GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA

STATE REPORT

VOL. 6

PAHANG

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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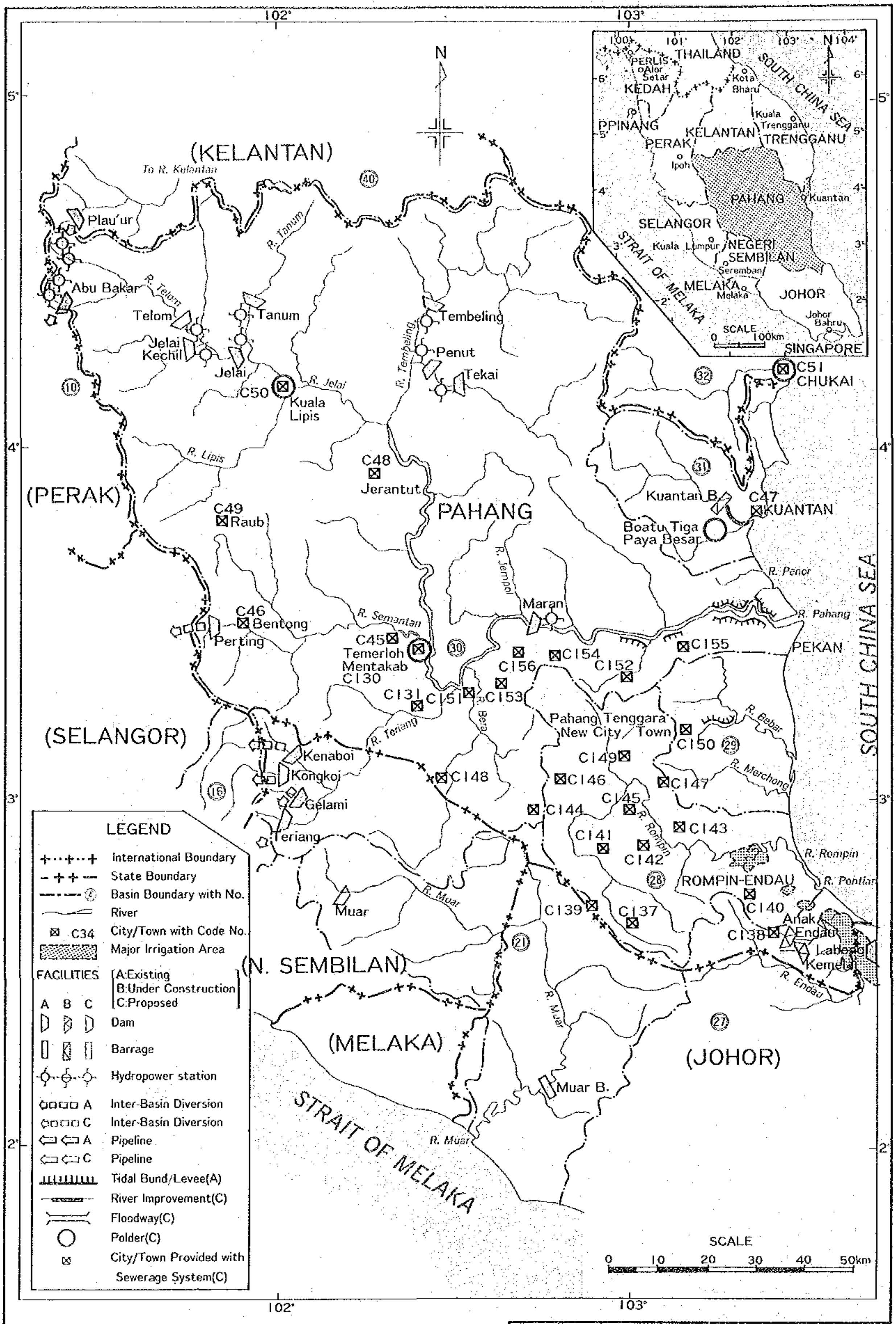

Recommended Plan
for the State of Pahang

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

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ABBREVIATIONS

(1) Plan

FMP	:	First Malaysia Plan
SMP	:	Second Malaysia Plan
TMP	:	Third Malaysia Plan
4MP	:	Fourth Malaysia Plan
5MP	:	Fifth Malaysia Plan
6MP	:	Sixth Malaysia Plan
7MP	:	Seventh Malaysia Plan
NEP	:	New Economic Policy
OPP	:	Outline Perspective Plan
RESP	:	Rural Environmental Sanitation Program

(2) Domestic Organization

DID (JPT)	:	Drainage and Irrigation Department
DOA	:	Department of Agriculture
DOE	:	Division of Environment
DOF	:	Department of Forestry
DOFS	:	Department of Fishery
DOM	:	Department of Mines
DOS	:	Department of Statistics
EPU	:	Economic Planning Unit
FAMA	:	Federal Agricultural Marketing Authority
FELCRA	:	Federal Land Consolidation and Rehabilitation Authority
FELDA	:	Federal Land Development Authority
ICU	:	Implementation and Coordination Unit
MARDI	:	Malaysian Agricultural Research and Development Institute
MIDA	:	Malaysian Industrial Development Authority
MLRD	:	Ministry of Land and Regional Development
MMS	:	Malaysian Meteorological Service
MOA	:	Ministry of Agriculture
MOF	:	Ministry of Finance
MOH	:	Ministry of Health
MOPI	:	Ministry of Primary Industries

MRRDB	:	Malaysia Rubber Research and Development Board
NDPC	:	National Development Planning Committee
NEB (LLN)	:	National Electricity Board
PORIM	:	Palm Oil Research Institute of Malaysia
PWD (JKR)	:	Public Works Department
RDA	:	Regional Development Authority
RISDA	:	Rubber Industry Small-holders Development Authority
RRIM	:	Rubber Research Institute of Malaysia
SEB	:	Sabah Electricity Board
SEBC	:	State Economic Development Corporation
S(E)PU	:	State (Economic) Planning Unit
SESCO	:	Sarawak Electricity Supply Croporation
UDA	:	Urban Development Authority

(3) International or Foreign Organization

ADAA	:	Australian Development Assistance Agency
ADB	:	Asian Development Bank
ASCE	:	American Society of Civil Engineers
FAO	:	Food and Agriculture Organization of the United Nations
IBRD	:	International Bank for Reconstruction and Development
ILO	:	International Labour Organization
IMF	:	International Monetary Fund
IRRI	:	International Rice Research Institute
JICA	:	Japan International Cooperation Agency
JSCE	:	Japan Society of Civil Engineers
MOC	:	Ministry of Construction, Japan
OECD	:	Organization for Economic Cooperation and Development
OECF	:	Overseas Economic Cooperation Fund, Japan
UK	:	United Kingdom
UNDP	:	United Nations Development Program
UNSF	:	United Nations Special Fund
US or USA	:	United States of America
US/AID	:	United States Agency for International Development
USBR	:	United States Bureau of Reclamation
WHO	:	World Health Organization
WMO	:	World Meteorological Organization

(4) Others

B	:	Benefit
BOD	:	Biochemical Oxygen Demand
C	:	Cost
CIF	:	Cost, Insurance and Freight
COD	:	Chemical Oxygen Demand
D&I	:	Domestic and Industrial
dia	:	Diameter
EIRR	:	Economic Internal Rate of Return
El.	:	Elevation above mean sea level
Eq.	:	Equation
Fig.	:	Figure
FOB	:	Free on Board
FSL	:	Full Supply Level
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
H	:	Height, or Water Head
HWL	:	Reservoir High Water Level
LWL	:	Reservoir Low Water Level
O&M	:	Operation and Maintenance
Q	:	Discharge
Ref.	:	Reference
SITC	:	Standard International Trade Classification
SS	:	Suspended Solid
V	:	Volume
W	:	Width

ABBREVIATIONS OF MEASUREMENT

Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer
ft = foot
yd = yard

Area

cm^2 = sq.cm = square centimeter
m^2 = sq.m = square meter
ha = hectare
km^2 = sq.km = square kilometer

Volume

cm^3 = cu.cm = cubic centimeter
l = lit = liter
kl = kiloliter
m^3 = cu.m = cubic meter
gal. = gallon

Weight

mg = milligram
g = gram
kg = kilogram
ton = metric ton
lb = pound

Time

s = second
min = minute
h = hour
d = day
y = yard

Electrical Measures

V = Volt
A = Ampere
Hz = Hertz (cycle)
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = percent
PS = horsepower
° = degree
' = minute
" = second
°C = degree centigrade
10^3 = thousand
10^6 = million
10^9 = billion (milliard)

Derived Measures

m^3/s = cubic meter per second
cusec = cubic feet per second
mgd = million gallon per day
kWh = Kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/y = kilowatt hour per year
kVA = kilovolt ampere
BTU = British thermal unit
psi = pound per square inch

Money

M$ = Malaysian ringgit
US$ = US dollar
¥ = Japanese Yen

CONVERSION FACTORS

	From Metric System	To Metric System
Length	1 cm = 0.394 inch 1 m = 3.28 ft = 1.094 yd 1 km = 0.621 mile	1 inch = 2.54 cm 1 ft = 30.48 cm 1 yd = 91.44 cm 1 mile = 1.609 km
Area	1 cm^2 = 0.155 sq.in 1 m^2 = 10.76 sq.ft 1 ha = 2.471 acres 1 km^2 = 0.386 sq.mile	1 sq.ft = 0.0929 m^2 1 sq.yd = 0.835 m^2 1 acre = 0.4047 ha 1 sq.mile = 2.59 km^2
Volume	1 cm^3 = 0.0610 cu.in 1 lit = 0.220 gal.(imp.) 1 kl = 6.29 barrels 1 m^3 = 35.3 cu.ft 10^6 m^3 = 811 acre-ft	1 cu.ft = 28.32 lit 1 cu.yd = 0.765 m^3 1 gal.(imp.) = 4.55 lit 1 gal.(US) = 3.79 lit 1 acre-ft = 1233.5 m^2
Weight	1 g = 0.0353 ounce 1 kg = 2.20 lb 1 ton = 0.984 long ton = 1.102 short ton	1 ounce = 28.35 g 1 lb = 0.4536 kg 1 long ton = 1.016 ton 1 short ton = 0.907 ton
Energy	1 kWh = 3,413 BTU	1 BTU = 0.293 Wh
Temperature	°C = (°F − 32) · 5/9	°F = 1.8°C + 32
Derived Measures	1 m^3/s = 35.3 cusec 1 kg/cm^2 = 14.2 psi 1 ton/ha = 891 lb/acre 10^6 m^3 = 810.7 acre-ft 1 m^3/s = 19.0 mgd	1 cusec = 0.0283 m^3/s 1 psi = 0.703 kg/cm^2 1 lb/acre = 1.12 kg/ha 1 acre-ft = 1,233.5 m^3 1 mgd = 0.0526 m^3/s
Local Measures	1 lit = 0.220 gantang 1 kg = 1.65 kati 1 ton = 16.5 pikul	1 gantang = 4.55 lit 1 kati = 0.606 kg 1 pikul = 60.6 kg

Exchange Rate
(As average between July and December 1980)

\$1 = M\$2.22
¥100 = M\$1.03

1. INTRODUCTION

Malaysia's rapid development has begun to strain her water resources. Increasingly water stress has occurred in places where previously water was found abundant for use. The responsibility for water resources development and management in Malaysia has traditionally been fragmented among various departments and agencies in accordance with their respective functions and activities related to water. In the absence of a comprehensive system to coordinate the multifarious activities in water resources development and management, these activities tend to take place in isolation. This may lead to competition in water use and even duplication of activities and functions. An integrated approach to water resources development and management is therefore necessary to ensure future efficient use of water and other resources, and a study in this regard has become necessary.

The National Water Resources Study, Malaysia, has been carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with officials of the Government of Malaysia for 3 years since October, 1979 in order to establish a basic framework for the orderly planning and implementation of water resources development programs and projects and for rational water resources management consistent with the overall national socio-economic development objective.

The Final Report submitted now comprises Volume 1 Master Action Plan and Volume 2 Water Resources Development and Use Plan, being supported by the State Reports and Sectoral Studies.

The Master Action Plan contains recommendations on actions to be taken by the Federal and State Governments to ensure efficient and effective execution of water resources development and management in the future, including the national water policy, implementation program, financial system, water administration, institutional framework, legal provisions and further study.

The Water Resources Development and Use Plan is a translation of the national water policy into a long-term national master plan for water resources development, reflecting the needs based on socio-economic goals and also the availability of water and other resources as well as the extent and distribution of water stress.

Each volume of the State Reports is a version of the Water Resources Development and Use Plan compiled for a State or a group of States, including more information regarding the specific State or States. The State Report Volume 6 herein presented describes the matters for the State of Pahang.

The Water Resources Development and Use Plan was prepared to show general direction of water resources development in Malaysia, identifying future problems and needs and availability of water and other resources, based on analysis and interpretation of readily available data and information. Individual projects indicated are, therefore, only notional and no intention has been made to define any of their details.

2. BACKGROUND

2.1 The Land

The State of Pahang of 35,980 sq.km is located in the central part of the east coast of Peninsular Malaysia, between 101°20′ and 103°38′ east in longitude and 2°28′ and 4°47′ north in latitude. It faces the South China Sea and adjoins 6 States of the 11 States except the States of Perlis, Kedah, Pulau Pinang and Melaka.

The northern half of the State is mountainous. The southern half mainly is the plain of the Pahang river. In the south-eastern part lies a vast stretch of swamps. Rivers run parallel or perpendicular to the geological trend. They are the Pahang, Endau, Rompin, Marchong, Kuantan and other small rivers.

Geological feature of Pahang is a southern extension of that in Kelantan. It is characterized by granitic rock masses in the Main Range in the west and the eastern range and the meta-sedimentary rocks developed in the intermediate zone between them and in the east coastal zone. The meta-sedimentary faces cover various kinds of argillaceous and arenaceous rocks, some altered to phyllite, slate and quartzite, rudaceous rocks and conglomerates as well as pyroclastic rocks and limestones of Silurian to Cretaceous. General structural trends are north-northwesterly. Patches of continental sediments of Cretaceous to Jurassic are located in the hills behind the 20 km wide alluvial plain on the east coast. Major faults show two kinds of trends, northery and northwesterly. In the southern parts of the State, the latter appears predominant. Further, in Pahang Tengara area, west-northwesterly direction is the main trend of major faults which run through the eastern range granites and Permian meta-sediments.

Soils are mostly sedentary soils occurring on undulating plains and mountains. The areal extent of alluvial soils on coastal plains, riverine flood plain and terraces is 7,975 sq.km, accounting for 22% of the total for the State. Of this, 2,584 sq.km are evaluated as suitable for paddy, 1,179 sq.km for coconut and 388 sq.km for rubber, and 3,228 sq.km as suitable to marginal for coconut. In the sedentary soil area, 8,847 sq.km are suitable and suitable to marginal for rubber, 8,789 sq.km for coconut, and 8,171 sq.km for oil palm and cocoa, respectively, including suitable area of 815 sq.km for rubber, 717 sq.km for coconut, 517 sq.km for oil palm and cocoa.

Climate is usually hot and wet. Average annual rainfall is high of 2,000 mm - 3,000 mm, of which nearly 50% occurs in November to January being strongly affected by the northeast monsoon. Meteorological data at Kuantan (El.15.3 m) are summarized in Table 1.

2.2 The Rivers

Run-off in rivers wholly or partially located in the State of Pahang is estimated based on 1961 - 1979 records at the hydrological stations No.1737451 in the Johor river, No.3424411 in the Pahang river and No.5130432 in the Trengganu river. The surface run-off is 43 billion cu.m/y or 40% of rainfall of 107 billion cu.m/y. Evapotranspiration is 58 billion cu.m/y and groundwater recharge is 6 billion cu.m/y.

Organic pollution in the rivers is caused by domestic and industrial sewage, effluent from rubber factories, palm oil millls and animal husbandries. Biochemical oxigen demand (BOD) concentration of more than 5 mg/lit was measured during 1978/1979 in the Endau and Pahang rivers. Operation of mines, opening-up of residential areas, road construction and logging are major causes of high concentration of suspended solid (SS). In the 1978/1979 observation, SS concentration was more than 500 mg/lit in some stretches of the Kuantan river.

Rich alluvial aquifers occur in the flood plains of the Pahang river. Rock aquifers may be found in the sedimentary rocks of Silurian to Triassic and some granites.

The river characteristics in terms of river morphology, estuary, sediment and sea water intrusion in Pahang is as shown in Tables 2 through 4.

2.3 Watershed

Natural vegetation occupies 24,516 sq.km comprising hill forest of 21,937 sq.km, scrub forest of 1,245 sq.km, swamp forest of 809 sq.km and grassland of 525 sq.km. The varieties range from the mangroves on coastal fringes to the mixed dipterocarp forests in lowlying and hilly areas and the montane forests of the highlands.

The total forest decreased from 28,865 sq.km or 80% of the whole State in 1966 to 23,991 sq.km or 67% in 1979 by forest exploitation not only for logging purpose but also for execution of agricultural land development schemes.

Through the soil erosion potential evaluation in the Study, it was preliminarily estimated that the concentration of suspended solid was between 200 and 500 mg/lit at present in the middle and lower reaches of the Pahang river due to the surface soil loss occurred in its catchment area.

2.4 Present Socio-economic Condition

As illustrated in Fig. 1, the State of Pahang is administratively divided into nine districts. Towns having population of more than 10,000 in 1980 were Kuantan, Temerloh, Bentong, Raub and Kuala Lipis.

Population of Pahang was 800,000 in 1980 with the average annual growth rate of 4.6% during the period from 1970 to 1980. Population density increased from 15 persons/sq.km in 1970 to 23 persons/sq.km in 1980.

Gross regional product (GRP) increased from M$629 million in 1971 to M$1,183 million in 1980 in factor cost at 1970 constant price with the average annual growth rate of 7.3%. GRP of manufacturing sector shared M$41 million or 6.5% of the total in 1971 and M$191 million or 16.1% in 1980. Per capita GRP was M$1,443 in 1980 in factor cost at 1970 constant price and its average annual growth rate between 1971 and 1980 was 2.7%.

Major land use patterns in 1979 were forest of 23,991 sq.km, grassland of 525 sq.km, annual and perennial crop land of 6,107 sq.km, swamp of 3,309 sq.km and miscellaneous land of 2,085 sq.km. The land use in 1974 is shown in Fig.2.

Rubber, oil palm, coconut and cocoa are planted for earning of foreign currency by export. The total planted area as of 1979 was 177,700 ha for rubber, 248,400 ha for oil palm, 7,300 ha for coconut and 6,300 ha for cocoa. During the last five years since 1975, newly planted area under FELDA and FELCRA schemes totaled 19,200 ha for rubber and 75,600 ha for oil palm. RISDA replanted 10,000 ha of rubber in the existing smallholder's rubber areas during the said period, and private estates also increased by 1,100 ha their planted area of rubber. The annual production in 1979 totaled 125,700 tons of rubber as dry rubber content, 2,140,200 tons of oil palm as fresh fruit bunch, 17,800 tons of coconut as copra and 180 tons of cocoa as dry beans. Out of the above harvests, private estates produced 39,400 tons of rubber and 612,000 tons of oil palm. The remaining ones were put out from RISDA, FELDA and FELCRA schemes as well as smallholders.

In 28 mills located within the State, 341,200 tons of crude palm oil and 67,800 tons of palm kernel were extracted from oil palm through processing 1,527,200 tons of fresh fruit bunch brought in the mills throughout 1979.

In 1979/80, paddy was planted in 8,400 ha comprising main season wet paddy of 6,800 ha and off-season wet paddy of 1,600 ha. As the whole paddy field was 25,000 ha, the crop intensity in 1979/80 became 0.34. The total rice production in 1979/80 was 10,600 tons among which 8,100 tons were harvested in the main season and the remaining 2,500 tons were off-season wet paddy rice. This production met 3% of the estimated local consumption of 78,000 tons in the State in 1979/80.

During the period from 1970/71 to 1979/80, rice production fluctuated between 6,900 tons in 1977/78 and 31,400 tons in 1973/74 largely affected by climatic condition, even though paddy field which was provided with irrigation facilities increased from 15,200 ha to 19,300 ha.

3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

3.1 Domestic and Industrial Water Supply

Public water supply in Pahang is administered by the Water Supply Division of Public Works Department (PWD) of the State Government.

PWD supplies piped and treated water to the major towns in urban area and also to the minor towns and villages in rural area. The urban water supply system also commands some suburban rural areas nearby. The pipeline is connected to individual taps.

In 1978, twenty five PWD waterworks delivered 82,200 cu.m/d of water on an average. The population served water through PWD networks was estimated at 522,600 in 1980.

In the interior and isolated rural areas, untreated water supply system has been developed by the State Government by either withdrawing water from small river or digging shallow wells equipped with hand pumps with materials and technical advices from MOH, under the Rural Environmental Sanitation Program. It was estimated that 44,000 people were served water by the untreated water supply system in 1980. The water users are suggested to boil water before drinking.

In consequence, 566,600 people out of the total State population of 819,800 were estimated to be served water through PWD and RESP, corresponding to the service factor of 69% in 1980.

3.2 Irrigation

There are 25,000 ha of paddy fields: 19,200 ha are irrigated and 5,800 ha are rainfed. At present no major schemes are located in the State. There exist 273 irrigation schemes consisting of 192 control drainage, 46 gravity and 35 pumping gravity irrgation schemes. The largest irrigation scheme is the Paya Pahang Tua pumping irrigation scheme with a service area of 1,400 ha. The average size of schemes in the State is 79 ha, which is the smallest in Peninsular Malaysia. Location of irrigation areas is shown in Fig.3. Double cropping area is only 900 ha, which is 5% of total irrigation area of 19,200 ha. Paddy yield is 1.9 - 2.2 tons/ha in the main season and 1.4 - 2.3 tons/ha in the off-season according to the records from 1973 to 1978.

3.3 Flood Mitigation

Flood occurs between November and January, mostly in December. The damage by the recorded maximum flood in the State is estimated to be M$90.8 million at 1980 price level. Table 5 lists the inundated area and estimated damage by the recorded maximum flood by Basin. The inundated area is illustrated in Fig.4.

3.4 Power Generation

The Camelon Highland Scheme is a series of power stations in the States of Pahang and Perak. The uppermost reservoir being located at the southwest corner of the State of Kelantan. Within the State of Pahang, there are the Kanpong Raja power station of 0.7 MW, Kuala Terla power station of 0.5 MW, Robinson Falls power station of 0.9 MW, Habu power station of 5.5 MW. The Sultan Abu Bakar dam which diverts water to the Sultan Yussuf power station of 100 MW in the State of Perak. These power stations belong to the Telom river system which is located at the northwest corner of the State of Pahang. The Sempam power station of 6.6 MW is located near the middle of the western boundary of the State.

3.5 Inland Fishery

There are 236 ha of freshwater constructed ponds and 118 ha of tin mining pool used for fish culturing. The water use of the constructed ponds in 1979 was 3.20 million cu.m/y.

3.6 Inland Navigation

The principal river traffic in the lower reach of the Pahang river comprises marine and river fishing vessels. Some trade ships transport sawn timber from the sawmills located 6 km upstream of the river mouth. In the Rompin river, a few passenger and cargo boats navigate the river between the river mouth and 8 km upstream. In the upper reaches, village people use the river for their daily transport.

3.7 Sewerage System

No sewerage system is installed in Pahang. The installation of septic tank is compulsory by regulations in urban areas, while domestic sewage is directly discharged into nearby water course or onto land in rural area.

3.8 Water Purification System in Private Sector

The Federal DOE started to monitor the river water quality since 1978 in Pahang with the frequency ranging from twice a year to once a month in 5 river water quality control regions.

There are 17 rubber factories in the State. These factories produce SMR, latex concentrate and conventional grade of 150 tons/day and they discharge effluent of 1.63 million cu.m/y to nearby watercourses. The water quality at outlets of factories ranges from 8 to 3,000 mg/lit in BOD concentration and from 10 to 1,000 mg/lit in SS concentration.

There are 28 oil palm mills in operation of which total milling capacity amounts to 7,593 tons/hr in fresh fruit bunch (FFB). The volume of effluent from these mills is 1.21 million cu.m/y. The treated or raw effluent is and will be discharged from 18 mills into watercourses and from 10 mills onto land. The water quality ranges from 200 to 27,000 mg/lit in BOD concentration and SS concentration ranges from 15 to 30,000 mg/lit.

3.9 Watershed Management

The State Forestry Department is responsible for administration and regulation of forest exploitation, forest revenue collection, management and development of the State's forest resouces, and for planning and coordinating the development of wood-based industries.

At the end of 1979, the forest land was categorized into forest reserves of 5,732 sq.km, wild life and other reserves of 3,521 sq.km and Crown or State land of 14,738 sq.km. Out of the forest reserves, 4,914 sq.km was classified as productive forests comprising 4,890 sq.km of inland forests and 24 sq.km of mangrove forests. The remaining 818 sq.km were unproductive forests consisting almost entirely of protective hill forest. In the inland forest reserves, there remain 3,167 sq.km of unexploited forests which have been committed or licenced for development. The actual area opened for harvesting during 1979 was 132 sq.km corresponding to 4% of the unexploited forests.

Besides forest exploitation, execution of large-scale land development schemes for tree crop plantations, housing estates and construction of highway in mountainous and hilly areas have caused sheet and gully erosion problems on steeply dissected land.

All the activities mentioned above are also sources of man-made sedimentation. In the future, the suspended solid concentration of river flow will be over 500 mg/lit in the middle and lower reaches of the Pahang river, if all the present forest lands having a slope of less than 2 degrees and non-erodable soils are converted to tree crop plantations and those located on slope lands ranging from 3 to 6 degrees and on erodable soil areas with a slope of less than 2 degrees are exploited for logging purpose. In case that regeneration of the existing exploited forests will be artificially accelerated by conducting enrichment planting and regular planting in parallel with the above-mentioned development, the suspended solid concentration will not be substantially reduced.

3.10 Dams

Table 6 lists three dams at various stages in Pahang.

There are two dams in operation in the State: the Labong dam for irrigation purpose and the Abu Bakar dam for hydropower purpose. The tail race water of the Abu Bakar dam is diverted to another basin in Perak.

The Kuantan Barrage for the purposes of water supply and tidal prevention is now under construction.

4. FUTURE WATER DEMAND AND ASSOCIATED PROBLEMS

4.1 Projected Socio-economic Condition

The socio-economic framework was projected based on the planned values of 4MP and the Outline Perspective Plan (OPP) as well as the latest figures of 1980 Population Census as the preliminary field count. For the projection, an assumption was made that the 4MP/OPP target of GDP be achieved by 1990 and thereafter the growth rate be 7.5% between 1990 and 2000. Outcome for the State of Pahang is described hereunder.

The average annual growth rate of population in the period from 1980 to 2000 was estimated to be 3.5%. Projected population is 1.20 million in 1990 and 1.62 million in 2000, respectively. Tables 7 and 8 show the projected population by urban and rural area in the State of Pahang. In the Study, the urban area includes cities/towns each of which population in 2000 was estimated to be not less than 10,000.

GRP in factor cost at 1970 constant price was projected to be M$2,491 million in 1985, M$4,265 million in 1990 and M$9,281 million in 2000 with the average annual growth rate of 10.9% between 1980 and 2000.

Projected gross value of output in manufacturing sector will increase from M$553 million in 1980 to M$2,244 million in 1985, M$4,791 million in 1990 and M$11,967 million in 2000 at factor cost in 1970 prices as shown in Table 9.

The future rice consumption in the State was estimated to be 144,200 tons in 1990 and 194,100 tons in 2000. To raise the average rice self-sufficiency rate in Peninsular Malaysia up to 85% in 1990 and in 2000 as well, implementation of the following irrigation development plans is indispensable: (1) provision of irrigation system for the existing rainfed paddy field of 5,800 ha and the newly reclaimed paddy field of 21,900 ha, (2) stabilization of irrigation water supply during the wet season to the existing irrigated paddy field of 12,600 ha and (3) development of new irrigation water resources during the dry season to increase by 12,500 ha double cropping area among the existing irrigated paddy field. The total rice production anticipated under the above plans will be 98,000 tons in 1990 and 168,900 tons in 2000.

Oil palm planting area was projected to increase to 273,200 ha in 1990 and 301,200 ha in 2000. The prospected processing amount of oil palm in the State will be 4.5 million tons as fresh fruit bunch in 1990 and 5.1 million tons in 2000.

Rubber planting area was projected to be kept in the present hectarage of 158,000 ha in 1990 and 2000. The total processing amount was projected to be 120,000 ton as dry rubber content in 1990 and 210,000 ton in 2000.

4.2 Basin Division

For the purpose of the Study, the land was divided into Basins each being a river basin or a group of river basins as shown in Fig.5. Each Basin is further divided into effective area and ineffective area. The former is the upper part of the Basin in which part of the water uses was assumed to return into lower stretches of the river. The latter is the remainder of the Basin, in which water used and surface flow originating therefrom were assumed to run totally into the sea. The boundary of the two areas is normally located below the lowest intake site, herein called the balance point, in the major river in the Basin. The total catchment area, effective area, the location of balance point and assumed river maintenance flow (see Section 5.2) are as shown in Table 10.

As shown in Fig.5, five basins are wholly or partly located in the State of Pahang: located within the State are a northern part of the Endau Basin, most part of the Rompin Basin, whole of Bebar Basin, the Pahang Basin Except for a southwestern part and the whole Kuantan Basin.

4.3 Domestic and Industrial Water Demand

Domestic and industrial water demand was projected based on the projected population and gross value of output in manufacturing sector for 1990 and 2000.

For the domestic water supply, it was assumed that the entire population in the State would be fully served by piped water supply in 2000. Assumption was made that 50% of the total industrial water demand would be served by piped water supply. Table 11 shows the assumed per capita daily use of domestic water and service factor. The unit net manufacturing water use per gross value of manufacturing output by commodity group was assumed as shown in Table 12.

In Pahang, the total water demand will reach 193 million cu.m/y in 1990 and 455 million cu.m/y in 2000 as shown in Table 13. Major demand centers are Kuantan, Mentakab, Jerantut, Temerloh and Raub among which Kuantan has the largest demand for both industrial water and domestic water in 2000.

All the urban water demand was assumed to be supplied by surface water both in 1990 and 2000. However, in Kota Bharu in the State of Kelantan and in Sandakan and Lanbuan in the State of Sabah, groundwater use was assumed. For rural water supply, the share of groundwater use was assumed based on the estimated safe yield for each district.

The location of demand centers of domestic and industrial water is shown in Fig.5.

4.4 Irrigation Water Demand

The irrigated land development was projected taking into account information obtained from DID and the assumed rate of self-sufficiency in domestic rice production in the State. As shown in Table 14, the projected irrigation area will increase from 19,200 ha in 1980 to 37,700 ha in 1990 and 46,900 ha in 2000. The ratio of double cropping area to the total irrigation area will rise from 5% in 1980 to 50% in 1990 and 54% in 2000.

The irrigation water demand was calculated for 1990 and 2000 as shown in Table 15. Irrigation efficiency applied is 55% for both major and minor irrigation projects. The annual irrigation water demand will be 785 million cu.m in 1990 and 1,039 million cu.m in 2000, respectively.

4.5 Fish Pond Water Demand

The future hectarage of freshwater fish pond was projected to increase from 280 ha in 1980 to 660 ha in 1990 and 1,237 ha in 2000. The total water demand for freshwater fish culture will rise from 3.84 million cu.m/y in 1980 to 8.95 million cu.m/y in 1990 and 16.81 million cu.m/y in 2000.

4.6 River Utilization Ratio and Water Deficit

The relative burden of water use on a river is indicated by the river utilization ratio, which is the ratio of water demand to natural run-off. All natural flow cannot meet water demand, because it mostly runs to the sea as flood flow. It was estimated that natural flow would often fail to meet all water demand if the river utilization ratio is not less than 10% under the hydrological condition in Malaysia. The area with river utilization ratio of not less than 10% is, therefore, herein called the water stress area. Table 16 shows the estimated long-average natural run-off, projected water demand and river utilization ratio.

The river utilization ratio was calculated for each basin for 1990 and 2000 as shown in Table 16. In the State of Pahang, only the Kuantan Basin among the concerned five were estimated to have a river utilization equal to or more than 10% in 2000; the other four Basins to have the ratio of less than 10%.

In order to determine the total requirement for storage supply and water diversion, the water deficit at the balance point was calculated for each Basin, assuming the hydrological condition in the recorded period.

Natural runoff in each basin was estimated on 5-day basis, based on daily hydrological records prepared by DID. The recorded period was 19 years from 1961 to 1979 for the Peninsular Malaysia and ranged from 10 to 15 years for Sabah and Sarawak.

Groundwater potential is still to be clarified. Groundwater development will be essential especially for the villages with difficulty of access of clean surface water. Groundwater use is assumed for some rural domestic water supplies based on the estimated safe yield in each district.

A part of water taken from a river returns to the river. It is herein called the return flow. The return flow from irrigated paddy was assumed to be 20% of irrigation water demand within the effective area. The return flow from domestic and industrial water use within the effective area was estimated depending on the purpose of water use ranging from 8 to 100%.

The water withdrawal is herein defined as the net reduction in river flow which is required to meet the water demand and it was calculated by the water demand deducted by the return flow and groundwater use.

Certain discharge is necessary to sustain normal water use and environmental condition in the river. It is herein called the river maintenance flow as will be explained in more detail in Section 5.2. The rate of river maintenance flow was assumed as shown in Table 10.

All the water demand can be met and all the water use can be sustained if river flow is more than the sum of water withdrawal and river maintenance flow, and if otherwise river flow is in deficit. The water deficit was calculated by the water withdrawal plus river maintenance flow less the natural run-off in each 5-day period.

The estimated water deficit varies depending on the assumed hydrological condition. Among the hydrological conditions in the recorded period of N years, that resulting the largest annual volume of water deficit is herein regarded as the driest condition and called 1/N drought, that resulting the second largest annual volume of water deficit is called 2/N drought, and so on. The estimated water deficit by Basin under 1/N to 5/N drought is as shown in Table 17.

The water deficit shown in Table 17 was calculated under without-dam condition. If the estimated supply capacity of the existing and under-construction dams listed up in Table 6 is taken into account, the above-mentioned water deficit will be reduced in Basins where dam is located. It is noted that the water deficit in each Basin was calculated only at the balance point and it indicates an overall balance in the Basin. There may be the cases that river flow is in deficit in some section upstream of the balance point if major demand is located upstream.

4.7 Water Quality

To estimate BOD concentration in the river, BOD load flowing into a river was calculated based on the water use by pollution source. Major pollution sources are the domestic and industrial water users comprising 28 urban areas, 28 palm oil mills, 17 rubber factories, animal husbandry in the rural areas. However, waste water from Kuantan was assumed to be directly discharged to the sea.

It was assumed that BOD concentration in the effluent remains at the present level, except that the land disposal system is progressively applied in the palm oil mills and rubber factories as shown in Table 18. BOD concentration along the main streams of rivers was calculated for the condition that the rate of run-off at just downstream of each outlet of effluent was equal to the assumed rate of river maintenance flow at taht point, and the residual purification ratio varies in the range of 0.7 to 0.9 according to the characteristics of the rivers.

Discharge ratio, run-off ratio and BOD concentration assumed by type of pollution source for 1990 and 2000 are as shown in Table 19. A portion of water is consumed by being incorporated in products, by evaporation and by leakage in the process it is used and treated. The ratio of water after consumption to that before consumption is called the discharge ratio. A portion of water is again lost during the travel that water is released by the consumer and it enters into a river. The ratio of water reaching the river to that discharged by the consumer is the run-off ratio.

The projected maximum BOD concentration in Pahang will not be more than 5 mg/lit except for the Endau, the Rompin and the Bebar rivers in 1990 and 2000. This projection states that most rivers are little polluted presently and will be still clean in 1990 and 2000.

4.8 Watershed Problems

Annual rate of soil erosion ranges from about 30 tons/sq.km in natural forest to over 6,000 tons/sq.km in cleared land shifting cultivation land. Soil erosion reduces productivity in soil and also causes sedimentation in rivers. Erosion potential was studied in relation with soil erodability, slope and land use. Present annual erosion rate is estimated to be 250 tons/sq.km.

If all natural forest on slope of less than 6 degrees is disturbed, erosion rate will increase to 2,150 tons/sq.km. An exercise indicates that erosion rate is 850 tons/sq.km, if natural forest on slope of less than 2 degrees is cleared and converted to rubber farm. Reforestration in the disturbed forest can reduce erosion in a long run.

Based on these considerations, the following conclusions are preliminarily drawn:

(1) Forest clearing should be limited within the land of 2 degrees in slope.

(2) After clearing forest, such land use as appropriately protecting soils against erosion should be undertaken.

(3) As a long-term program for preservation of productive forest and soil conservation, reforestation should be undertaken in the disturbed forest.

It has been believed that forest clearing results in reduction of low river flow and increase of flood discharge. Experimental records in this respect in other countries are inadequate to draw conclusions applicable to Malaysia. There are also some experimental data in Malaysia but they are still insufficient for quantification. This aspect has not been analysed, but this does not mean that the importance of forest conservation in water resources conservation can be neglected.

5. STRATEGIES FOR WATER RESOURCES DEVELOPMENT AND USE

5.1 Problem Areas

Water resources use can be classified into instream uses, consumptive uses and energy potential use. Instream uses include navigation, fish catch and recreation. Consumptive uses are domestic and industrial water supply and irrigation. Energy potential use is hydropower generation. Water resources are liable to be deteriorated by man-made actions. Rivers are polluted by sewage and industrial effluent. Mining, logging, urban area development and road construction increases sedimentation in the rivers. Water resources have adverse characteristics such as drought and flood. Drought may constrain ordinary water uses. Rivers inundate vast lands and causes damages even loss of life.

Engineering measures are envisaged, corresponding to the characteristics of water resources and their use. Maintenance of low flow is required for sustaining not only instream water use but consumptive water use and environmental quality. Domestic and industrial water supply system and irrigation system and fishponds are provided to give consumptive water users access to water, also adjusting water quality to the use. When consumptive water use increases, competition may take place among the instream water users and consumptive water users, especially in the dry spell. Dams and basin transfer facilities are source development measures to augment low flow in the river so that all water uses can be sustained. Hydropower station is a measure to develop hydroelectric potential. Pollution abatement is to adjust water quality to water uses and requirement from the viewpoint of environmental quality.

The strategies for the water resources development and use are set for the following categories:

(1) maintenance of low flow necessary for sustaining various water uses and environmental quality;

(2) development of water supply and irrigation systems;

(3) source development for balancing water demand and supply;

(4) hydropower development;

(5) conservation of water quality; and

(6) flood mitigation.

5.2 Maintenance of Low Flow

Water has been utilized as need arises without causing any hazard yet to other water use in most rivers in Malaysia. The reduction of river flow due to intensified water use will, however, hurt various water users. The adverse effect of a small reduction of river flow may not be hazardous, but hazard becomes significant and irretrievable if small reductions accumulate.

It is proposed to establish the concept of river maintenance flow. The river maintenance flow is the minimum discharge which is required to maintain water depth, flow velocity, water quality, channel stability, aquatic eco-system and scenery to the extent necessary for navigation, fish catch, operation and maintenance of intakes, maintenance of river facilities, sea water repulsion, prevention of estuary clogging, conservation of groundwater, preservation of riparian land and people's amenity.

The river maintenance flow is the indicator of the allowable limit of water withdrawal from the river and is to be considered in allocating and developing water resources. Water withdrawal should not be increased, if it is expected to impair the river maintenance flow frequently. Source development such as construction of dam and inter basin water diversion system will be conducted, if it is necessary to augment low flow in the river to allow expected increase in water withdrawal, while sustaining the river maintenance flow. An estuary barrage will be constructed, if it contributes to the reduction of the required rate of river maintenance flow through preventing sea water intrusion and through maintaining water level for the intakes located in the estuary area.

The river maintenance flow should be sustained to the extent possible, but its temporary reduction can be allowed to a certain extent. The river flow which corresponds to the subsistence level of water uses is herein called the essential river maintenance flow. The river maintenance flow may not be reduced to the essential river maintenance flow even if an extreme drought takes place. When the essential river maintenance flow is needed to be sustained under any drought, water withdrawal from the river should be reduced.

The river maintenance flow should be determined individually for each river, based on the conditions particular to the river. The river maintenance flow may require a costly development, if its rate is set considerably high. It should be determined based on the minimum requirement in each river. On the other hand, the river maintenance flow should not be so low as the recorded minimum flow, which is too small to sustain the existing water uses and environmental quality. It is preliminarily assumed that the rate of river maintenance flow is equal to the daily natural discharge of 97% in probability of exceedence as shown in Table 10 and that of essential river maintenance flow is equal to the daily natural discharge of 99% in probability of exceedence, referring to examples in several countries.

5.3 Development of Water Supply and Irrigation Systems

Water supply system and irrigation system have been developed, in order to transmit water from sources and to distribute it to the consuming ends.

Domestic and industrial water supply is conducted along with the objectives of national economic development, regional development and social well-being improvement. The service factor of urban water supply system is already high, and the development of rural water supply system has been forcefully promoted in the recent years. Taking into account the Government policy prevailing, it is assumed that the public water supply system will be developed to supply domestic water to all people by 2000 and to supply 50% of industrial water, except that 10% of rural people in Sabah and Sarawak will still not be publicly supplied, because of remoteness and non-availability of suitable water source.

Irrigation development on paddy, including the tertiary development is carried out along with the objectives of national economic development, improvement of food self-sufficiency and increase in farmers' real income. It is assumed that the irrigation facilities will be provided in accordance with the projected land development schedule.

5.4 Source Development

Balancing water demand and supply is the requisite for water resources development and use. The water demand projection was made assuming that concerned agencies would take appropriate measures for water saving such as recyclic use of water and increase in efficiency of facilities and utilization of sea water. Where frequent water deficit are foreseen even with these water saving measures, the development of source facilities such as water storage and/or interbasin diversion are proposed.

The strict adherence to the river maintenance flow will result in the construction of costly facilities even in the rivers in which water use is small compared with natural flow. Analysis showed that all the water demand could be met for more than 85% of time in the rivers of less than 10% in river utilization, if a temporary reduction in the river maintenance flow to a minor extent is permitted. With these considerations, it is proposed that the source development should be implemented only in the rivers in which the river utilization ratio will be more than 10%.

5.5 Water Pollution Abatement

Water pollution abatement is considered from the viewpoint of environmental quality and maintenance of water uses. River water can be treated ordinarily for domestic and industrial use, if its quality is on an adequate level from the viewpoint of environmental quality.

The concept of water quality standard in the river should be established as the indicator showing the target of water pollution abatement, which is performed by reducing pollution load discharged into the river.

The biochemical oxygen demand (BOD) is the oxygen used to meet the metabolic needs of aerobic micro-organisms in water rich in organic matter. Self-purification mechanism of river is greatly reduced and the aquatic ecosystem is also affected if BOD concentration in the rivers is more than 5 mg/lit. Odour occurs if the BOD concentration is over 10 mg/lit. Pre-treatment is necessary if BOD concentration in raw water is more than 2 mg/lit for domestic water supply and 5 mg/lit for industrial water supply. River water quality standards in terms of BOD concentration in several countries are illustrated in Fig.6. The target for water pollution abatement is set in terms of BOD concentration in the river, because BOD concentration is the most common and important parameter of man-made pollution of inland water.

The measures for organic pollution abatement in the river are the improvement of purification system of effluent from the palm oil mills and rubber factories as well as public sewerage development.

5.6 Hydropower Development

Power demand in Malaysia is growing at a high rate, while the existing power supply system largely depends on thermal power. Nation's energy policy directs the development of hydroelectric potential and the saving in fuel resources.

Hydroelectric potential in Sarawak has been estimated to be more than 20,000 MW. The Upper Rajang Hydroelectric Development is being studied in order to develop hydropower of 4,550 MW in the upper Rajang river in Sarawak. Power generated will be transmitted not only to Sabah and Sarawak but to Peninsular Malaysia by constructing submarine transmission line of 700 km. The total construction cost of the development has been estimated to be M$11 billion including the interconnection system. Further development including power supply to ASEAN countries has also been envisaged.

Due to uncertainties in the inter-connection systems for power transmission to Peninsular Malaysia and Sabah and also in the establishment of energy intensive industries in the State of Sarawak, this vast potential is, however, assumed to be made available only after the year 2000. The strategy of hydropower development is thus set to contribute to bridge power demand and supply balance up to 2000.

According to a recent projection by NEB, the maximum power demand in Peninsular Malaysia in 2000 will be 9,140 MW, while the installed capacity of existing and under construction hydropower totals only 1,206 MW at present. It is recommended that all known potential of economical hydropower of 1,026 MW in Peninsular Malaysia should be developed by 2000 for the maximum contribution in balancing power demand and supply.

There is a large power potential in Sabah and Sarawak, in addition to that in the Rajang river. The maximum power demand in 2000 has been projected to be a little over 1,000 MW each. Although power demand is generally fragmented into small isolated demand centers, hydropower development should be envisaged for such major demand centers as Kota Kinabalu in which the maximum power demand will be 460 MW in 2000 and Kuching in which the maximum power demand will grow to 295 MW by 2000. Such hydropower development should be capable of supplying to Tawau, Sandakan and Labuan if some or all of them are interconnected with Kota Kinabalu. It is recommended to develop hydropower in Sabah and Sarawak to such an extent that the incremental power demand in major demand centers can be met up to 2000.

5.7 Flood Mitigation

Flood mitigation contributes to the national economic development and social well-being by reducing flood damage and protecting people's life. The measures for flood mitigation should be provided in consonance with the socio-economic development.

The structural measures for the flood mitigation are channel improvement, bypass floodway, polder, flood control dam and their combinations as described below:

(1) Channel improvement: Channel improvement will increase the discharge capacity of river by reshaping the river channel and constructing levees including protection work against erosion and sedimentation in the river.

(2) Bypass floodway: Bypass floodway is a short-cut canal for flood where there are certain constraints for channel improvement. The discharge capacity of the floodway is usually determined to allow releasing the excess water of the original channel.

(3) Polder (Ring Bund): Polder is a ring bund to protect an area of high damage potential. It includes the construction of drainage canal and drainage pump for the protected area.

(4) Flood control dam: A flood control dam will retain flood temporarily. A single purpose flood control dam can hardly be justified, unless the flood damage is tremendous. The inclusion of flood control purpose into the dams proposed for other purposes is studied. The flood control space in the dam is determined to reduce the design flood discharge to 1/4, as a rule.

Non-structural measures are proposed for such river stretch as where structural measures are not applicable or where supplemental measures are required. They are the restriction of development and resettlement plan as described below:

(1) Restriction of development: The restriction of development is the control of damageable values in the flood vulnerable areas by restricting new development.

(2) Resettlement plan: The resettlement plan is also the restriction of development but it includes the resettlement of people.

In addition to the above-mentioned measures, flood forecasting and warning system is proposed for some river basins having more than 5,000 inhabitants liable to flood hazard as shown in Table 20.

5.8 Inland Fishery

Development of inland fishery contributes to the national economic development and social well-being by providing fish protein source and for eradicating poverty through providing employment opportunity in rural areas.

Inland fisheries activities comprise fishing and culturing in various waters such as rivers, lakes and reservoirs, tin mining pools, paddy fields, constructed ponds and mangrove areas. Along with the Government's policy for fish culture development presented in 4MP, the areal development was estimated in this Study. The beneficial and adverse effects of inland fishery development are shown in those of recommended plan for water demand and supply balance.

6. ALTERNATIVE STUDIES

6.1 Scope of Alternative Studies

In Chapter 5, the rate of river maintenance flow was provisionally assumed and the targets for domestic and industrial water supply, irrigation, water demand and supply balance and hydropower development were set. Herein presented are such alternative studies as those for water demand and supply balance plan by varying risks in supply, hydropower development plan by power supply system development plan, pollution abatement plan by target water quality standard, and flood mitigation plan for varying target of protection. Hydropower development alternatives are presented only for Sabah. For Peninsular Malaysia, it was assumed that all the known power potential should be fully developed by 2000 following the preliminary development schedule prepared by NEB. For Sarawak, as mentioned in 5.6, the hydropower potential was assumend to be so developed as to bridge demand and supply up to 2000.

The criteria for alternative setting and for comparison of the public expenditure and beneficial and adverse effects of alternatives are described hereunder, wherein, costs and effects were all estimated based on the criteria described in Chapter 7.

6.2 Water Demand and Supply Balance Alternatives

Both the instream water use and the consumptive water use can be sustained if river flow is more than the river maintenance flow. If otherwise, river flow should be augmented by developing source facilities such as dam for regulation of river flow or diversion facilities to transfer water from a river to another. A source development plan was proposed for each water stress Basin of which river utilization ratio in the projected year would be not less than 10% and the existing source facilities could not meet the estimated water deficit.

Natural flow varies not only seasonally but from year to year to a large extent. Any measures cannot meet all water demand under an extremely dry condition. In planning source facilities, water supply capacity is usually determined allowing a certain risk. If the risk is set considerably small, the source facilities are costly and if otherwise, adverse effects such as reduction in production and people's dissatisfaction may take place. The water demand and supply balance alternatives were proposed assuming different levels of risk.

Alternative sizes of the proposed source facilities were determined based on the following criteria:

Alternative B1: The supply capacity of source facilities is determined against the driest condition ever recorded; 1/N drought where N denotes the length of hydrological records in years.

Alternative B2: The supply capacity of source facilities is determined against the second driest condition ever recorded; 2/N drought.

Alternative B3: The supply capacity of source facilities is determined against the fourth driest condition (4/N drought) for Peninsular Malaysia and the third driest condition (3/N drought) for Sabah and Sarawak, ever recorded. This was proposed based on the difference in the length of hydrological records. (These conditions approximately correspond to 5-year drought according to Hazen's plotting method.)

A dam is constructed to retain water in the flood period and release it to augment river flow for the use in the dry period. Once a dam is constructed, inflow into the dam can be retained at any time, so far the storage capacity is available. It is required for a dam to release water at a rate which, together with the natural flow from the downstream catchment area, is sufficient to supply water demand while sustaining the river maintenance flow. In other words, the supply capacity of a dam is determined to supply all the water deficit. By doing so, the dam can develop water to meet the future water demand not affecting adversely on the existing water users.

The proposed dams were those either identified on 1/63,360 or 1/50,000 maps or proposed in previous studies. The water supply capacity of each dam was estimated based on hydrological record and on assumed storage capacity. The total water supply capacity of the proposed dams in a basin was determined to meet the total water deficit in the basin, allowing an operational loss which was assumed to be 10 to 20% of the water deficit.

If the total water supply capacity of all the proposed dams in a basin is not enough, diversion of water from other basin was proposed and, if necessary, the construction of a dam in the latter basin was further proposed.

In Pahang, no water stress area was identified, because all the five Basins wholly or partly located in the State showed the river utilization ratio of less than 10% for 1990 and 2000. The Endau Basin was, however, regarded as a water stress area because source facilities such as the Anak Endau and Kemelai dams are under construction for the purpose of irrigation for the Rompin Endau project areas of 5,472 ha in the coastal plain of the Endau river. The Kuantan barrage was also included in the proposed plan, as it is under construction.

The Pahang river of 29,300 sq.km in catchment area is the largest river carrying a large amount of run-off, while it is adjacent to heavy water stress areas in the west coast. An analysis showed that the construction of four dams one of which is in the State of Pahang, is necessary in the Pahang river basin to regulate and divert water for the domestic and industrial water supply in the Kelang valley region and Port Dickson in Alternatives B1 and B2. The construction of a dam in the Bera river, a tributary of the Pahang river is also required to develop and divert water for the use in the Melaka-Muar region if Alternative B1 is selected. Among these, the Perting dam for the Kelang valley and the Bera dam for the Melaka/Muar region are located in the State of Pahang. The Palon dam proposed in the Muar river is located across the boundary between the statea of Pahang and Negeri Sembilan.

The estimated public development expenditure and manpower requirement showed a large differences among the alternatives, indicating that a high guarantee of supply would be costly and requires a large manpower. A high guarantee of supply would bring a low value of internal rate of return, because benefit is little sensitive to the risk of supply. Alternative B1 can guarantee safe supply all the time even under the driest condition ever recorded but some interruption in safe supply have to be involved in the other alternatives. Considerations were made also of adverse effects such as removal of people from the proposed reservoir areas and change in fish fauna, and beneficial effects such as fish culture and recreation in a lake created.

It is recommended that Alternative B1 sho ld be selected for the Basins where domestic and industrial water demand is predominant in accordance with the common understanding in Malaysia that domestic and industrial water supply should be sustained even under the serious drought.

Irrigation facilities have been designed against a drought of 5-year in return period in Malaysia, this criterion corresponds to the criteria in Japan, Korea, Indonesia and other countries in Southeast Asia. Under the condition that irrigation demand is already high, grading-up of the above-mentioned criterion will immediately require a large investment for source development. With these considerations, it is recommended to select Alternative B3 for the Basins where water is predominantly used for irrigation.

The location of potential and proposed water source facilities is shown in Fig.7 for Alternative B1. The alternative plans for water demand and supply balance are shown in Tables 21 through 23 for Alternatives B1, B2 and B3 respectively.

6.3 Hydropower Development Alternatives

A hydropower development plan for Peninsular Malaysia was recommended without alternative study.

6.4 Water Pollution Abatement Alternatives

Two alternative plans for water pollution abatement were proposed setting target BOD concentration in the river as mentioned below.

Alternative P1: 5 mg/lit in BOD concentration in 1990 onwards

Alternative P2: 10 mg/lit in BOD concentration in 1990 onwards

If the reduction of BOD concentration in a stretch of a river is found necessary to attain the target, the improvement of purification method in all palm oil mills and rubber factories in the river was, first of all proposed. The Basins where the improvement was proposed for both the alternatives for 1990 and 2000 were the Muar, Endau and Rompin Basins.

If there still remains a river stretch of higher BOD concentration than the proposed limit, the construction of a sewerage system in the urban area upstream of the river stretch was proposed: it is not the case in the State of Pahang and therefore, the two alternatives are identical.

No treatment measures were assumed for the sewage from the towns of less than 50,000 in population and rural areas and for the effluent from animal husbandry. With these conditions, it was estimated that some river stretches in the west coast of Peninsular Malaysia would show higher BOD concentration than the target value.

The ordinary treatment method for the domestic water supply is the sedimentation, filtration and chlorination, if BOD concentration in raw water is not more than 2 mg/lit. The ordinary treatment method for the industrial water supply is the sedimentation, if BOD concentration in raw water is not more than 5 mg/lit. Pre-treatment facilities are needed to varying extent for raw water with BOD concentration above these limits. For BOD concentration in raw water more than the above-mentioned limit but not more than 20 mg/lit, pre-treatment is carried out by the rapid sand-filter bed and activated carbon absorption (secondary treatment). For BOD concentration between 20 and 200 mg/lit, an aerated lagoon process such as aerated lagoon or maturing pond (primary treatment) is further needed. The cost for pre-treatment facilities was taken into account for the economic comparison of the alternatives.

The public development expenditure and manpower requirement were estimated in this Study to hardly vary between the two alternatives. The results of economic benefit cost analysis also showed little difference between the alternatives; although the economic cost is larger than the economic benefit, the water pollution abatement should be conducted from the viewpoint of environmental and social well-being impacts. Meanwhile, the problem is that the public development expenditure and manpower requirement would be largely concentrated in the earlier part of development, i.e., in 4MP and 5MP periods. In order to avoid this concentration, it is necessary to slow-down the rate of development up to 1990. With these considerations, it is recommended that the pollution in the river should be gradually abated by setting the target BOD concentration at 5 mg/lit for 2000.

6.5 Flood Mitigation Alternatives

Three alternatives are proposed for the flood mitigation:

Alternative F1: Structural measures are provided by 2000 for the entire river system to protect 90% of people within the flood prone area.

Alternative F2: Structural and non-structural measures are provided by 2000 for densely populated areas to protect 50% of people within the flood prone area.

Alternative F3: Structural and non-structural measures are provided by 2000 so far as such measures are economically viable.

The return period of design flood is assumed to be 20-year for the river stretch where the estimated annual flood damage is less than M$20,000/km and the population is 500 persons/km, and 50-year for the other river stretches, but 100-year if loss of life has been recorded.

The problem rivers were divided into stretches of 30 to 60 km in length. The measures explained in Section 5.7 were compared and the most economical measures was selected for each river stretch. The resulted alternative plans for the State are as outlined in Table 24.

Alternative F1 appeared to require a prohibitively large expenditure for the whole Malaysia. Alternative F3 should be implemented if considered from the viewpoint of national economic development, but it will increase the disparity between developed and underdeveloped areas. Taking into account the fact that social well-being objective has been emphasized through discussions between Malaysian Government officials and the Study Team, it is recommended that Alternative F2 should be taken up for the period up to 2000.

The flood mitigation alternatives including Alternative F1,F2 and F3 are illustrated in Figs.8 through 10.

7. RECOMMENDED PLAN

A Water Resources Development and Use Plan is recommended, based on the comparison of alternatives. Its outline is illustrated in Cover Map.

7.1 Public Water Supply and Irrigation Development Plan

Public water supply system including WD system and RESP system is recommended to be provided to meet all the urban and rural domestic water demands and 50% of industrial water demand by 2000 in accordance with the plan shown in Tables 25 through 27. However, 10% of the rural people in Sabah and Sarawak will still not be publicly supplied, because of the remoteness and non-availability of suitable water source.

Irrigation water supply system will be constructed in accordance with the schedule assumed in Table 14.

7.2 Source Development

The recommended water source development plan for balancing water demand and supply is summarized in Table 28. The water source development plan in the problem area is mentioned hereunder.

7.2.1 Perting dam project and Palong dam project

The Kelang valley including Kuala Lumpur, Petaling Jaya, Shah Alam and Kelang is most populated and industrialized region in Malaysia. Total population is mostly urban and it is estimated to be 1.8 million for 1980, 2.7 million for 1990 and 4 million for 2000. Domestic and industrial water demand was already 367 million cu.m or 34% of natural flow in 1980 and it will grow to 686 million cu.m/y by 1990 and 1,091 million cu.m/y by 2000, even if water intensive industries remain at 1985 level.

There are 2 dams in operation, one dam under construction and one dam under detailed design within the State of Selangor. Herein, the construction of 3 additional dams is proposed within the State of Selangor, but the supply capacity is still insufficient. It is necessary to develop and divert water in tributaries of the Pahang river for the use in the Kelang valley by constructing 3 dams, of which the site of the Perting dam is located in the State of Pahang.

The Palong dam project is recommended for the integrated water resources development in the Melaka/Muar region where water demand is large but storage possibility is limited. The Palong dam site is located across the boundary of the States of Pahang and Negeri Sembilan.

The dams needed for balancing water demand and supply in other states than those where the dams are located should be planned to store flood water for diversion, while such amount of low flow as required for use including the river maintenance flow should be released to the rivers where dams are located for the use within the State. By planning so, the facilities can provide more stable flow to the users within the State and also they can contribute to flood mitigation in the State.

7.2.2 Other source development plans

There are two plans of local importance proposed by relevant agencies, though they were not identified in the Study. The Anak Endau dam and weir, and the Kemelai dam are under construction for the Rompin Endau irrigation project of 6,100 ha. The Kuantan barrage will be constructed in the near future to protect water supply intakes against sea water intrusion.

7.3 Water Pollution Abatement Plan

The recommended plan for the water pollution abatement in the river is the improvement of purification method in the palm oil mills in the Muar, Endau and Rompin Basins.

Although it is ineffective for the water pollution abatement in the river, sewerage development in Kuantan is assumed from the viewpoint of public health. The recommended plan for water pollution abatement is shown in Tables 29 through 31.

7.4 Flood Mitigation Plan

The recommended plan for flood mitigation is mentioned hereunder and is summarized in Table 32.

7.4.1 Pahang river flood mitigation plan

Floods in the Pahang river is so large that they can significantly be mitigated by neither dam nor river improvement. The flood in 1971 inundated 3,000 sq.km in which the population in 1980 was estimated to be 400,000. The recommended plan is to provide ring bunds to populated towns such as Pekan (2,000 persons), Temerloh (15,000), Mentakab (9,000) and Kuala Lipis (11,000). Some contribution on flood mitigation can be expected from the dams proposed for hydropower generation, though the effect is minor. It is recommended to provide flood control storage spaces to the Tekai, Tembeling, Telom and Jelai Kechil dams. Even with these measures, number of protected people will be only around 63,000, which is far below the target. Resettlement of people from the areas seriously affected by flood to the new towns of the Pahang Tenggara development project needs to be considered.

7.4.2 Kuantan river flood mitigation plan

The Kuantan river flooded 230 sq.km in 1971. The affected population was estimated to be 30,000. Kuantan town located at the estuary of the Kuantan river was partly flooded. The recommended plan is to protect 20,000 people in 22 sq.km within Kuantan town by providing channel improvement of 6 km at the estuary and ring bund surrounding Batu Tiga/Paya Besar area.

7.5 Hydropower Development Plan

The hydropower potential is high in the Pahang river basin. The plan presented in Table 33 is recommended to match with the national energy policy.

The Tembeling upper dam is recommended for a multipurpose dam with the installed capacity of 110 MW for hydropower generation. The dam will incidentally contribute to the water demand and supply balance for D&I water supply and irrigation water supply as well.

The Maran dam is recommended for hydropower development with the installed capacity of 130 MW and incidentally for irrigation.

The other recommended plans for hydropower development include the Tekai & Penut dam (installed capacity of 74 MW), the Telom Hilir dam (98 MW), the Jelai Kechil dam (60 MW), the Jelai dam (10 MW) and the Tarum 1 dam (5 MW).

The location of these hydropower dams are presented in Cover Map.

7.6 Cost Estimate

The construction costs of the proposed facilities were estimated at the constant price in December, 1980.

The construction costs consist of direct construction cost (contract amount), engineering and administration, land acquisition and physical contingency. The direct construction cost was estimated based on the actual costs and previous estimate for similar projects in Malaysia. Major unit costs assumed are listed in Tables 34 and 35. The physical contingency was assumed to be 30%. The construction cost is disbursed in five years antecedent to the year of commission of the proposed facilities. The construction cost of the untreated rural water supply, however, was assumed to be disbursed in one year exceptionally.

The construction costs were estimated for all the proposed facilities to be commissioned in 1985 onward, including storage and diversion facilities, domestic and industrial water supply system, irrigation system, flood mitigation facilities and public sewerage system, but the sunk cost was not estimated.

The purification facilities for the palm oil mills and rubber processing factories were assumed to be privately financed.

According to the present practice, it was assumed that the construction cost of sewerage system borne by private sector is the house connections in the existing town area, and branch sewers and house connections in the new town areas. In estimating the sewerage treatment capacity in the new town area, it was assumed that the population within the existing town area will remain unchanged and the treatment capacity is allocated in proportion to the population.

The development expenditure and recurrent expenditure in public sector for the recommended plan was estimated as shown in Tables 36 and 37.

7.7 Beneficial and Adverse Effects

The beneficial and adverse effects of the recommended plans were evaluated from the viewpoints of national economic development, environmental quality and social well-being. The beneficial and adverse effects of the recommended plans comprising each aspect of national economic development, environmental quality and social well-being are presented in Tables 38 and 39 for water demand and supply balance, in Table 40 for water pollution abatement, in Table 41 for flood mitigation, and in Table 42 for hydropower development.

7.7.1 National economic development

The beneficial and adverse effects of the recommended plans for the national economic development account are calculated as the annual equivalent of economic benefits and costs, assuming a discount rate of 8% for an evaluation period of 50 years between 1981 and 2030.

The prices of internationally traded goods and services were estimated based on the World Bank projection up to 1990, or the international market price in December, 1980. The prices of locally traded goods and services were the normalized price in December, 1980. The transfer payments such as tax and local contractors' profit are deducted from all prices. The ratio of transfer payment to the financial cost was assumed to be 20% of financial cost referring to the ratio of tax revenue to GDP at purchasers' price in 1980 in 4MP.

The domestic and industrial water supply benefit was estimated based on the least-costly alternative facilities cost criteria. The cost of the above-mentioned alternative facilities including dams and the proposed intake, conveyance, treatment and distribution systems is regarded as the benefit of domestic and industrial water supply without drought damage.

There should be established a rule for the emergency operation against the drought in which both the rate of water withdrawal and rate of river maintenance flow should be sustained as much as possible and the river flow should be kept not below the essential river maintenance flow. Herein a simplified rule was assumed: water withdrawal for use continues until the river flow after the water withdrawal lowers to the essential river maintenance flow and thereafter the water withdrawal is reduced so that river flow no longer lowers. Consequently, the reduction in supply for domestic and industrial water and irrigation water is calculated through the period in which run-off record is available, allowing low flow after the water withdrawal to be equal to the essential river maintenance flow. The reduction in benefit is calculated assuming that it is proportional to the reduction in the supply.

The economic farmgate price of paddy during the evaluation period was estimated to be M$640/ton based on the projected price of 5% broken rice, FOB Bangkok. Estimated paddy yield, gross value, production cost and net value are estimated for 1990 and 2000 as shown in Table 43. The hectarage of newly reclaimed land and upgraded lands from rainfed paddy to irrigated or control drainaged paddies, single crop to double crop and minor scheme to major scheme were estimated for the future. Then the irrigation benefit is obtained as the incremental net production value.

The sewerage benefit is the willingness-to-pay by served people and saving in the cost of purification of industrial waste. It was herein assumed to be 0.6% of real income of served people and to be the same percentage of gross value of manufacturing production of served industries.

Pre-treatment facilities are necessary if BOD concentration in raw water is more than 2 mg/lit for domestic water supply and 5 mg/lit for industrial water supply. Its costs can be saved, if the proposed water pollution abatement measures reduce BOD concentration in the river below this limit. This saving in cost is counted as a part of water pollution abatement benefit.

Under the flood mitigation benefit, average value of reduction in annual damage by the proposed measures only is counted, while land enhancement benefit is counted in the irrigation benefit. It is assumed that the damageable value in the flood prone area will increase at a rate of gross regional product of the state.

The fish culture benefit was estimated to be M$2,000/ha for the fish pond and M$1.6 million/reservoir for the cage culture in the created reservoir.

Benefit of the created lake recreation is estimated by use of the concept of willingness-to-pay of the visitors to the lake. The willingness-to-pay is measured in terms of the travelling, or fuel cost of the vehicles to the recreation area. The said cost is assumed to be M$0.1/km.

The economic cost is calculated as the annual equivalent of the construction cost and OMR cost. It is noted that the private sector cost of industrial water supply facilities, purification facilities in palm oil mills and rubber factories and sewerage facilities are included in the economic cost of water pollution abatement measures.

The economic internal rate of return (EIRR) is calculated as the discount rate with which the present worth of benefit equals to that of cost.

7.7.2 Environmental quality

The beneficial and adverse effects of the recommended plans from the viewpoint of environmental quality are descriptively displayed.

The river maintenance flow is the requisite for the conservation of river environment and adequate water use. The effect on the river maintenance flow is evaluated as the number of days when the river maintenance flow can be sustained in the driest year ever recorded.

The water surface of created reservoir provides favorable scenery, place of recreation and enhancement of wildlife. The beneficial effect of created lake is counted by the water surface area.

The reduction in length of river stretches in which BOD concentration will be more than 5mg/lit is regarded as the beneficial effect of water pollution abatement.

The channel improvement stabilizes the river channel and provides favorable condition for navigation and other instream water use. The length of improved river stretches is counted as a parameter showing the beneficial effect on environmental quality.

If a dam is constructed, some species of fish would probably disappear in certain length of river stretch immediately downstream of the dam showing an adverse effect on ecological system, though such adverse effect can be compensated by possible cage culture in the created reservoir.

7.7.3 Social well-being

The income increase, health improvement, life saving, and reduced risk in water supply are counted as the beneficial effect from the viewpoint of social well-being. The adverse effect is the inevitable removal of people for the purpose of construction of proposed facilities.

8. PLAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

8.1 Assumed GDP Growth Rate

The recommended plan mentioned in the foregoing Chapter 7 is based on an assumption that the growth rate of GDP is 7.7% in the period from 1980 to 1985, 8.4% from 1985 to 1990, and 7.5% from 1990 to 2000, in accordance with 4MP and OPP.

For reference, a plan under a lower economic growth was prepared, assuming that Malaysia's economy might be affected by a long-lasting world-wide economic depression. The growth rate of GDP assumed was 7% in the period from 1980 to 1985, 6% from 1985 to 1990, and 5% from 1990 to 2000.

8.2 Parameters Predominantly Related to GDP Per Capita

The parameters dominated by GDP per capita are the urbanization ratio, share of manufacturing sector in GDP, gross value of industrial output, power consumption per capita, domestic water consumption per capita and value of flood damage, so far related with the water resources development and use. These parameters under the condition of lower economic growth were estimated assuming a functional relationship with GDP per capita.

8.3 Assumed Targets

The service factor and per capita daily use (PCDU) in domestic water supply and rate of irrigation development may be affected by the economic growth and by the socio-economic policy as well. It is herein assumed that, in case of the lower economic development, the target service factor and PCDU in domestic water supply for 2000 is delayed by five years but the rate of irrigation development does not change even under the lower economic development. The estimated service factor and PCDU under the condition of lower economic growth are shown in Table 44. The domestic and industrial water demand estimated under the condition of lower economic growth is shown in Table 45.

8.4 Development Plan

The development plan under the condition of lower economic growth is tabulated in Tables 46 through 52.

8.5 Public Expenditure

The public development and recurrent expenditures are estimated for the case of lower economic growth as shown in Tables 53 and 54.

8.6 Beneficial and Adverse Effects

The beneficial and adverse effects of the water resources development and use plan for the case of lower economic growth are summarized in Tables 55 through 58.

TABLES

Table 1 METEOROLOGICAL DATA IN PAHANG

Kuantan, El 15.3 m

	Mean Air Temperature (°C)	Relative Humidity (%)	Sunshine Hours (hrs.)	Open Water Evaporation (mm)	Rainfall (mm)
Jan.	24.4	84.3	5.49	130	344
Feb.	25.0	83.0	6.45	134	150
Mar.	25.7	83.2	6.90	156	110
Apr.	26.6	83.6	7.15	156	144
May	26.7	84.6	6.67	147	170
June	26.5	84.1	6.11	141	146
July	26.3	83.7	6.59	144	151
Aug.	26.2	83.8	6.20	146	172
Sep.	26.1	84.1	5.60	147	190
Oct.	25.9	85.9	5.20	136	236
Nov.	25.2	88.4	3.67	116	302
Dec.	24.6	89.1	3.41	106	615
Annual	25.8	84.8	5.79	1,659	2,730
Daily Max.	35.5	98.5			
Min.	16.8	61.0			

Table 2 RIVER CHARACTERISTICS IN PAHANG (1/3)

Basin No.	Item	Description
27	Endau river	
	(A) River Morphology	Meanders existing in lower tidal reaches but not active. Banks seem stable with only minor erosion at local places (Sembrong, Kahan rivers). Rapids existing near Kuala Sg. Jasin.
	(B) Estuary	No major problem at present, but sand dune developing on both banks. River mouth shallow, but seems in a equilibrium condition.
	(C) Sediment	No problems existing. No sand bars/ shoals observed.
	(D) Sea Water Intrusion	Tidal effect up to 80 km along river course. Confluence with Sg. Mentelong is saline at regular interval.
28	Rompin river	
	(A) River Morphology	Meanders in lower tidal reaches and some local erosion, but no adverse problems. Being protected by swamp jungle banks, generally in a stable regime.
	(B) Estuary*	River mouth is shallow. Coastal sediment intruding into river mouth, but seems in equilibrium condition. Future observation recommended.
	(C) Sediment	Estimated sediment yield: 250 $m^3/km^2/y$. Sediment transport capacity of river in balance with sediment yields.
	(D) Sea Water Intrusion	2,000 ppm at Sg. Limau confluence (50 km). 200 ppm at Kg. Taran (90 km). Tidal effect up to 95 km. Release of min. 5 m^3/s required for saline-free water at Rompin Irrigation intake.

Remarks; *: Major problems requiring some improving measures

Table 3 RIVER CHARACTERISTICS IN PAHANG (2/3)

Basin No.	Item		Description
29	Marchong/Behar river		
	(A)	River Morphology	Meanders and minor erosion in lower tidal reaches. Although detailed information not available, river to be in equilibrium condition in view of primeval river regime.
	(B)	Estuary	Shallow river mouth due to coastal sediment causing a difficulty of marine boat navigation. Condition at Bebar river mouth seems slightly better. Future observation needed.
	(C)	Sediment	No problem reported. Condition to be similar to Rompin river basin.
	(D)	Sea Water Intrusion	No adverse problem at present.
30	Pahang river		
	(A)	River Morphology	River appears to meander, but generally controlled by high banks. Little evidences of significant instability and erosion of banks, except some local erosions in Lipis river and near Pekan. Localized erosion also in middle reaches. Generally in a stable regime.
	(B)	Estuary*	River sediment is mainly depositing in south delta, which will ultimately be closed. Difficulty in marine boat navigation during low tide.
	(C)	Sediment	4.5×10^6 m^3/y at Temerloh. No significant aggradation/degradation of bed levels. Existence of sand shoals and S/S observation records suggest high yield.
	(D)	Sea Water Intrusion	Tidal influence up to 23.4 km. No saline problem existing at present.

Remarks; *: Major problems requiring some improving measures

Table 4 RIVER CHARACTERISTICS IN PAHANG (3/3)

Basin No.	Item		Description
31	Kuantan river		
	(A)	River Morphology	Meandering in lower swamp reaches, but seems not active. River banks generally stable, although some minor erosion at localized places. No immediate problem arising.
	(B)	Estuary*	Sand dune develops on both banks. Navigation channel shallow (1.5 m depth at low tide, according to fishermen). Extent of sand dunes not changed so much from 1 : 63,630 maps (1971), therefore seems in equilibrium.
	(C)	Sediment*	Extensive sand deposits and shoals, active sediment movement. Estimated yield for design; 30 $m^3/km^2/y$ x 2. Tailings from Sg. Kenau, Sg. Belat, Agriculture development in upper Kuantan.
	(D)	Sea Water Intrusion*	Salt water problem at JKR's Kg. Kobat intake (17 kg). Tidal effect up to 40 km. Release of min. flow of 300-350 mgd. recommended.

Remarks; *: Major problems requiring some improving measures

Table 5 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN PAHANG

Basin No.	River Basin	Year	Flooded Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
27	Endau	1969	268	1	0.2
	Pontian	1969	154	1	0.4
28	Rompin	1971	792	3	0.7
29	Bebar	1971	978	2	0.6
	Merchong	1971	509	-	-
30	Pahang	1971	3,085	287	83.7
31	Kuantan	1971	229	29	5.2
	Total		6,015	323	90.8

Table 6 LIST OF EXISTING AND PLANNED DAMS IN PAHANG

Name	River	Purpose/ Year of Commission	Organi-zation	Catch-ment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^6 m^3/y)
Existing						
Labong	Endau	IR	DID	-	-	0
Abu Bakar	Pahang	HY	NEB	183	-	0 (To Basin 10)
Under Construction						
Kuantan/ Barrage	Kuantan	TB, WS	PWD	-	-	0

Remarks; WS: Domestic and industrial water supply
FM: Flood mitigation
HY: Hydropower
TB: Tidal barrage

Table 7 HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN PAHANG (1/2)

Unit: 10^3

District	City/Rural	Historical	Projected			Average Annual Growth (%)
		1980	1985	1990	2000	1980-2000
55. Rompin	PT 1	15	28	31	31	3.7
56. Pekan	PT 2	2	8	12	16	11.0
57. Temerloh	PT 3	-	4	8	10	6.2
	PT 4	1	8	9	12	13.2
	PT 5	1	7	13	17	15.2
	PT 6	4	24	33	42	12.5
	PT 7	-	7	8	10	2.4
	PT 8	4	7	19	21	8.6
	PT 9	4	8	9	10	4.7
	PT 10	4	9	10	10	4.7
	PT 11	3	11	13	15	8.4
	PT 12	19	23	25	25	1.4
	PT 13	-	2	8	11	12.0
	PT 14	-	20	24	24	1.2
	PT 15	-	19	23	23	1.3
	PT 16	-	-	11	14	2.4
	PT 17	11	12	12	12	0.4
	PT 18	8	10	10	10	1.1
	PT 19	5	6	12	12	4.5
	PT 20	-	1	33	33	26.3
	130. Mentakab	9	11	13	18	3.5
	45. Temerloh	15	16	18	22	1.9
	131. Teriang	9	10	12	17	3.2
	Rural	218	93	20	13	-13.1
	District Total	332	344	386	428	1.3
58. Bentong	46. Bentong	25	25	27	30	0.9
	Rural	54	89	104	117	3.9
	District Total	79	114	131	147	3.2
59. Kuantan	47. Kuantan	145	224	333	653	7.8
	Rural	42	29	26	24	-2.8
	District Total	187	253	359	677	6.6
60. Jerantut	48. Jerantut	7	9	11	17	4.5
	Rural	69	134	163	184	5.1
	District Total	76	143	174	201	5.0

Table 8 HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN PAHANG (2/2)

Unit: 10^3

District	City/Rural	Historical 1980	Projected 1985	Projected 1990	Projected 2000	Average Annual Growth (%) 1980-2000
61. Raub	49. Raub	25	27	30	38	2.1
	Rural	43	40	38	37	0.7
	District Total	68	67	68	75	0.5
62. Lipis	50. Kuala Lipis	11	11	12	14	1.2
	Rural	46	44	42	42	0.5
	District Total	57	55	54	56	-0.1
63. Cameron Highlands	Rural	21	28	30	33	2.3
Total	Urban Total	327	547	779	1,167	6.6
	Rural Total	493	457	423	450	-0.4
	State Total	820	1,004	1,202	1,617	3.5

Table 9 HISTORICAL AND PROJECTED GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP IN PAHANG

Unit: M$$10^6$

Item	Year 1980	1985	1990	2000
Food	177	853	1,783	3,293
Textile	0	0	1	3
Wood	304	949	1,603	2,316
Paper	0	0	0	0
Publishing	2	17	62	417
Chemical	4	29	199	1,072
Rubber	44	243	659	2,337
Non-metal	9	55	154	628
Basic metal	0	0	0	0
Machinery	13	98	329	1,897
Others	0	0	1	4
Total	553	2,244	4,791	11,967

Remarks; In factor cost at 1970 prices

Table 10 BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN PAHANG

Basin No.	Basin	Total Catchment Area (km^2)	Effective Catchment Area (km^2)	Balance Point (km)	River Maintenance Flow (m^3/s)
27	Endau	4,740	4,350	25	30.2
28	Rompin	4,285	3,730	40	20.0
29	Bebar	1,895	570	49	4.2
30	Pahang	29,300	27,650	44	143.0
31	Kuantan	2,025	1,635	13	11.6

Remarks; The location of balance point is the river length in km measured upstream from the estuary.

Table 11 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PAHANG

City/Rural	Service Factor (%) Estimated 1980	Projected 1985	Projected 1990	Projected 2000	Per Capita Daily Use (lpcd) Estimated 1980	Projected 1985	Projected 1990	Projected 2000
1. Urban Area								
C137 PT1	80	85	90	100	160	175	190	220
C138 PT2	56	85	90	100	115	153	190	220
C139 PT3	0	85	96	100	0	90	180	220
C140 PT4	56	85	96	100	115	148	180	220
C141 PT5	56	85	90	100	115	153	190	220
C142 PT6	56	85	90	100	115	153	190	220
C143 PT7	0	85	96	100	0	90	180	220
C144 PT8	56	85	90	100	115	153	190	220
C145 PT9	56	85	96	100	115	148	180	220
C146 PT10	56	85	90	100	115	153	190	220
C147 PT11	56	85	90	100	115	153	190	220
C148 PT12	80	85	90	100	160	175	190	220
C149 PT13	0	85	96	100	0	90	180	220
C150 PT14	0	85	90	100	0	95	190	220
C151 PT15	0	85	90	100	0	95	190	220
C152 PT16	0	0	90	100	0	95	190	220
C153 PT17	80	85	90	100	160	175	190	220
C154 PT18	56	85	90	100	115	153	190	220
C155 PT19	56	85	90	100	115	153	190	220
C156 PT20	0	85	90	100	0	95	190	220
45 Temerloh	80	85	90	100	160	175	190	220
46 Bentong	80	85	90	100	160	175	190	220
47 Kuantan	100	100	100	100	170	185	200	250
48 Jerantut	56	85	90	100	115	153	190	220
49 Raub	80	85	90	100	160	175	190	220
50 Kuala Lipis	80	85	90	100	160	175	190	220
130 Mentakab	56	85	90	100	115	153	190	220
131 Teriang	56	85	90	100	115	153	190	220
2. Rural Area								
PWD Rural	47	67	73	76	75	100	125	175
MOH Rural	9	21	23	24	40	48	55	70
3. Non-Pipe-Served Area	-	-	-	-	40	40	40	40

Table 12 NET UNIT MANUFACTURING WATER USE PER GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP

Unit: $m^3/d/M\$10^6/y$

	Commodity Group	Assumed/1 1975	Estimated/2 1980	Projected 1985/2	Projected 1990 & 2000
1.	Food	77.0	75.0	73.0	71.0
2.	Textile	79.0	77.0	75.0	73.0
3.	Wood Product	12.0	12.3	12.7	13.0
4.	Paper Product	581.0	560.7	540.3	520.0
5.	Publishing	10.0	10.0	10.0	10.0
6.	Chemicals	140.0	136.7	133.3	130.0
7.	Rubber Manufacturing	126.0	105.7	85.3	65.0
8.	Non-metal	88.0	86.7	69.3	68.0
9.	Basic Metal	53.0	51.7	50.3	49.0
10.	Machinery	16.0	17.3	18.7	20.0
11.	Miscellaneous	48.0	48.3	48.7	49.0

Remarks; /1: Assumed from data in Japan in 1970
/2: Obtained by interpolation

Note; The values indicated are net manufacturing water use (excluding the water used cyclically) per M$10^6 of the gross value of manufacturing output at 1970 price.

Table 13 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN PAHANG

Unit: 10^6 m^3/y

Basin No.	City/Rural	Estimated 1980 D&I	Projected 1985 D	I	Total	1990 D	I	Total	2000 D	I	Total
27	41 Keluang	10.7	4.5	14.2	18.7	5.6	19.1	24.7	8.9	34.0	42.9
	C151	0.0	1.5	1.7	3.2	1.9	2.9	4.8	2.4	5.4	7.8
	City Total	10.7	6.0	15.9	21.9	7.5	22.0	29.5	11.3	39.4	50.7
	Rural	6.6	3.5	4.8	8.3	5.4	3.9	9.3	7.6	3.7	11.3
	Basin Total	17.3	9.5	20.7	30.2	12.9	25.9	38.8	18.9	43.1	62.0
28	C139	0.0	0.2	0.4	0.6	0.5	1.0	1.5	1.1	2.5	3.6
	C141	0.0	0.3	0.6	0.9	1.1	1.6	2.7	1.8	3.9	5.7
	C142	0.2	1.8	2.1	3.9	2.8	4.0	6.8	4.4	10.2	14.6
	C143	0.0	0.3	0.6	0.9	0.5	1.0	1.5	1.1	2.5	3.6
	C146	0.2	0.4	0.8	1.2	0.8	1.3	2.1	1.1	2.5	3.6
	C147	0.2	0.8	1.0	0.9	1.1	1.6	2.7	1.6	3.7	5.3
	C148	1.8	1.7	2.0	3.7	2.1	3.1	5.2	2.6	5.9	8.5
	C149	0.0	0.1	0.2	0.3	0.5	1.0	1.5	1.2	2.5	3.7
	C150	0.0	1.5	1.7	3.2	2.0	3.0	5.0	2.5	5.6	8.1
	City Total	2.4	7.1	9.4	16.5	11.4	17.6	29.0	17.4	39.3	56.7
	Rural	2.1	1.1	0.5	1.6	0.3	0.5	0.8	0.2	0.5	0.7
	Basin Total	4.5	8.2	9.9	18.1	11.7	18.1	29.8	17.6	39.8	57.4
29	C140	0.0	0.4	0.7	1.1	0.5	1.1	1.6	1.3	2.8	4.1
	Rural	0.6	0.3	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.1
	Basin Total	0.6	0.7	0.7	1.4	0.6	1.1	1.7	1.4	2.8	4.2
30	45 Temerloh	2.1	1.1	4.8	5.9	1.5	9.2	10.7	2.3	32.3	34.6
	46 Bentong	1.8	1.9	0.8	2.7	2.2	1.5	3.7	3.2	5.4	8.6
	48 Jeramtut	1.4	0.4	5.1	5.5	0.9	10.0	10.9	1.8	34.7	36.5
	49 Raub	2.1	2.0	2.3	4.3	2.6	4.4	7.0	4.0	15.5	19.5
	50 Kuala Lipis	1.0	0.8	1.0	1.8	1.0	1.5	2.5	1.5	3.4	4.9
	118 Bahau	1.1	0.9	0.7	1.6	1.1	1.0	2.1	1.7	1.6	3.3
	130 Mentakab	1.1	0.8	3.6	4.4	1.1	7.0	8.1	1.9	24.5	26.4
	131 Teriang	0.5	0.7	0.9	1.6	1.0	1.5	2.5	1.8	3.9	5.7
	C137	1.4	2.1	2.5	4.6	2.6	3.8	6.4	3.3	7.3	10.6
	C138	0.2	0.4	0.7	1.1	1.0	1.5	2.5	1.7	3.9	5.6
	C144	0.2	0.3	0.6	0.9	1.6	2.4	4.0	2.2	5.1	7.3
	C152	0.0	0.0	0.0	0.0	0.9	1.4	2.3	1.5	3.4	4.9
	C153	1.0	0.9	1.1	2.0	1.0	1.5	2.5	1.3	2.8	4.1
	C154	0.5	0.7	0.9	1.6	0.8	1.3	2.1	1.1	2.5	3.6
	C155	0.3	0.3	0.5	0.8	1.0	1.5	2.5	1.3	2.8	4.1
	C156	0.0	0.0	0.1	0.1	2.8	4.0	6.8	3.5	7.9	11.4
	City Total	14.7	13.3	25.6	38.9	23.1	53.5	76.6	34.1	157.0	191.1
	Rural	17.9	18.4	7.9	26.3	23.8	7.4	31.2	34.7	9.4	44.1
	Basin Total	32.6	31.7	33.5	65.2	46.9	60.9	107.8	68.8	166.4	235.2
31	47 Kuantan	14.3	19.9	10.8	30.7	32.0	21.2	53.2	78.4	73.6	152.0
	Rural	1.5	0.7	1.0	1.7	0.8	1.1	1.9	1.1	1.7	2.8
	Basin Total	15.8	20.6	11.8	32.4	32.8	22.3	55.1	79.5	75.3	154.8
Total		70.8	70.7	76.6	147.3	104.9	128.3	233.2	186.2	327.4	513.6
(State Total for Pahang)		(48.6)	(59.9)	(56.0)	(115.9)	(89.9)	(102.9)	(192.8)	(165.3)	(289.3)	(454.6)

Remarks; Water demand: Total source demand
D: Domestic water demand
I: Industrial water demand

Table 14 ESTIMATED AREA OF IRRIGATED PADDY FIELD IN PAHANG

Unit: ha

Basin No.	Basin Name	Scheme	1980 Main Season	1980 Off Season	1990 Main Season	1990 Off Season	2000 Main Season	2000 Off Season
27.	Endau	Major	-	-	5,472	3,852	5,472	5,472
28.	Rompin	Major	-	-	5,859	5,859	5,859	5,859
		Minor	-	-	69	-	69	-
29.	Bebar+	Minor	221	-	869	-	869	-
30.	Pahang	Major	-	-	5,261	2,023	13,354	7,284
		Minor	18,451	905	19,303	6,997	20,493	6,880
31.	Kuantan	Minor	511	-	827	-	827	-
Total			19,183	905	37,660	18,731	46,943	25,495

Note; + marked after the name of Basin shows the inclusion of other Basin than the stated Basin.

Table 15 ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN PAHANG

Unit: 10^6 m^3/y

Basin No.	Basin Name	Scheme	1980	1990	2000
27.	Endau	Major	-	97	118
28.	Rompin	Major	-	125	125
		Minor	-	1	1
29.	Bebar+	Minor	3	9	9
30.	Pahang+	Major	-	117	333
		Minor	316	423	440
31.	Kuantan+	Minor	8	13	13
Total			327	785	1,039

Note; + marked after the name of Basin shows the inclusion of other Basin than the stated Basin.

Table 16 RIVER UTILIZATION RATIO BY BASIN IN PAHANG FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Basin Name	Surface Runoff in Effective Area (1)	1990 Source Demand D&I	1990 Source Demand Irr.	1990 Source Demand Total (2)	1990 Ratio (2)/(1) (%)	2000 Source Demand D&I	2000 Source Demand Irr.	2000 Source Demand Total (2)	2000 Ratio (2)/(1) (%)
27	Endau	5,046	39	210	249	5	62	274	336	7
28	Rompin	3,340	30	126	156	5	58	126	184	6
29	Bebar	695	2	9	11	2	4	9	13	2
30	Pahang	24,238	108	585	693	3	235	818	1,053	4
31	Kuantan	1,691	55	13	68	4	155	13	168	10

Table 17 ANNUAL DEFICIT BY BASIN IN PAHANG FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Drought Level 1/N Deficit	1/N Year	2/N Deficit	2/N Year	3/N Deficit	3/N Year	4/N Deficit	4/N Year	5/N Deficit	5/N Year
1990										
27	433.2	1963	132.8	1962	106.9	1961	93.5	1968	71.0	1971
28	312.1	1963	86.1	1962	61.8	1961	52.2	1968	46.9	1971
29	52.0	1963	17.5	1961	17.3	1962	12.8	1968	6.8	1971
30	215.4	1965	73.8	1963	58.2	1979	52.7	1977	1.7	1969
31	0.6	1969	0.4	1963	-	-	-	-	-	-
2000										
27	553.7	1963	156.9	1961	155.5	1962	129.9	1971	113.0	1968
28	318.9	1963	88.6	1962	65.0	1961	54.5	1968	49.8	1971
29	52.5	1963	17.7	1961	17.5	1962	13.1	1968	7.0	1976
30	225.3	1965	97.8	1977	90.5	1963	69.5	1979	8.0	1967
31	7.9	1969	3.8	1963	2.0	1972	0.2	1961	-	-

Table 18 ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES IN PAHANG

Unit: %

	1980	1990	2000
Palm oil mills	25	50	75
Rubber factories	0	10	20

Table 19 DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL IN PAHANG

Pollution Source	Year	Discharge Ratio	BOD Concentration (mg/lit)	Runoff Ratio	Infiltration Ratio
Domestic					
Urban sewerage	1999 & 2000	0.9	30	1.0	0.2
Urban non-sewerage	1990	0.9	160	0.6	0
	2000	0.9	140	0.6	0
Rural	1990 & 2000	0.8	200	0.1	0
Manufacture					
Urban sewerage	1990 & 2000	1.0	30	1.0	0.2
Urban non-sewerage }	1990	1.0	205	0.6	0
Rural }	2000	1.0	155	0.1	0
Palm Oil Mill					
With P.S./1	1990	0.55	50	0.6	0
	2000	0.3	50	0.6	0
Without P.S.	1990	0.55	22,000	0.6	0
	2000	0.3	22,000	0.6	0
Land disposal	1990	0.1	50	0.6	0
	2000	0.1	50	0.6	0
Rubber Factories					
With P.S.	1990	0.9	50	0.6	0
	2000	0.8	50	0.6	0
Without P.S.	1990	0.9	2,320	0.6	0
	2000	0.8	2,320	0.6	0
Land disposal	1990	0.1	50	0.6	0
	2000	0.1	50	0.6	0
Animal Husbandry	1990 & 2000	1.0	200/2	0.1	0

Remarks; /1: Purification System
/2: g/d/head

Table 20 PROPOSED FLOOD FORECASTING AND WARNING SYSTEM IN PAHANG

Basin No.	River Basin	People Rel'ved by F/F (10^3)	Construction Cost (M$$10^6$)	Construction Period
30	Pahang/1	99.1	1.0	5MP
31	Kuantan	8.5	0.5	5MP
Total		107.6	1.5	

Remarks; /1: Additional flood forecasting stations be recommended.

Table 21 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN PAHANG

(1) DAM

Basin No.	Facilities	Purpose	Catch-ment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
27	Anak Endau dam	IR	36	38	33	76	1983 - 1987
27	Kemelai dam	IR	44	47	41	30	1983 - 1987
30	Perting dam	WS	88	119	59	214*	1994 - 1998
30	Bera dam	WS	258	171	180	21**	1985 - 1989
31	Kuantan Barrage	WS	-	-	-	20	U/C 1981 - 1985

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
30	Perting diversion (tunnel)	Pahang to Selangor 30 to 13-15	4	6*	1994 - 1998
30	Bera diversion (canal)	Pahang to N.Sembilan 30 to 21	13	32*	1985 - 1989

Remarks; IR = Irrigation; WS = Water Supply; U/C = Under Construction
Construction cost is the financial cost at 1980 constant price.
* = For diversion to Kelang Valley.
** = For diversion to Muar river.

Table 22 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN PAHANG

(1) DAM

Basin No.	Facilities	Purpose	Catch-ment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
27	Anak Endau dam	IR	36	28	12	45	1983 - 1987
27	Kemelai dam	IR	44	34	35	18	1983 - 1987
30	Perting dam	WS	88	119	59	214*	1994 - 1998
31	Kuantan barrage	WS	-	-	-	20	U/C 1981 - 1985

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
30	Perting diversion (tunnel)	Pahang to Selangor 30 to 13-15	4	6*	1994 - 1998

Remarks; IR = Irrigation; WS = Water Supply; U/C = Under Construction
Construction cost is the financial cost at 1980 constant price.
* = For diversion to Kelang Valley.

Table 23 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN PAHANG

Basin No.	Facilities	Purpose	Catch-ment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Net Supply Capacity ($10^6 m^3/y$)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
27	Anak Endau dam	IR	36	26	11	38	1983 - 1987
27	Kemelai dam	IR	44	31	30	15	1983 - 1987
31	Kuantan barrage	WS	-	-	-	20	U/C 1981 - 1985

Remarks; WS = Water Supply; U/C = Under Construction; IR = Irrigation

Table 24 OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN PAHANG

Basin No.	Basin Name	R.I. (km)	Dam (nos)	F.W. (km)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3 ha)	C.C. (M$$10^6$)
	ALTERNATIVE F1								
30	Pahang	523	3	-	-	-	316	267	1,914
31	Kuantan	56	-	-	-	-	50	17	106
	Total	579	3	-	-	-	366	284	2,020
	ALTERNATIVE F2								
30	Pahang	-	3	-	4	10	63	3	412
31	Kuantan	6	-	-	1	-	27	2	34
	Total	6	3	-	5	10	90	5	446
	ALTERNATIVE F3								
30	Pahang	-	3	-	4	112	63	3	412
31	Kuantan	6	-	-	1	-	27	2	34
	Total	6	3	-	5	112	90	5	446

Remarks; R.I. : River improvement,
F.W. : Floodway,
Pold.: Polder,
N.S. : Non-structural measure, in person
P.P.: Population protected (the year 2000)
F.A.: Flood area relieved
C.C.: Construction cost

Table 25 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PAHANG

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
21	C145		2.4	85	6.8	3.3	90	8.1	7.1	100	10.0
27	C151		6.9	85	16.2	10.1	90	20.7	15.3	100	23.0
28	C139		1.2	85	3.4	3.0	90	7.2	7.1	100	10.0
	C141		1.8	85	6.0	5.8	90	11.7	11.5	100	17.0
	C142		8.4	85	20.4	14.2	90	29.7	28.8	100	42.0
	C143		1.8	85	6.0	3.0	90	7.2	7.1	100	10.0
	C146		2.4	85	7.7	4.7	90	9.0	7.1	100	10.0
	C147		3.9	85	9.4	5.8	90	11.7	10.7	100	15.0
	C148		7.9	85	19.6	11.2	90	22.5	17.0	100	25.0
	C149		0.6	85	1.7	3.0	90	7.2	7.7	100	11.0
	C150		6.9	85	17.0	10.7	90	21.6	15.9	100	24.0
29	C140		2.4	85	6.8	3.3	90	8.1	8.2	100	12.0
30	45	Temerloh	10.6	85	13.6	18.4	90	16.2	55.9	100	22.0
	46	Bentong	6.6	85	21.3	9.0	90	24.3	17.8	100	30.0
	48	Jerantut	9.0	85	7.7	17.8	90	9.9	57.8	100	17.0
	49	Raub	9.3	85	23.0	14.2	90	27.0	35.6	100	38.0
	50	Kuala Lipis	3.9	85	9.4	5.5	90	10.8	9.6	100	14.0
	130	Mentakab	7.8	85	9.4	14.0	90	11.7	42.7	100	18.0
	131	Teriang	3.6	85	8.5	3.6	90	10.8	11.5	100	17.0
	C137		9.9	85	23.8	13.2	90	27.9	21.1	100	31.0
	C138		2.4	85	6.8	5.5	90	10.8	11.2	100	16.0
	C144		1.8	85	6.0	8.5	90	17.1	14.5	100	21.0
	C152		0.0	0	0.0	4.9	90	9.9	9.6	100	14.0
	C153		4.5	85	10.2	5.5	90	10.8	8.2	100	12.0
	C154		3.6	85	8.5	4.7	90	9.0	7.1	100	10.0
	C155		1.8	85	5.1	5.5	90	10.8	8.2	100	12.0
	C156		0.3	85	0.9	14.2	90	29.7	22.7	100	33.0
31	47	Kuantan	76.3	100	224.0	128.5	100	333.0	347.1	100	653.0
	Total		197.9	91	499.2	351.1	94	734.4	824.1	100	1167.0

Table 26 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PAHANG

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
27	Endau	14.2	54.5	59.8	20.8	74.1	81.7	28.6	99.9	90.7
28	Rompin & Pontian	21.1	66.7	18.6	1.2	73.3	4.4	0.9	76.9	3.0
29	Bebah & Merchong	0.9	66.7	6.8	0.3	72.7	1.6	0.3	78.6	1.1
30	Pahang & Penor	53.9	67.8	323.8	69.3	73.7	350.7	100.4	76.7	369.3
31	Kuantan	2.1	66.1	12.5	2.4	72.8	12.3	3.3	76.3	11.9
Total		92.2	-	421.5	94.0	-	450.7	133.5	-	476.0
Pahang		48.5	66.5	304.6	60.9	72.7	307.4	92.8	76.1	344.0

Remarks; TC: Treatment capacity required in the corresponding year in 10^3 m^3/d
SF: Service factor in %
SP: Served population in 10^3 persons

Table 27 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PAHANG

Basin No.	Basin Name	1985 SD	1985 SF	1985 SP	1990 SD	1990 SF	1990 SP	2000 SD	2000 SF	2000 SP
27	Endau	0.1	5.5	6.0	0.1	4.1	4.5	0.0	2.0	0.2
28	Rompin & Pontian	0.1	20.8	5.8	0.0	23.3	1.4	0.0	23.1	0.9
29	Bebar & Merchong	0.0	20.6	2.1	0.0	22.7	0.5	0.0	21.4	0.3
30	Pahang & Penor	1.9	18.8	89.8	2.5	21.0	100.1	3.7	23.3	112.5
31	Kuantan	0.1	20.6	3.9	0.1	23.1	3.9	0.1	23.7	3.7
Total		2.2	-	107.6	2.7	-	110.4	3.8	-	117.6
Pahang		1.9	20.9	95.7	2.4	22.8	96.5	3.5	23.9	108.0

Remarks; SD: Source demand in the rural area in the corresponding year in 10^6 m^3/y
SF: Service factor in the rural area in %
SP: Served population in the rural area in 10^3 persons

Table 28 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PAHANG

(1) DAM

Basin No.	Facilities	Purpose	Catch-ment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Net Supply Capacity ($10^6 m^3/y$)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
27	Anak Endau dam	IR	36	26	11	38	1983 - 1987
27	Kemelai dam	IR	44	31	30	15	1983 - 1987
30	Perting dam	WS	88	119	59	214*	1994 - 1998
31	Kuantan barrage	WS	-	-	-	20	U/C 1981 - 1985

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construc-tion Cost (M$$10^6$)	Construc-tion Period
30	Perting diversion (tunnel)	Pahang to Selangor 30 to 13-15	4	6*	1994 - 1998

Remarks; IR = Irrigation; WS = Water Supply; U/C = Under Construction
Construction cost is the financial cost at 1980 constant price.
* = For diversion to Kelang valley.

Table 29 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN TREATMENT CAPACITY IN PAHANG

Unit: m^3/d

Basin		1981 - 1990			1991 - 2000		
No.	Name	Palm Oil	Rubber	Total	Palm Oil	Rubber	Total
21	Muar	1,292	7,076	8,368	1,332	1,224	2,556
27	Endau	1,852	244	2,096	1,684	188	1,872
28	Rompin	1,308	0	1,308	4	0	4
Total		4,452	7,320	11,772	2,020	1,412	4,432

Table 30 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PAHANG

Basin	City/Town		1990			2000		
No.	No.	Name	Treatment Capacity ($10^3 m^3/d$)	Service Factor (%)	Served Popu-latin (10^3)	Treatment Capacity ($10^3 m^3/d$)	Service Factor (%)	Served Popu-lation (10^3)
31	C47	Kuantan	75	60	200	288	80	522
Total			75	-	200	288	-	522

Table 31 POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN PAHANG

Basin No.	Basin Name	Without Project: BOD Load into River (ton/d) PR	UI	RA	Total	Without Project: Max. BOD in River (mg/lit)	With Project: BOD Load into River (ton/d) PR	UI	RA	Total	With Project: Max. BOD in River (mg/lit)
21	Muar	20	7	1	28	30	0	5	2	7	7
27	Endau	15	9	0	24	29	0	4	0	4	7
28	Rompin	5	9	0	14	9	2	4	0	6	5
29	Bebar	0	1	0	1	7	0	1	0	1	7
30	Pahang	41	37	1	79	4	41	37	1	79	4
31	Kuantan	6	0	0	6	4	6	0	0	6	4
	Total	87	63	2	152	-	49	51	3	103	-

Remarks; PR: Palm oil mill and rubber factory effluent
UI: Urban sewer and industrial effluent
RA: Rural sewer and animal husbandry

Table 32 RECOMMENDED FLOOD MITIGATION PROGRAM IN PAHANG

Basin No.	Name of River	R.I. (km)	F.W. (km)	Dam (nos)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
By 1990									
30	Pahang	-	-	2	1	10	35	2	132
31	Kuantan	-	-	-	-	-	-	-	-
	Total	-	-	2	1	10	35	2	132
By 2000									
30	Pahang	-	-	3	4	10	63	3	412
31	Kuantan	6	-	-	1	-	27	2	34
	Total	6	-	3	5	10	90	5	446

Remarks; R.I. : River improvement,
F.W. : Floodway,
Pold.: Polder,
N.S. : Non-structural measure, in population (2000)
P.P.: Population protected (the year 2000)
F.A.: Flood area relieved
C.C.: Construction cost

Table 33 RECOMMENDED HYDROPOWER DEVELOPMENT PLAN IN PAHANG

Basin No.	Project	Catchment Area (km^2)	Active Storage (10^6m^3)	Surface Area (km^2)	Install. Capacity (MW)	Annual Energy (GWh)	Purpose	Regulated Outflow (m^3/s)	Construction Cost (M$$10^6$)	Year of Commission
30	Tembeling (Upper)	2,850	1,730	250	110	440	HY (IR,WS)	44	310	1988
30	Tekai & Penut	1,390	1,070	68	74	370	HY,FM (IR,WS)	27	258	1990
30	Telom Hilir	1,200	500	28	98	480	HY,FM	28	191	1991
30	Jelai Kechil	890	560	70	60	300	HY,FM	21	250	1992
30	Maran	25,000	-	197	130	680	HY,IR	-	431	1993
30	Jelai	3,060	138	88	10	34	HY	4	69	1996
30	Tarum 1	730	140	18	5	14	HY	4	59	1997
	Total	35,120	4,138	719	487	2,318		128	1,568	

Remarks; Construction cost is the financial cost at 1980 constant price.
( ) = incidental function

Table 34 ASSUMED UNIT CONSTRUCTION COST (1/2)

1. Compensation on Land (M$$10^6/km^2$)

Irrigated paddy	2.5	Urban area class S	100
Rainfed paddy	1.5	Urban area class A	10
Tree crop field classes A & B	1.5	Urban area class B	5
Tree crop field class C	0.5	Village area class A	5
Forest class A	0.5	Village area class B	1
Forest class B	0.1		

S: very good access, A: good access
B: poor access, C: very poor access

2. Resettlement (M$$10^3$/household)

Urban	30	Rural	10

3. Civilwork

Dam	M$48-66 per m^3 of embankment volume
Canal	M$50-94/m per m^3/s of discharge capacity
Tunnel	M$160-182/m per m^3/s of discharge capacity
Pipeline	M$990-1,980/m per m^3/s of discharge capacity
Barrage/Weir	M$1,320/m per m^3/s of 100-y maximum capacity
Pumping station	M$7,700-14,300 m^3/s of discharge capacity

4. River Facilities

Channel improvement (M$$10^6$/km)

200 m^3/s	0.2 - 0.4
500 m^3/s	0.3 - 0.6
1,000 m^3/s	0.4 - 0.8
10,000 m^3/s	1.2 - 2.9

Floodway (M$$10^6$/km)

200 m^3/s	0.2 - 0.5
500 m^3/s	0.4 - 0.9
1,000 m^3/s	0.5 - 1.2
2,000 m^3/s	0.7 - 1.8

Polder

Protection bund	M$150-700 x 10^3/km
Drainage system	M$540 x 10^3/km
Drainage pump	M$150-380 x 10^3 per m^3/s

Remarks; Unit construction costs include the engineering and administration cost, but the physical contingency is not included.

Table 35 ASSUMED UNIT CONSTRUCTION COST (2/2)

5. D&I Water Supply System

Pipeline	M$430/m per m^3/s of discharge capacity
Treatment plant	M$710 per m^3/d of capacity
Distribution system	M$1,300 per m^3/d of capacity

6. Sewerage System M$157 x 10^6 per 100 x 10^3 m^3/d

7. D&I Pre-treatment System

Aerated lagoon	M$38 x 10^6 per 100 x 10^3 m^3/d
Rapid sandfilter bed	M$112 x 10^6 per 100 x 10^3 m^3/d

8. Power Facilities

Generating equipment

Rated head more than 140 m	M$275-440 per kW
Rated head 20 - 80 mm	M$550-880 per kW
Rated less than 30 m	M$1,320-1,540 per kW
Transmission line	M$162-194 x 10^3 per km

9. Irrigation Facilities

From rainfed paddy to irrigated paddy	M$11,370 per ha
From new reclaimed land to irrigated paddy	M$12,300 per ha
From irrigated single cropped paddy to double	M$6,150 per ha
Tertiary development and rehabilitation	M$5,470 per ha

Remarks; Unit construction costs include the engineering and administration cost, but the physical contingency is not included.

Table 36 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN PAHANG

Unit: $M\$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	52	21	0	0	73
Irrigation	24	308	109	59	500
Inland Fishery	4	22	47	71	144
Public Water Supply	197	384	420	169	1,170
Public Water Supply; Pre-treatment facilities	21	30	27	11	89
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	46	80	81	32	239
Flood Mitigation	5	129	146	169	447
Total	349	974	830	511	2,662

Remarks; (1): At 1980 constant price
(2): The amount shown for 4MP is the additional budget, assuming that the original budget can provide the capacity necessary up to 1985.

Table 37 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN PAHANG

Unit: $M\$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	1	2	2	5
Irrigation	0	2	25	33	60
Inland Fishery	0	1	4	9	14
Public Water Supply	0	34	75	110	219
Public Water Supply; Pre-treatment facilities	0	3	6	9	18
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	0	16	32	45	93
Flood Mitigation	0	56	73	100	229
Total	0	113	217	308	638

Remarks; (1): At 1980 constant price
(2): Recurrent expenditure on the capacity, which is to be constructed by the original budget for 4MP, is not included.

Table 38 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PAHANG

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	($M\$10^6$)	38
D&I water supply	($M\$10^6$)	99
Fish culture	($M\$10^6$)	6
Reservoir recreation	($M\$10^6$)	5
Total	($M\$10^6$)	148
1.2 Economic Cost		
Irrigation	($M\$10^6$)	18
D&I water supply	($M\$10^6$)	98
Fish culture	($M\$10^6$)	6
Dams, barrages & diversion facilities	($M\$10^6$)	3
Total	($M\$10^6$)	125
1.3 EIRR	(%)	10
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	8
2.2 Adverse Effect		
Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	3
3. Social Well-being		
3.1 Beneficial Effect		
Number of farm households benefited by proposed irrigation in 2000	(10^3)	15
Number of people served by proposed public water supply in 2000	(10^3)	1,619
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	2

Remarks; All effects by proposed hydropower project are not shown except irrigation, D&I water supply and lake recreation benefit.

Table 39 SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN PAHANG

Unit: days

Basin No.	Basin Name	Safe Supply Period		Safe Maintenance Flow Period	
		Plan Implemented	Natural Flow	Plan Implemented	Natural Flow
31	Kuantan	365	340	365	319

Remarks; Natural Flow: Natural flow only is depended upon, with neither existing nor proposed facilities.

Table 40 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PAHANG

Item			Amount
1.	National Economic Development		
	1.1 Economic Benefit		
	Sewerage	($M\$10^6$)	6
	Saving in pre-treatment for D&I water supply	($M\$10^6$)	20
	Total	($M\$10^6$)	26
	1.2 Economic Cost		
	Sewerage	($M\$10^6$)	12
	Private purification facilities/2	($M\$10^6$)	2
	Pre-treatment for D&I water supply	($M\$10^6$)	4
	Total	($M\$10^6$)	18
2.	Environmental Quality		
	2.1 Beneficial Effects		
	Length of river stretch where BOD concentration is not more than 10 mg/lit in 2000 compared with without project condition (Study length = 974 km)	(km)	974/750/1
	Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 974 km)	(km)	894/534/1
	2.2 Adverse Effect		-
3.	Social Well-Being		
	3.1 Beneficial Effects		
	Number of people served by proposed sewerage system in 2000	(10^3)	522
	3.2 Adverse Effect		-

Remarks; /1: (Length of river stretch with Project)/(Length of river stretch without Project) and including the river stretch in the State of N.Sembilan and Johor.

/2: Including the rubber factories and palm oil mills in such part of the State of N.Sembilan and Johor as located in Basin 21, 27 and 28.

Table 41 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PAHANG

Item		Recommended Plan
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M10^6)	9.1
1.2 Economic Cost		
Flood mitigation work	(M10^6)	13.3
1.3 EIRR	(%)	5.0
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	6
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	90
Population served by proposed flood warning system in 2000	(10^3)	108
Area relieved from flood hazards	(10^3 ha)	5
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	3

Table 42 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR HYDROPOWER DEVELOPMENT FOR PENINSULAR MALAYSIA

Item			Amount
1.	National Economic Development		
1.1	Economic Benefit		
	Power generation	(M10^6)	344
1.2	Economic Cost		
	Dam & power facilities	(M10^6)	107
1.3	EIRR	(%)	22
2.	Environmental Quality		
2.1	Beneficial Effect		
	Surface area of reservoir created	(km^2)	1,170
2.2	Adverse Effect		
	Number of sites where kind of fish might be reduced being located immediately downstream of dam	(nos. of site)	13
3.	Social Well-being		
3.1	Adverse Effect		
	Number of people to be removed for construction of facilities	(10^3)	23

Remarks; (1): Figures in this table cover 3 States, i.e. Pahang, Trengganu and Kelantan.

(2): Economic benefit other than power generation benefit is not shown here, but included in the water demand and supply account.

Table 43 SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN PAHANG

	Yield (ton/ha)	Unit Price (M$/ton)	Gross Value (M$/ha)	Production Cost (M$/ha)	Net Value (M$/ha)
(1) Major Irrigation Scheme (Rompin Endau and Trans Pahang)					
Double cropping	8.0	640	5,120	1,671	3,449
Single cropping	3.8	640	2,432	803	1,629
(2) Minor Irrigation Scheme					
Double cropping	7.2	640	4,608	1,502	3,106
Single cropping	3.4	640	2,176	739	1,437
(3) Rainfed Scheme					
Single cropping	1.7	640	1,088	629	459

Table 44 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

	Service Factor (%)				Per Capita Daily Use (lpcd)			
	Estimated	Projected			Estimated	Projected		
City/Rural	1980	1985	1990	2000	1980	1985	1990	2000
1. Urban Area								
C137 PT1	80.0	85.5	90.0	95.0	160.0	170.0	185.0	210.0
C138 PT2	55.9	87.4	90.0	95.0	75.0	95.0	185.0	210.0
C139 PT3	-	87.4	95.0	99.0	-	95.0	115.0	155.0
C140 PT4	55.9	87.4	95.0	99.0	75.0	95.0	115.0	210.0
C141 PT5	55.9	87.4	90.0	95.0	75.0	95.0	185.0	210.0
C142 PT6	55.9	85.0	90.0	95.0	75.0	170.0	185.0	210.0
C143 PT7	-	87.4	95.0	99.0	-	95.0	115.0	155.0
C144 PT8	55.9	87.4	90.0	95.0	75.0	95.0	185.0	210.0
C145 PT9	55.9	87.4	95.0	99.0	75.0	95.0	115.0	155.0
C146 PT10	55.9	87.4	95.0	99.0	75.0	95.0	115.0	155.0
C147 PT11	55.9	85.0	90.0	95.0	75.0	170.0	185.0	210.0
C148 PT12	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
C149 PT13	-	87.4	95.0	95.0	-	95.0	115.0	210.0
C150 PT14	-	85.0	90.0	95.0	-	170.0	185.0	210.0
C151 PT15	-	85.0	90.0	95.0	-	170.0	185.0	210.0
C152 PT16	-	-	90.0	95.0	-	-	185.0	210.0
C153 PT17	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
C154 PT18	55.9	87.4	95.0	99.0	75.0	95.0	115.0	155.0
C155 PT19	55.9	87.4	90.0	95.0	75.0	95.0	185.0	210.0
C156 PT20	-	87.4	90.0	95.0	-	95.0	185.0	210.0
45 Temerloh	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
46 Bentong	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
47 Kuantan	100.0	100.0	100.0	100.0	170.0	180.0	195.0	240.0
48 Jerantut	55.9	87.4	90.0	95.0	75.0	95.0	185.0	210.0
49 Rab	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
50 Kuala Lipis	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
130 Mentakab	55.9	85.0	90.0	95.0	75.0	170.0	185.0	210.0
131 Teriang	55.9	85.0	90.0	95.0	75.0	170.0	185.0	210.0
2. Rural Area								
PWD Rural	47.0	66.5	72.3	75.3	75.0	95.0	115.0	155.0
MOH Rural	8.9	20.9	22.7	23.7	40.0	45.0	55.0	65.0
3. Non-Pipe-Served Area	-	-	-	-	40.0	40.0	40.0	40.0

Table 45 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: $10^6 m^3/y$

Basin No.		City/Rural	Estimated 1980	Projected 1985			1990			2000		
			D&I	D	I	Total	D	I	Total	D	I	Total
27	41	Kelang	10.8	4.3	13.6	17.9	5.1	16.3	21.4	6.7	24.6	31.3
	C151		0.0	1.2	1.4	2.6	1.7	2.1	3.8	2.0	3.8	5.8
		City Total	10.8	5.5	15.0	20.5	6.8	18.4	25.2	8.7	28.4	37.1
		Rural	6.6	3.5	4.7	8.2	5.5	3.9	9.4	10.5	3.8	14.3
		Basin Total	17.4	9.0	19.7	28.7	12.3	22.3	34.6	19.2	32.2	51.4
28	C139		0.0	0.2	0.3	0.5	0.4	0.0	0.4	0.6	1.6	2.2
	C141		0.0	0.3	0.5	0.8	1.0	0.0	1.0	1.4	2.7	4.1
	C142		0.2	1.6	1.8	3.4	2.5	0.0	2.5	3.6	6.9	10.5
	C143		0.0	0.3	0.5	0.8	0.4	0.0	0.4	0.6	1.6	2.2
	C146		0.2	0.3	0.7	1.0	0.5	0.0	0.5	0.6	1.6	2.2
	C147		0.2	0.7	0.8	1.5	1.0	1.2	2.2	1.3	2.5	3.8
	C148		1.8	1.6	1.7	3.3	1.8	2.3	4.1	2.2	4.2	6.4
	C149		0.0	0.1	0.2	0.3	0.4	0.7	1.1	1.0	1.8	2.8
	C150		0.0	1.2	1.5	2.7	1.8	2.3	4.1	2.1	4.0	6.1
		City Total	2.4	6.3	8.0	14.3	9.8	6.5	16.3	13.4	26.9	40.3
		Rural	2.1	1.4	0.5	1.9	0.8	0.5	1.3	2.0	0.5	2.5
		Basin Total	4.5	7.7	8.5	16.2	10.6	7.0	17.6	15.4	27.4	42.8
29	C140		0.0	0.3	0.6	0.9	0.4	0.0	0.4	1.1	2.0	3.1
		Rural	0.6	0.5	0.0	0.5	0.3	0.0	0.3	0.8	0.0	0.8
		Basin Total	0.6	0.8	0.6	1.4	0.7	0.0	0.7	1.9	2.0	3.9
30	45	Temerloh	2.1	1.1	4.5	5.6	1.3	7.3	8.6	1.7	20.3	22.0
	46	Bentong	1.8	1.8	0.7	2.5	2.0	1.1	3.1	2.4	3.2	5.6
	48	Jerantut	1.4	1.4	4.8	6.2	0.9	7.7	8.6	1.3	21.5	22.8
	49	Paub	2.1	2.0	2.1	4.1	2.4	3.6	6.0	3.0	9.6	12.6
	50	Kuala Lipis	2.0	0.8	0.9	1.7	0.9	1.1	2.0	1.1	2.2	3.3
	118	Bahau	1.1	0.8	0.7	1.5	1.0	0.9	1.9	1.2	1.1	2.3
	130	Mentakab	1.1	0.8	3.4	4.2	1.0	5.5	6.5	1.4	15.2	16.6
	131	Teriang	0.5	0.7	0.8	1.5	0.9	1.1	2.0	1.3	2.5	3.8
	C137		1.4	1.8	2.1	3.9	2.3	2.9	5.2	2.7	5.1	7.8
	C138		0.2	0.3	0.6	0.9	0.9	1.1	2.0	1.3	2.5	3.8
	C144		0.2	0.3	0.5	0.8	1.4	0.0	1.4	1.8	3.4	5.2
	C152		0.0	0.0	0.0	0.0	0.8	1.0	1.8	1.2	2.4	3.6
	C153		1.0	0.8	0.9	1.7	0.9	1.1	2.0	1.1	2.0	3.1
	C154		0.5	0.4	0.7	1.1	0.5	0.9	1.4	0.6	1.6	2.2
	C155		0.3	0.2	0.4	0.6	0.9	1.1	2.0	1.1	2.0	3.1
	C156		0.0	0.0	0.1	0.1	2.5	3.0	5.5	2.9	5.4	8.3
		City Total	15.7	13.2	23.2	36.4	20.6	39.4	60.0	26.1	100.0	126.1
		Rural	17.4	18.3	7.5	25.8	24.0	7.3	31.3	41.3	9.3	50.6
		Basin Total	33.1	31.5	30.7	62.2	44.6	46.7	91.3	67.4	109.3	176.7
31	47	Kuantan	14.3	19.2	10.2	29.4	29.6	16.4	46.0	62.4	45.8	108.2
		Rural	1.5	0.7	1.0	1.7	0.7	1.1	1.8	0.9	1.7	2.6
		Basin Total	15.8	19.9	11.2	31.1	30.3	17.5	47.8	63.3	47.5	110.8
Total Pahang			71.4	68.9	70.7	139.6	98.5	93.5	192.0	167.2	218.4	385.6
			49.6	56.4	50.7	107.1	83.2	71.1	154.3	143.7	189.1	332.8

Remarks; D: Domestic water demand
I: Industrial water demand
Total: Total source demand

Table 46 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
21	145		1.8	85	6.0	1.1	90	7.2	4.1	96	8.6
27	151		5.8	85	14.5	8.5	90	18.9	11.8	95	20.0
28	139		1.1	85	3.4	1.1	90	6.3	4.1	96	8.6
	141		1.9	85	5.1	3.0	90	10.8	8.5	95	14.3
	142		7.1	85	18.7	7.1	90	27.0	21.4	95	36.1
	143		1.9	85	5.1	1.1	90	6.3	4.1	96	8.6
	146		2.2	85	6.8	1.6	90	8.1	4.1	96	8.6
	147		3.3	85	8.5	4.9	90	10.8	7.9	95	13.3
	148		7.1	85	17.9	9.0	90	20.7	12.9	95	21.9
	149		0.5	85	1.7	2.5	90	6.3	5.8	95	9.5
	150		6.0	85	15.3	9.0	90	19.8	12.3	95	20.9
29	140		1.9	85	6.0	1.1	90	7.2	6.3	95	10.5
30	45	Temerloh	10.1	85	13.6	15.1	90	15.3	35.9	95	17.1
	46	Bentong	6.3	85	21.3	7.9	90	22.5	12.1	95	23.8
	48	Jerantut	8.4	85	7.7	14.5	90	9.9	36.4	95	13.3
	49		9.0	85	23.0	12.3	90	26.1	23.6	95	29.5
	50		3.8	85	9.4	4.7	90	9.9	6.6	95	11.4
	130	Mentakab	7.7	85	9.4	11.5	90	10.8	27.1	95	14.3
	131	Teriang	3.2	85	8.5	4.7	90	9.9	7.9	95	13.3
	137		8.5	85	21.3	11.2	90	25.2	15.9	95	26.6
	138		1.9	85	6.0	4.7	90	9.9	7.9	95	13.3
	144		1.9	85	5.1	4.1	90	15.3	10.7	95	18.0
	152		0.0	0	0.0	3.8	90	9.0	7.1	95	12.4
	153		3.8	85	9.4	4.7	90	9.9	6.3	95	10.5
	154		2.5	85	7.7	3.0	90	8.1	4.1	96	8.6
	155		1.1	85	4.3	4.7	90	9.9	6.3	95	10.5
	156		0.3	85	0.9	11.8	90	27.0	17.0	95	28.5
31	47	Kuantan	73.2	100	222.0	114.0	100	316.0	257.0	100	541.0
	Total		182.3	92	478.6	282.7	94	684.1	585.2	98	973.0

Table 47 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PAHANG UNDER THE CONDITION OF POWER ECONOMIC GROWTH

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
27	Endau	13.9	54.6	61.4	21.1	73.6	90.9	37.7	96.6	141.0
28	Rompin & Pontian	3.6	66.4	23.3	2.4	72.0	13.4	5.7	75.5	24.0
29	Behar & Merchong	1.2	66.7	8.6	0.9	72.1	4.9	2.1	75.2	8.8
30	Pahang & Penor	52.1	67.8	335.2	69.0	73.2	382.0	117.5	75.9	496.8
31	Kuantan & Others	2.1	66.1	12.5	2.1	71.8	11.7	2.7	75.2	10.3
Total		72.9	-	441.0	95.5	-	502.9	165.7	-	680.9
Pahang		48.2	66.5	322.0	61.2	72.3	346.1	111.2	75.3	469.3

Remarks; TC: Treatment capacity required in the corresponding year in 10^3 m^3/d
SF: Service factor in %
SP: SErved population in 10^3 persons

Table 48 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Basin Name	1985 SD	1985 SF	1985 SP	1990 SD	1990 SF	1990 SP	2000 SD	2000 SF	2000 SP
27	Endau	0.1	5.7	6.4	0.1	4.4	5.4	0.0	0.9	1.3
28	Rompin & Pontian	0.2	20.8	7.3	0.1	22.6	4.2	0.2	23.6	7.5
29	Bebar & Merchong	0.1	20.9	2.7	0.0	22.1	1.5	0.1	23.9	2.8
30	Pahang & Penor	2.0	18.8	93.1	2.6	20.9	108.9	4.5	22.9	149.9
31	Kuantan+	0.1	20.6	3.9	0.1	22.7	3.7	0.1	23.4	3.2
Total		2.5	-	113.4	2.9	-	123.7	4.9	-	164.7
Pahang		2.2	20.9	101.0	2.5	22.7	108.6	4.4	23.7	147.4

Remarks; SD: Source demand in the rural area in the corresponding year in 10^6 m^3/y
SF: Service factor in the rural area in %
SP: Served population in the rural area in 10^3 persons

Table 49 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Facilities	Purpose	Catch-ment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Net Supply Capacity ($10^6 m^3/y$)	Construc-tion Cost ($M\$10^6$)	Construc-tion Period
27	Anak Endau dam	IR	36	26	11	38	1983 - 1987
27	Kemelai dam	IR	44	31	30	15	1983 - 1987
31	Kuantan barrage	WS	-	-	-	20	U/C 1981 - 1985

Remarks; WS = Water Supply; U/C = Under Construction; IR = Irrigation

Table 50 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: m^3/d

Basin		1981 - 1990			1991 - 2000		
No.	Name	Palm Oil	Rubber	Total	Palm Oil	Rubber	Total
21	Muar	1,292	7,076	8,368	1,332	1,224	2,556
27	Endau	1,852	244	2,096	1,684	188	1,872
28	Rompin	1,308	0	1,308	4	0	4
Total		4,452	7,320	11,772	3,020	1,412	4,432

Table 51 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
31	C47	Kuantan	49	45	142	166	65	352
Total			49	-	142	166	-	352

Table 52 RECOMMENDED FLOOD MITIGATION PROGRAM IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Name of River	R.I. (km)	F.W. (km)	Dam (nos)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
By 1990									
30	Pahang	-	-	2	1	10	35	2	132
31	Kuantan	-	-	-	-	-	-	-	-
	Total	-	-	2	1	10	35	2	132
By 2000									
30	Pahang	-	-	3	4	10	63	3	412
31	Kuantan	6	-	-	1	-	26	2	34
	Total	6	-	3	5	10	89	5	446

Remarks; R.I. : River improvement, P.P.: Population protected (the year 2000)
F.W. : Floodway,
Pold.: Polder, F.A.: Flood area relieved
N.S. : Non-structural measure, in population (2000) C.C.: Construction cost

Table 53 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE OF RECOMMENDED PLAN IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	52	21	0	0	73
Irrigation	24	308	109	59	500
Inland Fishery	4	28	53	65	150
Public Water Supply	174	315	330	133	952
Public Water Supply; Pre-treatment facilities	17	24	20	8	69
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	31	48	47	19	145
Flood Mitigation	5	129	146	167	447
Total	307	873	705	451	2,336

Remarks; (1): At 1980 constant price
(2): The amount shown for 4MP is the additional budget, assuming that the original budget can provide the capacity necessary up to 1985.

Table 54 ESTIMATED ANNUAL RECURRENT EXPENDITURE OF RECOMMENDED PLAN IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	1	2	2	5
Irrigation	0	2	25	33	60
Inland Fishery	0	1	4	11	16
Public Water Supply	0	28	59	85	172
Public Water Supply; Pre-treatment facilities	0	3	5	6	14
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	0	10	20	27	57
Flood Mitigation	0	56	73	100	229
Total	0	101	188	264	553

Remarks; (1): At 1980 constant price
(2): Recurrent expenditure on the capacity, which is to be constructed by the original budget for 4MP, is not included.

Table 55 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item			Amount
1.	National Economic Development		
	1.1 Economic Benefit		
	Irrigation	(M$$10^6$)	38
	D&I water supply	(M$$10^6$)	69
	Fish culture	(M$$10^6$)	7
	Reservoir recreation	(M$$10^6$)	5
	Total	(M$$10^6$)	119
	1.2 Economic Cost		
	Irrigation	(M$$10^6$)	18
	D&I water supply	(M$$10^6$)	68
	Fish culture	(M$$10^6$)	7
	Dams, barrages & diversion facilities	(M$$10^6$)	3
	Total	(M$$10^6$)	96
	1.3 EIRR	(%)	11
2.	Environmental Quality		
	2.1 Beneficial Effect		
	Safe maintenance flow period (2000)		See Table
	Surface area of lake created	(km^2)	7
	2.2 Adverse Effect		
	Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	2
3.	Social Well-being		
	3.1 Beneficial Effect		
	Number of farm households benefited by proposed irrigation in 2000	(10^3)	15
	Number of people served by proposed public water supply in 2000	(10^3)	1,589
	Safe supply period (2000)		See Table
	3.2 Adverse Effect		
	Number of people to be removed for construction of facilities	(10^2)	1

Remarks; All effects by proposed hydropower project are not shown except irrigation, D&I water supply and lake recreation benefit.

Table 56 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	3
Saving in pre-treatment for D&I water supply	($M\$10^6$)	17
Total	($M\$10^6$)	20
1.2 Economic Cost		
Sewerage	($M\$10^6$)	7
Private purification facilities /2	($M\$10^6$)	2
Pre-treatment for D&I water supply	($M\$10^6$)	20
Total	($M\$10^6$)	29
2. Environmental Quality		
2.1 Beneficial Effects		
Length of river stretch where BOD concentration is not more than 10 mg/lit in 2000 compared with without project condition (Study length = 974 km)	(km)	974/759 /1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 974 km)	(km)	971/585 /1
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	352
3.2 Adverse Effect		-

Remarks; /1: (Length of river stretch with Project)/ (Length of river stretch without Project) and including the river stretch in the State of N. Sembilan and Johor.

/2: Including the rubber factories and palm oil mills in such part of the State of N.Sembilan and Johor as located in Basin 21, 27 and 28.

Table 57 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PAHANG UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M$ 10^6)	3.6
1.2 Economic Cost		
Flood mitigation work	(M$ 10^6)	13.3
1.3 EIRR	(%)	0.6
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	6
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	89
Population served by proposed flood warning system in 2000	(10^3)	107
Area relieved from flood hazards	(km^2)	5
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	3

Table 58 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR HYDROPOWER DEVELOPMENT FOR PENINSULAR MALAYSIA UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Power generation	(M$ 10^6)	270
1.2 Economic Cost		
Dam & power facilities	(M$ 10^6)	81
1.3 EIRR	(%)	23
2. Environmental Quality		
2.1 Beneficial Effect		
Surface area of reservoir created	(km^2)	1,064
2.2 Adverse Effect		
Number of sites where kind of fish might be reduced being located immediately downstream of dam	(nos. of site)	11
3. Social Well-being		
3.1 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	23

Remarks; (1): Figures in this table cover 3 States, i.e. Pahang, Trengganu and Kelantan.

(2): Economic benefit other than power generation benefit is not shown here, but included in the water demand and supply account.