GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA

STATE REPORT

VOL. 8

KELANTAN

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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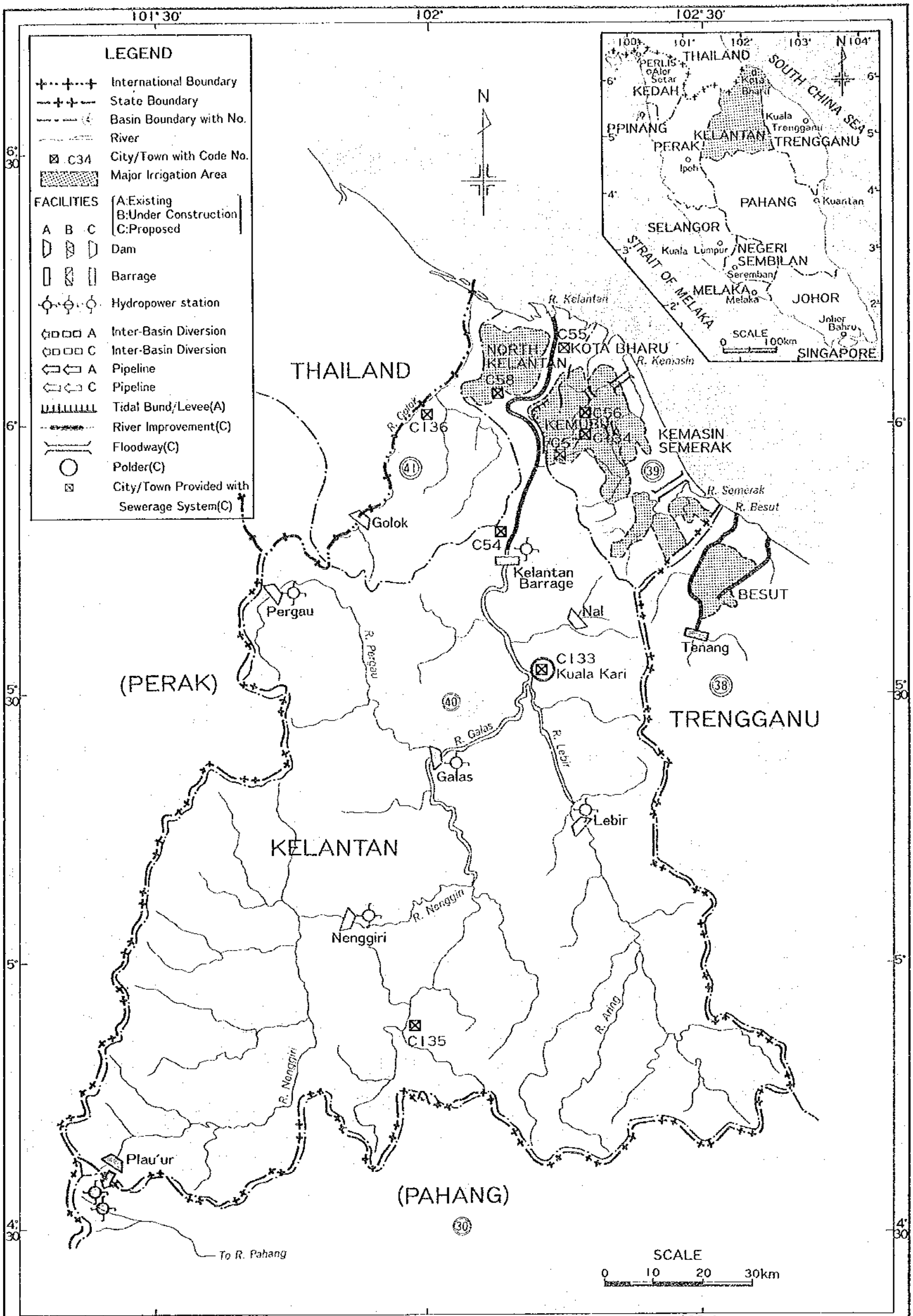

Recommended Plan for the State of Kelantan

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 informations regarding the specific State or States. The State Report Volume 8 herein presented describes the matters for the State of Kelantan.

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 Kelantan of 15,030 sq.km is located in the northern-most part of the east coast of Peninsular Malaysia, between 101°20′ and 102°40′ east in longitude and 4°33′ and 6°15′ north in latitude. It faces the South China Sea and the States of Pahang and Trengganu across the watershed of the east ridge in the west.

The central and southern parts of the State is mountainous, lying between the main and west ridges. Plains extend in the northern part along the Kelantan river. Rivers run parallel or perpendicular to the geological trend. They are the Kelantan, Kemasin, Semerak, Golok and other small rivers.

Almost 87% of the area of Kelantan is the Kelantan river basin, and the rest forms the basins of minor rivers in the coastal region where terrain of the Carboniferous - Triassic meta-sediments and the intrusive granites and coastal alluvium develop.

Eastern border range of the Kelantan river basin consists of massive granitic rocks. Western border is the so-called Main Range which is also composed of granite fringed by calcareous and argillaceous meta-sediments of Silurian. The middle part of the basin is mainly composed of Triassic - Jurassic shales, sandstones, pyroclastic rocks and low grade schists and Permian meta-sedimentary rocks of argillaceous, arenaceous and calcareous natures. All the geological provinces and structures show northerly or north-northwesterly trends.

Soils are almost sedentary soils occurring on undulating plains and mountains. The areal extent of alluvial soils on coastal plains, riverine flood plain and low riverine terrace is 1,890 sq.km, accounting for 13% of the total of the State.

Climate is usually hot and wet. Average annual rainfall is high of 2,500 mm - 3,000 mm, of which about 50% occurs in November to January being strongly affected by the northeast monsoon. Meteorological data at Kota Bharu (El.406 m) are summarized in Table 1.

2.2 The Rivers

Run-off in rivers wholly or partially located in the State of Kelantan is estimated based on 1961 - 1979 records at the hydrological station No.5721422 in the Kelantan river. The surface run-off is 22 billion cu.m/y or 56% of rainfall of 39 billion cu.m/y. Evapotranspiration is 15 billion cu.m/y and groundwater recharge is 2 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. Data of biochemical oxygen demand (BOD) in the 1978/1979 was not available. Operation of mines, opening-up of residential areas, road construction and logging are major causes of high concentration of suspended solid (SS). Data of SS concentration was not available.

Alluvial aquifer occurs in the flood plain of the Kelantan river, but sea water intrudes near the seashore. Rock aquifers may be found in the sedimentary rocks of Silurian to Triassic. Domestic and industrial water supply of this state is wholly dependent on the groundwater resources in the alluvial aquifer.

The river characteristics in terms of river morphology, estuary, sediment and sea water intrusion in Kelantan is as shown in Tables 2 and 3.

2.3 Watershed

Natural vegetation occupies 9,675 sq.km comprising hill forest of 8,871 sq.km, scrub forest of 557 sq.km, swamp forest of 60 sq.km and grassland of 187 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 12,066 sq.km or 80% of the whole State in 1966 to 9,488 sq.km or 63% 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 less than 100 mg/lit in all rivers of the State showing less effect by surface soil loss occurred in the catchment areas.

2.4 Present Socio-economic Condition

As illustratted in Fig.1, the State of Kelantan is administratively divided into nine districts. Towns having population of more than 10,000 in 1980 were Kota Bharu, Tanah Merah, Peringat, Pangkal Kalong, Kadok, Pasir Mas and Kuala Krai.

Population of Kelantan was 0.9 million in 1980 with the average annual growth rate of 2.7% during the period from 1970 to 1980. Population density increased from 47 persons/sq.km in 1970 to 62 persons/sq.km in 1980.

Gross regional product (GRP) increased from M$402 million in 1971 to M$764 million in 1980 in factor cost at 1970 constant price with the average annual growth rate of 7.4%. GRP of manufacturing sector shared M$14 million or 3.5% of the total in 1971 and M$41 million or 5.4% in 1980. Per capita GRP was M$818 in 1980 in factor cost at 1970 constant price and its average annual growth rate between 1971 and 1980 was 4.5%.

Major land use patterns in 1979 were forest of 9,488 sq.km, grassland of 187 sq.km, annual and perennial crop land of 2,568 sq.km, swamp of 260 sq.km and miscellaneous land of 2,538 sq.km. Fig.2 shows the land use in 1974.

Rubber, oil palm, coconut and cocoa are planted for earning of foreign currency by export. The total planted area as of 1979 was 77,000 ha for rubber, 14,200 ha for oil palm, 18,800 ha for coconut and less than 100 ha for cocoa. During the last five years since 1975, newly planted area under FELDA and FELCRA schemes totaled 800 ha for rubber and 3,200 ha for oil palm. RISDA replanted 9,000 ha of rubber in the existing smallholders' rubber areas during the said period, and private estates also increased by 4,400 ha their planted area of rubber. The annual production in 1979 totaled 40,700 tons of rubber as dry rubber content, 104,600 tons of oil palm as fresh fruit bunch and 45,400 tons of coconut as copra. Out of the above harvests, private estates produced 16,200 tons of rubber and 79,800 tons of oil palm. The remaining ones were put out from RISDA, FELDA and FELCRA schemes as well as smallholders.

In four mills located within the State, 45,800 tons of crude palm oil and 10,300 tons of palm kernel were extracted from oil palm through processing 205,000 tons of fresh fruit bunch brought in the mills throughout 1979.

In 1979/80, paddy was planted in 81,400 ha comprising main season wet paddy of 60,800 ha, main season dry paddy of 1,200 ha and off-season wet paddy of 19,400 ha. As the whole paddy field was 90,700 ha, the crop intensity in 1979/80 became 0.90. The total rice production in 1979/80 was 150,700 tons among which 107,600 tons were harvested in the main season including 1,100 tons of dry paddy rice and the remaining 42,000 tons were off-season wet paddy rice. This production met 100% of the estimated local consumption of 88,800 tons in the State of 1979/80 and covered the supply shortage of rice in other States.

During the period from 1970/71 to 1979/80, rice production fluctuated between 119,100 tons in 1975/76 and 152,200 tons in 1978/79 largely affected by climatic condition, even though paddy field which was provided with irrigation facilities increased from 23,000 ha to 41,000 ha.

3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

3.1 Domestic and Industrial Water Supply

Public water supply in Kelantan 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 command some suburban rural areas nearby. The pipeline is connected to individual taps.

In 1978, the ten PWD waterworks delivered 27,400 cu.m/d of water on an average. The population served water through PWD networks was estimated at 290,400 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 110,000 people were served water by the untreated water supply system in 1980. The water users are suggested to boil water before drinking.

In consequence, 400,400 people out of the total State population of 933,600 were estimated to be served water through PWD and RESP, corresponding to the service factor of 43% in 1980.

3.2 Irrigation

There are 90,700 ha of paddy fields: 38,800 ha are irrigated and 51,900 ha are rainfed. Existing major schemes are the Kembu pumping irrigation scheme of 18,000 ha and the North Kelantan Irrigation scheme of 12,000 ha. The former is located on the right bank of the Kelantan river in the northern part of the State, and the latter is located on the left bank of it as shown in Fig.3. Operation and maintenance of both schemes are undertaken by KADA. The North Kelantan irrigation scheme comprizes three continuous areas, i.e the Pasir Mas (2,100 ha), Sungai Lemal (9,300 ha) and Alor Pasir schmes (600 ha), which are under rehabilitation as the nation's first tertiary irrigation and drainage development program. Among total irrigation area of 38,800 ha, 29,100 ha are double cropping paddy area. Paddy yield is 1.8 - 2.2 tons/ha in the main season and 1.8 - 2.7 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$114.8 million at 1980 price level. Table 4 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 Pelauur river is a tributary of the Kelantan river, being located at the southwest corner of the State of Kelantan. The Plau'ur dam located in this tributary has been operated to divert water to the Kanpong Raja power station of 0.7 MW, which is the uppermost power station of the Camelon Highland Scheme, a series of power stations in the States of Kelantan, Pahang and Perak.

3.5 Inland Fishery

There are 60 ha of freshwater constructed ponds and 5 ha of tin mining pool used for fish culturing. The water use of the constructed ponds in 1979 was 810,000 cu.m/y.

3.6 Inland Navigation

The river traffic in the Kelantan river comprises passenger, cargo and marine fishing boats. Passenger boats operate in two routes. Cargo boats ply in the route between the small islands at the mouth of the Kelantan river and Kota Bharu. These boats carry mainly coconut and banana.

3.7 Sewerage System

No sewerage system is installed in Kelantan. The installation of septic tank is compulsory by regulations in urban areas, while domestic sewerage 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 Kelantan with the frequency ranging from twice a year to once a month in 3 river water quality control regions.

There is 7 rubber factories in the State. These factories produce SMR, latex concentrate and conventional grade of 47 tons/day and they discharge effluent of 1.22 million cu.m/y to nearby watercourses. The water quality at outlets of factories ranges from 28 to 200 mg/lit in BOD concentration and from 17 to 452 mg/lit in SS concentration.

There are 5 oil palm mills in operation of which total milling capacity amounts to 563 tons/hr in fresh fruit bunch (FFB). The volume of effluent from these mills is 103,000 cu.m/y. The treated or raw effluent is and will be discharged from 4 mills into watercourses and from a mill onto land. The water quality ranges from 500 to 1,000 mg/lit in BOD concentration and SS concentration ranges from 400 to 600 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 2,398 sq.km, wild life and other reserves of 1,088 sq.km and Crown or State land of 6,002 sq.km. Out of the forest reserves, 1,860 sq.km was classified as productive forests comprising inland forests. The remaining 538 sq.km were unproductive forests consisting almost entirely of protective hill forest. In the inland forest reserves, there remain 1,156 sq.km of unexploited forests which have been committed or licenced for development. The actual area opened for harvesting during 1979 was 105 sq.km corresponding to 9% of the unexploited forests.

Besides forest exploitation, execution of large-scaled 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 lower reach of the Kelantan river and range from 100 to 400 mg/lit in its middle reach, 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 5 lists two dams in operation in Kelantan.

One is the Plau'ur Diversion dam for hydropower purpose and the other is the Bukit Kuang dam for irrigation purpose.

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 Kelantan is described hereunder.

The average annual growth rate of population in the period from 1980 to 2000 was estimated to be 2.0%. Projected population is 1.17 million in 1990 and 1.39 million in 2000, respectively. Table 6 shows the projected population by urban and rural area in the State of Kelantan. 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$1,465 million in 1985, M$2,439 million in 1990 and M$5,870 million in 2000 with the average annual growth rate of 10.7% between 1980 and 2000.

Projected gross value of output in manufacturing sector will increase from M$139 million in 1980 to M$462 million in 1985, M$971 million in 1990 and M$4,762 million in 2000 at factor cost in 1970 prices as shown in Table 7.

The future rice consumption in the State was estimated to be 140,400 tons in 1990 and 166,900 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 49,100 ha and (2) stabilization of irrigation water supply during the wet season to the existing irrigated paddy field of 41,600 ha. The total rice production anticipated under the above plans will be 267,500 tons in 1990 and 337,700 tons in 2000.

Oil palm planting area was projected to increase to 24,080 ha in 1990 and 26,540 ha in 2000. The prospected processing volume of oil palm in the State will be 310,000 ton as fresh fruit bunch in 1990 and 470,000 ton in 2000.

Rubber planting area was projected to be kept in the present hectarage of 60,500 ha in 1990 and 2000. The total processing amount was projected to be 20,000 ton as dry rubber content in 1990 and 30,000 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 8.

As shown in Fig.5, four Basins are wholly or partly located in the State of Kelantan: located within the State are a part of the Besut Basin, most part of the Kemasin/Semarak Basin, the whole Kelantan Basin and the eastern part of the Golok 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 9 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 10.

In Kelantan, the total water demand will reach 99 million cu.m/y in 1990 and 311 million cu.m/y in 2000 as shown in Table 11. Major demand centers are Kota Bharu, Kuala Krai, Tanah Merah and Pengkal Kalong among which Kota Bharu has the largest demand for both the 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 Labuan 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 12, the projected irrigation area will increase from 38,800 ha in 1980 to 66,600 ha in 1990 and 87,900 ha in 2000. The ratio of double cropping area to the total irrigation area is 75% in 1980 and will be 64% in 1990 and 60% in 2000.

The irrigation water demand was calculated for 1990 and 2000 as shown in Table 13. Irrigation efficiency applied is 55% for both major and minor irrigation projects. The annual irrigation water demand will be 1,252 million cu.m in 1990 and 1,635 million cu.m in 2000 respectively.

4.5 Fish Pond Water Demand

The future hectarage of freshwater fish pond was projected to increase from 70 ha in 1980 to 420 ha in 1990 and 778 ha in 2000. The total water demand for freshwater fish culture will rise from 970,000 cu.m/y in 1980 to 5.70 million cu.m/y in 1990 and 10.57 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 14 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 14. In the State of Kelantan, only the Kelantan Basin among the concerned three were estimated to have a river utilization equal to or more than 10% in 2000; the other two 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 8.

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 15.

The water deficit shown in Table 15 was calculated under without-dam condition. If the estimated supply capacity of the existing and under-construction dams listed up in Table 5 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 5 urban areas, 9 palm oil mills, 7 rubber factories, animal husbandry in the rural areas. However, waste water from Kota Bharu 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 16. 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 that 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 17. 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 Kelantan will not be more than 5 mg/lit except for the Kemasin river 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 1,900tons/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 8 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 18.

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.

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 should 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 alternative plans for water demand and supply balance are shown in Tables 19 through 21 for Alternatives B1, B2 and B3 respectively. The location of potential and propsed water source facilities is shown in Fig.7 for Alternative B1.

6.3 Hydropower Development Alternatives

A hydropower development plan for Peninsuular 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. There were no Basins where the improvement was proposed for both the alternatives for 1990 and 2000.

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 Kelantan 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 22.

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 PWD 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 23 through 25. 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 12.

7.2 Source Development

The recommended water source development plan for balancing water demand and supply is summarized in Table 26. The water source development plan in the problem area is mentioned hereunder.

Fig.11 illustrates the recommended water demand and supply balance program for Kelantan river basin.

7.2.1 Kelantan river basin source development plan

The coastal flood plain of the Kelantan river basin has been developed for paddy cultivation. There are the North Kelantan irrigation project of 11,600 ha and Kembu irrigation project of 18,000 ha. Minor irrigation projects of 8,600 ha in 1980 will increase to 12,800 ha by 1990 and 17,000 ha by 2000. Population of the Kelantan river basin of 555,000 in 1980 will grow to 758,000 by 1990 and 971,000 by 2000. Total water demand is estimated to be 876 million cu.m for 1980, 931 million cu.m for 1990 and 1,201 million cu.m for 2000. Water resources as a whole is sufficient to support the water demand, but the Nal dam has been proposed in a tributary for balancing local water demand and supply. An analysis, however, showed that water would become tight by 2000.

It is herein recommended that the Nenggiri dam, which has been proposed for hydropower development, should be constructed as a multipurpose dam integrating water demand and supply balance purpose.

7.2.2 Other source development plan

There is a plan of local importance proposed by relevant agencies, though that was not identified in the Study. An international committee has been established for the development of the Golok river, which flows along the borderline between the State of Kelantan and Thailand and the construction of the Golok dam has been proposed.

7.3 Water Pollution Abatement Plan

The recommended plan for the water pollution abatement in the river is the public sewerage system in Penkal Kalong.

Although it is ineffective for the water pollution abatement in the river, sewerage development in Kota Bharu is recommended from the viewpoint of public health. The recommended plan for water pollution abatement is shown in Tables 27 through 29.

7.4 Flood Mitigation Plan

The recommended plan for flood mitigation is mentioned hereunder and is summarized in Table 30.

7.4.1 Kelantan river flood mitigation plan

Severe flood occurred in 1926, 1931, 1965, 1967, 1969, 1972, 1973, 1975 and 1979. Of these the flood in 1967 was the biggest one. The damage potential and the number of people affected are estimated to be more than M$100 million and 625,000 respectively at 1980 level in the Kelantan plain. The flooding is caused by overbank from the Kelantan river.

The recommended flood mitigation program for the Kelantan river basin was worked out assuming that the Lebir and Dabong dams would be operational by 1995. It includes the river improvement for 65 km of river stretch between the Guillemard bridge and the estuary, construction of a polder (ring bund) for Kuala Kerai and provision of flood mitigation storage in the 2 dams, in order to protect 380,000 people in 78,000 ha. The construction cost was estimated to be M$400 million at 1980 constant price. An alternative if no dam would be constructed was also studied. The construction cost was estimated to be M$600 million. Although the estimated cost is very preliminary based on 1/63,360 map, this large difference in cost indicated that the proposed 2 dams are quite effective for the flood mitigation. The Lebir and Dabong dams together can regulate floods of almost 80% of the Kelantan river basin and they can reduce the flood discharge by 30%, besides generating a large hydropower. Furthermore, source development will, sooner or later, become necessary to support the growing water demand in the coastal plain. Early implementation of the Lebir and Dabong dams is worth for serious consideration from the viewpoint of integrated development of the Kelantan river basin.

7.5 Hydropower Development Plan

The hydropower potential is high in the Kelantan river basin. The plan presented in Table 31 is recommended to match with the national energy policy.

The Lebir dam (with the installed capacity of 120 MW) and the Dabong dam (97 MW) in the Kelantan river basin will exert a significant effects on the water demand and supply balance and flood control as well. The Pergau dam (100 MW) and the Kelantan barrage (40 MW) will be the single purpose dams for hydropower. The Nenggiri dam (82 MW) will be a multi-purpose dam for hydropower, D&I water supply and irrigation water supply purposes. The location of these dams is 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 32 and 33. 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 34 and 35.

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 36 and 37 for water demand and supply balance, in Table 38 for water pollution abatement , in Table 39 for flood mitigation, and in Table 40 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 41. 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 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 fa orable 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 42. The domestic and industrial water demand estimated under the condition of lower economic growth is shown in Table 43.

8.4 Development Plan

The development plan under the condition of lower economic growth is tabulated in Tables 44 through 50.

8.5 Public Expenditure

The public development and recurrent expenditures are estimated for the case of lower economic growth as shown in Tables 51 and 52.

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 53 through 56.

TABLES

Table 1 METEOROLOGICAL DATA IN KELANTAN

Kota Baru, El 4.6 m

	Mean Air Temperature (°C)	Relative Humidity (%)	Sunshine Hours (hrs.)	Open Water Evaporation (mm)	Rainfall (mm)
Jan.	25.5	80.5	7.19	144	191
Feb.	26.0	78.8	8.15	148	61
Mar.	26.7	79.0	8.52	177	89
Apr.	27.7	79.0	8.99	185	91
May	27.9	79.5	7.99	167	101
June	27.5	79.9	6.89	155	140
July	27.2	80.3	7.12	155	157
Aug.	26.9	81.9	7.18	157	170
Sep.	26.8	82.0	6.75	158	196
Oct.	26.6	83.6	5.73	143	310
Nov.	25.8	86.4	4.36	122	672
Dec.	25.7	84.5	4.46	119	568
Annual	26.7	81.3	6.94	1,830	2,746

Daily	Max.	35.5	95.9
	Min.	18.3	62.1

Table 2 RIVER CHARACTERISTICS IN KELANTAN (1/2)

Basin No.	Item	Description
39	Kemasin/Semerak river	
	(A) River Morphology	Meanders exist in whole reaches, but no active meandering/erosion reported. River regime seems generally in stable, except at Kuala where river course changeable due to coastal action.
	(B) Estuary	Active sand bars formation due to littoral drift. Navigation almost difficult (0.5 - 1.0 m depths at river mouth). Sand bars partially breached during flood flow period.
	(C) Sediment	Estimated yield rate 0.2 - 0.3 mm/y. No adverse silting at present, except at river mouth. Coarse sediment seems to be trapped, not being carried out to sea.
	(D) Sea Water Intrusion	Possibly up to Kg. Pusu Besar in Kemasin, up to upstream of Pasir Puteh in Semerak. Problem existing in irrigation water supply.
40	Kelantan river	
	(A) River Morphology	Only internal meander pattern within a straight channel. Banks are under continuous attack by gullying in places, causing riverbed aggravation of 5 mm/y.
	(B) Estuary*	Delta region is growing due to river-borne sediment as well as by sediment transported westward along coast. Formation of sand bars and pits active.
	(C) Sediment*	Estimated yield rate: 140 $m^3/km^2/y$. Development in hinterlands accelerating sediment yield. 80% from Galas/Lebir catchments. Silting is excessive in lower reaches, 20 mm/y bed aggravation.

Remarks; *: Major problems requiring some improving measures

Table 3 RIVER CHARACTERISTICS IN KELANTAN (2/2)

Basin No.	Item		Description
	(D)	Sea Water Intrusion	Possibly intrusion up to Pasir Mas. No problem at present, but adverse effect possible on future irrigation intake. 80 m^3/s release required to limit the intrusion at Kota Bharu.
41	Golok river		
	(A)	River Morphology	River appears to meander, but no adverse problem reported at present. Erosion observed at meanders in middle/ upper reaches.
	(B)	Estuary *	Formation of sand dunes progressive due to westward littoral drift. Shallow river mouth causing marine fish boat navigation difficult.
	(C)	Sediment	Sand bars in upper reaches (1 : 63,360 maps). Sediment yield partly due to logging operation. Yield rate possibly large.
	(D)	Sea Water Intrusion	Possibly not up to Kg. Jumbu. No problem reported at present.

Remarks; * : Major problems requiring some improving measures

Table 4 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN KELANTAN

Basin No.	River Basin	Year	Flooded Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
39	Peng Datu	1967	144	107	15.9
	Kemasin	1967	191	59	10.3
	Semerak	1967	266	78	15.8
40	Kelantan	1967	860	330	63.0
41	Golok	1967	264	52	9.8
	Total		1,727	626	114.8

Table 5 LIST OF EXISTING AND PLANNED DAMS IN KELANTAN

Name	River	Purpose/Year of Commission	Organi-zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^6 m^3/y)
Existing						
Plau'ur Diversion Dam	Nenggiri	HY	NEB	-	-	0
Bukit Kuang Dam		-	DID	-	-	0

Remarks; WS: Domestic and industrial warer supply
FM: Flood mitigation
HY: Hydropower

Table 6 HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN KELANTAN

Unit: 10^3

District	City/Rural	Historical 1980	Projected 1985	1990	2000	Average Annual Growth (%) 1980-2000
70. Ulu Kelantan	135. Gua Musang	6	8	10	17	5.3
	Rural	10	12	12	7	-1.8
	District Total	16	20	22	24	2.0
71. Pasir Puteh	Rural	89	94	95	80	-0.5
72. Machang	Rural	63	65	66	58	-0.4
73. Tanah Merah	54. Tanah Merah	10	11	13	18	3.0
	Rural	76	85	86	61	-1.1
	District Total	86	96	99	79	-0.4
74. Bachok	Rural	82	88	89	71	-0.7
75. Kota Bharu	55. Kota Bharu	182	255	344	567	5.8
	56. Peringat	15	17	18	23	2.2
	57. Pangkal Kalong	24	30	37	56	4.3
	134. Kadok	13	14	17	22	2.7
	Rural	65	53	52	97	2.0
	District Total	299	369	468	765	4.8
76. Pasir Mas	58. Pasir Mas	15	16	18	23	2.2
	136. Rantau Panjang	5	7	8	12	4.5
	Rural	112	116	115	97	-0.5
	District Total	132	139	141	132	0.2
77. Tumpat	Rural	95	101	102	84	-0.6
101. Kuala Krai	133. Kuala Krai	14	19	26	46	6.1
	Rural	58	62	62	52	-0.5
	District Total	72	81	88	98	1.6
Total	Urban Total	284	377	491	784	5.2
	Rural Total	650	676	679	607	-0.3
	State Total	934	1,053	1,170	1,391	2.0

Table 7 HISTORICAL AND PROJECTED GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP IN KELANTAN

Unit: M$$10^6$

Item	Year 1980	1985	1990	2000
Food	58	193	297	723
Textile	6	23	39	132
Wood	34	73	91	172
Paper	0	0	0	0
Publishing	4	21	56	500
Chemical	10	47	269	2,101
Rubber	23	88	175	815
Non-metal	1	2	5	24
Basic metal	0	0	0	0
Machinery	3	15	37	284
Others	0	1	2	11
Total	139	463	971	4,762

Remarks; In factor cost at 1970 prices

Table 8 BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN KELANTAN

Basin No.	Basin	Total Catchment Area (km^2)	Effective Catchment Area (km^2)	Balance Point (km)	River Maintenance Flow (m^3/s)
39	Kemasin	1,020	310	35	4.8
40	Kelantan	13,100	12,600	31	164.5
41	Golok	895	835	8	14.0

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

Table 9 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN KELANTAN

City/Rural	Service Factor (%)				Per Capita Daily Use (lpcd)			
	Estimated	Projected			Estimated	Projected		
	1980	1985	1990	2000	1980	1985	1990	2000
1. Urban Area								
54 Tanah Merah	40	55	70	100	160	175	190	220
55 Kota Bahru	80	85	90	100	170	185	200	250
56 Peringat	40	55	70	100	160	175	190	220
57 Pangkal Kalong	40	55	70	100	160	175	190	220
58 Pasir Mas	40	55	70	100	160	175	190	220
133 Kuala Krai	40	55	70	100	160	175	190	220
134 Kadok	40	55	70	100	160	175	190	220
135 Gua Musang	40	55	70	100	119	155	190	220
136 Rantau Panjang	40	55	70	100	119	150	180	220
2. Rural Area								
PWD Rural	16	33	37	39	75	100	125	175
MOH Rural	17	52	58	61	44	48	55	70
3. Non-Pipe-Served-Area	-	-	-	-	40	40	40	40

Table 10 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 11 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN KELANTAN

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	1985 I	1985 Total	1990 D	1990 I	1990 Total	2000 D	2000 I	2000 Total
39	56	Perimgat	0.9	0.9	0.7	1.6	1.2	1.2	2.4	2.4	5.4	7.8
	57	Pangkolkalong	1.3	1.6	1.2	2.8	2.6	2.4	5.0	5.9	13.3	19.2
	134	Kadok	0.7	0.7	0.5	1.2	1.2	1.1	2.3	2.3	5.2	7.5
		City Total	2.9	3.2	2.4	5.6	5.0	4.7	9.7	10.6	23.9	34.5
		Rural	4.2	5.4	0.1	5.5	8.3	0.1	8.4	10.8	0.1	11.4
	Basin Total		7.1	8.6	2.5	11.1	13.3	4.8	18.1	21.4	24.0	45.4
40	54	Tanah Merah	0.8	0.6	1.5	2.1	0.9	3.4	4.3	1.9	20.4	22.3
	55	Kota Buhru	14.6	20.0	7.9	27.9	30.3	17.9	48.2	68.1	105.6	173.7
	58	Pasir Mas	0.8	0.8	0.5	1.3	1.2	1.2	2.4	2.4	6.9	9.3
	133	Kuala Krai	1.0	1.1	1.7	2.8	0.4	3.9	4.3	1.3	23.1	24.4
	135	Gua Musang	0.3	0.3	0.3	0.6	0.7	0.7	1.4	1.8	4.1	5.9
		City Total	17.5	22.8	11.9	34.7	33.5	27.1	60.6	75.5	160.1	235.6
		Rural	6.8	9.9	0.7	10.6	12.9	0.8	13.7	16.5	1.3	17.8
	Basin Total		24.3	32.7	12.6	45.3	46.4	27.9	74.3	92.0	161.4	253.4
41	136		0.2	0.3	0.3	0.6	1.8	0.5	2.3	4.9	2.8	7.7
		Rural	2.2	3.3	0.1	3.4	4.4	0.1	4.5	4.8	0.1	4.9
	Basin Total		2.4	3.6	0.4	4.0	6.2	0.6	6.8	9.7	2.9	12.6
Total			33.8	44.9	15.5	60.4	65.9	33.3	99.2	123.1	188.3	311.4
(State Total for Kelantan)			(33.8)	(44.9)	(15.5)	(60.4)	(65.9)	(33.3)	(99.2)	(123.1)	(188.3)	(311.4)

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

Table 12 ESTIMATED AREA OF IRRIGATED PADDY FIELD IN KELANTAN

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
39.	Kemasin+	Major	-	-	8,904	4,857	8,904	4,857
		Minor	-	-	1,831	462	6,096	2,345
40.	Kelantan+	Major	29,630	28,628	29,630	28,628	29,630	28,628
		Minor	8,581	447	12,814	3,502	17,046	6,556
41.	Golok	Minor	607	-	13,426	5,047	26,245	10,094
Total			38,818	29,075	66,605	42,496	87,921	52,480

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

Table 13 ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN KELANTAN

Unit: 10^6 m^3/y

Basin No.	Basin Name	Scheme	1980	1990	2000
39.	Kemasin+	Major	-	159	159
		Minor	-	25	97
40.	Kelantan	Major	746	678	678
		Minor	106	179	270
41.	Golok	Minor	7	211	431
Total			859	1,252	1,635

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

Table 14 RIVER UTILIZATION RATIO BY BASIN IN KELANTAN 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* Irri.	1990 Source Demand* Total (2)	1990 Ratio (2)/(1) (%)	2000 Source Demand* D&I	2000 Source Demand* Irri.	2000 Source Demand* Total (2)	2000 Ratio (2)/(1) (%)
39	Kemasin	532	18	0**	18	3	18*	0**	18	2
40	Kelantan	18,522	76	1,203**	12,798	7	293*	1,586**	1,879	10
41	Golok	1,580	5	49**	54	3	9	49**	58	4

Remarks; D&I: Domestic and Industrial Water Supply
* : Demand increase after 1990 is planned to be diverted from Basin 40
** : Demand is planned to be diverted from Basin 40

Table 15 ANNUAL DEFICIT BY BASIN IN KELANTAN 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										
39	3.4	1963	1.2	1961	0.6	1969	0.2	1962	-	-
40	309.2	1963	101.5	1969	92.9	1962	18.6	1962	13.1	1977
41	13.0	1963	4.6	1961	2.7	1969	0.9	1962	-	-
2000										
39	11.3	1963	5.4	1961	4.4	1969	1.8	1977	1.2	1962
40	798.7	1963	406.6	1961	383.7	1969	300.3	1977	207.1	1972
41	38.3	1963	19.0	1961	14.3	1969	7.3	1977	4.7	1962

Table 16 ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES IN KELANTAN

Unit: %

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

Table 17 DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL IN KELANTAN

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	170	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 18 PROPOSED FLOOD FORECASTING AND WARNING SYSTEM IN KELANTAN

Basin No.	River Basin	People Rel'ved by F/F (10^3)	Construction Cost (M$$10^6$)	Construction Period
39	Kemasin/Semarak	7.1	0.3	4MP
40	Kelantan/1	213.5	0.7	4MP
41	Golok	12.7	0.2	4MP
Total		233.3	1.2	

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

Table 19 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN KELANTAN

(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
40	Nenggiri dam	WS, IR	3,940	201	960	243	1995 - 1999

(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
39	Kemasin diversion (irrigation canal)	Kelantan 40 to 39	1990:11.7 2000:18.0	*	-
41	Golok diversion (irrigation canal)	Kelantan 40 to 41	1990:10.3 2000:24.2	*	-

Remarks; WS = Water supply; IR = Irrigation
* = Cost included in irrigation facilities.
Construction cost is the financial cost at 1980 constant price.

Table 20 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN KELANTAN

(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
40	Nenggiri dam	WS, IR	3,940	49	490	195	1995 - 1999

(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
39	Kemasin diversion (irrigation canal)	Kelantan 40 to 39	1990:11.7 2000:18.0	*	-
41	Golok diversion (irrigation canal)	Kelantan 40 to 41	1990:10.3 2000:24.2	*	-

Remarks; WS = Water supply; IR = Irrigation
* = Cost included in irrigation facilities
Construction cost is the financial cost at 1980 constant price.

Table 21 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN KELANTAN

(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 (M10^6)	Construc-tion Period
40	Nenggiri dam	WS, IR	3,940	35	360	165	1995 - 1999

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construc-tion Cost (M10^6)	Construc-tion Period
39	Kemasin diversion (irrigation canal)	Kelantan 40 to 39	1990:11.7 2000:18.0	*	-
41	Golok diversion (irrigation canal)	Kelantan 40 to 41	1990:10.3 2000:24.2	*	-

Remarks; WS = Water supply; IR = Irrigation
* = Cost included in irrigation facilities
Construction cost is the financial cost at 1980 constant price.

Table 22 OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN KELANTAN

Basin No.	Basin Name	R.I. (km)	Dam (nos)	F.W. (km)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M10^6)
	ALTERNATIVE F1								
39	Kemasin	-	-	16	-	-	266	60	102
40	Kelantan	65	2	-	1	-	408	78	378
41	Golok	73	-	-	-	-	50	27	73
	Total	138	2	16	1	-	724	165	553
	ALTERNATIVE F2								
39	Kemasin	-	-	-	-	-	116	14	-
40	Kelantan	65	2	-	1	-	406	78	378
	Total	65	2	-	1	-	522	92	378
	ALTERNATIVE F3								
39	Kemasin	-	-	16	-	-	266	60	102
40	Kelantan	65	2	-	1	-	408	78	378
41	Golok	10	-	-	-	-	20	6	17
	Total	75	2	16	1	-	694	144	497

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 23 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN KELANTAN

Basin No.	Code No.	City/Town	1985			1990			2000		
			TC	SF	SP	TC	SF	SP	TC	SF	SP
39	56	Peringat	3.6	55	9.4	5.2	70	12.6	15.3	100	23.0
	57	Pangkal Kalong	6.0	55	16.5	11.0	70	25.9	38.1	100	56.0
	134	Kadok	2.7	55	7.7	5.2	70	11.9	14.8	100	22.0
40	54	Tanah Merah	3.8	55	6.0	7.7	70	9.1	36.4	100	18.0
	55	Kota Bahru	70.1	85	216.8	116.7	90	309.6	364.4	100	567.0
	58	Pasir Mas	3.0	55	8.8	5.2	70	12.6	17.8	100	23.0
	133	Kuala Krai	5.5	55	10.5	7.1	70	18.2	38.9	100	46.0
	135	Gua Musang	1.1	55	4.4	3.0	70	7.0	11.8	100	17.0
41	136	Rantau Panjan	1.1	55	3.8	6.0	70	5.6	18.9	100	12.0
	Total		96.9	75	283.9	167.1	84	412.5	556.4	100	784.0

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

Table 24 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN KELANTAN

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
39	Kemasin & Semarak	10.5	33.0	71.8	14.8	37.0	80.9	19.6	38.9	84.0
40	Kelantan+	16.6	33.0	113.7	23.5	37.0	128.4	29.8	38.9	116.8
41	Golock	5.4	33.0	37.5	7.8	36.9	42.4	9.0	38.9	35.7
Total		32.5	-	223.0	46.1	-	251.7	58.4	-	236.5
Kelantan		32.8	33.0	223.0	46.1	37.0	251.7	58.5	38.9	236.5

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 25 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN KELANTAN

Unit: 10^6 m^3/y

Basin No.	Basin Name	1985 SD	1985 SF	1985 SP	1990 SD	1990 SF	1990 SP	2000 SD	2000 SF	2000 SP
39	Kemasin & Semarak	1.4	51.8	112.7	3.2	38.0	127.0	4.3	61.1	132.0
40	Kelantan+	3.7	51.8	178.6	5.0	58.0	201.6	6.8	61.1	183.5
41	Golock	1.2	51.8	58.9	1.7	58.0	66.6	1.8	61.1	56.0
Total		6.3	-	350.2	9.9	-	395.2	12.9	-	371.5
Kelantan		6.3	51.8	350.2	9.9	58.0	395.2	12.9	61.1	371.5

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 26 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN KELANTAN

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Net Supply Capacity ($10^6 m^3/y$)	Construction Cost (M10^6)	Construction Period
40	Nenggiri dam	HY, WS, IR	3,940	35	360	165*	1983 - 1987
40	Nal dam**	IR	-	-	-	-	1985 - 1989
41	Golok dam	IR	64	5	32	39	1985 - 1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
39	Kemasin diversion (irrigation canal)	Kelantan 40 to 39	1990:11.7 2000:18.0	***	-
41	Golok diversion (irrigation canal)	Kelantan 40 to 41	1990:10.3 2000:24.2	***	-

Remarks; WS = Water supply; IR = Irrigation
* = Cost of hydropower generation is borne by the hydropower development plan.
** = Planned by DID but features are not finalized.
***= Cost included in irrigation facilities.
Construction cost is the financial cost at 1980 constant price.

Table 27 RECOMMENDED PUBLIC SEWERAGE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN KELANTAN

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
39	C57	Pengkal Kalong	10	85	32	47	100	56
Total			10	-	32	47	-	56

Table 28 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN KELANTAN

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
40	C55	Kota Bahru	79	70	241	333	80	454
Total			79	-	241	333	-	454

Table 29 POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN KELANTAN

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)
39	Kemasin	0	5	0	5	23	0	2	0	2	9
40	Kelantan	5	12	1	18	1	3	3	2	8	1
	Total	5	17	1	23	-	3	5	2	10	-

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

Table 30 RECOMMENDED FLOOD MITIGATION PROGRAM IN KELANTAN

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									
39	Kemasin	-	-	-	-	-	50	6	-
40	Kelantan	5	-	1	1	-	40	5	41
	Total	5	-	1	1	-	90	11	41
By 2000									
39	Kemasin	-	-	-	-	-	116	14	-
40	Kelantan	65	-	2	1	-	406	78	378
	Total	65	-	2	1	-	522	92	378

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

Table 31 RECOMMENDED HYDROPOWER DEVELOPMENT PLAN IN KELANTAN

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
40	Pergau	227	68	4	100	540	HY	2	190	1988
40	Lebir	2,474	2,834	247	120	410	HY, FM	72	568	1991
40	Nenggiri	3,940	200	49	82	430	HY, IR WS	146	196*	1988
40	Galas (Dabong)	7,480	580	105	97	530	HY, FM	198	368	1994
40	Kelantan Barrage	12,100	-	-	40	275	HY	-	300	1995
	Total	26,221	3,682	405	439	2,185		418	1,622	

Remarks; Construction cost is financial cost at 1980 constant price.
* = M$165 x 10^6 for D&I supply deducted.

Table 32 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)		Floodway (M\$$10^6$/km)	
200 m^3/s	0.2 - 0.4	200 m^3/s	0.2 - 0.5
500 m^3/s	0.3 - 0.6	500 m^3/s	0.4 - 0.9
1,000 m^3/s	0.4 - 0.8	1,000 m^3/s	0.5 - 1.2
10,000 m^3/s	1.2 - 2.9	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 33 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 34 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN KELANTAN

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	103	101	0	0	204
Irrigation	73	396	268	158	895
Inland Fishery	4	15	45	45	109
Public Water Supply	110	285	344	139	878
Public Water Supply; Pre-treatment facilities	0	1	0	0	1
Public Sewerage (Effective for river water pollution abatement)	9	16	17	7	49
Public Sewerage (Others)	52	93	96	38	279
Flood Mitigation	17	34	112	215	378
Total	368	941	882	602	2,793

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 35 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN KELANTAN

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	3	5	5	13
Irrigation	0	5	35	55	95
Inland Fishery	0	0	3	8	11
Public Water Supply	0	21	53	82	156
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	0	3	7	9	19
Public Sewerage (Others)	0	18	36	53	107
Flood Mitigation	0	9	12	56	77
Total	0	59	151	268	478

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 36 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN KELANTAN

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	(M$$10^6$)	55
D&I water supply	(M$$10^6$)	71
Fish culture	(M$$10^6$)	5
Reservoir recreation	(M$$10^6$)	2
Total	(M$$10^6$)	133
1.2 Economic Cost		
Irrigation	(M$$10^6$)	31
D&I water supply	(M$$10^6$)	70
Fish culture	(M$$10^6$)	5
Dams, barrages & diversion facilities	(M$$10^6$)	7
Total	(M$$10^6$)	113
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)	200
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)	73
Number of people served by proposed public water supply in 2000	(10^3)	1,392
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 37 SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN KELANTAN

Unit: days

Basin No.	Basin Name	Safe Supply Period		Safe Maintenance Flow Period	
		Plan Implemented	Natural Flow	Plan Implemented	Natural Flow
39	Kemasin	344	310	300	258
40	Kelantan	344	269	300	238

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

Table 38 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN KELANTAN

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	5
Saving in pre-treatment for D&I water supply	($M\$10^6$)	1
Total	($M\$10^6$)	6
1.2 Economic Cost		
Sewerage	($M\$10^6$)	16
Private purification facilities	($M\$10^6$)	0
Pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	16
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 = 205 km)	(km)	205/182 /1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 205 km)	(km)	188/165 /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)	510
3.2 Adverse Effect		-

Remarks; /1: (Length of river stretch with Project)/ (Length of river stretch without Project)

Table 39 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN KELANTAN

Item			Recommended Plan
1.	National Economic Development		
1.1	Economic Benefit		
	Damage reduction	(M$$10^6$)	24.7
1.2	Economic Cost		
	Flood mitigation work	(M$$10^6$)	9.3
1.3	EIRR	(%)	16.2
2.	Environmental Quality		
2.1	Beneficial Effect		
	Length of improved stretch	(km)	65
2.2	Adverse Effect		-
3.	Social Well-Being		
3.1	Beneficial Effect		
	Number of protected people by proposed facilities in 2000	(10^3)	522
	Population served by proposed flood warning system in 2000	(10^3)	233
	Area relieved from flood hazards	(10^3 ha)	92
3.2	Adverse Effect		
	Number of people to be removed for construction of facilities	(10^3)	26

Table 40 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	(M$ 10^6)	344
1.2 Economic Cost		
Dam & power facilities	(M$ 10^6)	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 41 SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN KELANTAN

	Yield (ton/ha)	Unit Price (M$/ton)	Gross Value (M$/ha)	Production Cost (M$/ha)	Net Value (M$/ha)
(1) Major Irrigation Scheme					
- Kemasin Semarak					
Double cropping	7.5	640	4,800	1,630	3,170
Single cropping	3.5	640	2,240	774	1,466
- North Kelantan					
Double cropping	8.0	640	5,120	1,672	3,448
Single cropping	3.8	640	2,432	810	1,622
- KADA II					
Double cropping	8.5	640	5,440	1,722	3,718
Single cropping	4.1	640	2,624	845	1,779
(2) Minor Irrigation Scheme					
Double cropping	7.0	640	4,480	1,544	2,936
Single cropping	3.3	640	2,112	730	1,382
(3) Rainfed Scheme					
Single cropping	1.6	640	1,024	568	456

Table 42 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN KELANTAN 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								
54 Tanah Merah	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
55 Kota Bahru	80.0	85.0	90.0	95.0	170.0	180.0	195.0	220.0
56 Peringat	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
57 Pangkal Kalong	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
58 Pasir Mas	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
133 Kuala Krai	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
134 Kadok	40.0	65.0	75.0	90.0	160.0	170.0	185.0	210.0
135 Gua Musang	40.0	65.0	75.0	90.0	75.0	95.0	185.0	210.0
2. Rural Area								
PWD Rural	16.0	33.0	36.2	38.3	75.0	95.0	115.0	155.0
MOH Rural	17.0	51.8	56.8	60.2	40.0	45.0	55.0	65.0
3. Non-Pipe-Served-Area	-	-	-	-	40.0	40.0	40.0	40.0

Table 43 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

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
39	56	Peringat	0.9	0.9	0.6	1.5	1.2	0.8	2.0	1.7	2.1	3.8
	57	Pangkol Kalong	1.3	1.7	1.1	2.8	2.5	1.6	4.1	4.3	5.0	9.3
	134	Kadok	0.7.	0.8	0.5	1.3	1.2	0.7	1.9	1.6	2.0	3.6
		City Total	2.9	3.4	2.2	5.6	4.9	3.1	8.0	7.6	9.1	16.7
		Rural	4.2	6.0	0.1	6.1	7.8	0.1	7.9	10.7	0.1	10.8
		Basin Total	7.1	9.4	2.3	11.7	12.7	3.2	15.9	18.3	9.2	27.5
40	54	Tanah Merah	0.8	0.7	1.5	2.2	1.0	2.3	3.3	1.4	7.7	9.1
	55	Kota Buhru	14.7	19.2	7.6	26.8	28.1	12.1	40.2	47.6	39.8	87.4
	58	Pasir Mas	0.8	0.9	0.5	1.4	1.2	0.8	2.0	1.7	2.7	4.4
	133	Kuala Krai	1.1	1.1	1.7	2.8	1.8	2.6	4.4	3.5	8.7	12.2
	135	Gua Musang	0.3	0.4	0.3	0.7	0.7	0.5	1.2	1.3	1.5	2.8
		City Total	17.7	22.3	11.6	33.9	32.8	18.3	51.1	55.5	60.4	115.9
		Rural	6.8	9.7	0.8	10.5	12.9	0.9	13.8	17.9	1.1	19.0
		Basin Total	24.5	32.0	12.4	44.4	45.7	19.2	64.9	13.4	61.5	134.9
41		Rural	2.2	4.6	0.1	4.7	4.5	0.1	4.6	6.4	0.1	6.5
Total			33.8	46.0	14.8	60.8	62.9	22.5	85.4	98.1	70.8	168.9
Kelantan			33.8	46.0	14.8	60.8	62.9	22.5	85.4	98.1	70.8	168.9

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

Table 44 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Code No.	City/Town	1985			1990			2000		
			TC	SF	SP	TC	SF	SP	TC	SF	SP
39	56	Peringat	3.3	65	10.4	4.7	75	12.8	8.5	90	17.1
	57	Pangkai Kalong	6.3	65	18.9	9.3	75	26.3	20.3	90	41.4
	134	Kadok	3.0	65	9.1	4.7	75	12.0	7.9	90	16.2
40	54	Tanah Merah	4.1	65	7.2	6.3	75	9.8	15.9	90	13.5
	55	Kota Bahru	67.1	85	214.2	101.4	90	293.4	202.5	95	446.5
	58	Pasir Mas	3.3	65	10.4	4.7	75	12.8	9.3	90	17.1
	133	Kuala Krai	5.8	65	12.4	9.0	75	18.8	23.6	90	34.2
	135	Gua Musang	1.6	65	5.2	3.0	75	7.5	6.3	90	12.6
	Total		94.5	79	287.8	143.1	86	393.4	294.3	94	598.6

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

Table 45 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
39	Kemasin & Semarak	9.6	33.0	72.0	13.6	36.2	80.5	19.9	38.3	87.8
40	Kelantan & Others	16.3	33.0	115.1	22.3	36.2	132.1	33.8	38.3	147.9
41	Golock	3.9	33.0	39.2	7.8	36.2	45.7	11.8	38.3	52.0
Total		29.8	-	226.3	43.7	-	258.3	65.5	-	287.7
Kelantan		31.3	33.0	226.3	43.7	36.2	258.3	65.4	38.3	287.7

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 46 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN KELANTAN 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
39	Kemasin & Semarak	2.3	51.8	113.0	3.1	56.8	126.4	4.1	60.2	137.9
40	Kelantan	3.7	51.8	180.8	5.2	56.8	207.6	6.8	60.2	232.4
41	Golock	1.3	51.8	61.6	1.8	56.8	71.7	2.5	60.2	81.7
Total		7.3	-	355.4	10.1	-	405.7	13.4	-	452.0
Kelantan		7.3	51.8	355.3	10.1	56.8	405.8	13.4	60.2	452.0

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 47 RECOMMENDED SOURCE DEVELOPMENT PLAN IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Net Supply Capacity ($10^6 m^3/y$)	Construction Cost (M$$10^6$)	Construction Period
40	Nenggiri dam	HY, WS, IR	3,940	35	360	165**	1995 - 1999
40	Nal dam***	IR	-	-	-	-	1985 - 1989
41	Golok dam	IR	64	5	32	39	1985 - 1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
39	Kemasin diversion (irrigation canal)	Kelantan 40 to 39	1990:11.7 2000:18.0	*	-
41	Golok diversion (irrigation canal)	Kelantan 40 to 41	1990:10.3 2000:24.2	*	-

Remarks; WS = Water supply; IR = Irrigation
* = Cost included in irrigation facilities
** = Cost of hydropower generation is borne by the hydropower development plan.
*** = Planned by DID but features are not finalized yet.
Construction cost is the financial cost at 1980 constant price.

Table 48 PUBLIC SEWERAGE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
39	C57	Pengkal Kalong	6	60	21	22	100	46
Total			6	-	21	22	-	46

Table 49 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
40	C55	Kota Bahru	38	40	130	134	65	306
Total			38	-	130	134	-	306

Table 50 RECOMMENDED FLOOD MITIGATION PROGRAM IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Name of River	R.I. (km)	F.W. (km)	Dam (nos)	Pold. (nos)	N.S. (km^2)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
By 1990									
39	Kemasin	-	-	-	-	-	50	6	-
40	Kelantan	5	-	1	1	-	40	5	41
	Total	5	-	1	1	-	90	11	41
By 2000									
39	Kemasin	-	-	-	-	-	116	14	-
40	Kelantan	65	-	2	1	-	401	78	378
	Total	65	-	2	1	-	517	92	378

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

Table 51 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE OF RECOMMENDED PLAN IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M\$ 10^6

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	0	17	149	166
Irrigation	73	396	268	158	895
Inland Fishery	4	15	21	33	73
Public Water Supply	88	169	176	73	506
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	5	8	9	4	26
Public Sewerage (Others)	26	43	44	17	130
Flood Mitigation	17	34	112	215	378
Total	213	665	647	649	2,174

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 52 ESTIMATED ANNUAL RECURRENT EXPENDITURE OF RECOMMENDED PLAN IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M\$ 10^6

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	0	0	1	1
Irrigation	0	5	35	55	95
Inland Fishery	0	0	2	5	7
Public Water Supply	0	16	33	48	97
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	0	2	3	5	10
Public Sewerage (Others)	0	9	17	24	50
Flood Mitigation	0	9	12	56	77
Total	0	41	102	194	337

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 53 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	$(M\$10^6)$	55
D&I water supply	$(M\$10^6)$	34
Fish culture	$(M\$10^6)$	3
Reservoir recreation	$(M\$10^6)$	2
Total	$(M\$10^6)$	94
1.2 Economic Cost		
Irrigation	$(M\$10^6)$	31
D&I water supply	$(M\$10^6)$	34
Fish culture	$(M\$10^6)$	3
Dams, barrages & diversion facilities	$(M\$10^6)$	2
Total	$(M\$10^6)$	70
1.3 EIRR	(%)	12
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	200
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)	73
Number of people served by proposed public water supply in 2000	(10^3)	1,339
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 54 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	2
Saving in pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	2
1.2 Economic Cost		
Sewerage	($M\$10^6$)	8
Private purification facilities	($M\$10^6$)	0
Pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	8
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 = 205 km)	(km)	205/204 /1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 205 km)	(km)	205/182 /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)

Table 55 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN KELANTAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M$ 10^6)	14.0
1.2 Economic Cost		
Flood mitigation work	(M$ 10^6)	9.3
1.3 EIRR	(%)	11.5
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	65
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	517
Population served by proposed flood warning system in 2000	(10^3)	231
Area relieved from flood hazards	(km^2)	92
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	25

Table 56 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.

FIGURES

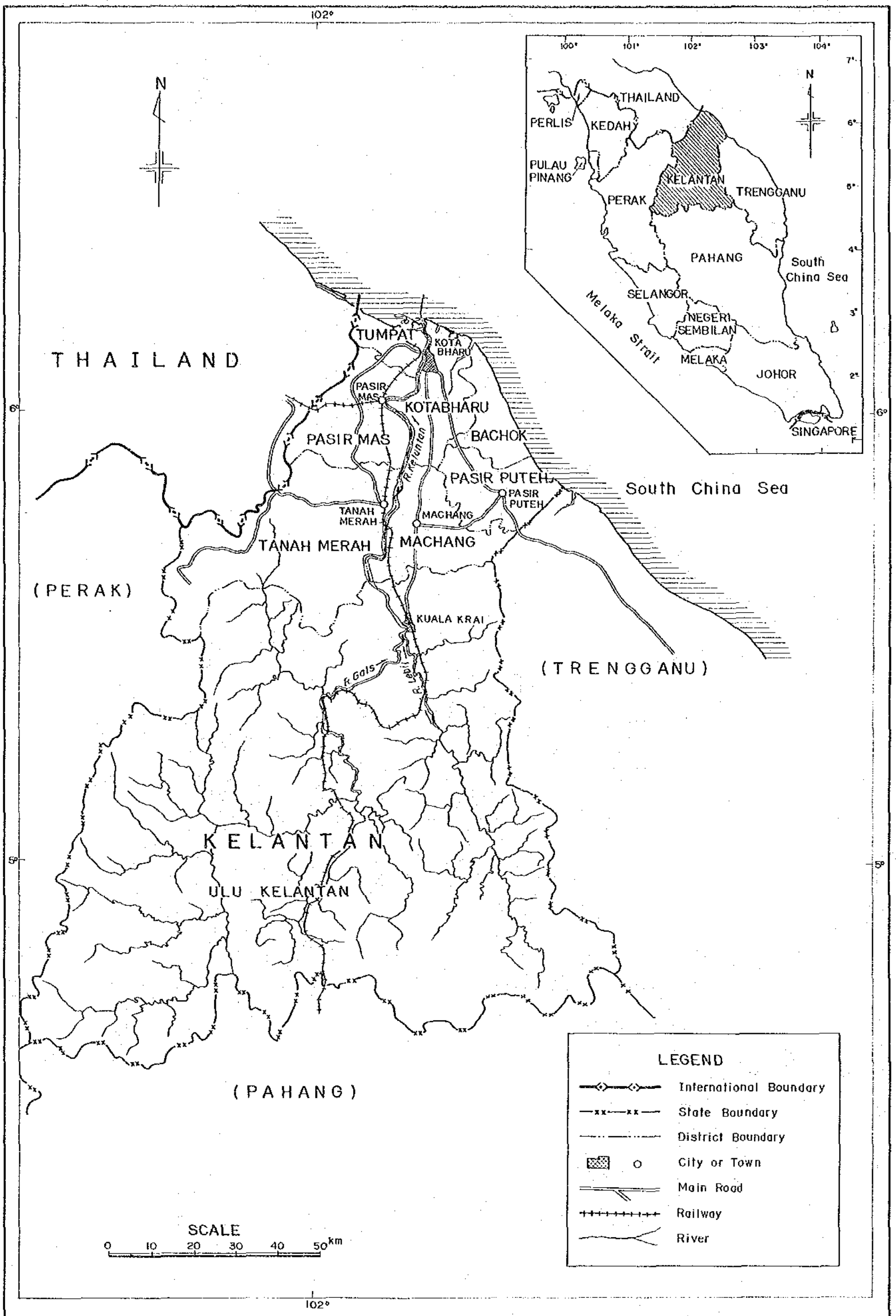

Fig.1 Map of the State of Kelantan

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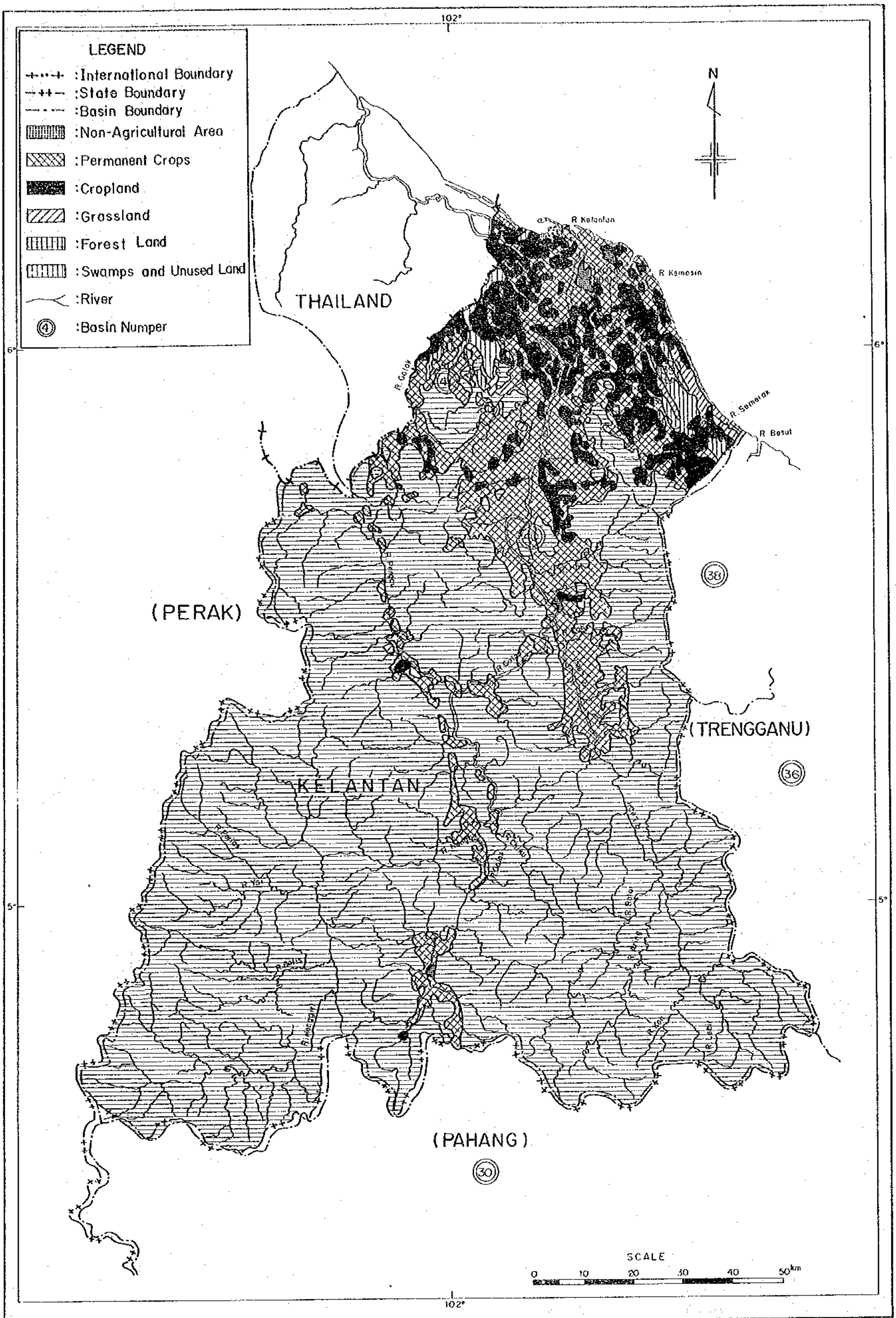

Fig. 2 Present Land Use

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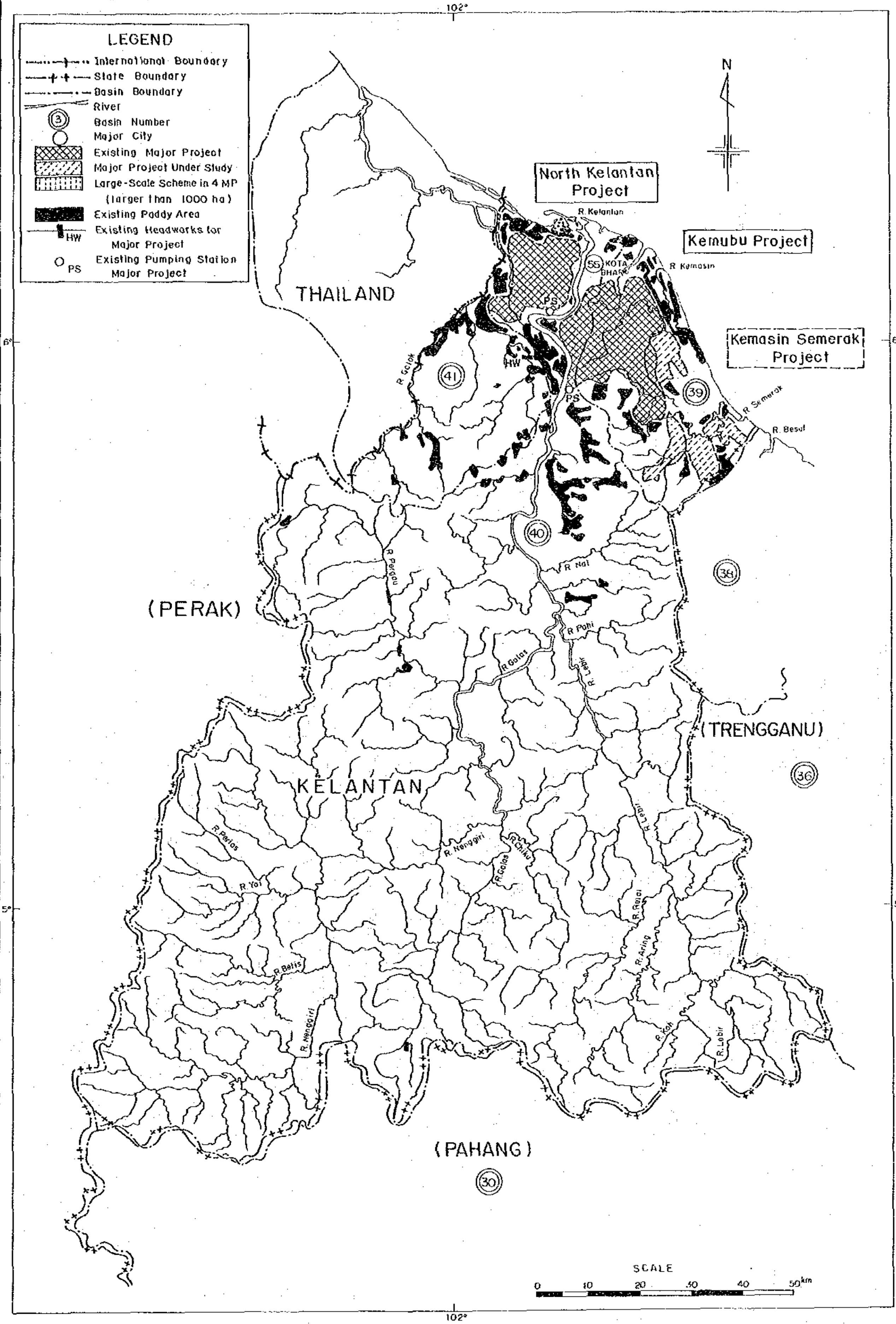

Fig. 3 Location of Paddy Field

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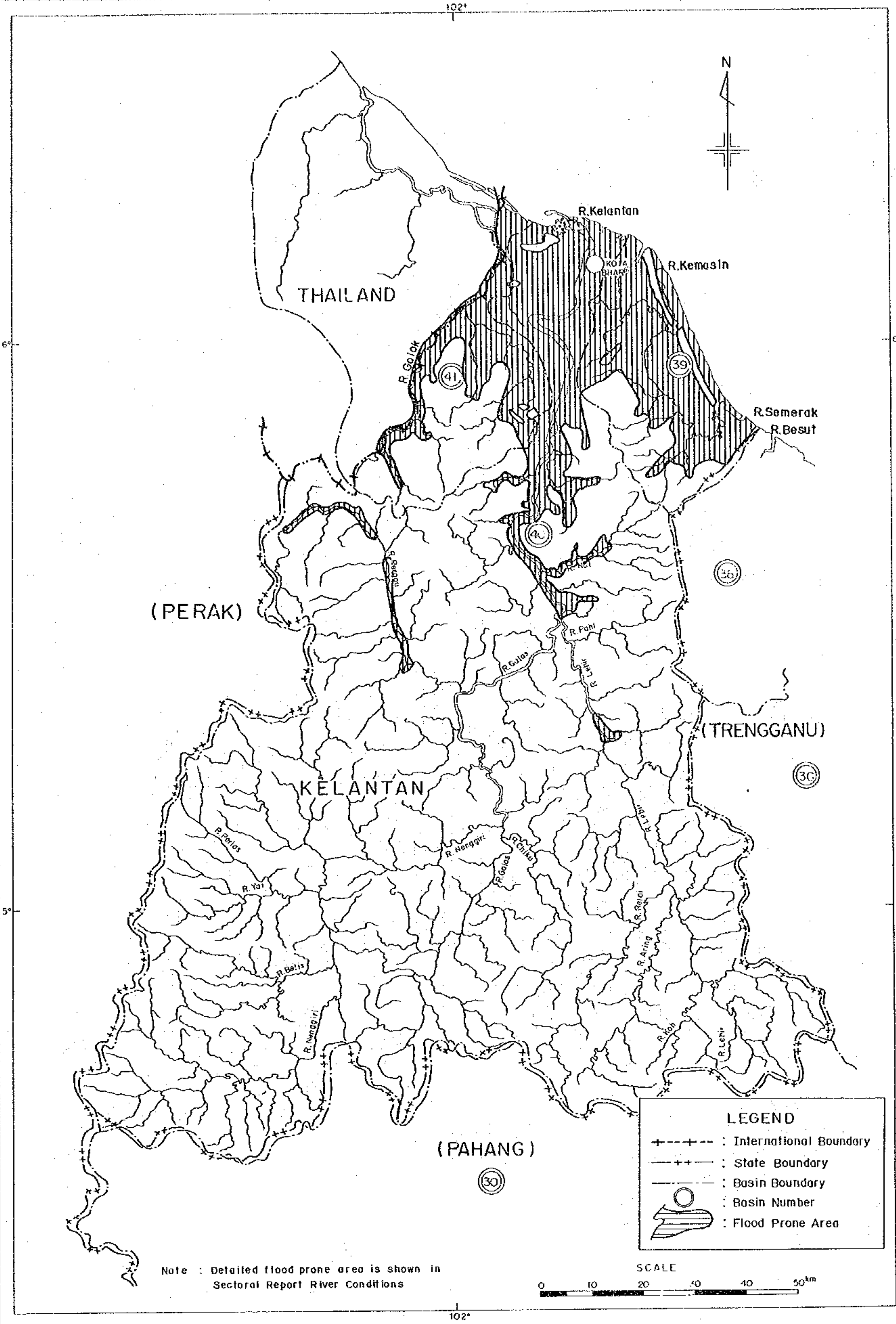

Fig. 4 Flood Prone Area In Kelantan

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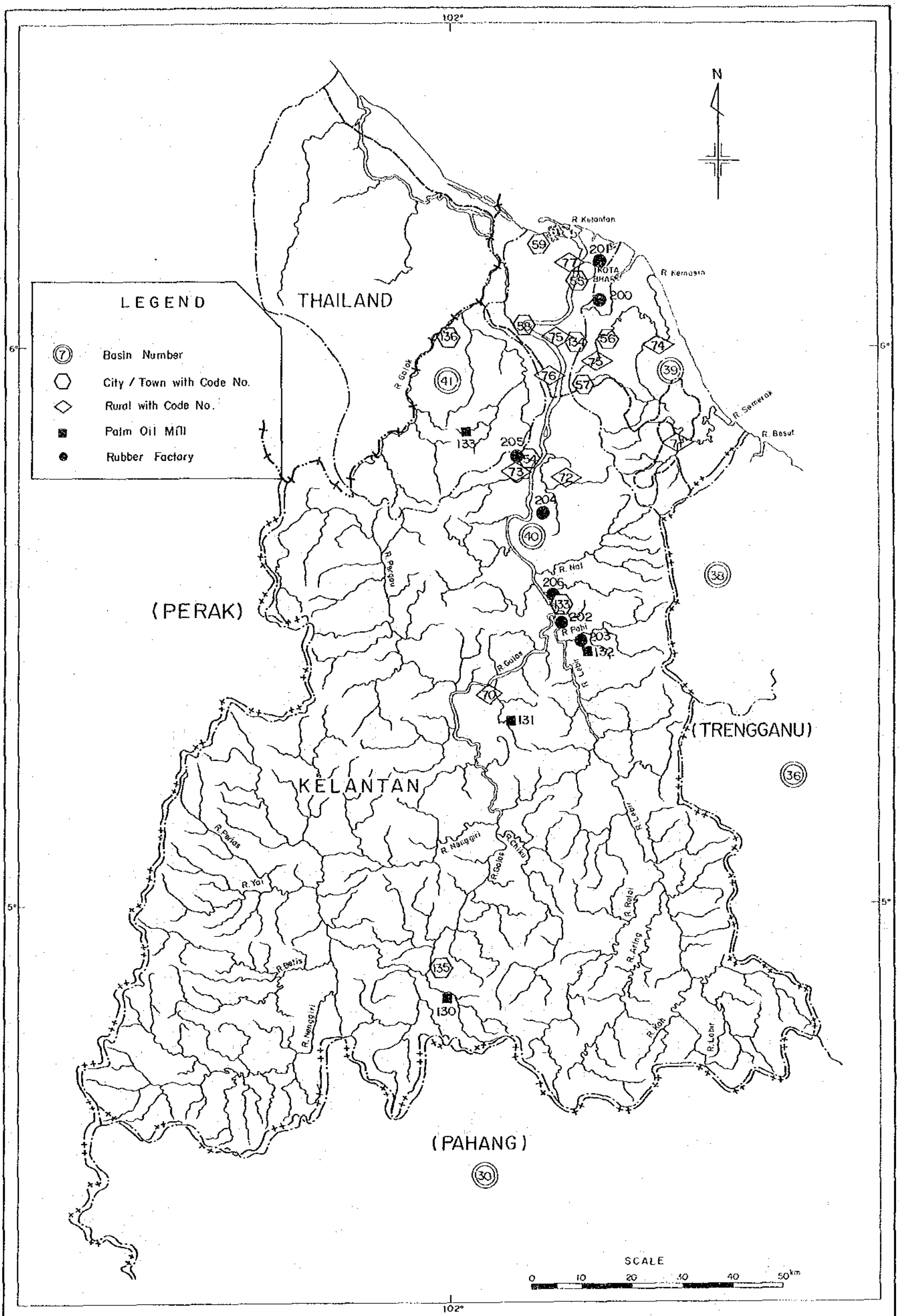

Fig. 5 Location of Demand Centers and Pollution Sources

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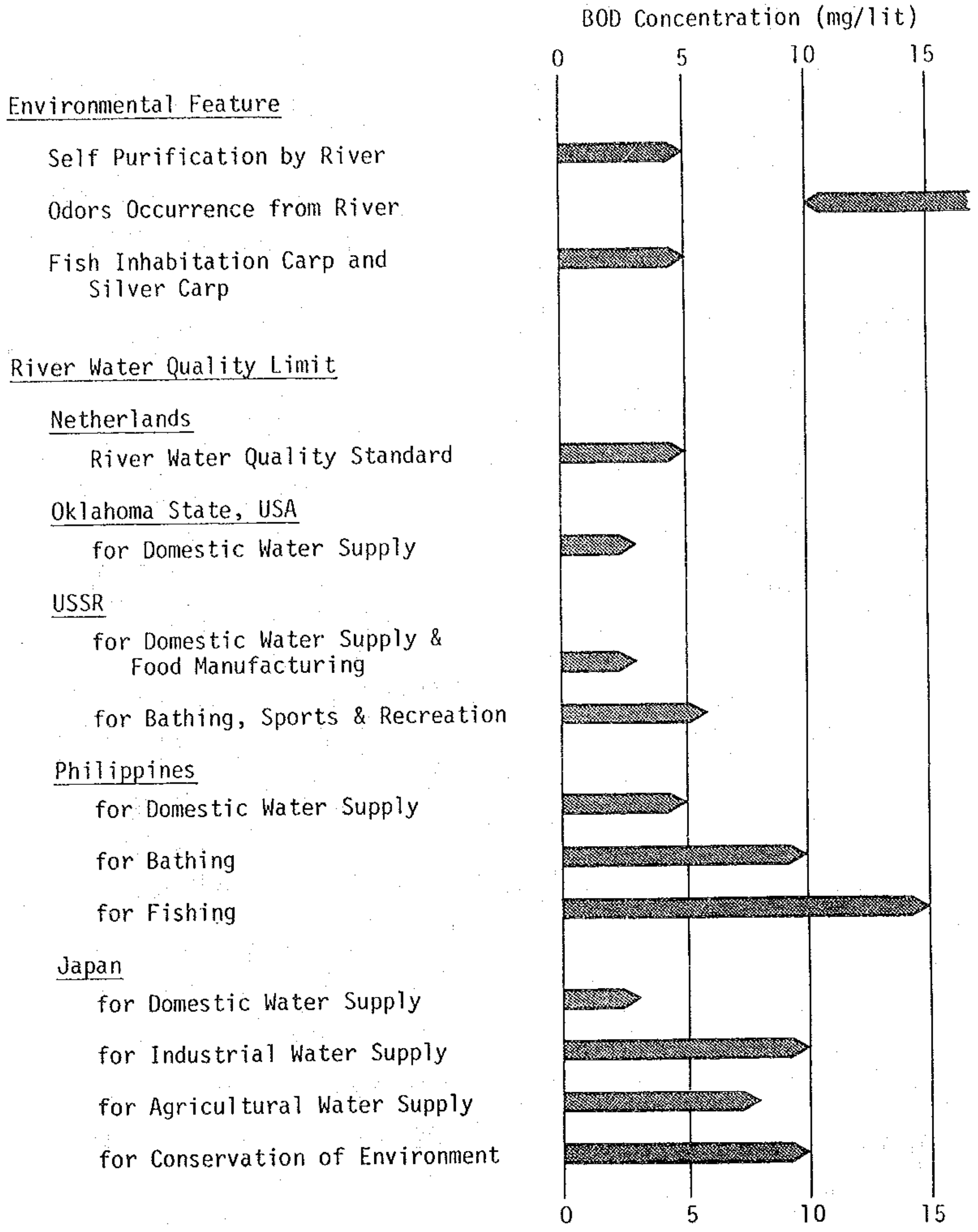

Fig. 6 Relationships between BOD Concentration and Environmental Feature and River Water Quality Limit

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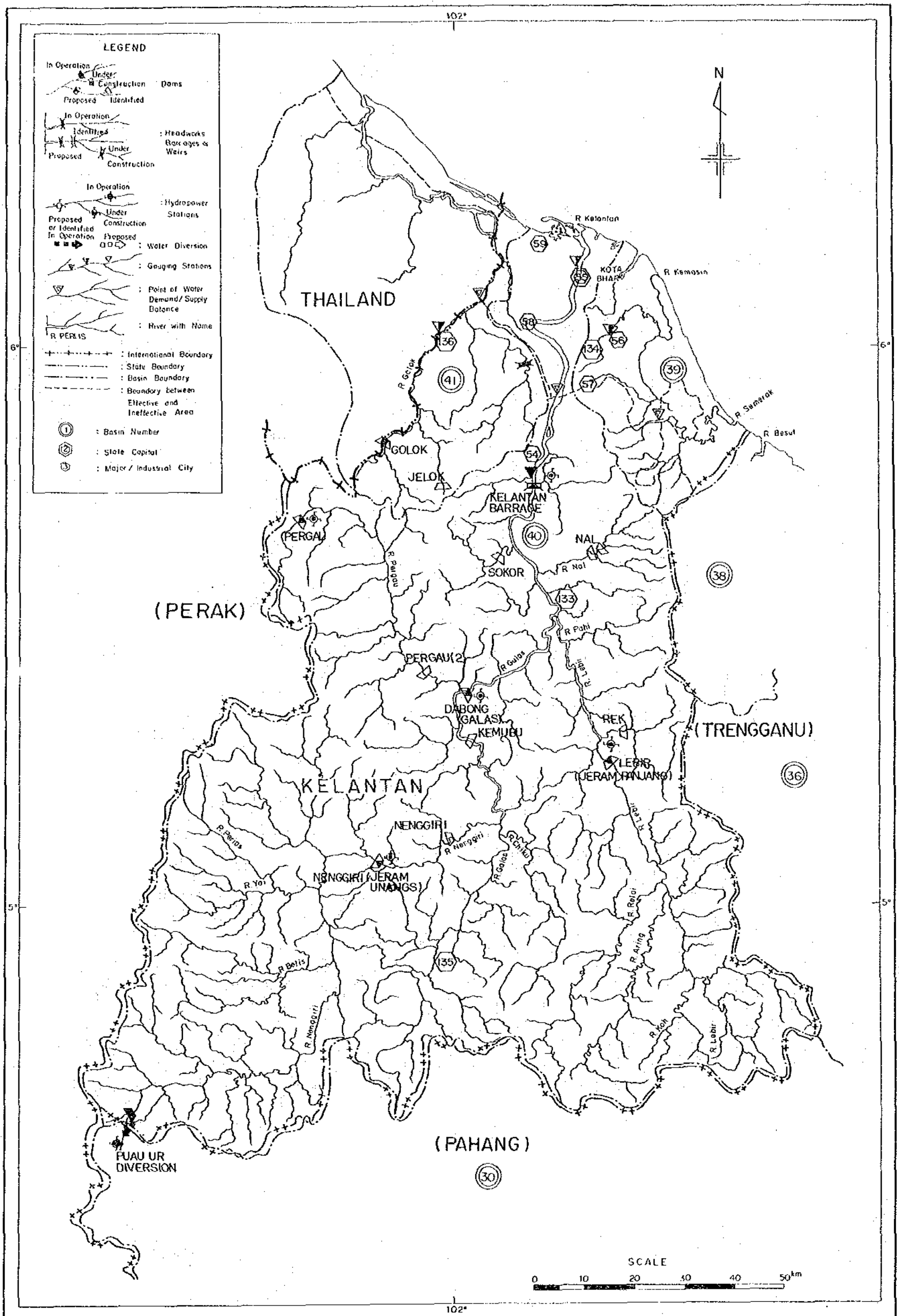

Fig. 7 Location of Potential and Proposed Water Source Facilities, Alternative B1

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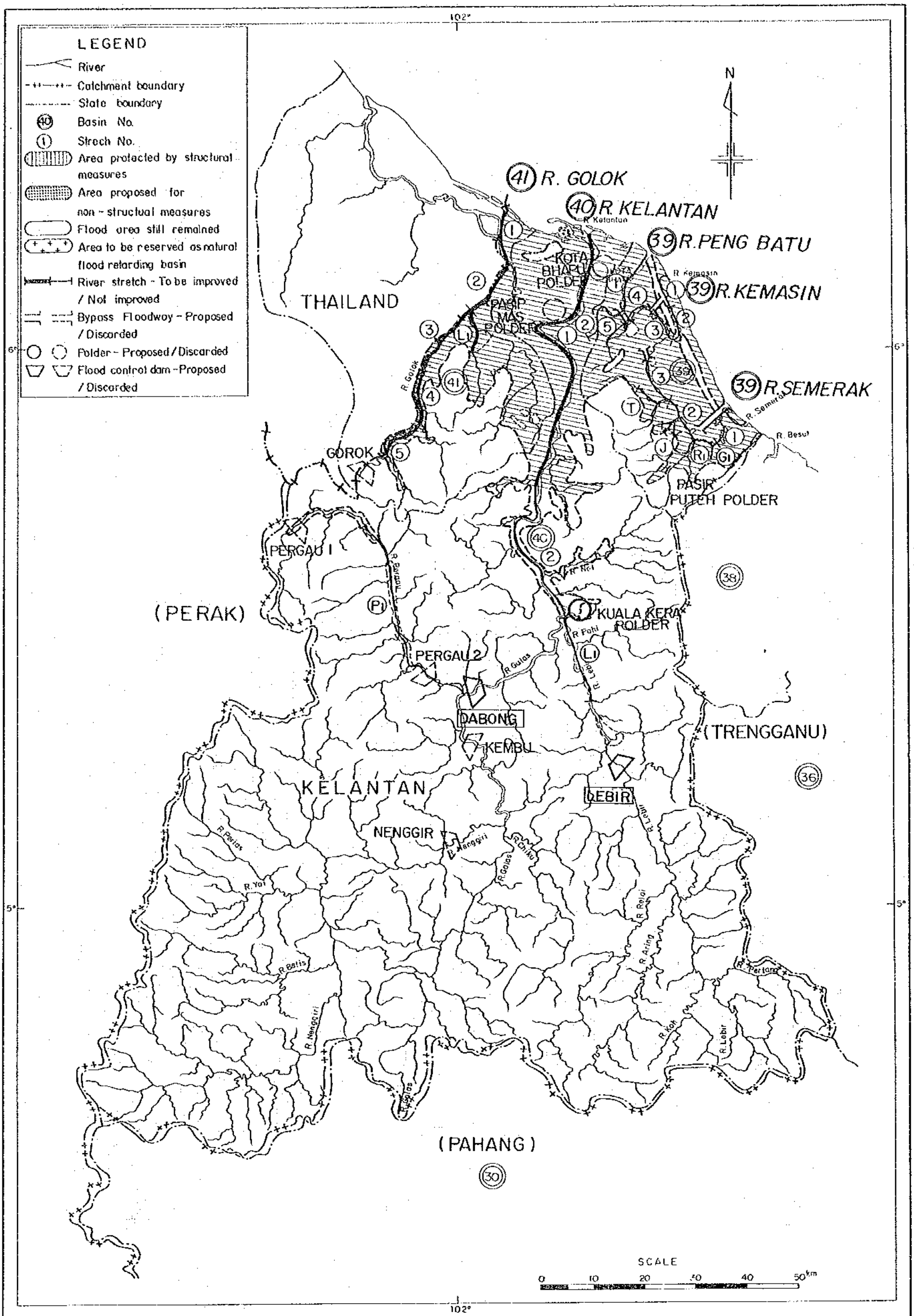

Fig. 8 Flood Mitigation Alternatives, Alternative F1

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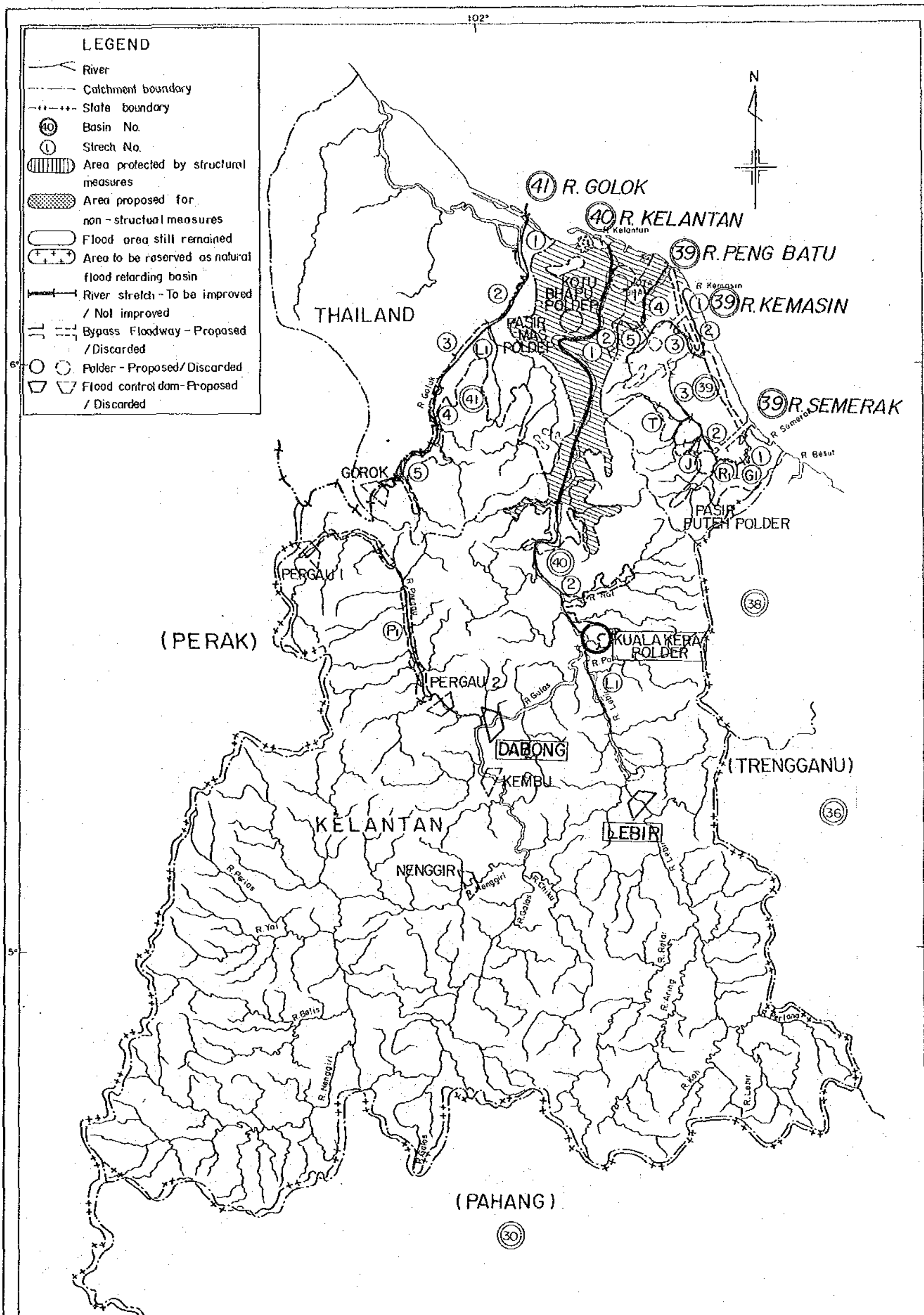

Fig. 9 Flood Mitigation Alternatives, Alternative F2

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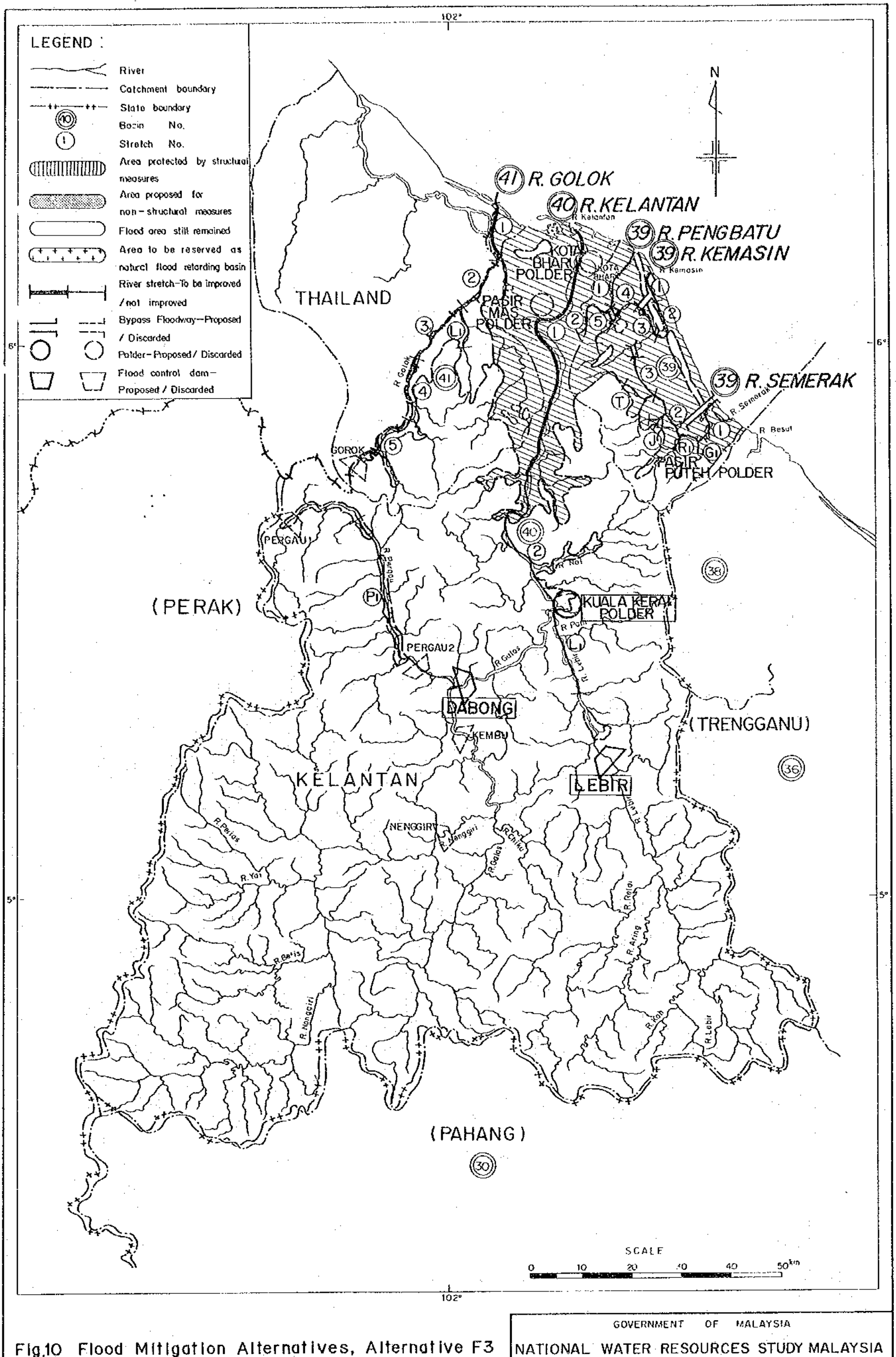

Fig.10 Flood Mitigation Alternatives, Alternative F3

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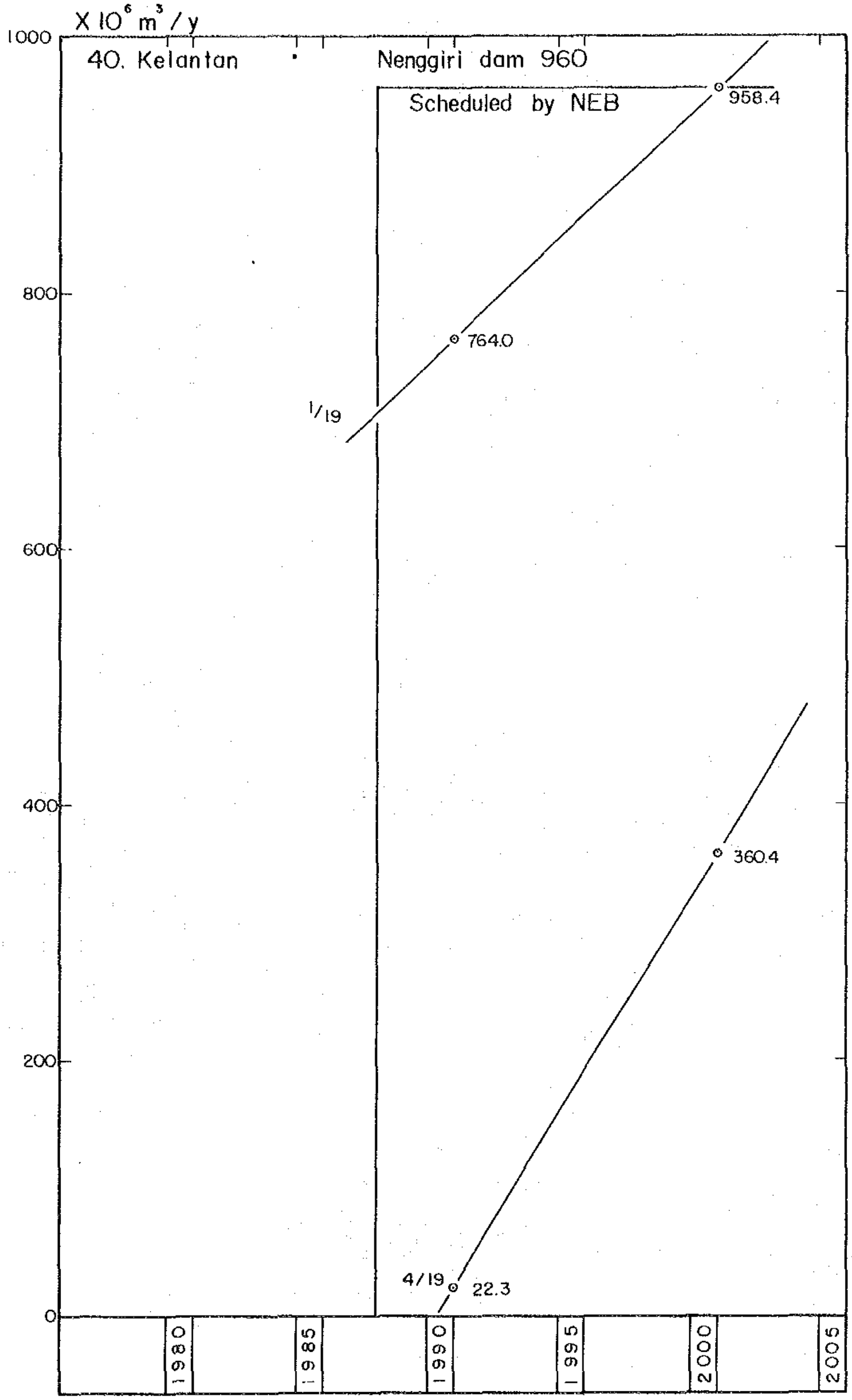

Fig.11 Recommended Water Demand and Supply Balance Program for Kelantan River Basin

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