Thailand Country Report

For

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Thailand

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CHAPTER 1
INTRODUCTION

1.1 Background

Thailand is an agricultural country, mostly with rice farming, which is contributed to by water resources. In the past, there were ample water resources, which have nurtured the agricultural sector for many centuries. Water resources development and supply for the past 50 years has stressed supplying more water for dry-season cultivation, thus rapidly increasing water use in the agricultural sector. In addition, an increase in population and concentration of economic activities has brought greater water demand. In past development, natural resources were wastefully exploited without clear control measures and forest areas were encroached upon for agriculture and development. The development and water resources consumption in various aspects have had impacts on water quality. Furthermore, attitudinal conflicts and limitations to water resources project development have caused more serious water supply problems. The aforementioned water resources problems have occurred in basin areas, which have been dealt with as necessary or demanded. With regard to relevant strategies, they did not include guidelines or measures covering all aspects and lacked clear priority, thus causing inefficient problem solving.

On July 25, 2000, the cabinet approved "The National Water Vision" and on October 31, 2000, the cabinet approved "The National Water Policy", which show broad guidelines but do not detail measures under 4-year Performance Plan (2006-2009) for systematic water management and some problems are not contained in the strategic plan of 4-year Performance Plan as well as clear development plans in basin projects or related projects in various basins.

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1.2 Objectives

To formulate the strategies for water resources management of the country that reveal an overview of the basins and basin groups in solving water resources-related problems according to the National Water Policy, government policies and National Economic and Social Development Plans as a framework for improving short-term action plans and plan/project measures requiring medium and long- term implementation among relevant agencies, which involve participation of organizations, people and agencies concerned. The objectives of the strategic plan formulation are as follows:

1) To provide the strategic plans for water resources management at national, basin-group and basin levels

2) To provide the database in MIS and GIS for water resources management

3) To provide a short, medium and long-term master plan for water resources management

4) To provide a tool for formulating policies, planning and making decisions on water resources management among executives

1.3 Situations and Problems of Water Resources

1) Water situation—For the past 40 years, there have been 17,553 small, medium and large-scale water resources projects developed with an irrigation and benefit area of 40.863 million rai and active capacity of 76,131 MCM. The storage of large-scale reservoirs, each having a storage capacity of over 100 MCM, is equal to 68,823 MCM, with an active capacity of 45,434 MCM and controlled water accounting for 21%. Meanwhile, water demand is rapidly increasing and change of land use for development of urban communities, agriculture, industries and construction of public utilities for development have made many areas experience floods, drought, water shortage and water pollution more frequently, which tend to be increasingly severe.

2) Flooding—For the past 40 years, almost all provinces in Thailand experienced floods in 1974, 1975, 1978, 1980, 1983, 1989, 1995, 2001 and 2002. The most severe floods occurred in 1975, 1983, 1995 and 2002 respectively. The statistics of flooded areas and satellite images since 1983 suggest that the flood-affected areas include an agricultural area of 26.5 million rai and urban area of 6.8 million rai. Critically flood-prone areas include 64 areas in urban/municipal zone, covering 845,625 rai and in rural community zone, covering 2,173,750 rai. In addition, there are 2,370 villages with flashflood and landslide risk. The value of the damage to agriculture, public utilities and urban communities from 1989-2001 was estimated to be 69,266 million baht

3) Drought and water shortage—In Thailand for the past 40 years, drought occurred in 1967, 1968, 1972, 1977 and 1979. That in 1979 was the severest, which was caused by a very long rain spell from July to September and average annual rainfall that was lower than normal value in all regions. The areas vastly affected include the North and Central Plains, northern and western parts of the Northeast, and upper part of the Southeast, which greatly damaged and affected the national economy, especially in the agricultural and industrial sectors, which require agricultural products as the raw materials as well as electricity generation. Moreover, they affected people's livelihood due to water shortage for domestic use and electricity generation and damage to agricultural products. Drought crises caused immense damage to Thailand in 1986, 1987, 1990, 1994, 1999, 2002 and 2005, especially in 1994 and 1999, when drought occurred in vast areas in almost all regions of the country. In Lower North and Central Plains, there was allocation of water from Bhumibol and Sirikit Dams

4) Deteriorating water quality can be summarized as follows:

(1) Basins with very poor water quality: 3 basins, namely the Tha Chin Basin, Mun Basin in Lower Lam Takhong River, and Songkhla Lake Basin

(2) Basins with deteriorating water quality: 8 basins, namely the Ping Basin (Kuang River), Chao Phraya Basin (Middle and Lower Chao Phraya River and the Lop Buri River), Pa Sak Basin (Pa Sak River), Tha Chin Basin (Middle Tha Chin River), Mun Basin (Upper Lam Takhong River), Bang Pakong Basin (Bang Pakong and Nakhon Nayok Rivers), East Coast Basin (Rayong and Prasae Rivers), and South-eastern Basin (Chumphon River)

(3) Basins with good and fair water quality: 15 basins, namely the Northern Mekong Basin, Kok Basin, Wang Basin, Yom Basin, Nan Basin, Sakae Krang Basin, Northeastern Mekong Basin, Chi Basin, Prachin Buri Basin, Mae Klong Basin, Phetchaburi Basin, West Coast Basin, Tapi Basin, Pattani Basin, and South-western Basin

CHAPTER 2
FRAMEWORK FOR PLAN FORMULATION

2.1 Basins Groups

For Formulation of the Strategic Plans for Water Resources Management in 25 Basins, the basin boundaries were defined to facilitate formulation of plans in accordance with administrative characteristics, connection of resources as well as hydrological characteristics. Accordingly, the basins are classified according to the criteria:

1. Hydrological criteria, involving analysis and synthesis of hydrological data. According to the physical characteristics, among 25 main basins in Thailand, there are 9 basin groups, flowing into the Mekong River, the Salawin River or directly flowing into seas (on the side of the Gulf of Thailand and Andaman Sea). The 9 basin groups include the Mekong Sub-basin Group, Salawin Sub-basin Group, Chao Phraya-Tha Chin Basin Group, Mae Klong Basin Group, Bang Pakong Basin Group, East Coast Gulf Basin Group, West Coast Gulf Basin Group, South-eastern Basin Group (on the side of the Gulf of Thailand) and South-western Basin Group (on the side of the Andaman Sea).

2. Managerial criteria, involving geographical, socio-economic, environmental, demographic conditions, exploitation, and concordance with the strategies. Accordingly, among major 25 basins of Thailand, there are 6 basin groups based on the following criteria:

1) Basin conditions in different regions, namely North, Central Plain, Northeast, East, West and South

2) Topographical characteristics of the basins and linkage of water resources with other related natural resources as well as exploitation of water resources, e.g. water diversion from the Salawin or Mekong Sub-basins to the Chao Phraya Basin

3) Administrative, demographic, land use and socio-economic characteristics

4) Provincial and province cluster strategy

2.2 Framework for Plan Formulation

To solve water-resources related problems in the basin and basin group areas, guideline and framework for formulating the strategic and action plans for short, medium and long-term resolution, consisting of:

1. Guidelines for flood mitigation

1) Protection and rehabilitation of forest conditions and solving land problems in forest areas, of which the operation framework involves protection and rehabilitation of forest areas so as to maintain their forest ecological conditions as much as possible/soil erosion prevention and reduction/acceleration of solving land problems in forest areas

2) Conservation and rehabilitation of forest areas/water bodies/stream/wetland areas, of which the operation framework involves improvement of laws concerning the boundary of streams, water bodies and wetland areas/return of water areas, wet areas and water bodies encroached for by the government sector, private sector and communities/strict enforcement of laws related to stream, water bodies and wetland areas and measures for punishing those ignoring duties/improvement/formulation of criteria for design of structures, dikes and gates affected by the dikes and change in land use in

streams for water transport and drainage/improvement of streams, public water bodies and wetland areas

3) Water deceleration/monkey cheeks/dams, of which the operation framework involves development flood-receiving areas, clear determination of monkey-cheek areas with support of regulations and operation guidelines, management/construction of storage and diversion system, enhancement of the efficiency of the existing reservoirs, use of paddy areas as flow deceleration areas, review of objectives and large-scale reservoir management

4) Land use, of which the operation framework involves employment of city planning and building measures, resettlement zoning, enterprise, construction of structures for long-term flood mitigation/determination of proper agricultural land use/public relations of flood and landslide as the information assisting in decisions on land use

5) Disaster forecast and warning/risk assurance, of which the operation framework involves development of reliable flood measurement, examination, analysis, forecast and warning system/enhancement of capacity of communities in arranging disaster-warning system with the government sector/provision of flood-risk insurance and employment of tax/financial measures for flood prevention and compensation for flood-receiving areas during crisis

6) Urban community protection, of which the operation framework involves provision of flood-prevention system for urban communities in line with water management in basin system/construction of diversion routes from the main stream to reduce inundation

7) Management organizations should provide agencies directly responsible for planning on work coordination with agencies concerned at basin and national level for unified and efficient flood management

2. Guidelines for drought and water shortage

1) Watershed conservation—For sustainable and equitable use of water resources in each area with public participation in conservation and rehabilitation of watershed areas to maintain their abundance and to have sustainable and equitable use of water resources through management of watershed rehabilitation, cultivation of ground-covering crops to reduce erosion and construction of check dams

2) Water allocation—There should be control of water use in each basin according to priority and determination of proportions of water use in each activity that are clear and accepted by all parties concerned and in line with water capital of each basin.

3) Natural water resources conservation—This involves registration of natural water bodies, prevention of stream encroachment and dredging and training water bodies in line with ecological system and local needs

4) Enhancement of water use efficiency—This should be done for different activities, i.e. agriculture, domestic use and industries with the following operation guideline:

- Enhancing water conveyance system's efficiency
- Raising Thai people's consciousness of the importance of water resources
- Providing water resources curriculum at all levels
- Prioritization of importance of water use and determination of proportions of water use in each activity through public hearing of stakeholders of each activity
- Allowing local organizations to play a role and invest in water management and improvement of water use efficiency in large-scale irrigation projects

5) Planning on management and control of land use in line with water resources and soil in agricultural and industrial areas

- Determination of economic agricultural areas in large-scale irrigation projects, e.g. Chao Phraya Project, Mae Klong Project and Phitsanulok Project
- Management and control of agricultural land use (zoning) in the northeast so that there is cultivation of plants suiting soil and water conditions, e.g. fast-growing and drought-tolerant plants
- Planning on control of industrial expansion in the East Basin and West Coast Basin areas
- Planning on development of industrial areas in the South-eastern Basins in line with the potential of water capital and environment in each area
- Promotion of developing special economic zones in three southern border provinces as the center of Islamic food export
- Systematic tourist area development planning in line with the existing water resources in South-western Basin, Samui Island, Pha-ngan Island, Tao Island and Ko Chang National Park

6) Water management planning in the agricultural sector in a systematic manner and enhancement of water use, which makes water use in agricultural sector of 70% of overall water demand

7) Water resources supply and development, including drilling of groundwater wells and construction of small-scale water resources projects to allow people in all areas to have sufficient water in all seasons

8) Development of water resources for multi purposes—To have water in different activities, e.g. agriculture, industry, waterworks and flood mitigation, there shall be study, planning and formulation of clear goals for medium and large-scale water resources development projects and water diversion projects in line with topographic conditions and water uses in each basin. The development requires public relations, for disseminating project briefing, mass relations for obtaining opinions and suggestions and consideration of environmental impacts.

3. Guideline for water quality improvement

1) Measures on water quality management

(1) Measures on solving municipal wastewater

- Reduction of wastewater at the sources
- Expansion of wastewater collection pipes and improvement of central wastewater treatment system
- Construction of municipal wastewater treatment system

(2) Measures on solving industrial wastewater

- Promotion and support of clean production technology in factories
- Determining that factories causing high pollution shall be located in industrial estate/industrial zone
- Support and provide technical advice on construction of wastewater treatment system and system maintenance to the entrepreneurs

(3) Measures on solving agricultural wastewater

- Provision of technical support and promotion concerning construction of wastewater treatment system and system maintenance from pig farms and aquaculture-breeding farms to the entrepreneurs
- Promotion of use of organic fertilizers
- Promotion and support of clean production technology in the agricultural sector

2) Measures on water quality conservation in water bodies and rivers

(1) Study of the capacity of support of toxins, especially organic substances of each water body/river

(2) Rehabilitation of water quality in the canals/rivers/basins

(3) Water allocation from large-scale reservoirs for wastewater mitigation

3) Social measures

(1) Campaign for and public relations for raising consciousness of and participation in conservation of rivers and other water bodies

(2) Creation of an understanding of and participation in control, prevention and resolution of water pollution at sources into the rivers and other water bodies

4) Economic measures

(1) Provision of an incentive to polluters in dealing with the wastewater problem

(2) Certification of environmentally-friendly production standard

5) Organizational and legal measures

(1) Coordination of operation to authorize local organizations to deal with polluters

(2) Strict law enforcement

(3) Strict control of importers of pesticide and industrial chemicals

(4) Enhancement of efficiency of monitoring and inspection and law enforcement to control drainage through participation process

4. Management

1) Issuance of water acts
2) Establishment of Department of Water
3) Issuance of by-laws
4) Strengthening Basin Committee
5) Establishment of organizations for management in normal and crisis period
6) National Water Resources Information Center
7) Basin Fund
8) Sustainable Water Resources Management Research Project

2.3 Framework for Plan Formulation

According to the management guidelines for solving water resources problems in the basins with regard to drought, flood and water quality, the framework for strategic plan formulation is as follows:

1) Determination of strategy groups for proactive water resources management with sustainable development and social and environmental consideration and integrated management. The three strategies include sustainable development strategy, proactive strategy and adjustment strategy

2) Preparation of plans/projects for solving the problems as plan/project groups according to each strategy

3) Stressing public participation for the strategic plan formulation with seminars in basin areas with agencies concerned and local stakeholders to result in integrated national water resources management participation

4) Stressing coordination with both government and private agencies concerned in formulation of the integrated strategic plans

CHAPTER 3
STRATEGIC PLANS FOR WATER RESOURCES MANAGEMENT

The objectives of the strategic plan formulation are in accordance with the presented management framework and guidelines. The action plans were also formulated to solve water resources-related problems in basin areas and basin groups as follows:

3.1 Goals

To solve the problems, the goals of strategic plan formulation were clearly set as the framework for plans/projects to solve problems according to the goals, which are as follows:

1) A Thai population of 72-80 million

2) 33% of the forest area will be conservation forest area, which is not less than 18% of the country area

3) In an agricultural area of 59 million rai, an agricultural area of 32 million rai will be suitable for being developed to be an irrigation area in line with water availability potential of the country and an agricultural area of 27 million rai can be developed to be a benefit area of small-scale projects

4) The average annual controlled water and runoff is of 66,000 MCM, which is 31% of all surface water

- Average annual controlled water 40,000 MCM
- Average annual usable runoff and groundwater 10,000 MCM
- Additional average annual controlled water 12,000 MCM
- Average annual demand management 4,000 MCM

5) Additional average annual groundwater extraction 6,000 MCM

6) Average annual diverted flow from basins in and outside the country 8,000 MCM

7) Control of water demand for agriculture, domestic use, industry and tourism

- Domestic consumption of full capacity of surface water 66,000 MCM
- Domestic consumption of full capacity of surface water and groundwater 72,000 MCM
- Domestic consumption of full capacity of water and addition of diversion 80,000 MCM

8) For agricultural areas without potential to be developed to be irrigation areas, there should be:

- Development of rained agriculture systems and water bodies in paddy fields
- Cultivation of economic drought-tolerant trees
- Adjustment of cultivation systems
- Promotion of non-agricultural occupations

9) Management and control of land use for agriculture to suit water availability in basins

- East coast basins—There should be control of industrial expansion, especially industries that need a lot of water and cause pollution.
- West coast basins—There should be plans on industrial development in line with water availability and diversion of water from Tha Sae and Rap Ro Dams.

- South-eastern basins—Water from the Tapi River can be used for industrial development.
- North basins—For industrial development, additional large-scale reservoirs should be developed.
- Central basins—For increasing industrial development, inflow augmentation projects should be developed.

10) For management and control of land use for tourism, water use shall be in line the area potential, water demand management and implementation of diversion projects respectively.

11) Water for maintaining ecosystem in basins where there are large-scales projects accounts for 15-20% of all water demand.

12) Flood protection should be provided for urban areas and economic areas and damage to agricultural areas should be alleviated to be at acceptable levels.

13) Water quality should be controlled to be at standard levels and the percentage of water bodies with poor and very poor water quality shall not exceed 15.

14) There should be efficient water resource management organizations to render equitable and sustainable water use.

3.2 Strategic Plans

In the strategic plan formulation, various aspects shall be considered, e.g. foundation of sustainable development with social, economic and environmental equilibrium with consideration of water resources limitation, efficient and effective natural resources and environmental exploitation, reservation and conservation of natural resources for long use, economic development with qualified expansion, and thorough and equitable income distribution based on principles, polices, national plans, missions of main agencies and other agencies with relevant missions, comprising:

1) Sustainable development
2) His Majesty the King's philosophy on Sufficiency Economy
3) The National Water Vision and Policy
4) The 10th National Economic and Social Development Plan (B.E. 2550-2554)
5) Strategies of main agencies, i.e. Department of Water Resources and Royal Irrigation Department

Strategies for water resources management—To solve water resources-related problems according to the goals, there are 3 strategies, namely sustainable economy strategy, proactive strategy and adjustment strategy with plans/projects as shown in **Figure 3-1**.

1) Sustainable economy strategy, comprising the following tactics:
   (1) Protection, reservation and rehabilitation of forest and watershed areas with balance and sustainability
   (2) Protection, reservation, rehabilitation, development and exploitation of natural water resources
   (3) Storage of sufficient water and efficient water use
   (4) Creation of balance of water use for all parties
   (5) Reduction of flood-prone areas and flood risks
   (6) Protection, reservation and rehabilitation of water quality of water resources

2) **Proactive strategy**, comprising the following tactics:
   (7) Inflow augmentation
   (8) Development of water grid system
   (9) Increment of water value

3) **Adjustment strategy**, comprising the following tactics:
   (10) Enhancement of capacity of integrated and participatory management
   (11) Development of database system, knowledge base and technology

3.3 Action Plans according to the Strategic Plans

In formulation of the action plans according to the strategic plans, plans/projects were prioritized based on the following criteria:

- Priority of main strategies of the basins
- Concordance with the basin strategies and provincial/province cluster strategies
- Engineering, socio-economic and environmental importance

Action plans for water resources management in each basin are 20-year plans divided into:

1) Short-term plans (year 1-5)
2) Medium-term plans (year 6-10)
3) Long-term plans (year 11-20)

The action plan formulation in basin groups is summarized as follows:

1) North and East Basins are important as watershed areas and sources of agricultural products, industries and tourism of the country. The important plans/projects in the basin action plans are as follows:

(1) The Salawin, Northern Mekong and Kok Basins—The relevant development plans for conservation of basin areas mainly deal with conservation, rehabilitation and development of small-scale water resources for domestic and agricultural use in small-scale project areas.

(2) Chao Phraya-Tha Chin Basins and their sub-basins—Short-term project development plans were formulated for conservation and rehabilitation watershed areas, determination of economic-agricultural areas in the Chao Phraya Project, cultivation of low-water consuming crops instead of out-season rice, cultivation of drought-tolerant trees in agricultural areas, rehabilitation of natural water resources, improvement of water use efficiency, development of small-scale projects, dredging and training of rivers, installation of disaster-warning system, use of agricultural areas for flood storage etc.

- Medium and long-term plans involve development of medium and large-scale water resources projects, flood prevention in community areas, dredging of diversion canals, wastewater treatment projects etc.
- Long-term plans propose Mae Kuang Udom Thara Reservoir Inflow Augmentation Project and Bhumibol Reservoir Inflow Augmentation Project.

2) Northeast Basins have agricultural areas exceeding the water potential in the basins, topographic restrictions and social conflicts concerning large-scale project development. The relevant plans/projects are as follows:

- Short-term plans involve supplying water for domestic use, improvement of water use efficiency, rehabilitation of natural water resources, cultivation of low-consuming crops in irrigation areas, cultivation of drought-tolerant trees in agricultural

areas, development of small-scale water resources projects, installation of flood-warning system, elevation of dikes for storing flood etc.

- Medium and long-term plans involve development of medium and large-scale water resources development projects (4 projects), flood prevention in urban community areas, wastewater treatment projects etc.
- Long-term plans involve development of Mekong-Chi-Mun Project

3) East Basins are where a great deal of water is used in industrial sector. In East Cost Basin areas in particular, water use in agricultural sector is high in the Bang Pakong Basin. Drought crisis is severe in Chanthaburi Province. The important relevant plans/projects in the action plans are as follows:

- Short-term plans involve development of small-scale water resources, improvement of acid soil, cultivation of low-water-consuming economic crops in irrigation areas, installation of flood-warning system, water diversion from Bang Pakong-Bang Phra Reservoir, construction of flood prevention system in urban communities in Chanthaburi Province.
- Medium-term plans involve development of medium-scale water resources projects, wastewater treatment projects, connection of water grid system in east coast areas etc.
- Long-term plans involve development of large-scale water resources projects etc.

4) West Basins are where water use for agricultural sector is found the highest in the Mae Klong Basin and Phetchaburi Basin and there are tourist attractions and industrial development in the West Coast Basin. The important plans/projects in the action plans are as follows:

- Short-term plans involve improvement of irrigation projects, determination of economic-agricultural areas in Mae Klong Project, cultivation of trees in the Lam Pha Chi and Huai Taphoen Sub-basins, cultivation of economic crops instead of out-season rice, development of small-scale water resources, installation of disaster-warning system, dredging and training of rivers, water allocation for wastewater management etc.
- Medium and long-term plans involve development of small-scale water resources projects, flood prevention in community areas, construction of wastewater treatment system etc.
- Long-term plans involve water diversion for industrial development in Prachuap Khiri Khan Province

5) South-eastern Basins have water bodies that are important tourist attractions of the country and have potential for industrial development. The relevant plans/projects in the action plans are as follows:

- Short-term plans involve supplying water for domestic use, development of small-scale water resources, improvement of irrigation system, dredging and training of rivers, installation of flood-warning system, construction of flood mitigation projects in Mueang District, Nakhon Si Thammarat Province, construction of water bodies in Ko Samui, Ko Pha-ngan and Ko Tao Districts etc.
- Medium-term plans involve development of medium-scale water resources and construction of flood mitigation projects.
- Long-term plans involve development of large-scale water resources and construction of water-conveyance system for development of industrial areas in Nakhon Si Thammarat and Surat Thani Provinces.

6) South-western Basin has water bodies that are important tourist attractions of the country, stressing eco-development. The relevant important plans/projects are as follows:

- Short-term plans involve construction of small-scale water resources, improvement of mines, construction of water bodies in Phuket Province.
- Medium and long-term plans involve construction of medium-scale water resources development projects and water diversion for domestic use and tourism.

Basin	Strategy			Total
	Sustainable economy strategy	Proactive strategy	Adjustment strategy	
North and central basins	262,649.90	109,303.26	1,505.85	**373,459.01**
Northeast basins	107,617.59	223,378.90	2,519.58	**333,516.07**
East basins	87,799.11	5,869.65	267.67	**93,936.43**
West basins	61,610.82	20,739.42	178.00	**82,528.24**
South-eastern basins	62,577.41	1,176.63	1,506.26	**65,260.30**
South-western basins	20,766.09	514.39	5.00	**21,285.48**
Total	**603,020.92**	**360,982.25**	**5,982.36**	**969,985.53**

3.4 Alternative Plans for Water Resources Management

Thailand is basically an agricultural country, of which the water demand for agriculture reaches 90% of overall water demand of the country while the gross domestic products from agriculture accounts for only 10% of overall gross domestic products of the country. Agriculturalists in rural areas have rather low economic status. To promote their life quality and reduce income gap, it is needed to empower them to access and exploit water resources and agricultural zoning should be determined to make cultivation suit soil and water conditions, which will also contribute to national economic development. Therefore, alternative plans were studied to serve as the guidelines for formulating the strategies for water resources management to gain the maximum benefits in the future.

The investment cost analysis in operation plans shows that the investment costs of water resources development projects and water distribution system, Bhumibol Reservoir Inflow Augmentation Project, and Mekong-Chi-Mun Project are of over 60% of overall investment costs. The alternative plans for water resources management to solve drought and water shortage are as follows:

Case 1: Existing conditions
Case 2: Improving existing conditions
Case 2.1: Reducing dry-season rice farms to cultivate field crops in an area of 2 million rai
Case 2.2: Improving the efficiency of irrigation systems
Case 2.3: Case 2.1 and 2.2
Case 3: Developing water resources projects in basins
Case 4: Developing Bhumibol Reservoir Inflow Augmentation Project
Case 5: Developing Mekong-Chi-Mun Project

The study results of the alternative plans are shown in **Table 3-1**, which can be summarized as follows:

1) A budget should be allocated for enhancing the efficiency of irrigation systems and reducing dry-season rice farms to be substituted for by crop fields.

2) Irrigation development plans should be prepared for a clear direction of irrigation project development.

3) Bhumibol Reservoir Inflow Augmentation Project should be developed to increase the stability of water use in the Chao Phraya Basin.

4) Mekong-Chi-Mun Project should be reduced so that it suits the investment and maximizes the benefits to northeastern areas, especially in the 1st phase.

3.5 Budgets according to the Strategic Plans

3.5.1 Total Investment Costs

According to action plans of each of three strategies, composed of 11 tactics under a budget of 969,986 million baht, of which the highest proportion belongs to north and central basins, 373,459 million baht (38.5% of all investment cost) and the lowest proportion belongs to south-western basins, 21,285 (2.2%) million baht as shown in **Figure 3-2**.

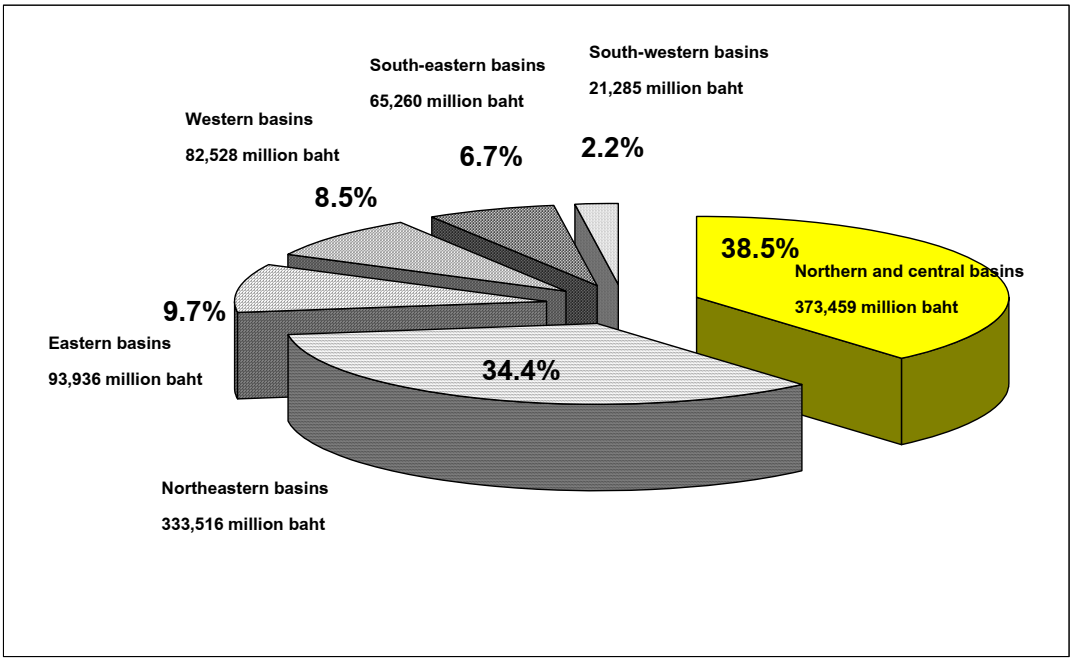

FIGURE 3-2 PROPORTIONS OF BUDGET BY BASIN GROUPS

3.5.2 Investment Costs according to the Alternative Plans

According to the strategic plans, the investment costs for development of water-resources projects at different levels and irrigation systems, Mekong-Chi-Mun Project, and Bhumibol Reservoir Inflow Augmentation Project are over 60% of overall investment costs. Therefore, alternative plans were prepared and it was proposed that Irrigation

Development Plan (IDP) should be prepared and Mekong-Chi-Mun Project should be in the 2nd and 3rd phase reduced so that the investment costs would decrease to 838,124 million baht and those of north-eastern basins would decrease to 201,655 million baht, accounting for 24.1% of overall investment costs as shown in **Figure 3-3**.

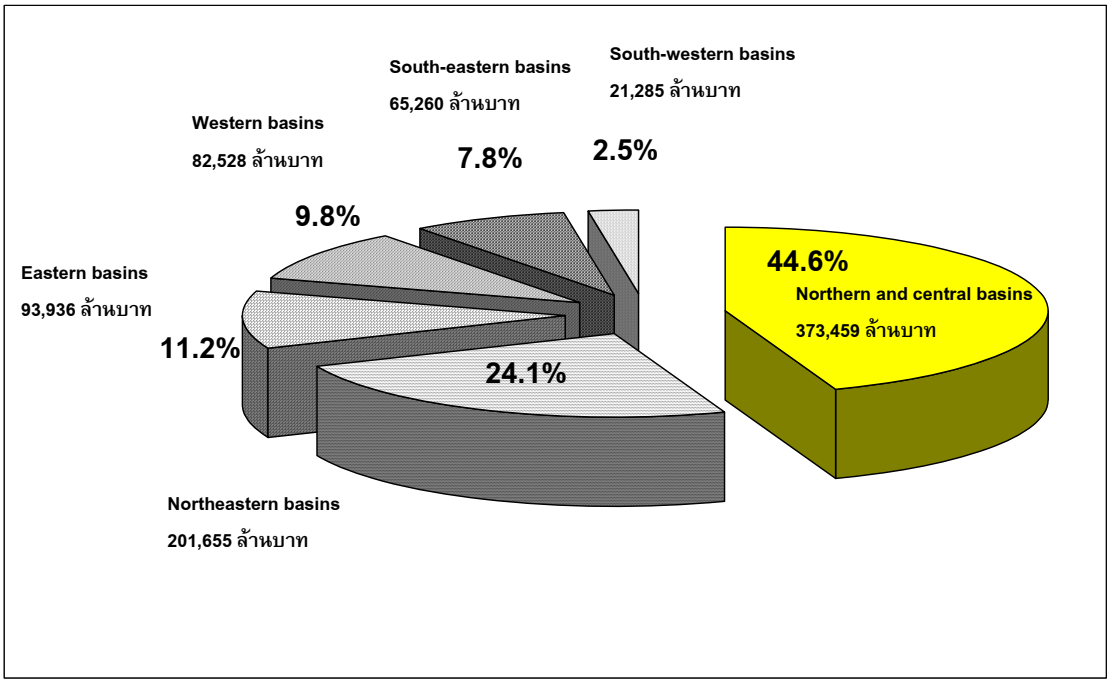

FIGURE 3-3 PROPORTIONS OF BUDGET BY ALTERNATIVE PLANS

3.5.3 Investment Cost according to the Action Plans

In the action plan formulation, annual investment costs in different phases of the National Economic and Social Development Plan from 2008-2027 .It is found that the investment cost planned in the 10th and 11th National Economic and Social Development Plan approximate to 50% of all investment costs, except for the Northeast, which has limitations to development of basin areas. The investment costs for the Northeast in the 10th and 11th National Economic and Social Development Plans account for only 38% whilst 62% of the budget is allocated for proactive strategies: development of inflow augmentation and water grid system. In conclusion, the investment costs in the 10th 11th, 12th and 13th National Economic and Social Development Plan account for 14%, 33%, 29% and 24% respectively of the overall investment costs. The total investment costs are 969,986 million baht and investment costs according to the alternative plans equal 838,124 million baht, which can be summarized as follows:

- North and central basins: Their investment costs according to the action plans are the highest, valued at 373,459 million baht due the fact that they cover an area making up 38% of the country's area and have the most severe water resources-related problems.
- East, west, and south-eastern basins: Their investment costs are next to those of north and central basins', which equal 93,936, 82,528 and 65,260 million baht respectively.

- South-western basins: Their investment costs are the lowest, 21,285 million baht because they cover a small area, accounting for 4% of the country's area and have the least severe water-resources related problems.

- North and central basins: Their investment costs in the 10th and 11th National Economic and Social Development Plan are higher than the average of the country, with a proportion of 20% and 34% respectively. The basins have water-resources related problems that should be the most urgently solved and have the highest potential for water-resources project development.

- Northeast basins: They face a lot of water-resources related problems, especially drought and water shortages but have limited development potential. Their investment costs in the 10th and 11th National Economic and Social Development Plan are lower than the average of the country, with a proportion of 7% and 31% respectively. Most investment costs are budgets of reservoir inflow augmentation projects, e.g. Mekong-Chi-Mun Project. Their investment costs in the 12th and 13th National Economic and Social Development Plan therefore reach 62%.

3.6 Outputs of the Strategic Plans for Water Resources Management in 25 Basins

The plan formulation will lead to solving flooding, drought and water shortage, wastewater and management problems as presented in the outputs of each National Economic and Social Development Plan, which are summarized as follows:

1. Solutions to flooding	Solve flooding in basins to be at acceptable levels and prevent flooding in important economic areas. The outcomes of each plan are as follows:
1.1 Protect and rehabilitate forest areas by **check dam**	- Increase in soil moisture and decrease in soil erosion through increasing forest areas into 119.07 million rai
1.2 Provide telemetering systems for flood forecast and warning	- Reduction of damage to human life and property caused by floods in 25 basins
1.3 Provide water drainage and diversion	- Reduction of damage to human life and property caused by floods in 25 basins
1.4 Protect urban communities and economic areas	- Flood protection in economic areas and 81 important urban communities
1.5 Store water in agricultural areas in Northeastern region	- Flood reduction by storing flood of 5,000 MCM
1.6 Provide **monkey-cheek** areas for receiving flood in Central region	- Flood reduction by storing flood of 2,000 MCM
2 Solutions to drought and water shortage	Provide clean water for domestic use and reduce drought in non-irrigation areas, and solve drought and water shortage in irrigation areas. The outcomes of each plan are as follows:
2.1 Provide water for domestic use	- Clean water for domestic use in all villages
2.2 Improve natural water bodies	- Increase in storage volume by 100 MCM
2.3 Manage water demand	
- Cultivate low water-consuming crops in an irrigation area of 1.6 million rai	- Reduction of water use in irrigation areas by 1,880 MCM
- Cultivate drought-tolerant plants in an agricultural area of 26 million rai	- Reduction of water use in non-irrigation areas - Increase in soil moisture - Economic woods for industries and energy
- Increase the efficiency of water use in an irrigation area of 16.23 million rai by 10%	- Reduction of water use in irrigation areas by 3,524 MCM

2.4 Develop medium and large-scale water resources projects with an active storage of 8,500 MCM	- Increase in irrigation and benefit areas into 59 million rai
2.5 Increase water availability in basins by 8,000 MCM	- Water for agriculture for an area of 4 million rai during the dry season - Water for water transportation in the Chao Phraya River - Water for domestic use and waterworks - Water for maintaining aquatic ecological system
3. Solutions to wastewater	Provide sufficient water for maintaining aquatic ecological system in the basins where there are large-scale reservoirs and the water quality is at acceptable levels. The outcomes of each plan are as follows:
3.1 Improve water quality	- Participatory control and management of wastewater at the sources
3.2 Allocate water for wastewater mitigation	- Increase in water drained from Chao Phraya Dam into 120 m^3/s - Drainage of water from large-scale reservoirs to maintain aquatic ecological system
3.3 Improve wastewater treatment plants	- Improved 14 wastewater treatment plants
3.4 Construct municipal wastewater treatment plants	- Additional 129 municipal wastewater treatment plants
4. Management	Water Resources Act and amendment of relevant laws
4.1 Integrated and participatory management	- Promotion of participation of all sectors and parties
4.2 Develop database system and knowledge	- Reduction of overlap of work plans and budgets of agencies with clear action plans

CHAPTER 4
GUIDELINE FOR PLAN IMPLEMENTATION, MECHANISM, AND MONITORING AND EVALUATION

4.1 Plan Implementation

To implement the Strategic Plans for Water Resources Management in 25 Basins and to evaluate the plan's achievement according to the indicators and goals efficiently and effectively, there shall be coordination process in plan implementation at area level. However, agencies at ministry and department level, especially those at area level can apply the strategies, measures and implementation guideline in accordance with each area's problems and conditions. Prior to the application, there shall be analysis and prioritization of the problems in each area.

1. Coordination process for plan implementation at area level

1) Creation of an understanding of the strategic plans and action plans at different levels

(1) National level: Agencies responsible for water resources at minister level of the Office of the Prime Minister, Ministry of Interior, Ministry of Industry, Ministry of Finance, Ministry of Transport, Ministry of Natural Resources and Environment, Ministry of Agriculture and Cooperatives, and Ministry of Education

(2) Regional level: Regional Irrigation office, Water Resources Regional Office and Regional Environment Office etc.

(3) Provincial and local organizations

2) Enhancement of capacity of local agencies in the area—Department-level agencies shall train basin and local agencies in plan formulation and implementation in an integrated manner.

3) National Water Resources Committee of Thailand designated Department of Water Resources to coordinate the plans among agencies playing a key role in mobilization, operation, monitoring and evaluation.

2) Mechanism of plan formulation—Implementation of the Strategic Plans for Water Resources Management in 25 Basins, which are national and basin plans in agencies of all levels, requires a central agency, which is National Water Resources Committee of Thailand and Department of Water Resources to coordinate work and implement the plans with other agencies.

4.2 Monitoring and Evaluation

To evaluate the strategic plan implementation, there shall be monitoring and evaluation through the following procedures:

1) Establishment of Monitoring Committee, consisting of representatives from the government sector and agencies concerned as well as civil societies and NGOs, who will participate in monitoring and evaluating the strategic plans and action plans for water resources management

2) Evaluation of the indicators in each strategy through monitoring and evaluating the performance of the relevant agencies according to the goals of the plans (half-plan period) as well as plan adjustment by departments responsible for the action plans and evaluation. The evaluation results will be submitted to Department of Water Resources,

which will process the results before submitting them to the Monitoring Committee for integrated strategic plan evaluation.

3) The Monitoring Committee will designate Department of Water Resources to create the database system for monitoring and evaluation of the plan implementation according to the strategic plans in order to report the progress, problems, obstacles and suggestions for enhancing the performance to National Water Resources Committee of Thailand and Monitoring Committee to improve the plans accordingly.

Chapter 5
Conclusion and Recommendation

5.1 Conclusion

In the formulation of Strategic Plans for Water Resources Management in 25 Basins to solve water resources-related problems in basins, important plans/projects in the three strategies are as follows:

1. Sustainable development strategy, under which the relevant plans/projects are as follows:

1) Reservoir management and enhancement of water consumption efficiency in irrigation projects

2) Flood prevention in areas, especially in the Yom, Nan, Chao Phraya and Tha Chin Basin areas

3) Wastewater management in the Chao Phraya, Lower Tha Chin, Prachin Buri, Mae Klong and East Coast basins, especially the Lower Tha Chin Basin in Samut Sakhon Province

4) Conservation and rehabilitation of a forest area of 14.4 million rai

5) Formulation of measures making agriculturalists reduce out-season rice farming in Chao Phraya Project to reduce water consumption and water use conflicts

6) Promotion of cultivation of low-water consuming economic crops

7) Determination of economic agricultural areas in large-scale irrigation projects, e.g. Greater Chao Phraya Project, Greater Mae Klong Project and Phitsanulok Project

8) Management and control of agricultural land use (zoning) in the Northeast so that there is cultivation of plants suiting soil and water conditions, e.g. fast-growing and drought-tolerant plants

9) Planning on contro0lling industrial expansion in East Basin areas by promoting and supporting industries with low water use and low environmental impacts

10) Planning on developing industrial areas in Nakhon Si Thammarat and Surat Thani Provinces to suit the potential of water capital and environment in the areas with use of water from the Ta Pi River

11) Promotion of developing special economic zones in three southern border provinces as the center of Islamic food export

12) Systematic tourist area development planning in line with the existing water resources in South-western Basin, Samui Island, Pha-ngan Island, Tao Island and Ko Chang National Park

13) Development of water resources on Phuket, Samui, Pha-ngan, Tao and Chang Islands to meet water demand for domestic use and tourism

14) Development of important large-scale water resources projects in Mae Wong Dam in Nakhon Sawan Province, Kaeng Suea Ten Dam in Phrae Province, Mae Taeng Dam in Chiang Mai Province, Nam Khek Dam in Phitsanulok Province, Chi Bon Dam in Chaiyaphum Province, Lam Dom Yai Dam in Ubon Ratchathani Province, Huai Samong, Sai Noi and Sai Yai Dams in Prachin Buri Province, Lower Khlong Phra Prong and Khlong Nong Kaew Dams in Sakaeo Province, Tha Sae and Rap Ro Dams in Chumphon Province etc. The medium and large-scale water resources development projects in areas are as follows:

Basin group	Capacity					
	30-100 MCM		Over 100 MCM		Total	
	Number of projects	Capacity (MCM)	Number of projects	Capacity (MCM)	Number of projects	Capacity (MCM)
North and central	28	1,559.69	8	2,469.00	36	4,028.69
Northeast	14	703.21	2	442.10	16	1,145.31
East	17	931.32	4	912.43	21	1,843.75
South-eastern	13	613.50	4	551.90	17	1,165.40
South-western	6	304.30			6	304.30
Total	78	4,112.02	18	4,375.43	96	8,487.45

2. Proactive strategy—Plans/projects for inflow augmentation and water grid system are as summarized below:

Project	Diverted flow (MCM/year)	Project status	Budget (million baht)
1. Mae Kuang Udom Thara Reservoir Inflow Augmentation Project	147.42	Feasibility study	5,279.62
2. Bhumibol Reservoir Inflow Augmentation Project	3,967.22	Feasibility study	51,967
(1) Lower Yuam Reservoir-Bhumibol Reservoir	(2,184.52)		(36,056)
(2) Nam Moei-Huai Khanaeng-Nam Mae Tuen	(1,782.70)		(15,911)
3. Mekong-Chi-Mun	3,500	Feasibility study and detailed design, phase 1	219,769*
4. Pipe Network System of Water Resources in East Coast Areas	276	Master plan study	
- Chachoengsao-Bang Phra Reservoir Pipeline Project	50	Constructed	
- Khlong Phra Ong-Bang Phra Reservoir Pipeline Project	70	Feasibility study	
- Chachoengsao-Bang Phra Reservoir Pipeline Improvement Project	13	Feasibility study	
- Prasae Reservoir-Nong Pla Lai Reservoir Diversion Project	85	Detailed design	333.36
- Khlong Wang Tanot-Prasae Reservoir Diversion Project	35	Detailed design	3,188.57
- Thap Ma Pond Water Diversion Project	10	Feasibility study	
- Small-scale water bodies	13	Preliminary study	

* Remark: Estimated costs in 2006

3. Adjustment strategy, under which the relevant plans/projects are as follows:

1) Creation of capacity of integrated and participatory management
2) Development of database
3) Building organizational capacity

5.2 Recommendation

1. Drought and water shortage—Thailand has limited water resources, burdened with a high cost of water resources supply and development and has lower potential of agricultural areas than that of its neighboring countries that are its agricultural rivals. Therefore, there should be enhancement agricultural, tourist and industrial capacity and efficiency as follows:

1) Formulation of clear strategies for agricultural, tourist and industrial development in line with local water resources for increasing the value of water and agricultural production capacity

2) Determination of economic agricultural areas in irrigation areas

3) Promotion of reduction of paddies and promotion of low-water consuming economic crops

4) Determination of clear direction of irrigation area development and formulation of irrigation development plans

2. Flood—Non-structural measures should be started first

1) Land use management, including city planning and land use boundary

2) Determination of monkey-cheek areas, agricultural area management for flood storage and water management for use during the dry season

3. Wastewater—There should be measures for controlling wastewater sources' treatment and management of wastewater before being released to the river.

4. Management

1) Improvement of the structure of duties of water-related agencies

2) Issuance of water resources acts

3) Amendment of water resources laws and acts

4) Enhancement of capacity of local and national water resources agencies

5) Decentralization of authorities and responsibilities to basin-level organizations

6) Establishment of organizations for water resources management in normal and crisis periods

7) National Water Resources Information Center

8) Basin Fund