OFFICE OF THE NATIONAL WATER RESOURCES

The Project of the Study of
Strategic Environmental Assessment
And the Master Plan of Water Resource Management

MAE KLONG RIVER BASIN

Executive Summary

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1. Background of the project

Mae Klong River Basin covers all eight provinces: Tak, Uthai Thani, Kanchanaburi, Suphan Buri, Nakhon Pathom, Ratchaburi, Samut Sakhon and Samut Songkhram. It has the area of 30,223.56 square kilometers or 18.89 million rai which is divided into 17 tributaries. Mae Klong River originates from Kwai Noi River and Kwai Yai river and passes through Kanchanaburi, Ratchaburi, Samut Songkhram, then empties into the Gulf of Thailand with its length about 589 kilometers.

Most of the watershed areas are forest in the National Reserved Forest, approximately 10.87 million rai or 57.54% of the watershed area; an agricultural area approximately 4.54 million rai. Mae Klong River Basin still faces water shortage problem during dry season in these districts in Kanchanaburi, such as Nong Prue Districts, Bo Ploy, Lao Khwan, Phanom Thuan, Makham Tia Dan, Sai Yok, Tha Muang and Muagn Kanchanaburi, and also Suan Phueng District, Chom Bueng District in Ratchaburi Province. The flood situation usually occurs at the confluence of tributaries such as Lam Phachi and Kwai Noi River, Lam Taphen and Khwae Yai River and the lowlands estuary and coastal plains of Mae Klong River Basin. There are also the problem of water quality in the plains along Mae Klong River and the estaury from the community, and chemicals from agriculture and livestock. There is also the declaration area for the special economic zone in Kanchanaburi, including Kaeng Sian Sub-district and Ban Kao Subdistrict in Mueang Kanchanaburi District.

From these problems in this area, it is necessary to expedite the water management system plan for the whole system and water needs management according to the city development due to the difficulty of water storage development and the links with neighboring countries, etc. Therefore, the National Water Resources Office as the central agency which set water resource management policy should make the study for the strategy environment evaluation in Mae Klong River Basin so that the the watershed development is friendly to the environment without any impacts or having an acceptable level of impact and in accordance with the 20-Year Water Resources Management Master Plan (2018-2037). It should also prepare Master Plan of the Water Resources Management, prioritizing future

development projects, preventing floods and solving drought problems for the framework of water resource management in Mae Klong River Basin so that all relevant agencies can implement, reduce redundancy of planning and establish the framework to manage ground water resources for maximum benefits

2. Objectives of the Study

1) To study and prepare the Strategic Environmental Assessment (SEA) report of Mae Klong River Basin.

2) To review and analyze the operations of water resource development in the studying areas for the past projects in order to prepare the master plan of the 20-year water resource management (2018-2037), to evaluate the results of the past operation during the year 2018-2021 and to set an action plan of water resource management in the year 2022-2027.

3. Scope of Study Area

Mae Klong River is the main river of Mae Klong River Basin which is approximate 589 kilometers long. It is originated from the confluence of Khwae Noi River and Khwae Yai River. It flows through Kanchanaburi, Ratchaburi, Samut Songkhram and flows out into the Gulf of Thailand. The study area covers the entire Mae Klong River Basin and other related basins. According to the Royal Decree Determining the Watershed B.E. 2021, the secondary law in the Water Resources Act B.E. 2561 which is published in the Government Gazette on February 11, 2021, Mae Klong River Basin consists of 17 tributaries, covering an area of 30,223.56 square kilometers or 18.89 million rai, covering the administrative areas of 8 provinces (Tak, Uthai Thani, Kanchanaburi, Suphan Buri, Nakhon Pathom, Ratchaburi, Samut Songkhram and Samut Sakhon) ,34 districts and 258 sub-districts which is shown in **Table 3-1** and **Figure 3-1**.

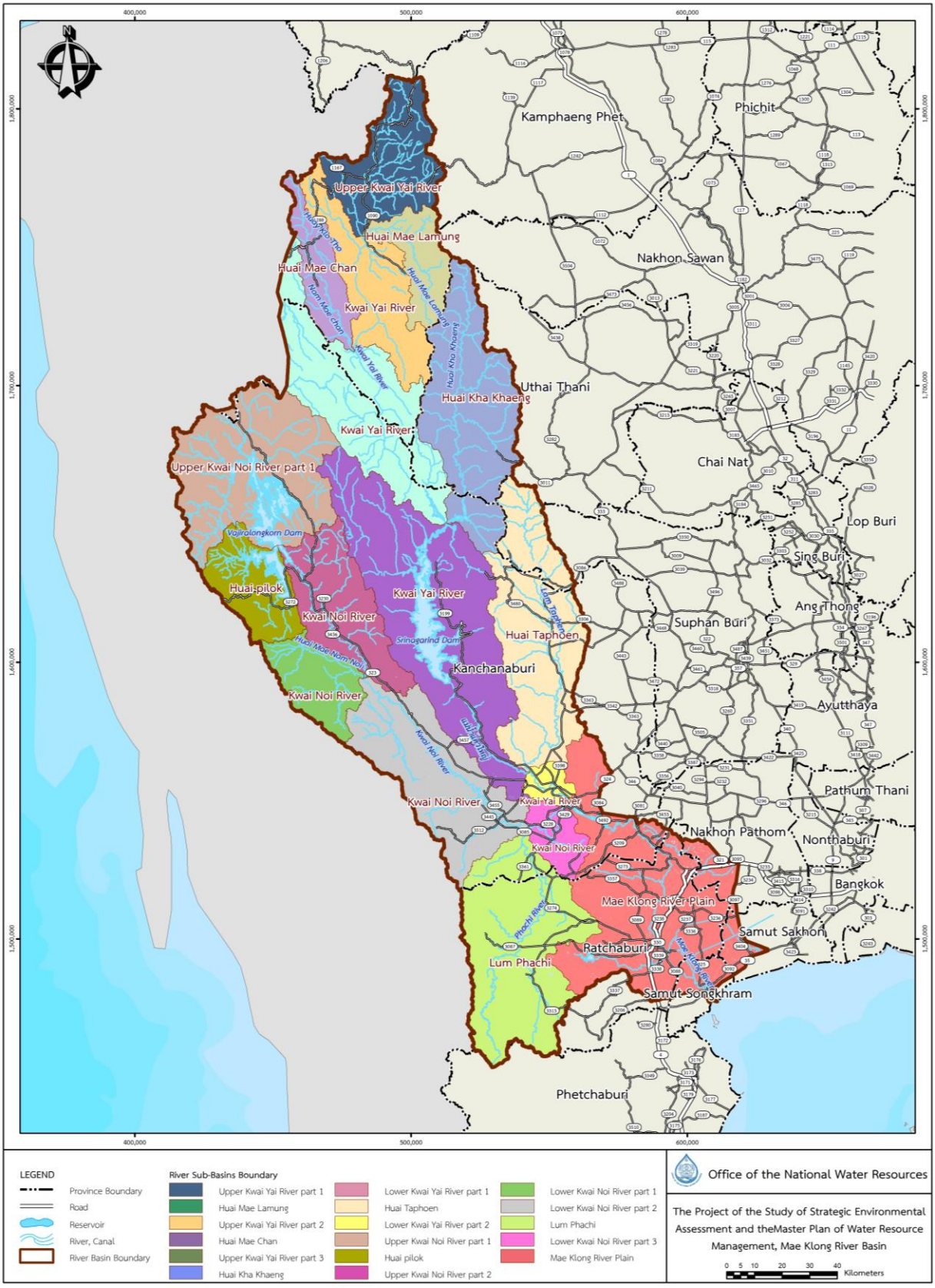

Figure 3-1 The Scope of Mae Klong River Basin

Table 3-1 Administrative boundaries in Mae Klong River Basin

No.	Province	Area (sq km)	% of the basin area	District		Sub-district		
1	Tak	4,817.93	15.94	1.1	Umphang	1. Mokro	2. Umphang	3. Nong Luang
						4. Mae Klong	5. Mae Chan	6. Mae Lamung
2	Uthai Thani	2,237.66	7.40	2.1	Ban Rai	1. Kaen Makrut	2. Khok Khwai	3. Chao Wat
				2.2	Lan Sak	1. Rabam		
				2.3	Huai Khot	1. Thonglang		
3	Kanchanaburi	17,327.03	57.33	3.1	Mueang Kanchanaburi	1. Chong Sadao	2. Wang Dong	3. Lat Ya
						4. Nong Bua	5. Kaeng Sian	6. Pak Phraek
						7. Tha Makham	8. Ban Nuea	9. Ban Tai
						10. Ban Kao	11. Nong Ya	12.Ko Samrong
						13. Wang Yen		
				3.2	Lao Khwan	1. Thung Krabam		
				3.3	Sai Yok	1. Sai Yok	2. Tha Sao	3. Wang Krachae
						4. Lum Sum	5. Sing	6. Bongti
						7. Si Mongkhon		
				3.4	Dan Makham Tia	1. Klondo	2. Nong Phai	3. Dan Makham Tia
						4. ChorakhePhueak		
				3.5	Thong Pha Phum	1. Chalae	2. Pilok	3. Tha Khanun
						4. Hin Dat	5. Huai Khayeng	6. Linthin
						7. Sahakon Nikhom		
				3.6	Tha Muang	1. Nong Khao	2.Thung Thong	3. Tha Lo
						4. Wang Sala	5. Khao Noi	6. Wang Khanai
						7. Tha Muang	8.Muang Chum	9. Ban Mai
						10. Rang Sali	11.Tha Takhro	12. Phang Tru
						13. Nong Tak Ya		
				3.7	Tha Maka	1. Takhram En	2. Don Chaem	3. Tha Ruea
						4. Tha Maka	5. Saen To	6. Yang Muang
						7. Tha Mai	8. Wai Niao	9. Phong Tuek
						10. Don Khamin	11. Tha Sao	12. Khok Tabong
						13. Khao Samsip Hap		
				3.8	Bo Phloi	1. Nong Ri	2. Nong Krang	3. Lum Rang
						4. Chong Dan	5. Bo Phloi	6. Nong Kum
				3.9	Phanom Thuan	1. Nong Rong	2.Thung Samo	
				3.10	Si Sawat	1. Khao Chot	2. Na Suan	3. DanMae Chalaep
						4. Mae Krabung	5. Nong Pet	6. Tha Kradan
				3.11	Sangkhla Buri	1. Laiwo	2. Nong Lu	3. Prangphle
				3.12	Nong Prue	1. Nong Pla Lai	2. Nong Prue	3. Somdet Charoen

Table 3-1 Administrative boundaries in Mae Klong River Basin (continue)

No.	Province	Area (sq km)	% of the basin area	District		Sub-district		
4	Suphan Buri	604.58	2.00	4.1	Dan Chang	1. Wang Yao	2. Dan Chang	3. Ong Phra
						4. Nikhom Krasiao		
5	Nakhon Pathom	252.74	0.84	5.1	Mueang Nakhon Pathom	1.Nakhon Pathom	2. Thap Luang	3. Ban Yang
						4. Phrong Maduea	5. NongPakLong	6. Wang Taku
						7. Sanam Chan	8. Lam Phaya	9. Phra Pathom Chedi
						10. Nong Din Daeng	11. Huai Chorakhe	12. Phra Prathon
						13. BangKhaem	14. ThanonKhat	15. Sa Kathiam
						16. Wang Yen	17. Suan Pan	18. Don Yai Hom
				5.2	Sam Phran	1. Talat Chinda		
6	Ratchaburi	4,586.19	15.17	6.1	Mueang Ratchaburi	1. Khao Raeng	2. NongKlangNa	3. Sam Ruean
						4. Tha Rap	5. KoPhlapphla	6. Hin Kong
						7. Lum Din	8. PhikunThong	9. Bang Pa
						10. Khok Mo	11. Nam Phu	12. Chedi Hak
						13. Phong Sawai	14. Na Mueang	15. Ban Rai
						16. Don Tako	17. Huai Phai	18. Khung Krathin
						19. Ang Thong	20. Khu Bua	21. Don Rae
						22. KhungNamWon		
				6.2	Photharam	1. Tao Pun	2. Nong Kwang	3. Khao Changum
						4. Don Krabueang	5. Chamrae	6. Ban Lueak
						7. Nong Pho	8. Photharam	9. Soi Fa
						10. Nang Kaeo	11. Don sai	12. Khlong Ta Khot
						13. Khlong Khoi	14. Ban Khong	15. Thammasen
						16. Chet Samian	17. Bang Tanot	18. Ban Sing
						19. Tha Chumphon		
				6.3	Chom Bueng	1. Kaem On	2. Dan Thap Tako	3. Boek Phrai
						4. Chom Bueng	5. Pak Chong	6. Rang Bua
				6.4	Damnoen Saduak	1. Don Khlang	2. Don Khlang	3. Bua Ngam
						4. Ban Rai	5. Phaengphuai	6. Don Phai
						7. Prasat Sit	8. Tha Nat	9. Si Surat
						10. Si Muen	11. Damnoen Saduak	12. Khun Phithak
						13 Ta Luang		

Table 3-1 Administrative boundaries in Mae Klong River Basin (continue)

No.	Province	Area (sq km)	% of the basin area	District		Sub-district		
6	Ratchaburi			6.5	Bang Phae	1. Don Yai	2. Wang Yen	3. Bang Phae
						4. Don Kha	5. Wat Kaeo	6. Hua Pho
						7. Pho Hak		
				6.6	Ban Pong	1. Krap Yai	2. Tha Pha	3. Pak Raet
						4. Lat Bua Khao	5. Ban Pong	6. Khao Khlung
						7. Nong Kop	8. Boek Phrai	9. Nong Pla Mo
						10. Khung Phayom	11. Suan Kluai	12. Nong O
				6.7	Ban Kha	1. Nong Phan Chan	2. Ban Kha	3. Ban Bueng
				6.8	Pak Tho	1. Ang Hin	2. Bo Kradan	3. Thung Luang
						4. Pa Kai	5. Nong Krathum	6. Wat Yang Ngam
						7. Pak Tho	8. Don sai	9. Yang Hak
						10. Wan Dao		
				6.9	Wat Phleng	1. Ko San Phra	2. Wat Phleng	3. Chom Prathat
				6.10	Suan Phueng	1. Pa Wai	2. Suan Phueng	3. Tha Khoei
						4. Tanao Si		
7	Samut Sakhon	181.74	0.60	7.1	Mueang Samut Sakhon	1. Chai Mongkhon	2. Bang Krachao	3. Bang Tho Rat
						4. Ka Long	5. Na Khok	
				7.2	Ban Phaeo	1. Ban Phaeo	2. Nong Bua	3. Nong Song Hong
						4. Lak Sam	5. Yokkrabat	6. Rong Khe
8	Samut Songkhram	215.69	0.71	8.1	Mueang Samut Songkhram	1. Nang Takhian	2. Lat Yai	3. Bang Kaeo
						4. Khlong Khoen	5. Ban Prok	6. Mae Klong
						7. Bang Khan Taek	8. Thai Hat	9. Bang Chakreng
						10. Laem Yai		
				8.2	Bang Khonthi	1. Bang Kung	2. Don Manora	3. Bang Khonthi
						4. Bang Yi Rong	5. Chom Pluak	6. Yai Phaeng
						7. Kradangnga	8. Rong Hip	9. Ban Pramot
						10. Bang Krabue	11. Bang Sakae	12 Bang Phrom
						13. Bang Nok Khwaek		
				8.3	Amphawa	1. Tha Kha	2. Mueang Mai	3. Bang Chang
						4. Khwae Om	5. Wat Pradu	6. Suan Luang
						7. Amphawa	8. Bang Khae	9. Bang Nang Li
						10. Plai Phongphang		
Total					**34**	**258**		

4. The Summary of the Strategic Environmental Assessment Study

1) Watershed Area: Mae Klong River Basin has a total area of 30,223.56 sq km. The watershed is divided physically into 17 tributaries (see Figure 3-1 and Table 3-1), covering 258 administrative sub-districts, 34 districts, in eight provinces: Tak, Uthai Thani, Kanchanaburi, Suphan Buri, Nakhon Pathom, Ratchaburi, Samut Songkhram and Samut Sakhon. These areas have Mae Klong River as the main river and important tributaries for water use activities, such as Khwae Yai, Khwae Noi, Lam Taphen, and Lam Phachi. Most of the agriculture, irrigation and industry development take place in the area of lower part of Mae Klong River Basin. There is water use for cultivation, consumption, and pushing the estuary water in both Mae Klong River Basin and Tha Chin River. It is also an important source of water for the Metropolitan Waterworks Authority. There is an average rainfall of 1,379 millimeters, with the highest average rainfall in Thong Pha Phum District, Sangkhlaburi District, Sai Yok District (Kanchanaburi Province), and the lowest average annual rainfall in these districts such as Lao Khwan, Si Sawat, Tha Maka. Tha Muang, Phanom Thuan in Kanchanaburi Province, Wat Phleng, Chom Bueng, Photharam in Ratchaburi Province and the average annual runoff for the whole basin is 16,541.67 million cubic meters.

2) Land Use: In 2020, there are the areas for land use: 67.12% for forested area, 24.06% for agricultural area, 2.99% for community area and 0.32% forindustrial area. The total agricultural area is approximately 4.545 million rai, which is 1.0303 million rai for agricultural area in the irrigated area and 3.242 million rai for rainwater agriculture.

3) Forest Resources and Legal Conservation Areas: Legal conservation areas include the national forest reservation of 17,390.14 sq km, or 57.5% of the watershed area. Most are forest conservation areas (Zone C), 9 national parks, 6 non-hunting areas and 5 wildlife sanctuaries totaling 18,107.88 square kilometers (11,317,425 rai), accounting for 59.91 percent of the river basin areas. Mangrove forests are maintained with a total of 16,427 rai, two world heritage sites: Thung Yai Naresuan Wildlife Sanctuary and Huai Kha Khaeng and Kaeng Krachan Forest Group. One of the important international wetareas or Ramsar site is Don Hoi Lod with approximately 875 sq km and 5 important international forest areas in Mae Klong River Basin has a tendency to change from the past. According to a search of the Information and Communication Technology Center of the Royal Forest Department in 2021, it was found that there are 11 degraded forest restoration projects in the Mae Klong River Basin, the area of 5,900 rai.

4) Economic Condition: The average gross provincial product (GPP) of the year 2019 has a total value of 1,291,359 million baht; increasing 39,050 million baht from 2018 (3.12 percent), which has gross provincial product value 1,252,309 million baht. The average population income is 224,003 baht per person per year and the main economy is in the industrial sector (52.22%), the service sector (36.65%) and the agriculture sector (11.13%), respectively. In the future trend, the province potential and the government promotion make the industrial sector still plays the most important role in driving the economy of this watershed area. At the same time, entrepreneurs will develop their trade potential. Higher investment and marketing in order to be able to compete to neighboring countries. However, most of the industrial sectors are the industrial continuing from the agricultural sectors, such as the food processing industry and sugar industry which require base of the production from the agricultural sector. Along with the occupation of the population mainly in the agricultural sector, so the creation of water security in the agricultural sector both in terms of procurement and reduction, and efficiency increase will be the important factor in driving the economy of this watershed area.

5) Population and Social Characteristics: In Mae Klong River Basin, there is a total population of 1,756,499 people according to the civil registration in 2019, with a total number of households of 676,983 households. The growth of the population is likely to increase, especially in the upstream and central areas of Mae Klong River Basin. Population needs more space for economic activities and living while in the lower area of Mae Klong River Basin, there is the decreasing of the proportion of population in the watershed.

6) Urban system: Urban system organization and roles and duties of urban communities at the particle level of lower northern provinces 1, lower northern provinces 2 and lower central provinces 2021, are classified of service center cities of Mae Klong River Basin from the particle level to the district level. These play a variety of roles such as tourism centers, investment trade and agriculture that affects water management. The center of particle level in Mae Klong River Basin from Mueang Ratchaburi District, Ratchaburi Province and through Lum Sum Subdistrict, Sai Yok District, Kanchanaburi Province has the direction of development as a center for ecotourism, the Western Region History and Dvaravati Civilization.

7) Travel: Mae Klong River Basin has the potential to attract tourists; it is important area of diversity of tourist attractions, natural, historical, cultural, traditions, waterfront communities and agricultural areas which remain identity, especially Kanchanaburi, Ratchaburi, Samut Songkhram provinces that have a variety of tourist attractions. However, the environment within some remote tourist attractions still needs to be restored and developed, and create the connection of tourism routes in the area as well as promoting the development of new interesting and possible tourism activities in the future. There are the average total of 15,628,172 tourists per year, earning 44,974 million baht from tourism. From the results of the assessment, there is an average increase in the number of tourists about 7.44% per year. So in the year 2039 Mae Klong River Basin will receive approximately 24.07 million visitors per year, with tourism revenue increasing to 67,003 million baht. Considering to the potential of the tourist area and the capacity to support the accommodation in the watershed area as a whole, it was found that there will still be sufficient to support the number of future visitors in the next 20 years.

8) Agriculture: The main agricultural crops in Mae Klong River Basin are sugarcane, rice, cassava, variety of fruit, such as mango, longan, lychee, coconut, pomelo and banana, perennial plants and vegetables. There are aquaculture areas and pig farms in the bottom area of the basin which the largest number of pig farms in Ratchaburi. The agricultural areas that use water from Mae Klong River Basin are divided into two groups. **The first group** is an agricultural area within Mae Klong River Basin, approximately 4.545 million rai which is divided into the areas with irrigation systems of large projects. (Only in Mae Klong River Basin), medium projects and small project which have electric water pumping total of 1.303 million rai. And the rest is 3.242 million rai are agricultural land in the rain-dwelling area, in dry season, the most is not planted due to lack of water. **The second group** is the area out of Mae Klong River Basin that receives irrigation water from Mae Klong Yai Project approximately 1.442 million rai, total of 5.988 million rai from agricultural land that uses water from Mae Klong River Basin.

9) Industry: At present, in Mae Klong River Basin: there are one industrial estate, namely Ratchaburi Industrial Estate, an industrial factory located in 2,799 watershed areas, which the investment amount is 228,389.17 million baht and the total number of workers is 137,827 people. Most of the factories are in the food industry. At the same time, there are also 1,867 community enterprises/community enterprise networks, most of them are located in Mae Klong River plain tributaries and Huai Taphen River Basin.

10) Development of water resources and irrigation: The current water resource development and irrigation projects consist of 3 large water resources development projects with a total storage capacity of 26,660 million cubic meters, and 10 large irrigation projects with a total irrigation area of 2.34 million rai. In addition, there are 18 medium-sized water resource development and irrigation projects with storage capacity, the total quarantine is 145 million cubic meters. The total irrigation area and the benefited area are 129,611 rai, and 213 small water resources development projects and electric water pumping projects, the total storage capacity is 57.24 million cubic meters, the irrigation area and the benefited area total of 256,090 rai. **The Projects of Water Resource and Irrigation Development in the Future**, there are 20 projects from the Royal Irrigation Department to develop water resources and irrigation projects of the Royal Irrigation Department, with a total storage capacity of 96.51 million cubic meters, with a total irrigation area of 83,640 rai and a total benefit area of 65,585 rai.

11) Potential for groundwater: Hydrogeological conditions: water supply of the groundwater layer in Mae Klong River Basin, including the total of Mae Klong River Basin is 30,117.82 square kilometers. Most of which have groundwater potential less than 2 cubic meters/hour, covering an area of 24,666.19 square kilometers. It has groundwater potential that can be developed and used without causing environmental impacts in Mae Klong River Basin with a total volume of 1,909 million cubic meters / year. In 2021, there are 1,915 groundwater wells that have been approved by the Department of Groundwater Resources, a total of 160.21 million cubic meters / year of groundwater use licenses, and have shallow groundwater wells a total of 16,686 wells, representing the use of shallow groundwater at 180.37 million cubic meters/year. When including groundwater use in Mae Klong River Basin from the aforementioned, it was found that the total groundwater use was approximately 340.58 million cubic meters/year. This is less than the potential of the groundwater usage development that not cause the environmental impacts. **For the issue of groundwater quality**, the overview of groundwater quality in Mae Klong River Basin was mainly characterized by temporary hard water or soft water, except in the coastal areas that shown brackish or saline water from seawater intrusion. It was also found iron and manganese values exceeding the standards of groundwater for consumption in some areas, and found the contamination of fecal coliform bacteria in many areas, so it should require continuous monitoring and surveillance of groundwater quality.

12) Water Demand: From the study of water demand according to various current activities, it was concluded that the total water demand was 12,017.20 million cubic meters. It consists of; **1) Water Demand for Agriculture and Irrigation**: There is a total of water demand for agriculture 8,135.80 million cubic meters which is divided into 2,862.20 million cubic meters for the outside irrigation areas, 5,273.60 million cubic meters for the irrigation areas (including losses in the water delivery system). **2) Water Demand for Consumer**: There is a total water demand for the current state of 91.63 million cubic meters/year which is divided into 32.27 million cubic meters of water in PWA and outside PWA. 59.36 million cubic meters. **3) Water Demand for Tourism**: At present, 2.11 million cubic meters/year **4) Water Demand for Industry**: 245.83 million cubic meters/year **5) Water Demand for Livestock**: The amount of water demand in the present condition is 29.18 million cubic meters/year. **6) Water Demand for Maintaining the Ecological Balance in Mae Klong River Basin**: The average annual water volume is 1,576.00 million cubic meters. **7) Water Demand from Chao Phraya River Basin and Tha Chin River Basin**: The rate of water diversion to the Chao Phraya Project at the lower west coast through the Jor-rakae - Sam Phan Klong, the average annual water volume is 699.37 million cubic meters, through Thasan-Bang Pla Canal; the average annual water volume is 699.37 million cubic meters. **Water diversion rate to produce tap water for the Metropolitan Waterworks Authority**, there is the maximum of the quantity not exceed 45 cubic meters /sec. At present, the actual volume of water diversion of the water supply canal is 537 million cubic meters. In the next 20 years, the total water consumption will trend to increase to 13,458.56 million million baht due to increasing water use from the activities 1) to 6) which will bring the total water demand of the entire basin closer to the limitation of the available cost water supply according to the basin's natural conditions. Water sources for consumption from groundwater sources will increase the demand for water. The areas trend to lack of water include Nong Prue District, Bo Ploy, Lao Khwan, Phanom Thuan, Sai Yok, Dan Makham Tia, Mueang Kanchanaburi and Tha Muang in Kanchanaburi Province and Suan Phueng District in Ratchaburi Province

13) Potential of Suitable Soil for Cultivation: Overview of agricultural areas within Mae Klong River Basin, there was a problem of land use that was not suitable for the land performance. The study was found that the quality of soil potential for cultivating crops and rice are good to moderate, for rice cultivating is in the lowland with a total of 720,291 rai, for field crops in the upland with a total of 2,736,777 rai, for fruit and perennial planting, with a total of 2,102,331 rai. However, at present, land use in the upland areas with good drainage

will easily risk water shortage in the growing season, especially during long periods of rain shortage, and the rice planting in upland areas uses water more than the planting in lowlands. The overall, the land use problem of this type is in the area of 125,480 rai. In addition, land use problems were found in field crops/fruit trees/perennial plants. In lowland with poor drainage, this causes drainage problems in the root of the plant which results the cost per rai of the produce is high but the product is low. This type of land use problem covers an area of 998,756 rai and has a land use problem in the upland area of 593,631 rai. In summary, Mae Klong River Basin has a good to moderate soil potential for crop cultivation at about 2.822 to 3.457 million rai. Therefore, agriculture from the past to the present, approximately one-third of the farmland is used for agriculture exceeding more than soil potential in the lowland and 38 percent of the agricultural area is not suitable for the potential of the land, resulting in low yield per rai and low profit. In the future trend, it will lose capacity of market competition as well as causing the faster degradation of soil resources.

14) The Problem of Drought and Drinking Water: In the upland of Mae Klong River Basin, it always faces drought during January-June every year. During the year 2014-2018, a total of 31,593 rai of agricultural land were damaged and a total of 97,424 households were affected. In the overview, water use of the population in Mae Klong River Basin is more than 80%, but there is still a problem of insufficient water for drinking. There are villages that still lack of water supply systems, scattered in 8 river basins: 5 provinces, 12 districts, 20 sub-districts and 34 villages.

15) The Problem of Flooding in the Upper Area of Mae Klong River Basin: Khwae Yai River and Kwai Noi River, have nature of flowing wild water and landslides from heavy rain and flood water from small tributaries converge in residential areas. Most occur in the area of the confluence of the tributaries where there is no water control on the upstream side, such as the confluence of Lamphachi with Kwai Noi River and the confluence of Huai Taphen with Kwai Yai River. **In Lam Phachi and Huai Taphen areas**: In Lam Phachi sub-basin and Huai Taphen, there are no reservoirs to control water in the upper area and it was found that Huai Taphen would face the flash floods type due to the small capacity of the river but water level can drop rapidly. Whereas in Lam Phachi, there was a problem of flooding at the boundary between Chom Bueng District in Ratchaburi Province and Dan Makham Tia District in Kanchanabur Province, especially in Dan Thap Tako Subdistrict, Chom Bueng District in Ratchaburi Province. This is because it is the area that has changed from the

sloped area to the relatively flat area, especially during the heavy rain in the watershed area. **In the estuary and coastal areas of the Mae Klong River Basin:** Its nature is flooding in lowland areas including agricultural areas, residential areas and commercial areas because of the drainage problems and sea water problems.

16) Water Quality in Water Resources: There is the trend of the deterioration of water quality in Mae Klong River, such as Ban Tha Ruea, Tha Maka District in Kanchanaburi Province, front area of Phanurangsee camp in Mueang Ratchaburi, Chaloem Phrakiat Bridge's 60th Birthday Anniversary, Ban Pong District in Ratchaburi Province, front area of Somdej Phra Phutthalertla Hospital, Mueang Samut Songkhram District and Somdet Phra Si Suriyen Bridge, Amphawa District in Samut Songkhram Province. Water quality in Kwai Noi River tends to deteriorate at the surrounding of Tha Sao Bridge in Sai Yok District and River Kwai Village Hotel, Sai Yok District in Kanchanaburi Province. Meanwhile, the water quality in Khwae Yai River tends to deteriorate at the surrounding of the end of the bridge of Srinakarin Dam, Si Sawat District in Kanchanaburi Province.

17) The Potential in the Area Development: In this watershed area, there are the potentials to develop from basic agriculture to agricultural industry and food industry. It also has a strong production base of agricultural products, growing rice, cultivation of fruit trees and perennial plants. It has a potential in the fisheries economy, aquaculture and salt farming. In addition, it has the potential to develop to the regional tourism center. Natural resources in reserved forests and national parks are watershed forest areas that can be developed for the recreation area, eco-tourism and the source of art and culture. It has the unique group of tribes and cultural tourism areas and the coastal areas for education and mangrove forests conservation.

18) Natural Resource and Environmental Problems in the Watershed Area: There is a facing problem of invasion the national forest reserves and forest conservation according to the law in order to occupy agricultural land. There is a problem of wastewater in the community area, tourist attraction in Muang District, Samut Songkhram Province, Ban Pong District in Ratchaburi Province, Si Sawat District, Sai Yok District and Mueang District in Kanchanaburi Province. The main cause of problem is the contamination of organic matter or sewage from the sewerage surrounding water use activities including in canal branches of Mae Klong River, such as Damnoen Saduak Canal and Khlong Wat Pradu which has the deteriorating water quality throughout the line. The main cause is about the bacterial contamination from sewerage of water use activities that has not wastewater treatment or

not meeting the standards, such as municipal sewage, the ranch or various enterprises. The problems with bank erosion and sedimentation in the downstream of Lam Phachi River Basin before it flows into Kwai Noi River causing the shallow of the river. This causes the water flow in the upstream water slow down and causes flooding to overflow of upstream of the river. Therefore, the development direction of Mae Klong River Basin should consider the conservation of natural resources together with the environment preservation.

19) Policies, Strategies, and Development Plans at Different Levels: From the study of related study: policies, strategies and development plans, It was found that the state policy has the direction of development to promote the provinces in tMae Klong River Basin to be: (1) a safe industrial agro-industrial city, using technology and innovation in the production and processing of the agricultural sector, along with the conservation of natural resources and the environment; (2) sources Ecotourism/Eco Tourism/Historical Tourism Religion and Culture (3) Develop competitive international trade and investment links and cross-border trade to Asia. This has been reflected in the development guidelines of the policy or the important government projects at the national level, such as infrastructure development strategies and logistics systems and the development strategies of the sectors, cities, and economic areas that have been defined in the 12th Development Plan, the Special Economic Development Zones Policy in a cluster format. of Kanchanaburi Province, Plan for the development of the intercity highway network between Bang Yai - Kanchanaburi - Ban Phu Nam Ron Project, the project to develop a road link between Ban Phu Nam Ron, Kanchanaburi Province and the city of Dawei, Republic of the Union of Myanmar, the project of ASEAN Highway Network in Thailand (from Ban Phu Nam Ron on the Thai-Burma border to end at Hat Lek District, Trat Province) and the railway project between Laem Chabang Port - Dawei Deep Sea Port, etc. These policies will attract investors in the industrial sector, also expand the labor market and promote the industry that further from the agricultural sector. There will be the change of land use to be for residential communities and industrial. The commercial tends to increase and community areas outside the municipality have the tendency to expand of population to the outside of the municipality.

20) Problem Conditions, Potential and Limitations of the River Basin: From the results of basic data of the River Basin together with the results of public participation a summary of the key points is shown in **Figures 4-1** to **Figures 4-3**

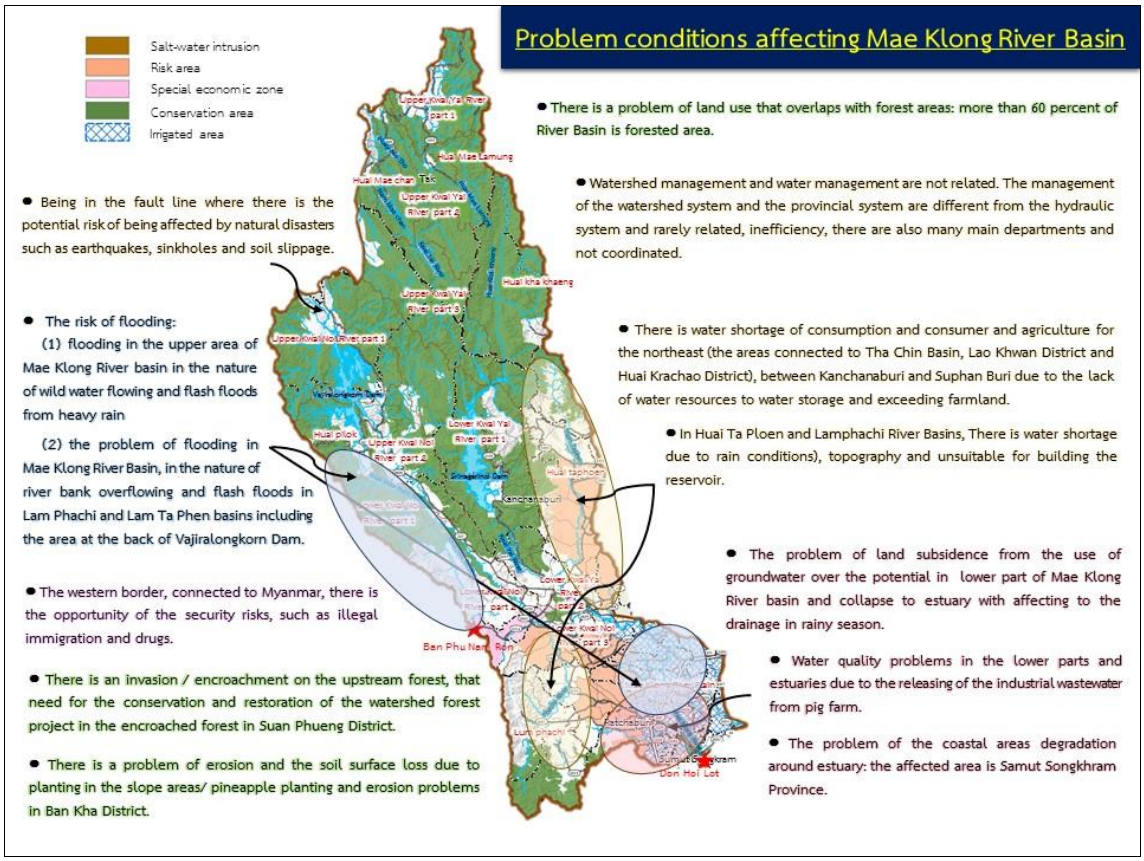

Figure 4-1 Problem conditions affecting Mae Klong River Basin

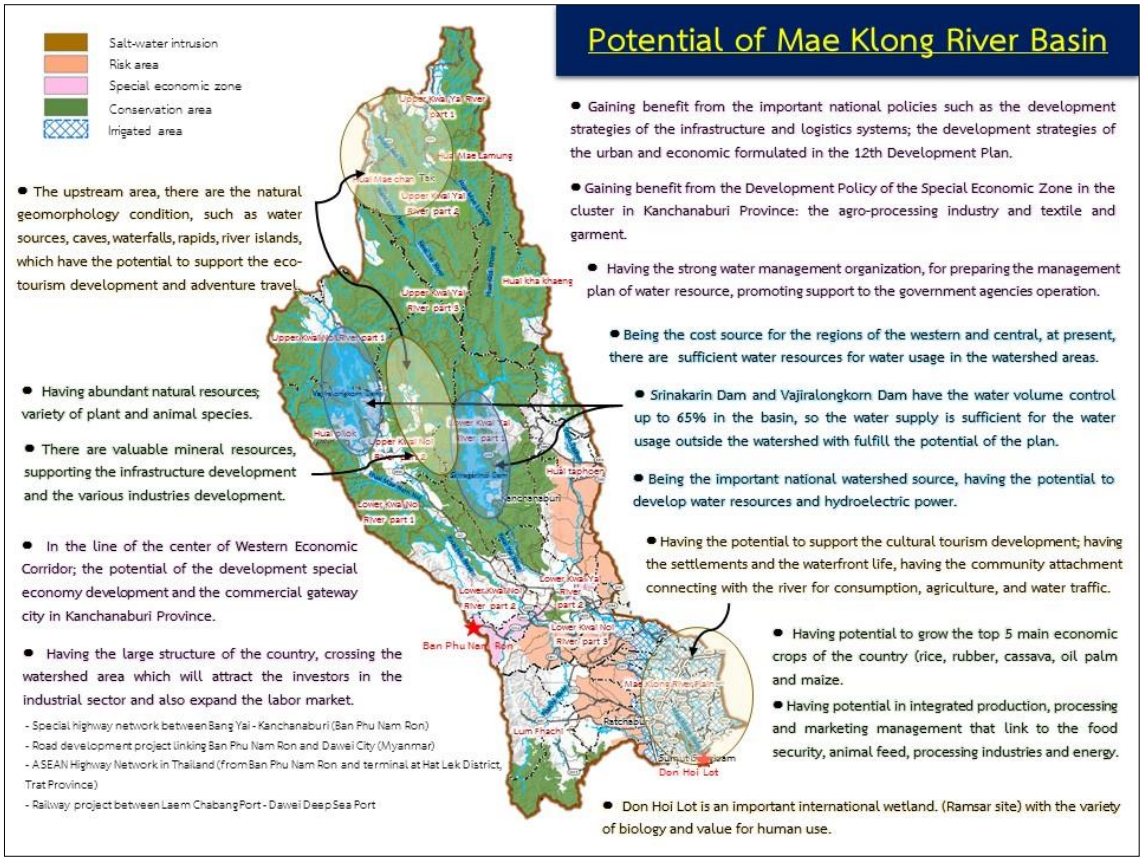

Figure 4-2 Potential of Mae Klong River Basin

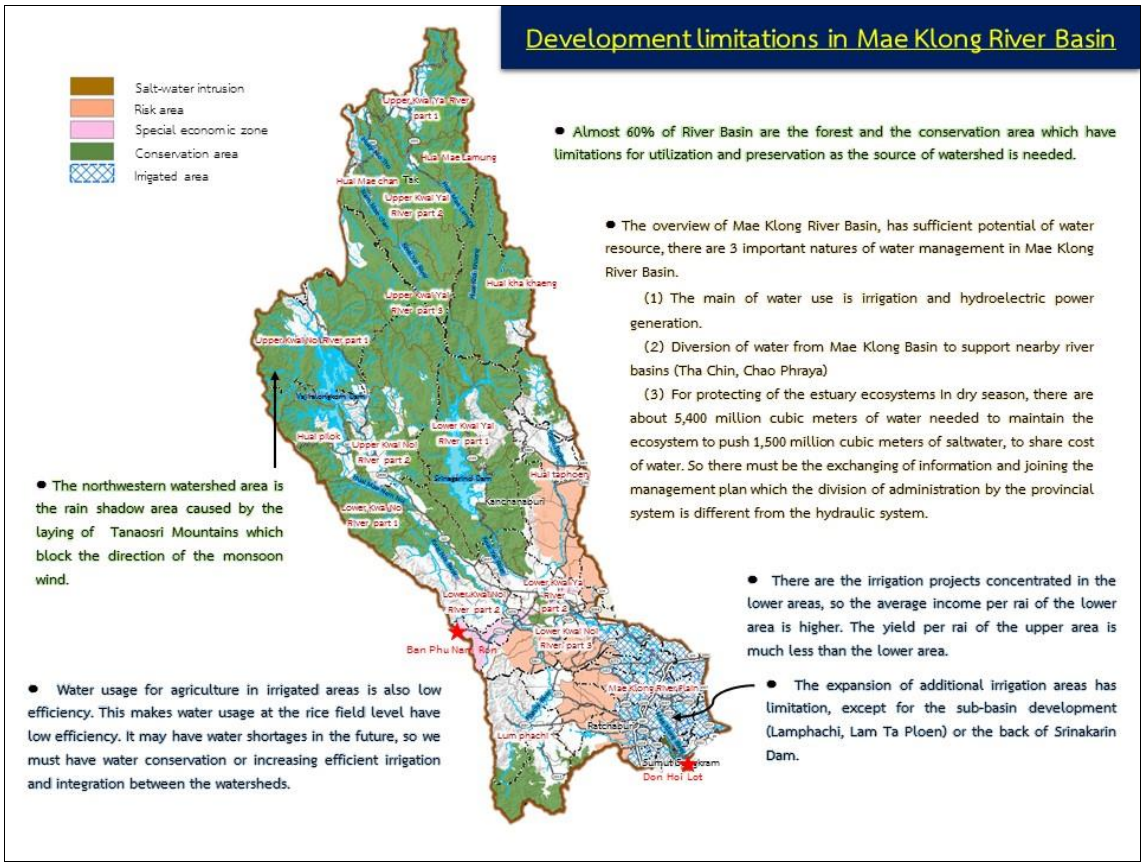

Figure 4-3 Development limitations in Mae Klong River Basin

21) Driving Force of Development, vision and strategic issues in watershed: The results of the analysis of the driving force of development from government policies and plans are shown that the driving force of development from the problem conditions of the watershed area, the driving force of development from the needs of the watershed area and trends of Mae Klong River Basin Development in the Future will change according to the condition of the country development and the government policies which are related to the problem condition of Mae Klong River Basin and the changes in global trends. The condition of Mae Klong River Basin has the potential to develop basic agriculture to the agricultural industry and food industry. Natural resources in reserved forests and national parks are watershed forest areas which can be developed to the recreation area, eco-tourism, the source of art and culture. There are unique tribal groups and cultural tourism areas. These will cause economic development in both the agricultural and Industry sectors, service sector and tourism sector in the future and will be the way to link economic development at the sub-regional and regional level. So the watershed development of Mae Klong River Basin must be prepared to deal with the problem and the constraints on water resources. From the above mentioned, the vision of water resource management of Mae Klong River

Basin is therefore defined as **"Integrating Management to Create Water Resource Security, Support for Consumption-Consumption Economic and Social Development under the Conservation of Natural Resources and Preserving the Quality of the Environment"** which was presented to the stakeholders through the process of public participation in the first sub-group meeting, then defined to formulate strategic issues. The objective is for the sustainable development; the indicators and the strategies for water resource management.

22) Analysis the Results of Spatial Water Resource Problems and Solutions: From the results of the study of basic information in various fields of Mae Klong River Basin and the process of participating in the strategic environmental assessment process, this was found that in Mae Klong River Basin, there were major problems with spatial water resources that need to be solved; the summary is shown in **Tables 4-1** to **Tables 4-6** and **Figure 4-4**. These will bring to be considered to Mae Klong River Basin development goals from the SEA study in the determination of the preliminary elements of the water resource management plan. In terms of water management for consumption-consumption, water production, flood management and water quality management, these considered together with the results of the mathematical model study and lead to the goal of the master plan of the 20-year water resource management in the next step.

Table 4-1 Issues of the spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Management of water for consumption

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Lat Ya	<u>1. No water supply system</u> • Some areas are far from the water source for tap water production. • Water quality in tap water production is not up to standard. • The local government has insufficient budget for the construction of the water supply system.	Developing, expanding the area, increasing efficiency of the water supply system of the village
	Thong Pha Phum	Tha Khanun		
	Sai Yok	Sai Yok		
	Tha Maka	Tha Sao		
	Phanom Thuan	Nong Rong		

Table 4-1 Issues of the spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Management of water for consumption

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Suphan Buri	Dan Chang	Dan Chang	**2. Water supply system not covered / the water distribution system damaged** • The condition of the area is high and has the limitation of water delivery. • Insufficiency of the water cost resources due to the increasing of the population especially during dry season. • The damage of water distribution system and lack of repairing make the water supply not cover in dry season and have the problems with water quality. • Lack of maps and underground water surveying to solve water supply problems. • Lack of budget to increase the potential of the water supply system governed by Local government/ village to cover every household. • The water distribution system is damaged from using. **3. The drinking water quality must be improved** • Water quality is not up to standard such as limestone, salty, brackish, rust. • No filter system. and some parts are damaged • Low quality of raw water in rainy season; turbid and highly contaminated sediments. • The water supply system in the mountain has lacks a filter system. • Raw water sources are of substandard water quality: contaminated by agrochemicals livestock ranch, etc. • The surface water quality is salinity: cannot be used to produce tap water. • The water supply production site is close to the sewage drainage site.	Developing, expanding the area, increasing efficiency of the water supply system of the village
Kanchanaburi	Mueng Kanchanaburi	Ban Tai, Nong Bua, Nong Ya, Wang Dong, Ko Samrong, Lat Ya		
	Thong Pha Phum	Tha Khanun, Chalae, Hin Dat, Pilok, Huai Khayeng, Linthin, Sahakon Nikhom		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Si Sawat	Dan Mae Chalaep, Na Suan, Tha Kradan		
	Sai Yok	Si Mongkhon, Wang Krachae, Lum Sum		
	Phanom Thuan	Don Ta Phet, Nong Rong		
	Bo Phloi	Bo Phloi		
	Sangkhla Buri	Laiwo, Prangphle, Nong Lu		
	Dan Makham Tia	Klondo, Dan Makham Tia, ChorakhePhueak		
	Tha Maka	Tha Maka, Tha Ruea		
Ratchaburi	Mueng Ratchaburi	Lum Din, Bang Pa, Don Rae, Nam Phu, Don Tako, Khu Bua, Ang Thong, Ko Phlapphla, Huai Phai		
	Damnoen Saduak	Damnoen Saduak, Prasat Sit, Si Surat		
	Ban Kha	Ban Kha, Nong Phan Chan, Ban Bueng		
	Chom Bueng	Dan Thap Tako, Kaem On		
	Ban Pong	Suan Kluai, Don Krabueang, Nong Pho, Krap Yai, Ban Pong, Boek Phrai		
	Bang Phae	Don Kha		
	Photharam	Khlong Khoi, Ban Khong, Bang Tanot, Don Phai		
	Suan Phueng	Pa Wai		
	Pak Tho	Pak Tho		
Samut Songkhram	Mueng Samut Songkhram	Bang Khan Taek, Ban Prok, Nang Takhian, Don Manora, Lat Yai, Laem Yai		
	Bang Khonthi	Bang Khonthi Bang Sakae		
Nakhon Pathom	Mueng Nakhon Pathom	Don Yai Hom, Sa Kathiam		

Table 4-1 Issues of the spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Management of water for consumption

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Suphan Buri	Dan Chang	Dan Chang	<u>4. No water supply system</u> ● Increasing of the population. ● Increasing of tourists in the area. ● Insufficiency of water cost sources to produce tap water. ● Local Authority/PWA lacks of the budget for constructing and expanding the service area. ● The small size of the former water supply system not enough for the demand of current water usage. ● Using tap water for agriculture. ● The insufficiency of the underground water supply system for all year round. ● Lack of good water management. ● The limitation of the area condition; cannot increase the potential of raw water storage for producing tap water.	Developing city water supply/ economic area
Kanchanaburi	Mueng Kanchanaburi	Pak Phraek, Ban Tai, Lat Ya, Ko Samrong		
	Nong Prue	Nong Prue, Nong Pla Lai, Somdet Charoen		
	Tha Maka	Khao Samsip Hap, Khok Tabong		
	Thong Pha Phum	Chalae, Pilok, Huai Khayeng, Hin Dat		
	Sangkhla Buri	Prangphle, Nong Lu		
	Si Sawat	Tha Kradan		
	Tha Muang	Ban Mai, Thung Thong		
	Dan Makham Tia	Klondo, ChorakhePhueak		
Ratchaburi	Mueng Ratchaburi	Nam Phu, Khung Nam Won, Don Tako, Don Rae, Khu Bua, Huai Chinnasee, Nong Klang Na		
	Chom Bueng	Dan Thap Tako		
	Pak Tho	Yang Hak		
	Photharam	Khao Changum, Khlong Ta Khot, Don sai, Chamrae, Chet Samian		
	Suan Phueng	Pa Wai		
Samut Songkhram	Mueng Samut Songkhram	Mae Klong, Lat Yai, Ban Prok, Laem Yai, Nang Takhian		
	Bang Khonthi	Bang Khonthi, Bang Sakae		

Table 4-2 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water security for production sector

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Suphan Buri	Dan Chang	Dan Chang, Nikhom Krasiao	**1. Too little rainfall** • The climate change • Deforestation of the upstream forest areas • The decreasing of the forest area in the basin • Lack of water storage in the upper area. • Lack of water management plan in the water shortage situation.	Developing water reservoirs / water supply system
Kanchanaburi	Mueng Kanchanaburi	Ban Tai, Ban Kao, Pak Phraek, Lat Ya, Wang Dong, Wang Yen, Nong Ya		
	Thong Pha Phum	Tha Khanun		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Bo Phloi	Lum Rang, Nong Ri, Nong Krang, Chong Dan,		
	Dan Makham Tia	Nong Phai, ChorakhePhueak, Dan Makham Tia, Klondo		
	Sai Yok	Si Mongkhon, Wang Krachae, Sai Yok		
	Si Sawat	Na Suan, Tha Kradan, Nong Pet		
	Phanom Thuan	Nong Rong		
	Lao Khwan	Thung Krabam		
	Tha Muang	Phang Tru, Nong Tak Ya, Rang Sali, Tha Takhro		
Ratchaburi	Mueng Ratchaburi	Khung Nam Won, Bang Pa, Khu Bua		
	Photharam	Khao Changum, Thammasen, Nong Kwang		
	Chom Bueng	Dan Thap Tako		
	Ban Kha	Ban Kha		
Suphan Buri	Dan Chang	Dan Chang, Nikhom Krasiao	**2. Longer period of rain shortage continuing for a long time** • The climate change • Little of the cumulating of rainfall at the beginging of rainy season. • Less amount of rainfall or not raining according to the season. • Lack of water storage in the area • No sufficient water allocation for the demand of utilization • High of water usage outside the sectors of the consumption and the agriculture • Having disputation of water between farmers and aquaculture.	- Optimizing water resources project and the original water delivery system - Water supply in rainwater farming areas
Kanchanaburi	Mueng Kanchanaburi	Ban Tai, Ban Kao, Pak Phraek, Lat Ya, Wang Dong, Wang Yen, Nong Ya		
	Dan Makham Tia	Nong Phai, ChorakhePhueak, Dan Makham Tia, Klondo		
	Thong Pha Phum	Tha Khanun, Huai Khayeng, Linthin		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Bo Phloi	Bo Phloi, Chong Dan, Nong Ri, Nong Kum, Lum Rang, Nong Krang		
	Tha Maka	Tha Maka		
	Sai Yok	Si Mongkhon, Wang Krachae, Sai Yok		

Table 4-2 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water security for production sector

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Ratchaburi	Mueng Ratchaburi	Khung Nam Won, Bang Pa, Khu Bua	**2. Longer period of rain shortage continuing for a long time** ● The climate change ● Little of the cumulating of rainfall at the beginging of rainy season. ● Less amount of rainfall or not raining according to the season. ● Lack of water storage in the area ● No sufficient water allocation for the demand of utilization ● High of water usage outside the sectors of the consumption and the agriculture ● Having disputation of water between farmers and aquaculture.	- Optimizing water resources project and the original water delivery system - Water supply in non-irrigated areas
	Photharam	Khao Changum Ban Lueak Ban Khong Thammasen Nong Kwang		
	Chom Bueng	Dan Thap Tako		
	Ban Kha	Ban Kha Ban Bueng Nong Phan Chan		
	Suan Phueng	Suan Phueng Pa Wai Tanao Si		
	Ban Pong	Suan Kluai Nong Pla Mo Khao Khlung		
	Bang Phae	Don Kha		
	Pak Tho	Yang Hak Don sai Lemon Palace Bo Kradan Huai Yang TonePak Tho Pa Kai		
	Wat Phleng	Wat Phleng Chom Prathat Ko San Phra		
Samut Songkhram	Mueng Samut Songkhram	Bang Kaeo, Lat Yai, Ban Prok		
	Amphawa	Amphawa		
Suphan Buri	Dan Chang	Dan Chang, Nikhom Krasiao	**3. The upland areas**	- Water Diversion/ Linking to the water source - Developing water resources for soil and water conservation/ community water resources/Pool
Kanchanaburi	Mueng Kanchanaburi	Pak Phraek		
	Sai Yok	Sai Yok, Wang Krachae		
	Si Sawat	Tha Kradan, Dan Mae Chalaep, Nong Pet, Khao Chot		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Bo Phloi	Chong Dan		
	Thong Pha Phum	Tha Khanun, Hin Dat, Linthin, Huai Khayeng, Sahakon Nikhom Pilok, Chalae		
	Sangkhla Buri	Nong Lu, Prangphle, Laiwo		
Ratchaburi	Ban Kha	Nong Phan Chan, Ban Bueng, Ban Kha		
	Suan Phueng	Suan Phueng, Pa Wai, Tanao Si		
	Chom Bueng	Chom Bueng, Dan Thap Tako, Rang Bua, Pak Chong, Boek Phrai		

Table 4-2 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water security for production sector

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Pak Phraek, Ban Kao, Lat Ya	<u>4. Lack of water storage</u> • The area condition is high and some are in the conservative forest area. • Lack of maintenance of medium-sized and small-sized of the water reservoirs to be use in the working condition. • Insufficiency of the water distribution system • Lack of water resources development in small tributaries • Not enough plans for developing and exploring the groundwater resources for agriculture and other uses. • Not enough areas to create water sources, have to the expropriation of the land. • Lack of improving of the monkey cheeks/large swamps • Low promoting of community wisdom for water management • Promoting to cultivate crops using a lot of water.	- Developing water reservoirs/ water supply system - Optimizing water resources project and the original water delivery system
	Dan Makham Tia	Klondo, Dan Makham Tia, ChorakhePhueak		
	Phanom Thuan	Don Ta Phet Nong Rong		
	Sai Yok	Lum Sum, Tha Sao, Sai Yok, Si Mongkhon, Wang Krachae, Sing, Bongti		
	Tha Maka	Tha Ruea		
	Bo Phloi	Bo Phloi, Chong Dan, Nong Ri, Nong Kum, Lum Rang, Nong Krang		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Thong Pha Phum	Tha Khanun, Hin Dat, Linthin, Huai Khayeng, Sahakon Nikhom, Pilok, Chalae		
	Sangkhla Buri	Laiwo		
Ratchaburi	Mueng Ratchaburi	Nong Klang Na, Ko Phlapphla, Huai Phai, Khao Raeng		
	Ban Kha	Ban Bueng, Nong Phan Chan		
	Suan Phueng	Suan Phueng, Pa Wai, Tanao Si		
	Photharam	Khao Changum, Thammasen, Ban Lueak, Ban Khong, Nong Kwang		
	Pak Tho	Wang Yang Ngam, Bo Kradan, Don sai, Pa Kai, Huai Yang Tone, Pak Tho		
Nakhon Pathom	Mueng Nakhon Pathom	Phrong Maduea, Thap Luang, Nong Din Daeng, Don Yai Hom		
Samut Songkhram	Mueng Samut Songkhram	Khlong Khoen, Nang Takhian, Tha Kha, Don Manora, Lat Yai		
	Amphawa	Bang Nang Li, Mueang Mai, Bang Khae, Khwae Om		

Table 4-2 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water security for production sector

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Lat Ya, Tha Sao, Pak Phraek	<u>5. Lack of water management plan</u> ● Lack of water management plan systematically ● Lack of improvement/maintenance of the irrigation system used for a long time ● The database of water resources and the amount of water in the area are still low. ● No water management plan at the local level. ● Having scramble to use water between farmers who grow each type of crop and farmers who are engaged in aquaculture ● Having water diversion to other river basins during dry season; make water shortage in Mae Klong River Basin	Determineing economic planting zones according to potential
	Bo Phloi	Bo Phloi, Chong Dan		
	Si Sawat	Khao Chot, Tha Kradan		
	Thong Pha Phum	Tha Khanun, Hin Dat, Pilok, Chalae, Huai Khayeng		
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Tha Muang	Khao Noi		
	Dan Makham Tia	Dan Makham Tia, Nong Phai, ChorakhePhueak		
	Tha Maka	Lam Phraya		
Ratchaburi	Mueng Ratchaburi	Khung Nam Won, Na Mueang, Khung Krathin, Khu Bua		
	Ban Pong	Krap Yai		
	Ban Kha	Ban Bueng, Nong Phan Chan, Ban Kha		
	Bang Phae	Don Kha		
	Photharam	Khlong Khoi, Bang Tanot, Ban Khong,		
	Suan Phueng	Suan Phueng, Pa Wai		
Nakhon Pathom	Mueng Nakhon Pathom	Phrong Maduea, Sa Kathiam, Nong Din Daeng, Don Yai Hom		
Samut Songkhram	Mueng Samut Songkhram	Mae Klong, Khlong Khoen, Ban Prok, Lat Yai		
	Amphawa	Bang Nang Li, Mueang Mai, Khwae Om		
	Bang Khonthi	Bang Khonthi		

Table 4-3 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Flood and Inundation Management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Lat Ya, Wang Dong, Ban Nuea, Wang Yen, Nong Bua, Nong Ya, Tha Makham, Ko Samrong, Pak Phraek	<u>1. A lot of rainfall</u> ● The flooding from flowing wild water ● Lack of water storage to slow down/delay the water upstream ● No processing system and notifying system to the public in advance ● Lack of drainage system in the area ● Flooding rising on the banks every year ● Facing the problem of flooding in communities / roadway for a long time. ● Difficult drainage in lowland	- Conserving and restoring of rivers, canals and natural water sources - Flood protection in urban community - Managing flooded areas/ slow-down water area - Optimizing water drainage
	Nong Prue	Nong Prue, Somdet Charoen, Nong Pla Lai		
	Si Sawat	Khao Chot		
	Thong Pha Phum	Tha Khanun, Huai Khayeng, Chalae		
	Bo Phloi	Nong Ri, Lum Rang, Nong Kum, Chong Dan		
	Tha Muang	Tha Muang, Ban Mai		
	Dan Makham Tia	Dan Makham Tia, Nong Phai, ChorakhePhueak, Klondo		
	Sai Yok	Sai Yok, Si Mongkhon, Sing		
	Sangkhla Buri	Wangka, Laiwo, Nong Lu		
	Phanom Thuan	Nong Rong		
	Tha Maka	Tha Maka, Tha Ruea		
Ratchaburi	Mueng Ratchaburi	Na Mueang, Lum Din, Don Tako		
	Ban Pong	Ban Pong, Suan Kluai		
	Ban Kha	Ban Bueng, Ban Kha		
	Chom Bueng	Dan Thap Tako, Kaem On		
	Damnoen Saduak	Bua Ngam		
	Photharam	Photharam		
	Pak Tho	Yang Hak		
	Suan Phueng	Suan Phueng, Pa Wai, Tanao Si, Tha Khoei		
Nakhon Pathom	Mueng Nakhon Pathom	Phrong Maduea, Thap Luang		

Table 4-3 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Flood and Inundation Management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Lat Ya, Wang Dong, Ban Nuea, Tha Makham, Pak Phraek, Wang Yen	2. The lowland condition ● Problem of sea water level rise ● Difficult drainage , requiring a high budget ● Prolonged flooding causes wastewater/ sanitation ● Having the invasion of the monkey cheeks / public areas.	- Conserving and restoring of rivers, canals and natural water sources - Flood protection in urban community - Managing flooded areas/ slow-down water area - Optimizing water drainage
	Nong Prue	Nong Prue		
	Dan Makham Tia	Dan Makham Tia, Nong Phai, ChorakhePhueak, Klondo		
	Thong Pha Phum	Linthin, Chalae		
	Bo Phloi	Lum Rang, Nong Kum		
Ratchaburi	Mueng Ratchaburi	Sam Ruean		
	Ban Pong	Pak Raet		
	Photharam	Khlong Khoi, Khlong Ta Khot, Chamrae, Ban Sing		
	Damnoen Saduak	Ban Rai		
Nakhon Pathom	Mueng Nakhon Pathom	Don Yai Hom		
Kanchanaburi	Mueng Kanchanaburi	Kaeng Sian, Tha Makham, Pak Phraek	3. Lack of water drainage system ● Having flooding after heavy rain for a long time. ● Not enough water drainage system, some out of order ● No connection of water drainage system between the local authorities ● Having waterway invasion ● Low efficiency of draining in the basin	
	Tha Muang	Tha Lo		
	Si Sawat	Dan Mae Chalaep, Khao Chot		
	Nong Prue	Nong Prue		
	Bo Phloi	Bo Phloi, Lum Rang, Nong Kum		
	Thong Pha Phum	Tha Khanun		
Ratchaburi	Bang Phae	Don Kha		
	Ban Pong	Nong Kop		
Samut Songkhram	Mueng Samut Songkhram	Mae Klong		
Nakhon Pathom	Mueng Nakhon Pathom	Sa Kathiam		

Table 4-3 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Flood and Inundation Management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Pak Phraek, Ban Nuea, Kaeng Sian, Wang Dong	4. Having water invasion / waterway obstruction ● Having invasion of residence and business establishments along the river area ● Having the obstruction of the waterway flowing make drainage difficulty ● The river boundary not clear	- Conserving and restoring of rivers, canals and natural water sources - Flood protection in urban community - Managing flooded areas/ slow-down water area - Optimizing water drainage
	Nong Prue	Nong Prue		
	Thong Pha Phum	Tha Khanun		
	Bo Phloi	Bo Phloi, Lum Rang		
	Tha Muang	Thung Thong		
	Dan Makham Tia	Dan Makham Tia, Nong Phai, ChorakhePhueak, Klondo		
	Tha Maka	Khok Tabong, Don Khamin, Khao Samsip Hap		
Ratchaburi	Mueng Ratchaburi	Sam Ruean, Khung Krathin, Khok Mo, Ang Thong, Ban Rai, Ko Phlapphla, Nong Klang Na, Don Tako, Phong Sawai, Khu Bua		
	Ban Kha	Ban Bueng		
	Chom Bueng	Dan Thap Tako, Kaem On		
	Photharam	Photharam, Ban Sing, Don sai, Ban Khong, Don Krabueang, Nong Pho		
Samut Songkhram	Mueng Samut Songkhram	Bang Khan Taek, Lat Yai		
	Amphawa	Yisan, Bang Nang Li		
	Bang Khonthi	Bang Sakae		

Table 4-4 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water quality management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Ban Tai, Ban Nuea, Tha Makham, Pak Phraek, Tha Lo, Kaeng Sian, Lat Ya	<u>1. Community / restaurant / hospital</u> • At Tha Sao Bridge, Sai Yok District, there is a group of bacteria: Total coliforms (TCB) above the standard values. • Problem of waste water from community/ restaurants. and establishments • community in the area without wastewater treatment system • Lack of wastewater treatment at the original source. • Having waste water source from a large communityborough/bazaar; the community sewage system is damaged. • The small-sized of the community' wastewater system not enough for the increasing amount of wastewater caused by the expansion of the community. • No water treatment of community and restaurant before releasing into water sources	- Preventing and reducing of wastewater at the upstream source - Optimizing in water treatment and controlling wastewater drainage to the environment
	Sai Yok	Tha Sao		
	Tha Muang	Tha Muang		
	Thong Pha Phum	Tha Khanun, Pilok		
Ratchaburi	Mueng Ratchaburi	Phikun Thong, Phong Sawai, Bang Pa		
	Ban Pong	Ban Pong, Boek Phrai, Tha Pha		
	Ban Kha	Ban Bueng		
	Photharam	Khlong Ta Khot, Chet Samian, Don sai, Ban Khong, Photharam, Thammasen		
	Damnoen Saduak	Damnoen Saduak, Bua Ngam, Si Surat, Don Phai		
Samut Songkhram	Mueng Samut Songkhram	Mae Klong, Khlong Khon		
	Bang Khonthi	Bang Phrom, Don Manora, Kradangnga		
	Amphawa	Amphawa		
Kanchanaburi	Bo Phloi	Lum Rang	<u>2. Industry</u> • Having waste water from the cassava yard in the area without control bad smell • Having wastewater from rubber factories in the area including the processing of small rubber latex in the community • Industrial factories in the type of sugar, tapioca starch, vermicelli, etc., some release wastewater • The wastewater treatment system of the factories not up to standard and unable to support the amount of wastewater produced in the factory, sometimes untreated wastewater ireleased into public waterways during rainy season	
	Tha Muang	Wang Khanai, Wang Sala		
	Tha Maka	Tha Ruea, Khao Samsip Hap		
	Thong Pha Phum	Linthin		
Ratchaburi	Mueng Ratchaburi	Dan Thap Tako, Huai Chinnasee, Sam Ruean, Bang Pa		
	Ban Pong	Ban Pong		
	Pak Tho	Pak Tho Pa Kai		
Nakhon Pathom	Mueng Nakhon Pathom	Sa Kathiam		
Samut Sakhon	Ban Phaeo	Lak Sam		
Samut Songkhram	Mueng Samut Songkhram	Mae Klong, Khlong Khon		
	Bang Khonthi	Don Manora, Bang Krabue, Bang Phrom, Kradangnga		
	Amphawa	Amphawa		

Table 4-4 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water quality management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Suphan Buri	Dan Chang	Dan Chang	**3. Chemicals used in agriculture** • All of the chemicals using for killing weeds and insects accelerating growth including the use of chemical fertilizers in field crops such as rice, sugarcane, cassava, corn, fruit trees, vegetable crops, etc., which are outstanding products and have a large area of cultivation.	- Preventing and reducing of wastewater at the upstream source - Optimizing in water treatment and controlling wastewater drainage to the environment
Kanchanaburi	Dan Makham Tia	Dan Makham Tia, Nong Phai, ChorakhePhueak, Klondo		
	Nong Prue	Nong Prue, Nong Pla Lai		
	Tha Muang	Wang Sala		
	Thong Pha Phum	Huai Khayeng, Chalae, Pilok, Sahakon Nikhom		
	Tha Maka	Tha Maka		
	Bo Phloi	Bo Phloi, Lum Rang, Nong Ri		
Ratchaburi	Mueng Ratchaburi	Khao Raeng, Phikun Thong, Phong Sawai, Bang Pa		
	Photharam	Photharam, Khlong Ta Khot Thammasen, Ban Khong		
	Chom Bueng	Chom Bueng, Dan Thap Tako		
	Suan Phueng	Suan Phueng, Pa Wai		
	Ban Kha	Nong Phan Chan, Ban Bueng, Ban Kha		
Kanchanaburi	Mueng Kanchanaburi	Ban Tai, Tha Makham, Pak Phraek	**4. Tourist Attraction** • Most of the establishments/ households are small-sized and having low standard of wastewater treatment system. Such problems will happen much during tourist season and long holiday season with ther large number of tourists entering the area.	
	Sai Yok	Tha Sao		
	Thong Pha Phum	Pilok		
Ratchaburi	Damnoen Saduak	Damnoen Saduak		
	Suan Phueng	Suan Phueng, Pa Wai		
Samut Songkhram	Amphawa	Bang Nang Li		

Table 4-4 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Water quality management

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Ratchaburi	Mueng Ratchaburi	Khu Bua, Bang Pa, Huai Phai, Nam Phu, Khok Mo, Sam Ruean, Ang Thong, Phong Sawai, Phikun Thong	**5. Livestock** ● Having chemicals usage in livestock farms and leaching of animal manure into natural water sources, affecting farmers in agriculture and aquaculture. ● Livestock farm locations close to public water sources that are used by the community for agriculture and consumption. ● The wastewater treatment system of the livestock farm is not up to standard. ● Smuggling to release wastewater from farms into waterways, especially during rainy season. ● Facing the problem of wastewater from pig farms overflowing into the public community pool used for water supply production ● Let livestock (cattle-buffalo) raising free. ● The location of the ranch (cow-pig) is close to the village. ● Propose a solution to solve the problem of farm group in Pak Tho District ● There is wastewater from biogas production in livestock farms.	- Preventing and reducing of wastewater at the upstream source - Optimizing in water treatment and controlling wastewater drainage to the environment
	Pak Tho	Don sai, Pak Tho, Wan Dao		
	Bang Phae	Don Kha, Bang Phae, Don Yai		
	Ban Pong	Don Krabueang, Lat Bua Khao, Krap Yai		
	Photharam	Photharam, Khlong Ta Khot, Don Krabueang, Nong Pho, Ban Sing, Tha Chumphon, Soi Fa		
Samut Songkhram	Amphawa	Bang Khae, Khlong Khon, Yisan, Wat Pradu		
	Bang Khonthi	Bang Sakae		
Ratchaburi	Damnoen Saduak	Si Muen Damnoen Saduak	**6. Saltwater problem** ● Sea water level rise ● No sluice to control water along the canal branch. ● Water drainage of Mae Klong Dam for pushing out the saltwater	
Samut Songkhram	Mueng Samut Songkhram	Lat Yai, Ban Prok		
	Bang Khonthi	Bang Nok Khwaek, Bang Yi Rong, Bang Phrom		

Table 4-5 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Rehabilitation of forest watersheds and degraded areas

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Suphan Buri	Dan Chang	Dan Chang, Wang Yao, Ong Phra	**1. Forest invasion / forest area degradation** • Invasion of adding forest areas conservation for agriculture, tourism and livestock • Overuse of forests, causing the slow-down restoration of forest area • Unbalanced use of forest resources, make the unbalance to the forest • Having illegal cutting of valuable trees in conservation forests and community forests • Having destruction of the upper part of the forest area	conserving and restoring the area of degraded watershed forest
Kanchanaburi	Mueng Kanchanaburi	Kaeng Sian		
	Sai Yok	Sai Yok, Tha Sao		
	Si Sawat	Khao Chot, Na Suan		
	Thong Pha Phum	Tha Khanun, Huai Khayeng, Chalae, Sahakon Nikhom		
	Nong Prue	Nong Pla Lai		
Ratchaburi	Mueng Ratchaburi	Lum Din, Khao Raeng		
	Chom Bueng	Kaem On, Dan Thap Tako		
	Ban Kha	Nong Phan Chan, Ban Bueng, Ban Kha		
	Suan Phueng	Suan Phueng, Pa Wai, Tanao Si		
Kanchanaburi	Dan Makham Tia	Dan Makham Tia, Klondo, ChorakhePhueak, Nong Phai	**2. Soil erosion** • Erosion of uncovered soil surface for agriculture • The structure of soil layer is sandy soil. • Having a lot of rainfall, washint the soil surface flowing into the water source • Lack of plants or trees covering the soil surface and slow down water flowing • No growing plants to cover soil surface or growing vetiver to be barrier to keep sediment	
	Thong Pha Phum	Huai Khayeng		
	Bo Phloi	Bo Phloi, Chong Dan, Lum Rang, Nong Kum, Nong Ri		
	Nong Prue	Nong Prue		
	Sai Yok	Sai Yok Tha Sao		
Ratchaburi	Photharam	Khlong Khoi, Bang Tanot		
	Ban Kha	Ban Kha		
Nakhon Pathom	Mueng Nakhon Pathom	Don Yai Hom		
Samut Songkhram	Mueng Samut Songkhram	Lat Yai, Nang Takhian		
	Amphawa	Bang Khae, Bang Nang Li		
Suphan Buri	Dan Chang	Dan Chang	**3. Erosion of the banks** • Most of them occur in Lam Phachi River Basin and Lam Taphan River Basin because of the sandy soil structure. • The narrow of river way • Heavy rain makes the amount of water more over than the river capacity. • The river is shallow and slope.	
Kanchanaburi	Dan Makham Tia	Dan Makham Tia, Klondo, ChorakhePhueak, Nong Phai		
	Bo Phloi	Bo Phloi, Chong Dan, Lum Rang, Nong Kum, Nong Ri		
	Nong Prue	Nong Prue		
Ratchaburi	Chom Bueng	Kaem On, Dan Thap Tako		
	Suan Phueng	Suan Phueng, Pa Wai		

Table 4-6 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Management and administration

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Mueng Kanchanaburi	Pak Phraek, Tha Makham	1. Lack of reuniting/organization for water management in the area ● There is no group uniting or organization ,in the area because the farmers or people do not realize the importance/benefits of reuniting concretely ● Lack of information. and the establishment form of water user organization	Promoting and developing the organization water resources management
	Thong Pha Phum	Huai Khayeng		
	Nong Prue	Nong Pla Lai, Nong Prue		
	Bo Phloi	Bo Phloi, Lum Rang		
	Lao Khwan	Lao Khwan		
	Dan Makham Tia	Klondo, Dan Makham Tia, ChorakhePhueak		
Ratchaburi	Photharam	Ban Khong		
	Ban Kha	Nong Phan Chan		
Kanchanaburi	Thong Pha Phum	Huai Khayeng, Tha Khanun	2. Unstrengten organization for water management in the area / lack of cooperation ● Unstrengten management group of water user organization ● Member/organization database is out of date. ● Lack of continuing training/study tour ● Lack of leadership and operational budgets	
Ratchaburi	Mueng Ratchaburi	Ko Phlapphla		
	Photharam	Ban Khong		
	Ban Pong	Ban Pong		
Kanchanaburi	Mueng Kanchanaburi	Wang Dong, Pak Phraek, Nong Bua	3. Lack of planning for water management, erosion, bank erosion ● No database planning for water resource management ● The plan of Mae Klong Watershed Management focuses on water usage by people at the back of Mae Klong Dam, not pay attention to preserve upstream forests. ● The amount of allocated water is insufficient to the demand for utilization. ● Lack of water reservoirs development in the area, in the irrigation area of Mae Klong project. ● No participation of public sector/water user group. for water allocation in Mae Klong Basin ● Having the water diversion to the outside of the watershed area, makes the water need for utilization in special time insufficient, escpecially in the agricultural sector.	
	Sai Yok	Sai Yok		
	Nong Prue	Nong Pla Lai, Nong Prue		
	Bo Phloi	Bo Phloi, Lum Rang		
	Thong Pha Phum	Huai Khayeng, Tha Khanun, Chalae		
	Dan Makham Tia	Klondo, Dan Makham Tia, ChorakhePhueak		
	Si Sawat	Khao Chot		
Ratchaburi	Bang Phae	Don Kha		
	Ban Pong	Ban Pong		
Nakhon Pathom	Mueng Nakhon Pathom	Sa Kathiam		
Samut Songkhram	Mueng Samut Songkhram	Ban Prok		
	Amphawa	Bang Khae		

Table 4-6 Issues of spatial development in the preparation of the Master Plan of Water Resources Management, Mae Klong River Basin: Management and administration

Problem Area			Key Points/ Causes	Solution
Province	District	Sub-district		
Kanchanaburi	Thong Pha Phum	Hin Dat, Huai Khayeng, Pilok	**4. Lack of government support** • The government pays less attention to water source development for community and local people • Lack of participation with other government agencies in planning • The determination of water utilization ratio in Mae River Basin is unreal and pay less attention to the importance of the agricultural sector.	Promoting and developing the organization water resources management
Ratchaburi	Photharam	Photharam		
	Ban Kha	Nong Phan Chan, Ban Kha		
Samut Songkhram	Bang Khonthi	Bang Sakae		
	Amphawa	Bang Nang Li		
Kanchanaburi	Thong Pha Phum	Pilok	**5. Lack of database of water resources** • Lack of database of the potential of small water resources development in the area • Water quality databases in branch rivers still little	
	Dan Makham Tia	Klondo, ChorakhePhueak		
	Tha Muang	Rang Sali		
Nakhon Pathom	Mueng Nakhon Pathom	Thap Luang		
Samut Songkhram	Amphawa	Yisan		

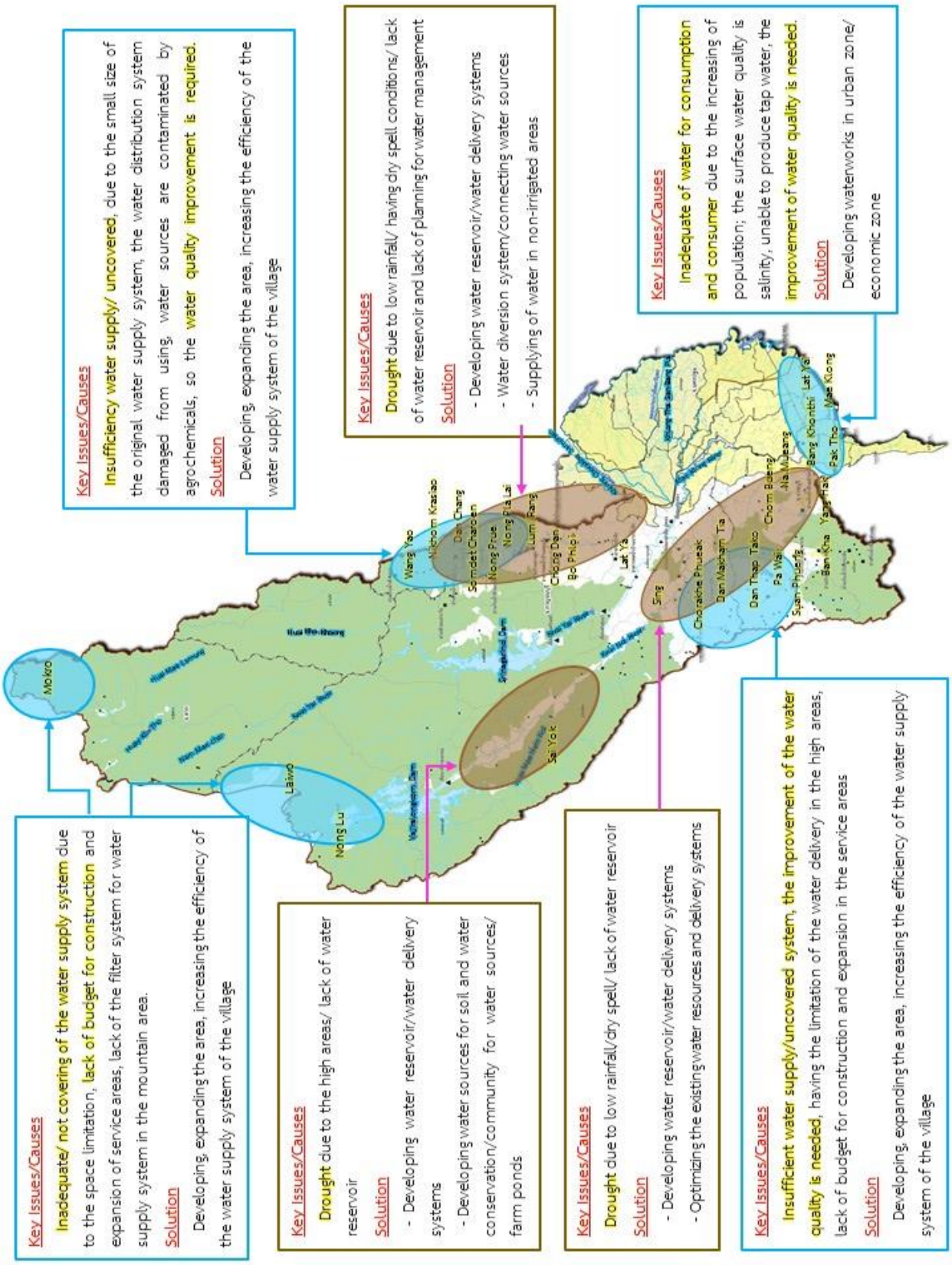

Figure 4-4 Spatial water resource problems and solutions Mae Klong River Basin

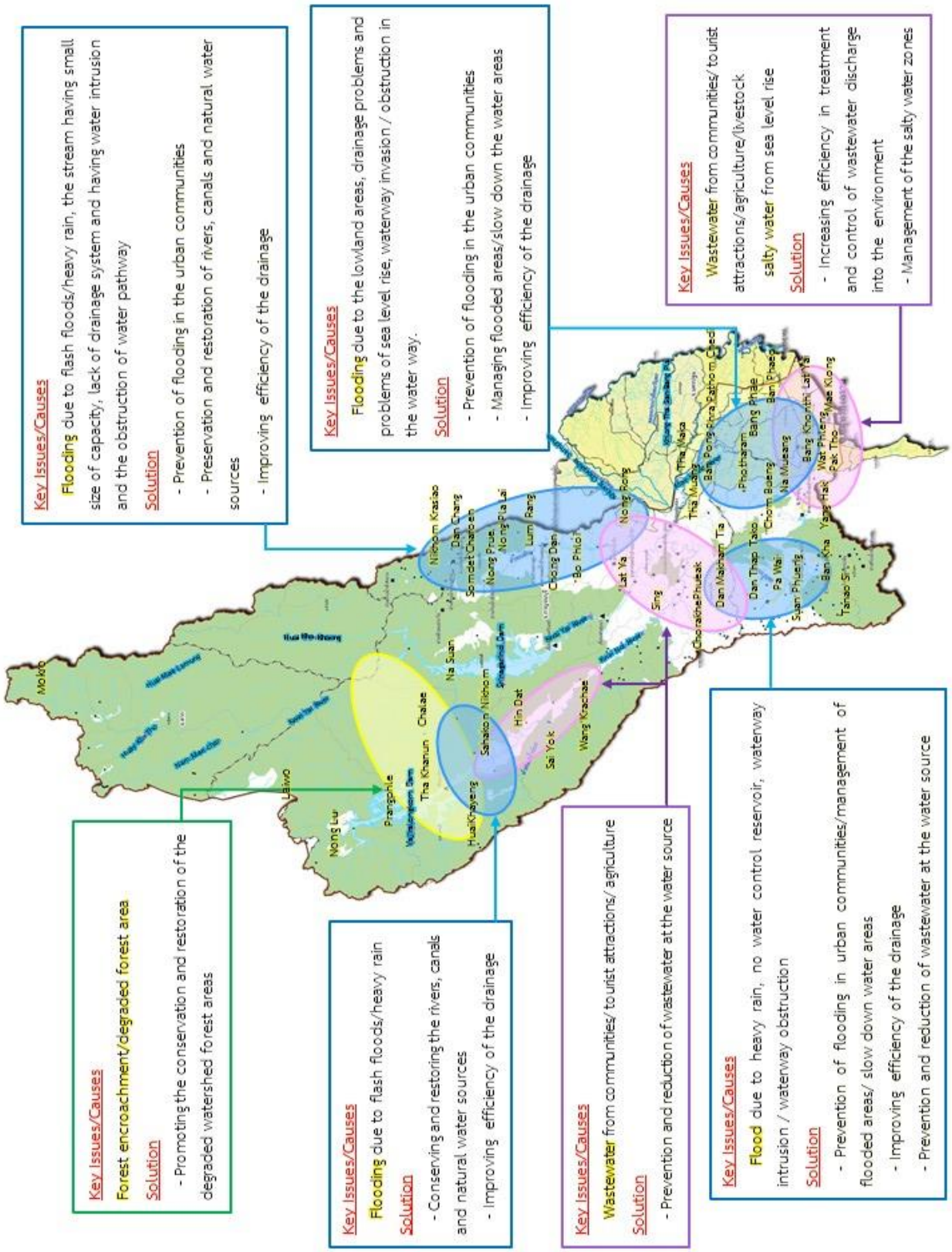

Figure 4-4 Spatial water resource problems and solutions Mae Klong River Basin (continue)

23) Guidelines for the Strategic Watershed Eevelopment, Mae Klong River Basin: These were obtained from the development process and options assessment in the Strategic Environmental Assessment process. The rersults have been presented to the stakeholders in each watershed branch for acknowledgment in the 1st and 2nd small group meetings. Most of the participants agreed with the mentioned results, and by the appropriate development direction of the area in Mae Klong River Basin in the future. It will be a form of mixed development between the tourism development and the agriculture development. Some of the tributaries, it still maintained the same cultivation system, while in some tributaries, it will be necessary to adjust the cultivation system to suit the soil potential and constraints of soil and water of the tributaries. The Master Plan of Water Resource Management in Mae Klong River Basin, therefore, is in the form of supporting the development policy, by considering to the capacity to support the area and solve natural resource and environmental problems related to water management for sustainable development with the development of water resource management, Mae Klong River Basin in 6 parts consisting of 18 development issues.

24) Linking the SEA study results to the Master Plan of the 20-year water resource management: The SEA study results were used for the Master Plan of the 20-year water resource management and the action plan of the 5-year water resource management in Mae Klong River Basin, which will be carried out only in relation to water resource management. The results of the developemet process and alternative evaluation show that the suitable development direction of Mae Klong River Basin in the future, will be the nature of mixed development between the tourism development and the agriculture development. Some of the tributaries still maintain the same cultivation system, whereas some tributaries need to adjust the suitable cultivation system for the potential and constraints of the soil and water of the tributaries. The Master Plan of Water Resource Management in Mae Klong River Basin, therefore is to support the development policy with the consideration to the capacity of the supporting area and solving natural resource and environmental problems related to water management for the sustainable development, consisting of 18 development issues. As mentioned in the previous section, based on the appropriate alternatives evaluation, this makes them aware of the amount of work and target areas that must be carried out in each aspect of each watershed branch. In the process of making plans/projects in the Master Plan of the 20-year water resource management and the action plan of the 5-year water resource management of Mae Klong River Basin, the recommendations of the sustainable measures from the SEA study were taken into account in formulating project plans that would respond to the implementation of the next appropriate watershed development direction.

5. The Master Plan of the 20-year water resource management

5.1 Targets of the Master Plan: In the preparation of the 20-Year Water Resources Management Master Plan and the 5-Year Water Resources Management Action Plan, the development goals are as follows:

1) The Development of water management for consumer and consumption

(1) Developing, expanding the area and increasing the efficiency water supply system of the village

- Improving water quality to meet the standards for 108 villages, 58 sub-districts in 22 districts
- Providing more water in the amount of 16.09 million cubic meters in 160 villages, 69 sub-districts, 23 districts
- Developing a new water supply system for 34 villages, 20 sub-districts, in 12 districts

(2) The Development of the water supply of the city/ economic areas

- Expanding the water supply system to 20 communities in 16 sub-districts, 10 districts
- Improving high efficiency and expanding to support future water needs in urban/economic areas, amount to 27.84 million cubic meters, by the Provincial Waterworks Authority, Ratchaburi branch and the Provincial Waterworks Authority, Samut Sakhon-Nakhon Pathom branch.

2) The Development of water security for production sector

- Developing water storage / water delivery systems / water diversion systems-linking water sources to help water scarcity in the nearby river basins and increasing the efficiency of water resources projects in irrigated areas, adding to 96.51 million cubic meters.
- Developing the community water resources / farm ponds, providing water to support the water use for crops in dry season in the rain forest area of 1,068.03 million cubic meters, representing the amount of water that must be procured 1,309.14 million cubic meters (including wasted water), covering 73 sub-districts.

3) The Development of flood and Inundation Management

- Protecting the important economic areas, most of which have the 100-year recurrence cycles in the lowland areas of Mae Klong River Basin, such as the community area of Mueang Kanchanaburi District, Tha Muang District Community, Tha Maka District Community (Kanchanaburi Province), Community area of Mueang Ratchaburi District, Ban Pong District, Community area of Photharam District, Community area of Damnoen Saduak District (Ratchaburi Province), Community area of Mueang Nakhon Pathom District (Nakhon Pathom Province), Community area of Mueang Samut Songkhram District, Community area of Amphawa District, Community area of Bang Khon Tee District (Samut Songkhram Province) a total of 137,137.5 rai.

- Relieving flooding in the community areas/reducing damage of agricultural areas, most of which have the 25-year recurrence cycle in the area of Huai Taphen River Basin in Bo Ploy District, Mueang Kanchanaburi District and Nong Prue District, a total of 67,681 rai in Lam Phachi River Basin, Dan Makham Tia District and Chom Bueng District, a total of 14,731 rai, and in the branch of Mae Klong Plain in 14 districts, a total of 348,510 rai.

- Increasing the drainage efficiency of the main drainage system/ Conserving and restoring of Mae Klong River and Kwai Noi River, total dredging length of 44,000 meters.

4) The Development of water quality management and water resource conservation

- Preventing and reducing the occurrence of wastewater at the source area of Mueang Ratchaburi District, Pak Tho District, Wat Phleng District (Ratchaburi Province), Amphawa District, and Bang Khon Tee District (Samut Songkhram Province).

- Increasing efficiency in the treatment and the control of wastewater discharge into the environment in 11 areas, such as in the community of Mueang Ratchaburi, Mueang Samut Songkhram, Amphawa, Wat Pradu, Ban Pong, Pak Tho, Ban Phaeo, Tha Maka, Damnoen Saduak, Thong Pha Phum and Sangkhlaburi.

- Managing saltwater in accordance with water use activities in the area of Mueang Samut Songkhram District, Bang Khon Thi District, Amphawa District (Samut Songkhram Province) and Ban Phaeo District (Samut Sakhon Province).

5) The Development of rehabilitation of forest watersheds and degraded areas

- Conserving and restoring of 14,450 rai of watershed forests, of which 5,900 rai are degraded forests, and conserving and preventing soil erosion in the watershed forest areas of 170,559 rai.

6) The Development of Management and administration

- Establishing the water user organization as well as encouraging water user organizations to participate in the process of the effective water resource management in Mae Klong River Basin and increasing knowledge on climate change adaptation.
- Promoting / campaigning to reduce water consumption

5.2 Plans/projects in the Master Plan of the 20-Year Water Resources Management: The Master Plan of the 20-Year Water Resources Management (2018-2037) has been considered and divided the plans/projects into 2 levels: 1) Master plans/projects for watershed area development, Mae Klong River Basin which consists of plans/planning for medium-sized projects and large-sized projects and the groups of project plans which have the concrete effect to the achievement of solving the problems of the watershed area according to Mae Klong River Basin development strategy; and 2) plans/planning of small projects of the water resource management unit in line with Mae Klong River Basin development strategy, a total of 4,448 projects, that have been implemented during the year 2018-2022, a total of 2,646 projects, remaining 1,118 projects in the short-term plans during the years 2023-2027, for the budget of 49,396.73 million baht and long-term plans during the years 2028-2037, a total of 684 projects with a budget of 10,405.90 million baht, summarized in **Table 5-1**

5.3 Master Plans/the main projects of Mae Klong River Basin Development: The Master Plan of the 20-Year Water Resource Management in Mae Klong River Basin, considering to the large and medium-sized development projects or the group of the similar project plans, are useful for the wide area, covering many districts and have the relatively high investment cost, and have the concrete effect to the problem-solving achievement of the watershed area. According to Mae Klong River Basin Development Strategy, it is classified as a group of master plans/projects for Mae Klong River Basin development, a total of 65 projects. Most of the main project development plans are in short-term plans.

Table 5-1 Summary of plans/projects considered in the master plan of the 20-Year Water Resources Management (2018-2037)

Water Management Plan	Plans/projects that has begun Year 2018-2022	Next phase of work plans/projects		Total
		short term plan (Year 2023-2027)	long term plan (Year 2028-2037)	
#1 Water management for consumption				
Total Amount (project)	279	110	-	389
Budget (million baht)	1,134.96	596.71	-	1,731.67
Households benefit (household)	35,011	27,538	-	62,549
#2 Water security for production sector				
Total Amount (project)	1,407	598	459	2,464
Budget (million baht)	16,134.52	38,661.76	7,505.67	62,301.95
Capacity (million cubic meters)	41.75	104.58*	659.62*	806
Benefit area (rai)	153,686	1,567,434	71,090	1,792,210
#3 Flood and Inundation Management				
Total Amount (project)	441	189	89	719
Budget (million baht)	6,582.89	9,569.82	2,154.70	18,307.41
Protected Area (Rai)	43,901	452,901	3,932	500,734
#4 Water quality management and water resource conservation				
Total Amount (project)	22	19	5	46
Budget (million baht)	329.63	206.95	552.00	1,088.58
#5 Rehabilitation of forest watersheds and degraded areas				
Total Amount (project)	358	144	103	605
Budget (million baht)	61.65	197.83	74.04	333.52
Rehabilitation of forest areas (rai)	-	14,450	-	14,450
Degraded areas (rai)	-	31,963	138,596	170,559
#6 Management and administration				
Total Amount (project)	139	58	28	225
Budget (million baht)	306.65	163.66	119.49	589.80
Total	**2,646**	**1,118**	**684**	**4,448**

5.4 Assessment of the economic impact and the worthiness of the plans/projects: According to the Master Plan of Mae Klong River Basin Management for the years 2018-2037, with a total of 4,448 projects, and the investment of 84,352.93 million baht, with a total economic impact of 521,009 million baht, representing a rate of return on investment (ROI) 3.4 times, these mean that every 1 baht of investment in the project, would create economic impact 3.4 baht. It can be concluded that the plans/projects according to the Master Plan of Mae Klong River Basin Management, are beneficial to the overall economy and are worth for the investment.

5.5 Achievement of the Master Plan of the 20-year Water Resources Management in Mae Klong River Basin, considered as shown in **Table 5-2**

6. Suggestion

1) Water management for consumption

- The water development for consumption is primarily considered to the surface water sources. Due to the groundwater for consumption, there may be problems with groundwater quality, such as salinity and hardness, which is caused by the geological features in this watershed area. However, in case of the improving groundwater quality for consumption, it is necessary to be improved water quality for consumption to meet the standards set by law for consumer or consumption. For the problems of salinity and hardness of the groundwater quality, there are the methods to improve, such as adding chemicals, slow filtration (drip system) and reversing osmosis (RO), etc.

2) Management of water security for production sector

- The result of the water simulation shows that in the condition of the normal water year or more than normal, the water supply in the agricultural sector, especially Mae Klong Yai Irrigation Area, is still sufficient for the demand, but in the areas outside irrigated areas, there is still the lack of water, because there is still the lack of an irrigation system to distribute water from cost water sources into farmland. However, in the condition of water year lower than normal or the amount rate of water inflow into Srinakarin Dam and Wachiralongkorn Dam lower than the average, there is the tendency to water shortage occuring within Mae Klong Yai irrigation area in dry season. Therefore, in the future, in case of increasing of water demand in Mae Klong River Basin for the activities outside the basin, it will be affected to the decreasing number of the cultivation areas of dry season in Mae Klong Yai Irrigation Area.

Table 5-2 Results of the 20-Year Water Resources Management Master Plan in Mae Klong River Basin

No.	Development	Indicators	Goals of master plan	Performance according to the master plan 20 years of water resource management				Achievement according to master plan	Driving unit
				Overall result	Projects already started (2018-2022)	Short term plan (2023-2027)	Long term plan (2028-2037)		
#1 Water management for consumption									
1	Development, expansion and optimization village water supply system								Local Administration/ RID/ PWA/ DWR/ DGR
	- Improve water quality to meet standards	Village	108	46	35	11	-	need to improve water quality for an additional 62 villages	
		Total Project	-	154	119	35	-		
	- Provide additional water	Village	160	50	36	14	-	need to supply additional water for 110 villages	
		Total Project	-	170	120	50	-		
	- Develop a new water supply system	Village	34	18	14	4	-	need to develop a new water supply system 16 villages	
		Total Project	-	16	12	4	-		
2	Waterworks development zone/economic zone								
	- Expansion of water supply systems	Area	20	20	20	19	-	-	
		Total Project	-	43	24	19	-		
	- Improving efficiency, expanding to support future water needs	Area	2	2	3	2	-	-	
		Total Project	-	6	4	2	-		
#2 Water security for production sector									
1	Procurement of water reservoirs /water distribution systems for sustenance in the dry season in non-irrigated areas	Tambon	105	105	67	38	31	-	RID/ DPT/ Local Administration/ DWR/ DGR
	- surface water resources	Total Project	-	377	242	70	65		
	- underground water source	Total Project	-	183	151	25	7		
2	Develop water reservoirs and water distribution systems in agricultural areas. Increasing the efficiency of water resources projects in irrigated areas							-	
	- develop water reservoirs	Capacity (mcm)	96.91		23.56	50.73	413.63*		
		Total Project	-	349	86	81	182		
	- develop water distribution systems in agricultural areas	Total Project	-	81	43	24	14		
	- improve the efficiency of the current water delivery system	Total Project	-	1,468	885	392	191		
3	Water diversion system development-linking water sources to help water shortage area							-	
	- Water diversion system for Lam Taphan Bon Reservoir	Total Project	3	3	-	3	-		
	- Srinakarin Dam Water Diversion Work (Phase 2)	Total Project	1	1	-	1	-		
	- Water diversion to help Chao Phraya-Tha Chin River Basin	Total Project	2	2	-	2	-		
4	Reducing the amount of water used by plants	Percentage falling	throughout the duration of master plan	100%	✓ 20%	✓ 60%	✓ 100%		
#3 Flood and Inundation Management									
1	Prevent flooding in urban areas	Area (rai)	137,138	69,812	4,699	61,181	3,932	67,326 rai remaining area that must be protected	Local Administration/ RID/ PWA/ DWR/ DGR
		Total Project	-	33	17	15	3		
2	Flood management / water softening area / flood relief	Area (rai)	430,922	430,922	39,202	391,720	-	-	
		Total Project	-	549	342	129	78		
3	Conservation and restoration of rivers and canals Natural sources/optimize the drain	Distance (km)	44,000	44,000	-	44,000	-	-	
		Total Project	-	155	82	45	8		
4	Use of area control measures		throughout the duration of master plan		✓	✓	✓		
#4 Water quality management and water resource conservation									
1	Prevent, fix and reduce wastewater at the source	Area	5	5	-	5	-	-	RID/ DPT/ Local Administration/ DWR/ DGR
		Total Project	-	1	-	1	-		
2	Increasing efficiency in treatment and controlling wastewater drain into the environment	Area	11	11	2	9	4	-	
		Total Project	-	21	7	10	4		
3	Saltwater management in accordance with water use activities	Percentage	throughout the duration of master plan	100%	✓	✓ 60%	✓ 100%	-	
4	Improve the saltwater barrier and the regulator along the saltwater barrier	Area	4	4	4	4	1	-	
		Total Project	-	24	15	8	1		
#5 Rehabilitation of forest watersheds and degraded areas									
1	Rehabilitation of forest watersheds	Area (rai)	14,450	14,450	-	14,450	-	-	RID/ Local Administration/ DNP
		Total Project	-	54	37	13	4		
2	Prevention and reduction of soil erosion	Area (rai)	170,559	170,559	-	31,963	138,596	-	
		Total Project	-	551	321	131	99		
#6 Management and administration									
1	Maintenance work, survey study for water resource management	Total Project		209	128	54	27	-	RID/ DWR/ DGR/ DNP/ DDPM/ Local Administration
2	Develop and optimize decision support database system	Total Project		16	11	4	1	-	
3	Promote/campaign to reduce water use	Percentage	throughout the duration of master plan	100%	✓	✓ 60%	✓ 100%	-	
4	Promoting public participation	Percentage		100%	✓	✓ 60%	✓ 100%	-	
5	Telemeter maintenance inspection	Percentage		100%	✓	✓ 100%	✓ 100%	-	

Note : * This is the preliminary water storage potential, the actual water storage volume depends on the results of the study.

- Mae Klong River Basin has a potential of 16,541.67 million cubic meters/year of runoff in natural waterways, with a total water use demand of the river basin at present of 12,017.20 million cubic meters/year, with a total of high demand for water in the agricultural sector of 8,135.80 million cubic meters/year. The amount of water for procuring water security in the production sector, is needed to be undertaken in the variety of the parallel. The development of the runoff reservoirs in the mainstream is necessary to be undertaken for the cost water source in dry season, including to help the flood alleviate and consumption. However, the development of medium-sized and large-sized of water reservoirs may have the impact on using the forest land as well as the impact on the land of the people property. Therefore, before the construction is occured, there should be the study for the measures to prevent and reduce the impact.

- The area away from the main stream and upland area, it is necessary to develop small water reservoirs which are scattered among farmers' fields. Therefore, farmers who use water should sacrifice some of their land for water storage. There should also be the campaign for using water economically or choosing the growing plants that need less water.

- Soil properties of the watershed, digging a small pond should be deep and narrow and also preventing the leakage to reduce water loss.

- Management plan for building water security in the production sector according to this strategy is considered on the basis of the agriculture of the alternative 2 and the alternative 4. In the future, if farmers' cultivation patterns change from the present, it will result in the amount of water supplied change accordingly.

- Creating water security in production sector, is considered to procure sufficient water sources for agriculture and agro-industry in irrigated areas together with improving the efficiency of water use in the agricultural sector. For the agriculture in the rainwater area, it focuses on the development of water sources for subsistence agriculture, outside the irrigated area, by considering water reserves to be sufficient to meet the average water demand during dry season.

3) Flood and Inundation Management

- In Lam Phachi and Huai Taphen sub-basins, it was found that Huai Taphen facing flood in the form of flash floods; due to the small capacity of the river, but the water level can drop rapidly. As for Lam Phachi, there will be a problem of flooding at the junction between Chom Bueng District in Ratchaburi and Dan Makham Tia District in Kanchanaburi, especially the area of Dan Thap Tako Subdistrict and Chom Bueng District in Ratchaburi

Province. This is because this area has changed the sloped land to the relatively flat area, and it will occur during the time of heavy rain in the watershed area. If there is no cut off the amount of flood water together with the conservation of watershed forest areas, it will be difficult to alleviate the flooding in this area. **In the estuary and coastal areas of Mae Klong River Basin**: there is characterized by flooding in lowland areas including agricultural areas, residential and commercial. The main cause is the drainage problems and the bolstered sea water. Determination of flooding reliefing measures needs to be considered with the urban planning measures and be required the combination of several water management structures, such as drainage and flood prevention systems for important communities, main river bank protection, building Monkey Cheeks/water raftering the overflowing riverbanks in low-lying areas, improving water barriers, improving the drainage of roads, etc.

4) Water quality management and water resource conservation

- The sources of wastewater that results in the deterioration of water quality come from the important sources such as communities, establishments, industries, plants and livestock farms and agricultural areas. Although some sources of wastewater have a wastewater treatment system, the treatment efficiency is insufficient, and in some places, wastewater is drained directly into water sources without treatment. During the past period, aquaculture farmers in Ban Laem District, Phetchaburi Province has complained that wastewater from Ratchaburi area has been drained into various canals and flows into Bang Tabun River, causing the death of aquatic animals, and the annual damage. Therefore, the management of wastewater from the source should be controlled together with promoting and publicizing the farmers in the area to use agricultural chemicals properly, promoting the public relations for people in the area and tourists to take care of surface water resources.

- The Rapid growth of aquatic weeds in irrigation canals and drainage canals cause problems in water management in Mae Klong Plain in the irrigation project areas, such as water hyacinth problems in the main drainage canals, being the severe problem during flooding, drainage problems of algae and water weeds in the main water delivery canal which is an earthen canal. The effects of water weed problems is the blocking of water use for irrigation purposes, effected to the decreasing of the waterspeed in the irrigation canal. If there is a large quantity, it will increase more evaporating of water. Reducing the amount of water in the delivery canals due to mortality deposition, including causing the following water quality problems by reducing the amount of oxygen in the water from breathing at night and by decay, blocking the passage of sunlight shining through water causing the halting of the growth

of underwater creatures. The amount of weeds covering the water surface will block the path of sunlight through water surface and also hind the various necessary nutrients for phytoplankton and zooplankton, so the annual arrangements by local authorities are required.

5) Rehabilitation of forest watersheds and degraded areas

- Conservation and restoration of forest areas for the conservation and upstream forest, pay attention to the areas that are still forests in conservation areas, such as national park areas, wildlife sanctuary and the Conservation Forest (Zone C) because there are the areas with direct responsibility. The operation model is based on the guidelines of the Bureau of Watershed Conservation and Management, Department of National Parks, Wild Animals and Plants, by continuing the operating throughout the period of the strategic plan. In addition, it should encourage to the community to participate for the conservation and restoration for the forest areas and upstream areas so that the people will see the importance of how to coexist and take advantage of forests without trespassing.

6) Management and administration

- Water resource management of Mae Klong River Basin is needed the organization that supervises the overall management of water resources in the whole system. Therefore, it is necessary to develop water user organizations for water resource management at all levels, to prepare water resource management plans, to develope database systems and participate to all stakeholders.

- In terms of water resource management in Mae Klong River Basin, the overview of water resources at present is quite sufficient. But the water use is still not efficient and effective enough and water management also has distribution problems. The irrigation projects are concentrated in the lower areas, these make more of the average income per rai. The yield per rai of the upper area was much less than the lower area, and had lack of water in specific areas. There are three important characteristics of water management in Mae Klong River Basin: 1) The main of water use is irrigation and hydroelectric power generation, 2) Considering to the water diversion from Mae Klong watershed to support neighboring river basins (Tha Chin, Chao Phraya) and 3) Preserving the ecosystem at the estuary of the river. At present, the total water demand for all activities in Mae Klong River Basin is equal to 12,017.20 million cubic meters/year or about 73% of the runoff volume in the basin. In the future, water resources of Mae Klong River Basin, will have the sufficient potential only in the year of the normal water supply or more than the norm only. In conclusion, Mae Klong River is the watershed that has been closed: there is still very little water left over the near future that there might face the

water shortage. Therefore, the future trend of project development both the water use in Mae Klong River Basin and the diversion of water outside the basin. **The important issue that must be taken into account is therefore, not the question of whether; "Is there enough water in Mae Klong River Basin?" but the question is "How will we do to allocate the sufficiency for the variety of the water use activities?".** By focusing on the development of water management, such as improving water use efficiency and water delivery to reduce water loss, there are the projects that urgently needed, especially in the tributaries of Mae Klong River basin. Water management from Vajiralongkorn Dam and Srinakarin Dam in accordance with the demand for water use and pushing saltwater water management in all reservoirs and irrigation projects with the emphasis on participatory management, development of medium and small water resources in Lam Phachi River Basin, Lam Taphen and some areas of Khwae Noi and Khwae Yai to solve the problem of poverty and solving severe water shortage problems at Tha Chin River Basin (Lao Khwan District and Huai Krachao District in Kanchanaburi Province).

7) The Development of the potential of agricultural production

- The plan of the agricultural promotion in Mae Klong River Basin, considering to the the problems of the production sector in the agricultural sector, therefore, there are several approaches, such as the developing of the potential of the agricultural production to increase the quality and productivity per unit, the developing of the comprehensive agricultural support programme, linking the agricultural industry, organizing stationary zones for economic plant areas, promoting agricultural knowledge, using technology to assist the production, alternating the high yield crops, developing capacity in production and processing, promoting the marketing of agricultural products and community production, providing land for farmers, improving the land utilization measures in the NESDB area and the promoting and developing the agricultural organizations. However, in many Work plans depend on government policies, which is beyond the decision-making power of the operational level, therefore, the success of the management plan for the development of the potential of the agricultural products, is necessary to rely mainly on the government's driving mechanism.

- Zoning of agricultural areas, controling land use together with water management will help the number of agricultural products of each type of economic crops in the suitable amount suitable to the market supporting the products. These will prevent oversupply and control the amount of water use for cultivation and reduce conflicts in water use activities, which have the positive effect on water management in the watershed.

8) The Development of Tourism

- The development of tourism potential to increase revenue from services and tourism for the community, it should consider the forms of tourism activities in accordance with the potential of Mae Klong River Basin. By focusing on creating eco-tourism, agricultural tourism, tourism of lifestyle and culture, these would integrate tourism with other sectors and utilize the tourism areas for the suitable potential of tourism source development and also conserve tourism areas and natural resources.

9) Master Plan for Water Resources Management in Mae Klong River Basin

- In Mae Klong River Basin, there are the areas with abundant natural resources and in the future trend, from the potential of the province and the promotion of the government, these make the industrial sector still plays the most important role in driving the economy of the watershed area. At the same time, entrepreneurs will develop their trade potential, higher investment and marketing in order to be able to compete in trade with neighboring countries. However, most of the industry sectors are characterized as the continuing industry from agricultural sector, such as food processing industry, sugar industry, which require the production base from the agricultural sector. Moreover, most of the population occupation are mainly in the agricultural sector. Therefore, the creation of water security in the agricultural sector both in terms of procurement, reduction and optimization, will be the important factors in driving the economy of this watershed area. Any development related to the development of water resources should be carefully planned and managed, compromise the favors to the majority of the people and have the least impacts. In this study, the framework of the Master Plan of the 20-year water resource management and the action plan of the 5-year water resource management have been already set, so it should urgently improve and develop according the plan and planning the mentioned, to upgrading the income and quality of life of the people in the watershed areas.

- Due to this study is the study that aims to find patterns and guidelines of the water resources development in the strategies level and to integrate the master plan and the action plan of the water resource management in Mae Klong River Basin. The project plans which were contained in the master plans and the action plans: some plans were the principles and guidelines that would be studied in more detail, including the problem-solving in some issues would be studied first, before formulating the project plan that lead to further action.

- In Mae Klong River Basin, there is still found the problem of water shortage for consumer and consumtion spread throughout the basin due to less development of surface water resources and in the rain shadow, groundwater resources generally have water quality problems, unstable water supply: may be water scarcity during dry season. Therefore, it is recommended that the Department of Groundwater Resources should accelerate the study of the potential of groundwater sources clearly and the potential for groundwater filling in the watershed area in detail to the village level .The results of this study will be a good guideline for problem-solving of water shortage for consumer and consumption and can lead to take action in the future.