respectively.

Table 6.1.5 COMPARISON STUDY OF ALTERNATIVES

Item	Sub-item	Description		
		Alternative-1	Alternative 2-1	Alternative 2-2
Technical Aspect	Technical difficulty for the construction	Technically, conventional method is applied and thus, any technical difficulty will not arise.	Same as Alt.-1	Same as Alt.-1
	Influence to enhancement of flood damage potential	Design high water level will not be changed, and thus no influence to flood damage potential	Design high water level will be heightened, and thus flood damage potential will be enhanced.	Same as Alt.-1 (no influence)
	Influence to inland drainage in urban area	River water level is as same as present condition, therefore no influence to drainage condition.	Due to heightening of flood barrier, drainage condition will be affected.	No influence to drainage condition.
	Contribution to drainage system improvement in lower delta area (east bank side)	Alt.-1 will not contribute to drainage system improvement in lower delta area.	Alt.2-1 will affect to drainage system improvement due to heightening of water level.	Diversion channel can be used as facilities for drainage system and thus it will greatly contribute.
Economic Aspect	Possibility to cope with the situation for enhancement of safety level in upstream (river improvement in upstream)	Alt.-1 cannot cope with the situation for enhancement of safety level in upstream.	Alt.2-1 can cope with the situation by further heightening of flood barrier.	Alt.2-2 can cope with the situation by further increase of flow capacity.
	Construction cost	Economically, the alternative requires the least cost among alternatives.	Economically, the alternative requires less cost compared with Alt.2-2.	Economically, the alternative requires the highest cost among alternatives.
Enviro. aspect	Benefit	The benefit is the least among alternatives.	The benefit is less compared with Alt.2-2.	The benefit is the highest.
	Natural environment	Alt.-1 will not have significant impact from ecological point of view.	Alt.2-1 will not have significant impact from ecological point of view.	Alt.2-2 will not have significant impact from ecological point of view.
Social Aspect	House evacuation and land acquisition	Alt.1 will not require any number of house evacuation and land acquisition.	Alt.2-1 will not require any number of house evacuation and land acquisition.	Alt.2-2 will require a large number of house evacuation and land acquisition.
	People affected, who live and/or are engaged in business activities in riparian area.	Alt.1 will not have any people affected, who live and/or are engaged in business activities in riparian area.	Alt.2-1 will have a large number of people affected due to heightening of flood barrier.	Alt.2-2 will not have any people affected, who live and/or are engaged in business activities in riparian area.
Other Aspect	People and assets which are not protected	Alt.1 will have many people and assets which are not protected.	People and assets in urban areas will be protected in principle by Alt.2-1.	People and assets in urban areas will be protected in principle by Alt.2-2.
	Influence to tourist industry	No significant influence to tourist industry will be expected.	Severe influence to tourist industry will be expected due to heightening of flood barrier.	No significant influence to tourist industry will be expected.
Other Aspect	Contribution to regional development	Regional development will be hampered.	No specific contribution will be expected.	Alt.2-2 will greatly contribute to regional development providing infrastructures.
	Contribution to water resources development	No specific contribution will be expected.	No specific contribution will be expected.	Diversion channel can be used as facilities for water resources development.
	Contribution to transportation system improvement	No specific contribution will be expected.	No specific contribution will be expected.	Diversion channel can be used as facilities for transportation.

Table 6.1.6 COMPARISON OF ALTERNATIVES

Item	Sub-item	Evaluation for Alternative		
		Alt.-1	Alt.2-1	Alt.2-2
Technical Aspect	Technical difficulty for the construction	○	○	○
	Influence to enhancement of flood damage potential	○	×	○
	Influence to inland drainage in urban area	○	×	○
	Contribution to drainage system improvement in lower delta area (east bank side)	○	○	◎
	Possibility to cope with the situation for enhancement of safety level in upstream (river improvement in upstream)	○	○	◎
Economic Aspect	Construction cost	◎	◎	×
	Benefit	○	○	○
Environmental Aspect	Natural environment	○	○	○
Social Aspect	House evacuation and land acquisition	○	○	×
	People affected, who live and/or are engaged in business activities in riparian area.	○	×	○
	People and assets which are not protected	×	○	◎
	Influence to tourist industry	○	×	○
	Contribution to regional development	×	○	◎
Others	Contribution to water resources development	○	○	◎
	Contribution to transportation system improvement	○	×	◎

Legend ◎ : Great advantage in comparison among three alternatives
 ○ : No advantage or no disadvantage
 × : Disadvantage

Table 6.1.7 AFFECTED AND BENEFICIAL AREAS BY ALTERNATIVES

Area	Affected Area			Beneficial Area		
	Alt.-1	Alt.2-1	Alt.2-2	Alt.-1	Alt.2-1	Alt.2-2
Ayuthaya	Not affected in principle.	Not affected in principle.	Land acquisition and house evacuation are required.	Not be beneficial in principle.	Not be beneficial in principle.	Be beneficial, if further enhancement of safety level is achieved.
Pathum Thani	Some areas cannot be protected.	- do -	- do -	Be beneficial in protected area.	Be beneficial by protection.	Be beneficial by protection.
Nonthaburi	Some areas cannot be protected.	- do -	- do -	Be beneficial in protected area.	Be beneficial by protection.	Be beneficial by protection.
Bangkok	Not affected in principle.	Many people will be affected by heightening of flood barrier.	- do -	Not be beneficial in principle.	Be beneficial by protection.	Be beneficial by protection.
Samut Prakan	- do -	Not affected in principle.	- do -	Not be beneficial in principle.	Be beneficial by protection.	Be beneficial by protection.
Upstream of Ayuthaya to Chainat	- do -	- do -	- do -*	Not be beneficial in principle.	Not be beneficial in principle.	Be beneficial, if further enhancement of safety level is achieved.

*: Minor land acquisition may be required when river improvement is provided in combination with diversion channel for enhancement of safety level of agricultural area.