JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE GOVERNMENT OF MALAYSIA
PRIME MINISTER'S DEPARTMENT
ECONOMIC PLANNING UNIT
MALAYSIA

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

VOLUME 2

MAIN REPORT

(FINAL REPORT)

JANUARY 1999

OTI ENGINEERING CO., LTD.
IN ASSOCIATION WITH
PASCO INTERNATIONAL INC.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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LIST OF REPORTS

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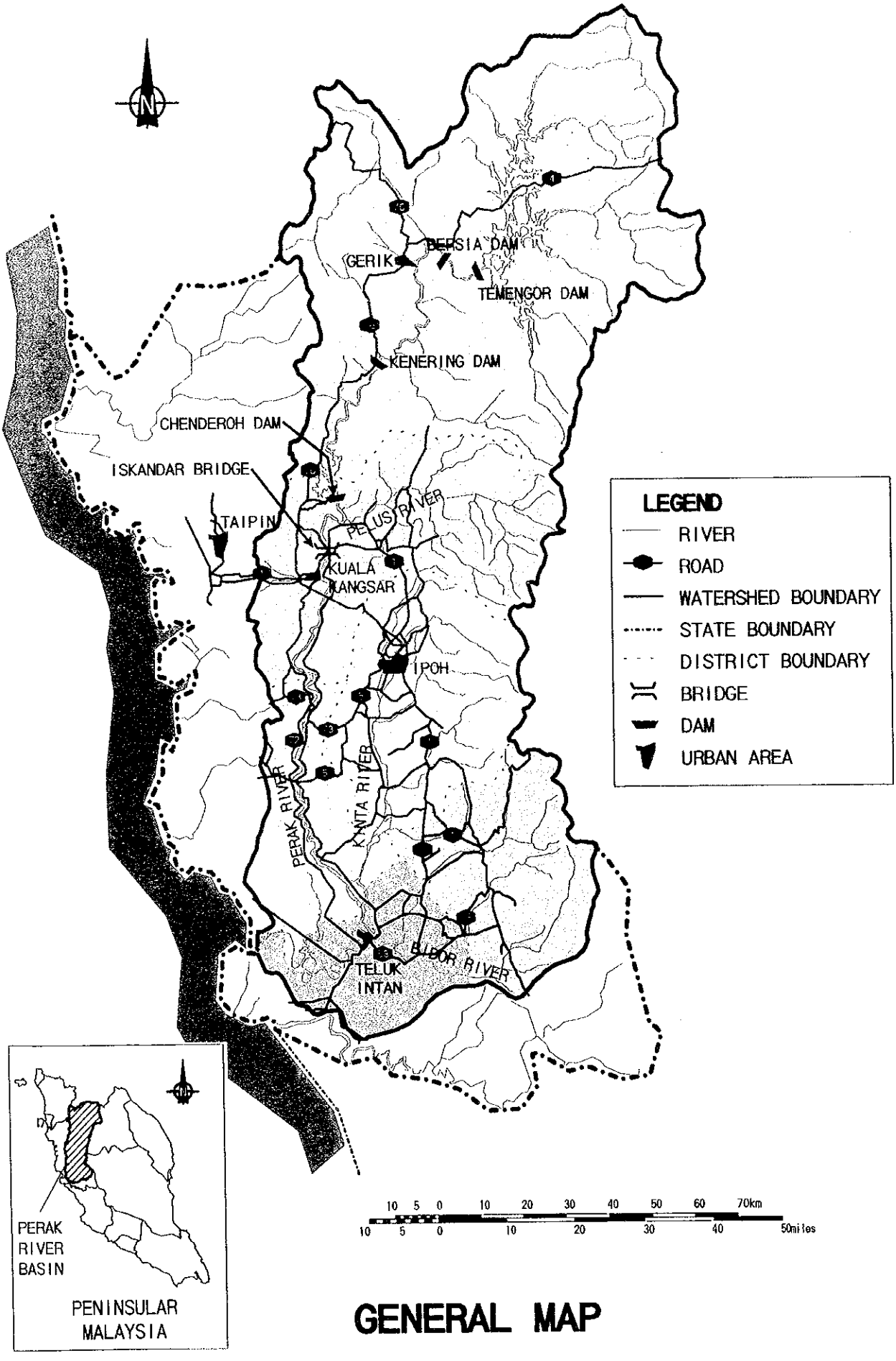
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GERIK
BERSIA DAM
TEMENGOR DAM
KENERING DAM
CHENDEROH DAM
ISKANDAR BRIDGE
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IPOH
PERAK RIVER
KINTA RIVER
TELUK INTAN
BIDOR RIVER
LEGEND
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ROAD
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STATE BOUNDARY
DISTRICT BOUNDARY
BRIDGE
DAM
URBAN AREA
10 5 0 10 20 30 40 50 60 70km
10 5 0 10 20 30 40 50miles
PERAK RIVER BASIN
PENINSULAR MALAYSIA

GENERAL MAP

PREFACE

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct a master plan and feasibility study on the Establishment of the River Basin Information System in Malaysia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team, headed by Mr. Makihiko Otogawa of CTI Engineering Co., Ltd., and composed of members from CTI Engineering Co., Ltd. and Pasco International Inc., to Malaysia four (4) times between March 1997 and October 1998. In addition, JICA set up an advisory committee headed by Mr. Tomonori Abe, Director of Second Research Department, Foundation of River & Basin Integrated Communications, Japan in March 1997, and Mr. Shuji Unno, Director of Second Research Department, Foundation of River & Basin Integrated Communications, Japan after September 1998, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Malaysia, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the Study.

January, 1999

Kimio Fujita
President
Japan International Cooperation Agency

January 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Sir:

We are pleased to submit herewith the Final Report for the Study on the Establishment of the River Basin Information System in Malaysia. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of a plan for the establishment of the river basin information system. Also included are the comments made by the Economic Planning Unit, Department of Irrigation and Drainage, and other authorities concerned of the Government of Malaysia during the technical discussion on the Draft Final Report in Malaysia.

The Final Report presents the Master Plan for the establishment of the river basin information system. It also presents the Feasibility Study on the development of a pilot system, called the "Operational System", and the results of the actual development works for the System.

In view of the urgency and necessity of socio-development, we recommend that the Government of Malaysia should adopt all means possible to promote the establishment of the river basin information system to the next stage of project implementation at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, the Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to the Economic Planning Unit, the Department of Irrigation and Drainage and other related authorities concerned of the Government of Malaysia for the close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,

MAKIHIKO OTOGAWA
Leader
JICA Study Team

THE STUDY ON THE ESTABLISHMENT OF
THE RIVER BASIN INFORMATION SYSTEM
IN MALAYSIA

VOLUME 2

MAIN REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND GLOSSARY

GOVERNMENT OFFICES

AIFM	:	Asian Institute of Forest Management
DGSM	:	Department of Geological Survey of Malaysia
DID	:	Department of Irrigation and Drainage
DGSM	:	Department of Geographic Survey of Malaysia
DOA	:	Department of Agriculture
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DOLM	:	Department of Lands and Mines
DOS	:	Department of Statistics
DSMM	:	Department of Survey and Mapping, Malaysia
DSMP	:	Department of Survey and Mapping, Perak
DWNP	:	Department of Wildlife and National Parks
EPU	:	Economic Planning Unit
ESRI	:	Environmental System Research Institute
EXCO	:	State Executive Council
FAMA	:	Federal Agricultural and Marketing Authority
FD	:	Forest Department
FDPM	:	Forest Department of Peninsular Malaysia
JICA	:	Japan International Cooperation Agency
JPLH	:	Pepper Marketing Board
LAP	:	Lembaga Air Perak (PWB: Perak Water Board)
LGD	:	Local Government Department
LKIM	:	Fisheries Development Authority of Malaysia
LPP	:	Farmers Organization Authority
MD	:	Marine Department
MIMOS	:	Malaysian Institute of Microelectronics
MMS	:	Malaysia Meteorological Service
MOA	:	Ministry of Agriculture
NCDP	:	National Committee on Database Processing
NIC	:	Network Information Center (under Ministry of Agriculture)
NITC	:	National Information Technology Council
NLDC	:	National Load Dispatch Center (under TNB)
NOC	:	Network Operation Center (under Ministry of Agriculture)
NRSC	:	National Remote Sensing Committee
PWB	:	Perak Water Board
PWD	:	Public Works Department
SEDC	:	State Economic Development Corporation
SEPC	:	State Economic Planning Committee
SEPU	:	State Economic Planning Unit
SPC	:	State Planning Committee
TCPD	:	Town and Country Planning Department Peninsular Malaysia
TNB	:	Tenaga Nasional Berhad (National Power Limited)
WMO	:	World Meteorological Organization

TECHNICAL TERMS FOR INFORMATION SYSTEM

ASCII	:	American Standard Code for Information Interchange
ATM	:	Asynchronous Transfer Mode
AVR	:	Automatic Voltage Regulator
C/S	:	Client-Server System

CAD	:	Computer Aided Design/Drafting
CD-R	:	Compact Disc Recordable
CD-ROM	:	Compact Disc Read Only Memory
CPU	:	Central Processing Unit
DB	:	Database
DDS/DAT	:	Digital Data Storage/Digital Audio Tape
DXF	:	Drawing Exchange Format (Drawing Interchange File)
EDP	:	Electronic Data Processing
FD	:	Floppy Disk
FEP	:	Front End Processor
FFW	:	Flood Forecasting and Warning
FSL	:	Full Supply Level
FTP	:	File Transfer Protocol
GIS	:	Geographic Information System
GUI	:	Graphic User Interface
HD	:	Hard Disk
HIS	:	Hydrological Information System
HTML	:	Hypertext Markup Language
IMS	:	Internet Map Server
INFOMIS	:	Integrated Forest Management Information System
IP	:	Internet Protocol
IPS	:	Image Processing System
ISDN	:	Integrated Services Digital Network
IT	:	Information Technology
ITV	:	Industrial Television
JARING	:	Joint Advanced Research Integrated Networking
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
MESAT	:	Malaysia East Asia Satellite
MIS	:	Management Information System
MSL	:	Minimum Supply Level
NaLIS	:	National Infrastructure For Land Information System
NFIS	:	National Forestry Information System
OCR	:	Optical Character Reader
O/M	:	Operation and Maintenace
OS	:	Operating System
RSO	:	Rectified Skew Orthomorphic
PA-RISC	:	Precision Architecture-Reduced Instruction Set Computing
PC	:	Personal Computer
PCI	:	Peripheral Component Interconnect
PFIA	:	Probable Flood Inundation Area
PIT	:	Portable Information Terminal
PSTN	:	Public Switched Telephone Network
RAM	:	Random Access Memory
RAS	:	Remote Access Server
RDBMS	:	Relational Database Management System
RS	:	Remote Sensing
SCSI	:	Small Computer System Interface
SMTP	:	Simple Mail Transfer Protocol
TCP/IP	:	Transmission Control Protocol/Internet Protocol
TIDEDA	:	Computer Program for Processing Time-Dependent Data
TIN	:	Triangulated Irregular Network
TM	:	Telemetry
UPS	:	Uniterruptible Power Supply
URL	:	Uniform Resource Locator

USLE	:	Universal Soil Loss Equation
VC	:	Virtual Channel
VP	:	Virtual Path
WAN	:	Wide Area Network
WWW	:	World Wide Web

WATER QUALITY TEST/ELEMENTS

Al	:	Aluminum	N	:	Nitrogen
As	:	Arsenic	Na	:	Sodium
BOD	:	Biological Oxygen Demand	NH3-N	:	Ammonical Nitrogen
Ca	:	Calcium	NO3-N	:	Nitrate
Cd	:	Cadmium	P	:	Phosphorous

WATER QUALITY TEST/ELEMENTS (CONTINUETION)

Cl	:	Chloride	Pb	:	Lead
CN	:	Cyanide	PCB	:	Polychlorinated Biphenyl
COD	:	Chemical Oxygen Demand	Po4-P	:	Phosphate as Phosphorous
Cu	:	Copper	Ra	:	Radium
DO	:	Dissolved Oxygen	S	:	Sulphide
F	:	Fluoride	Sr	:	Strontium
Fe	:	Iron	SS	:	Suspended Solids
Hg	:	Mercury	T-Cr	:	Total Chromium
K	:	Potassium	T-P	:	Total Phosphorus
MBAS	:	Methylene Blue Active Substance	TN	:	Total Nitrogen
Mg	:	Magnesium	WQI	:	Water Quality Index
Mn	:	Manganese			

UNITS OF MEASUREMENT

(Area)

Ha, ha	:	Hectare
m^2	:	square meter
km^2	:	square kilometer

(Weight)

Kg, kg	:	Kilogram
ton	:	1,000 kg

(Volume)

GRT	:	Gross Relative Tonnage
L, l, ltr	:	Liter
m^3	:	cubic meter
MCM		million cubic meters

(Electric)

MHz	:	Megahertz
VA	:	volt ampere
W	:	Watt

(Other Measurements)

Cu., cu.	:	cubic
cusec	:	cubic feet per second
m3/s	:	cubic meter per second
dia.	:	diameter
DPI	:	dot per inch
GB	:	gigabyte
Kbps	:	kilo bit per second
KB	:	kilo byte
Km, km	:	kilometer
Mbps	:	megabit per second
sec, s		second
Sq., sq.		square
H	:	hertz
kW	:	kilowatt
V		volt, voltage

MALAYSIAN TERMS

Jl.	:	jalan (road)
Kg.	:	kampong (village)
P., Pulau	:	island
Mk.	:	Mukim

CURRENCY

RM	:	Malaysian Ringgit
US$		United States Dollar
¥	:	Japanese Yen
Sg.	:	sungai (river)

OTHERS

EIRR	:	Economic Internal Rate of Return
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRDP	:	Gross Regional Domestic Products
LSD	:	Land and Survey Datum
MP	:	Malaysia Plan
OJT	:	On-the-Job Training
RBIS	:	Rver Basin Information System
RSO	:	Rectified Skewed Orthomorphic
VJR	:	Virgin Jungle Reserve

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Recent developments in land use have increased the flood damage potential in low-lying areas along the rivers. Moreover, river erosion and/or sedimentation have lead to the deterioration of river environments. River water resources also could not meet the rapid increment and diversification of water demand, and water shortage areas have been spreading throughout Malaysia. In addition to these problems, the value of riverside space (waterfront) as an amenity, as well as the conservation of river environment is going to be a major public concern since development near the rivers has been briskly going on especially at urban centers.

Thus, a comprehensive and consistent river basin management is going to be a very significant issue for coping with the ongoing dynamic changes of the river basin environment. River basin management at present is, however, undertaken by various government agencies without adequate inter-agency and/or interstate coordination. As a result, information related to river basin management activities are scattered and hardly exchanged among the agencies. Moreover, it is not easy to systematically refer to the river basin information which are voluminous and dynamic in nature requiring frequent updating and systematic storage.

As stated above, an information system linking the relevant agencies is indispensable for the comprehensive and consistent river basin management. Under such circumstances, the Government of Malaysia had requested the Government of Japan to extend technical cooperation to establish a river basin information system. In response to the request, the Government of Japan had decided to undertake "The Study on the Establishment of the River Basin Information System in Malaysia" (the Study) which was entrusted to the Japan International Cooperation Agency (JICA), the organization responsible for the implementation of its technical cooperation programs.

JICA dispatched a Study Team to Malaysia in March 1997, and the Study was carried out both in Malaysia and in Japan until December 1998. The Perak river basin was selected as the objective river basin through a series of discussions on the Inception Report between officials concerned of the Government of Malaysia and the JICA Study Team.

1.2 Objectives of the Study

A series of discussions with the officials concerned of the Government of Malaysia were made on the objectives of the Study in the early stage of the study period. The methodology of the Study was finally agreed, as presented below.

(1) Master Plan Study

The major issues on the present river basin management in the Perak river basin are to be clarified, and the basic policy and the strategy for establishment of the river basin information system (RBIS) are to be formulated in the Master Plan Study.

(2) Feasibility Study

The detailed plan and specifications of an operational river basin system are to be proposed for the Perak river basin. Cost estimation and evaluation of the proposed operational system are also to be made.

(3) Establishment of Operational System

A pilot river basin information system (called the "Operational System") is to be established for the Perak river basin within the study period, and a case study on particular issues of river basin management is to be carried out through the initial operation of the System. The Operational System will have all fundamental functions required of a river basin information system including a series of collection system, data transmission system, and data dissemination system.

(4) Transfer of Knowledge

Transfer of technology to the Malaysian counterpart personnel is to be carried out throughout the course of the Study.

1.3 Study Area

The objective area for both the Master Plan Study and the Feasibility Study is the Perak river basin that is located in Perak State with a catchment area of about 14,700km^2. The optimum river system development for the Perak river basin has been proposed based on the clarification on major issues of river basin management of the basin. Thus, the proposed plan would be a basin-wide river basin information system. However, further clarified is the expandability of the proposed system as well as the possibility of linkage of the proposed

system with other related information systems. These clarifications would facilitate the expansion of the objective area toward the nationwide coverage as envisioned for the future.

1.4 Contents of Report

The results of the Study are compiled in four volumes; namely, Volume 1, Summary; Volume 2, Main Report; Volume 3, Supporting Report, and Volume 4, Data Book. The Main Report gives a general presentation of all results of the Study, which is compiled in brief in Volume 1, Summary. The Supporting Report is divided into six (6) Sectors as enumerated below which present the details of the studies in each sector with supporting data compiled in the Data book.

(1) SECTOR I HYDROLOGY

(2) SECTOR II RIVER MANAGEMENT

(3) SECTOR III WATERSHED MANAGEMENT

(4) SECTOR IV RIVER BASIN INFORMATION SYSTEM

(5) SECTOR V ECONOMIC AND TECHNICAL EVALUATION

(6) SECTOR VI INSTITUTIONAL SETUP PLAN

CHAPTER 2 PRESENT FEATURES OF THE PERAK RIVER BASIN

2.1 Natural and Social Features of the Perak River Basin

The Perak River originates in the northern mountain range of more than EL. 4,000 feet (about 1,200 m). It runs southward and finally flows into the Strait of Malacca (refer to Fig. 2-1). As described in Subsection 1.3, the river has a catchment area of about 14,700 km^2 that covers about 70% of Perak State. The northern watershed boundary of the river borders on Thailand, while the eastern watershed boundary is on Kelantan State. The major tributaries are the Pelus River, the Kinta River and the Bidor River. Among these tributaries, the Kinta River flows down through Ipoh, the State Capital.

The present land use condition of the Perak river basin is as shown in Fig. 2-2 and Table 2-1. The forest land spreads out in the upper reaches covering 60% of the river basin, while agricultural lands are developed on the alluvial plain in the middle and lower reaches covering 30%. The first major crop area in the basin is the rubber plantation (taking about 13% of the basin), and the second is the palm oil plantation area (about 7% of the basin). There are many previous mining ponds, particularly in the lower reaches, which cover about 3% of the basin, and some of them are now being used for aqua-culture.

The Perak river basin is administratively divided into six (6) districts (refer to Fig. 2-3). The total basin population in 1996 was estimated at about 1,162,000 which was shared among the districts as shown below.

Name of District	Area (km^2)	Population (in thousands)	Population Density (person/km^2)
1. Hulu Perak	6,563	82 (7%)	13
2. Kuala Kangsar	2,541	147 (13%)	57
3. Kinta	1,985	628 (54%)	316
4. Perak Tengah	1,279	76 (7%)	59
5. Batang Pandang	1,651	94 (8%)	57
6. Hilir Perak	1,161	136 (12%)	117
Basin Total	15,180	1,162 (100%)	77

The basin population tends to concentrate on the Kinta river basin and the lower reaches of Perak river basin as shown in the population density of the Kinta and Hilir Perak districts. The Kinta District includes the City of Ipoh, the state capital of Perak State, and almost half of the basin's total population is in the district. In contrast to the Kinta and Hilir Perak districts, the Hulu Perak District which covers the forest reserve area in the upper reaches has a remarkably low population density.

2.2 Particular Features of the Perak River Basin

The particular features of the Perak river basin has been clarified by comparing it with the other fourteen (14) major river basins in Malaysia, as presented below.

(1) Land Use, Population and Hydrological Condition

The Perak river basin has the fourth largest catchment area of 14,700 km^2 following the Rejang river basin (51,315 km^2), the Phang river basin (29,300 km^2), and the Kinabatangan river basin (16,800 km^2). One of the particular features of the Perak river basin is the settlement area taking about 6% of the whole catchment area, which is the second highest rate next to the Klang river basin (refer to Table 2-2). The settlement area of Perak river basin has developed particularly in and around Ipoh that has the second largest urban population of about 469,000 next to Kuala Lumpur. The basin's total population is also the second largest next to the Klang river basin (refer to Table 2-3).

In spite of the high urbanization of the Perak river basin, the forest area is well preserved as seen in the coverage rate of forest area in the Perak river basin which almost corresponds to the average value of the major river basins in Malaysia (refer to Table 2-2). Such a wide forest area in the Perak river basin leads to the rather low population density as a whole. The population density of the Perak river basin is only 77 person/km^2, which ranks sixth among the river basins in Malaysia. Thus, land use in the Perak river basin is characterized by such conditions as the basin is already urbanized in the lower reaches while the upper reaches is still well preserved with the forest area.

The Perak river basin has an annual rainfall of about 2,300 mm which is higher than those of river basins in the south-west coast (less than 2,000 mm) but lower than those in the north-east coast (more than 2,500 mm). The Perak river basin is likely to have two (2) rainy periods during the inter-transitional monsoon seasons; from April to May and from October to November. The maximum monthly rainfall of the Perak river basin usually occurs from October to November.

The major concern on the river basin information system in this Study is the distribution of hydrological gauging stations. As shown in Table 2-4, the hydrological gauging stations controlled by DID are densely distributed in the basins

along the west coast of Peninsular Malaysia as compared with the other basins along the east coast and in Sabah/Sarawak.

The density of gauging stations in the Perak river basin is, however, the lowest among those of the major river basins along the west coast. The rainfall gauging stations in Perak river basin could barely satisfy the minimum necessary density (250 km^2/station) recommended by the World Meteorological Organization (WMO) and the discharge gauging stations fall less than the minimum necessary density (1,000 km^2/station) recommended by WMO. Nevertheless, the density of hydrological gauging stations in the Perak river basin is still far higher than those along the east coast and in Sabah/Sarawak.

(2) River Condition

River channels in Malaysia have a very gentle slope of less than 1/5,000 in the downstream and around 1/2,000 in the middle-stream. The channel slope of Perak River also falls under this general pattern, and its river channel with less than 1/5,000 stretches from the river mouth up to about 250 km upstream.

Due to such long gentle river channel, the Perak River tends to accumulate excessive sediment leading to the shallow riverbed. The sedimentation of the river has also been accelerated by the current logging activities in the upper reaches and the previous large sand volume dumped from tin mining sites in the basin.

Among the fifteen (15) major river basins, the Klang River is evaluated to be seriously polluted, and only five (5) of the rivers are clean as indicated by the annual water quality index (WQI) prepared by DOE (refer to Table 2-5). The water quality of the Perak River is now slightly polluted and tends to gradually worsen.

DOE and the Perak Water Board (PWB) agree that the turbidity of Perak river water is serious causing difficulties in treating the river water for domestic and industrial water supply. However, the annual loads estimated by DOE in 1998 do not indicate any notable value of suspended solids (SS) that was assumed to be high, if ever the Perak River has a high turbidity (refer to Table 2-5). At present, no notable deteriorated organic waste load is seen in the water of Perak River (refer to Table 2-6). As for the non-organic waste load, recently only the ammoniacal nitrogen (NH3-N) tends to increase, but is still within the tolerable range.

CHAPTER 3 MAJOR ISSUES ON THE PRESENT RIVER BASIN MANAGEMENT

3.1 Overview of River Basin Management in Malaysia

In Malaysia, various agencies are related to river basin management. The Department of Irrigation and Drainage (DID) undertakes gauging and management of river basin hydrology and river morphology, while the Department of Environment (DOE) carries out the monitoring and control of river water quality. However, a common monitoring point for both river flow discharge and river water quality hardly exists. As a result, although the concentration rate of water quality is monitored at a certain water sampling point, the corresponding pollutant load is not estimated due to the lack of information on river flow discharge.

Basin land conservation and/or development works are also undertaken by various agencies such as the Forest Department (FD) for forest conservation, the Department of Agriculture (DOA) for development of agricultural land, and the Economic Planning Unit (EPU) for urban and industrial development. Information on basin land development is, however, hardly furnished to the agencies concerned in river gauging and management. Such limited information on basin land development/conservation causes difficulty in clarifying the relationship between (a) river gauging data such as river flow discharge and river water quality and (b) basin land development conditions.

The government agencies related to river basin management have established or are going to establish their own information management systems. Most of the systems have been developed by the Federal government agencies, and their server machines have been installed in Kuala Lumpur. Therefore, the Federal government controls most of the basic information required for river basin management, but the actual river maintenance and/or management work is mainly undertaken by the State government based on the information provided by the Federal government. Such centralized information system could facilitate the systematic operation and maintenance of the system, but it also causes several inconveniences such as the delay of information to the State government.

Different authorities of the Federal and State governments also store non-digitized drawings and reports. That is, nationwide non-digitized data could be accessed through the Federal government, while the local data could be accessed through the State government. Such non-digitized data are, however, not well compiled by both the Federal and State

governments, and are often scattered and lost due to the shortage of qualified personnel to manage the data.

In view of the aforesaid conditions, the major issues on the present river basin management are attributed to the following four (4) items:

(1) A consistent river monitoring is hardly made, e.g., the monitoring points for river flow discharge and river water quality are seldom unified, causing difficulty in clarifying the river flow condition.

(2) Most of the existing database systems related to river basin management are for the exclusive use of a particular government agency and the information stored in the system is seldom exchanged with the other agencies. Such situation causes difficulty in obtaining a comprehensive river monitoring information and basin land development conditions.

(3) The Federal government has control over most of the river basin information while the State government is the principal body to execute the actual river basin management. Such a dual management system could cause delay in the transmission of information from the Federal government to the State government and difficulty in the execution of appropriate river basin management works unless an effective data transmission system is established.

(4) Non-digitized river basin information tends to be scattered and lost, and are not being used effectively.

3.2 Particular Issues on River Basin Management for the Perak River Basin

The particular issues on river basin management for the Perak river basin were clarified on various aspects including flood management, water resources management and river environmental management.

3.2.1 Flood Management

The present condition and major issues on flood management for the Perak river basin are as described below.

(1) Dam Control

Tenaga Nasional Berhad (TNB) controls four (4) hydropower dams in the upper reaches of the Perak river basin; namely, Temengor, Bersia, Kenering and Chenderoh. The principal features of these dams are as tabulated below.

Name of Dam	Catchment Area (km^2)	Capacity at FSL ($m^3 10^6$)	Completion Year
(1) Temengor	3,420	6,050	1978
(2) Bersia	140	58	1983
(3) Kenering	1,930	352	1984
(4) Chenderoh	1,000	95	1932

Note: The catchment area of each dam does not include the area of upstream dams.

Among these dams, the Temengor Dam at the uppermost stretch has the largest storage capacity of 6,050 million m^3, and the annual peak flood discharge as well as the inundation area has remarkably decreased since the dam was constructed in 1974 (refer to Fig. 3-1). However, there is still the risk of flood overflow in the Perak River even after the hydropower dams were constructed in the upper reaches. Inundation still occurs in the lower reaches of the Perak and Kinta rivers as experienced in 1985, 1991 and 1994.

During flood time, TNB and DID gauge the detailed dam reservoir level and the hydrological conditions (rainfall, river water level and discharge) in the basin, respectively, while those information are hardly exchanged between the agencies due to lack of data transmission system other than the public telephone line. As a result, TNB could not have a flexible dam operation and the existing hydropower dams hardly effect their full flood control potential, which is verified with minimal adverse effects of power generation as described in Chapter 9.

(2) River Channel Management

According to the interview survey with the Perak State DID, sedimentation in the middle-stretch of the Perak River is in progress forming many sandbars in the river course and making the riverbed shallow. Such river sedimentation could reduce the channel flow capacity and increase the risk of flood overflow of the river channel. The Perak State DID assumes that the sedimentation on the Perak River is produced by the excessive logging activities in the upper reaches, particularly, in the Pelus river basin.

However, a regular channel survey for the entire river stretch has not been carried out since 1970 and the results of channel survey before 1970 are substantially scattered. As a result, it is difficult to make a qualitative analysis on channel sedimentation. Moreover, the details of logging activities as well as other land developments in the upper reaches are not released to DID and the other agencies concerned in river management. Accordingly, the agencies could not also clarify the definite relationship between the logging activities/land development and the channel sedimentation.

(3) Flood Mitigation Works

Various flood mitigation plans have been formulated, and some of them implemented since 1920s for the Perak River and its main tributary, the Kinta River. The proposed and/or implemented flood mitigation schemes include various measures such as embankment, bund, diversion channel, and river channel dredging.

However, there does not exist any databank integrating these previous flood mitigation schemes. Lack of an integrated databank causes difficulties in figuring out the overall flood mitigation works and formulating a consistent flood mitigation plan for the river basin. From these viewpoints, it is indispensable to establish a database that could consistently compile the previous, ongoing and projected flood mitigation schemes.

(4) Management of Flood Hazard Area

Since the present river channel flow capacity could not be estimated due to lack of regular river channel survey, DID, the authority concerned in flood management, could not set up the probable flood inundation area along the river. Moreover, DID could neither obtain the land use information along the river nor the jurisdiction to control the excessive land development along the river. Under these conditions, it is practically difficult to execute an appropriate management on the flood hazard area.

3.2.2 Water Resources Management

(1) Management of River Maintenance Flow

TNB agreed with DID, in 1975, to guarantee a minimum flow discharge of 4,000 cusec (about 113 m^3/s or 0.015 $m^3/s/km^2$) at the Iskandar Bridge that is located at about 23 km downstream from Chenderoh Dam. The discharge of 4,000 cusec is

guaranteed by the outflow discharge from the Chenderoh Dam together with the natural runoff discharge generated from the Pelus River.

The Iskandar Bridge is one of the key gauging stations on the Perak River, and its daily flow discharge is monitored by the DID Hydrology Division. The gauged discharge data is, however, not transmitted to TNB. Moreover, the gauged data is not used even by DID to confirm if the discharge of 4,000 cusec is certainly guaranteed at the Iskandar Bridge.

Since TNB could not monitor the flow discharge at the Iskandar Bridge, it releases a maintenance discharge of 3,000 cusec (about 85 m^3/s) from the Chenderoh Dam instead of 4,000 cusec at the Iskandar Bridge. Thus, there is a difference between the guaranteed discharge at the Iskandar Bridge and the maintenance discharge from the Chenderoh Dam. The difference is supposed to be supplemented by the runoff discharge from the Pelus River which joins the Perak River at about 9 km downstream from the Chenderoh Dam (i.e., 14 km upstream from Iskandar Bridge).

However, the runoff discharge from the Pelus River is a natural phenomenon; therefore, the maintenance discharge from the Chenderoh could not always promise the guaranteed discharge at the Iskandar Bridge, particularly, in a serious drought year. Moreover, the guaranteed discharge was agreed more than 20 years ago, and the re-evaluation and/or periodical renewal of the discharge should have been made in due consideration of the updated water demand of the river. To cope with these issues, the following items were deemed necessary to be examined (refer to Chapter 9):

(a) A real-time monitoring system for both the discharge released from the Chenderoh Dam and the river flow discharge at Iskandar Bridge should be established;

(b) The guaranteed discharge should be ensured based on the daily monitoring on the above two objective discharges; and

(c) The guaranteed discharge should be updated according to the current water demand of the river.

(2) Water Supply Management

The present intake facilities on the Perak River are independently managed by DID (for irrigation water supply) and the Perak Water Board (for domestic/industrial water supply), and information is not mutually exchanged between the two agencies. Thus, no unified government agency presently monitors the overall water intake volume of the river basin and, as a result, no government agency could evaluate the adequacy of infinite water resources of the river as compared with the overall intake volume from the river. Moreover, water-right is not prescribed in Malaysia, and no government agency could rationally judge the applicability of the projected intake volume based on the clarification of infinite river water resources.

To cope with the aforesaid issues on water supply management, a unified agency is necessary to coordinate the present water users and develop an integrated database for water intake features (intake volume, intake location, etc.), as well as hydrological information on low flow regime and water quality of the river. The details on usage of river basin management for such water supply management have been clarified as presented in Chapter 9.

(3) Drought Management

When extreme droughts occur and the existing water intake volume exceeds the river flow discharge, the following drought management is required on the real-time base:

(a) To declare the drought to all water users and start drought management;

(b) To determine the priorities of retrenchment of water intake; and

(c) To allocate the actual retrenchment rate of water intake to each water intake point.

As mentioned above, there is no unified agency to monitor and/or supervise the low flow discharge as well as the overall registered intake volume for domestic/industrial water supply and irrigation water supply in the Perak river basin. Under such a situation, the above drought management could be hardly executed.

The appropriate drought management will require a complex information including the real-time gauging information on the river flow regime and the database

information (the non-real time monitoring system) on the registered water intake volume (refer to Chapter 9).

3.2.3 River Environmental Management

The river water quality and ecotourism are emphasized as the major objectives of river environmental management for the Perak River.

(1) Water Quality

All agencies related to river water quality such as DOE and PWB point out that the Perak mainstream contains serious turbidity that causes difficulty in treating water for domestic and industrial water supply. The agencies attribute the major cause of turbidity to the excessive logging activities in the upper reaches, particularly, in the Pelus river basin.

However, no detailed information on logging activities as well as land development activities in the upper reaches has been transmitted to DOE and other agencies related to river water quality. No coordination on control of logging activities also has been made between the Forest Department and the agencies concerned in the management of river water quality.

In addition to the turbidity of the Perak River, water of the Kinta River has also an aggravated BOD, COD, SS and DO as seen in the annual trend of water quality of both rivers for five years from 1992 to 1996 (refer to Fig. 3-2 and Table 3-1). The Water Quality Index (WQI) prepared by DOE also indicates the deterioration of water quality of Kinta River, particularly around Ipoh City as shown in Fig. 3-3. Such water pollution is deemed caused by effluent from the urban drains in Ipoh City and/or mining.

In connection with the water pollution, DOE had identified the organic pollutant sources such as industrial estates, pig farms, and rubber/palm oil factories (refer to Fig. 3-4). However, the monitoring on river water quality is not supported with the river discharge gauge, causing difficulties in making a quantitative analysis on the relationship between the pollution of river water and the pollutant sources.

(2) Ecotourism

Yayasan Perak, a subsidiary of the State Development Corporation of Perak, undertakes management to preserve the natural conditions/historical monuments along the Perak River and to develop tourism facilities such as camping sites, lodging and fishing facilities. However, information on the tourism attractions is not well known by the public, which leads to difficulties in promoting tourism.

Yayasan Perak also organizes navigation by boat as part of the tourism attractions, but difficulties on river navigation is being experienced due to the sediment on the river channel and the sand mining pipes crossing the river channel.

3.2.4 Watershed Management

Watershed management is closely related to the forest conservation in the upper reaches and the urban and industrial development in the flood hazard area as presented below.

(1) Forest Conservation

The present forest area of 8,270 km^2 (or about 56% of the river basin) spreads out in the upper reaches of the Perak River, and the area is delineated as the forest reserve area managed by the Forest Department. The delineated forest reserve area is further classified into the following three (3) categories (refer to Fig. 3-5):

(a) Water Catchment Area of 981 km^2 delineated along the river course, where no logging activity is allowed to preserve the river flow and channel conditions in the lower reaches;

(b) Virgin Forest of 3,819 km^2, where logging activity is allowed but not yet started; and

(c) Production Forest of 3,479 km^2, where logging activities are being carried out.

Logging activities are now being intensively carried out in the production area delineated in the Pelus river basin. Such logging activities may be one of the major causes of the present serious sedimentation of the river channel and the turbidity of the river water in the lower reaches of the Perak river. Moreover, further excessive logging activities in the Pelus river basin may cause other adverse effects on the downstream of Perak River such as increment of basin runoff flood discharge and aggravation of low flow regime. Thus, logging activities are closely related to the

river management works, and the information on the basin forest reserve conditions could be one of the important data sources for the proposed river basin management system.

(2) Urban and Industrial Development

The State Government of Perak has formulated the State's strategic development plan with four development corridors to develop urban and industrial centers in the State; namely, (1) the East-west corridor, (2) the North corridor, (3) the Central corridor, and (4) the South corridor (refer to Fig. 3-6). In line with the strategic plan, about 20% of the entire watershed of the Perak River (3,000 km^2) has been delineated as the development area (refer to Fig. 3-7).

Among the above development corridors, the Central and South corridors are projected along the river course in the lower reaches, and could overlap with the possible flood inundation area. The excessive land development in the Central and South corridors may increase the flood damage potential in the Perak river basin and further reduce the existing natural retarding effect on floods. Thus, in the same way as the aforesaid logging activities, the urban and industrial development in the basin are closely related to the river management works, and the information on the basin development conditions could be one of the important data sources for the proposed river basin management system.

CHAPTER 4 INVENTORY OF PRESENTLY AVAILABLE INFORMATION ON RIVER BASIN MANAGEMENT

4.1 River Gauging Information

4.1.1 Hydrological Information

DID is the main agency monitoring rainfall, river stage/discharge and the river suspended sediment through the following gauging stations:

Gauging Item	Number of Gauging Stations
Rainfall	62
River Stage and Discharge	12
River Suspended Sediment	10

The State DID collects the hydrological gauging data and forwards them to the Federal DID Hydrology Division at monthly intervals for centralized processing. On receipt, the Federal DID Hydrology Division checks the data, records them in the registers and then processes them using the Electronic Data Processing (EDP) System. After the data are processed with the EDP system, the processed data are stored into the Hydrological Data Bank System set up in the DID Hydrology Division. Through the EDP, the following digitized hydrological gauging data are made available:

Gauging Item	Available Information
Rainfall	• Hourly and daily rainfall depth
River stage	• Mean daily river stage • Maximum and minimum instantaneous river stage
River discharge	• Rating table for river stage-discharge • Mean daily discharge • Maximum and minimum instantaneous discharge
Suspended sediment discharge	• Rating table for river stage-discharge • Mean daily suspended discharge • Maximum and minimum instantaneous discharge

During the study period, the following issues were clarified based on the hydrological information on the Perak river basin:

(1) Density of Rainfall Gauging Stations

As mentioned before, there are 67 rainfall gauging stations in the Perak River and most of them are operated by DID. The average density of the existing DID rainfall

stations in the Perak river basin is 237 km2/station (14,700 km2/62 stations) and could satisfy the minimum density of one station per 100-250 km2 under normal undulating to flat terrain recommended by the World Meteorological Organization (WMO).

However, the rainfall stations are biased to the lower and middle reaches of the Perak river basin, and scarcely distributed in the upstream basin from the Chenderoh Dam (refer to Fig. 4 1). The density of rainfall stations of both DID and TNB in the upper reaches is only 788 km^2/station. Such scarce density of rainfall stations in the upper reaches is attributed to the difficult accessibility and is deemed to be extremely difficult to increase. Moreover, DID is quite reluctant to increase the number of hydrological stations due to the shortage of staff for installation and maintenance of new stations.

(2) Location of River Discharge Gauging Station

Along the mainstream of the Perak River, there exits only one (1) key river discharge gauging station at Iskandar Bridge along the downstream (refer to Fig. 4-2). Most of the existing major water intake points are located downstream from the gauging station and, therefore, the gauging station is quite useful to monitor the inflow discharge to the intake facilities. No river discharge gauging station is, however, installed downstream from the existing water intake facilities, causing difficulties in estimating the actual water intake volume. Under these conditions, it is deemed necessary to install several new river discharge gauging stations on the downstream from the Iskandar Bridge.

(3) Discharge Measurement

DID develops the discharge rating curves through regular discharge measurements with the current meter and cross-sectional surveys at river stage and discharge stations. The measurements are currently carried out around twice a month, while the cross-sectional surveys are once a year in principle. Suspended sediment measurements are also made at least once a month. These measurements are, however, made as a routine work according to a fixed timetable, and not in response to the change of river water level. Consequently, the measured river stage tends to concentrate within a narrow range, and the flood and low flow discharge are estimated by extraordinary extrapolation leading to little reliability. The typical example of such unfavorable condition is given by the existing gauging station at the

Iskandar Bridge, where the maximum observed flood revel was EL. 41.94 m while the measured river stage was only within 32.65 m to 33.64 m (refer to Fig. 4-3).

4.1.2 Water Quality Information

DOE monitors the water quality of Perak River and its tributaries about three times a year. The water sampling points for river water quality in the Perak river basin tends to increase and has reached 52 points in 1996 (refer to Table 4-1 and Fig. 4-4). The monitoring items include the human life items (such as pH, DO, BOD5, COD, SS, NH3-N) as well as the human health items (such as heavy metals, coliform, cyanide, phenolics, and pesticides) which are essential indices to clarify the river water quality and execute pollutant control.

DID has also monitored river water quality since 30 years ago. However, DID is reducing the number of its water sampling points which are currently limited to 12 points and has ceased to monitor organic water pollutants such as DO, BOD5, and COD in the recent 10 years.

PWB also monitors river water quality as raw water quality for the treatment plant of domestic water supply, but both monitoring points and monitoring items of PWB are covered by the DOE monitoring network. Thus, the monitoring on water quality by DID as well as PWB is of little significance on the river basin management work as compared with the monitoring by DOE.

As stated above, DOE is regarded as the eligible data source for water quality. The Federal DOE entrusts the water sampling works and the laboratory tests to a private firm and the Department of Chemistry, respectively. The results of the laboratory tests are finally processed and stored in the database system of the Federal DOE. A series of water sampling, laboratory test and data processing/storing works are under the management of the Federal DOE. Thus, all river water quality data has been digitized and are managed by the Federal DOE.

The items of water quality tests by DOE are judged to be adequate for the river basin management works covering all major organic chemicals as well as inorganic chemicals in accordance with the water quality standards and criteria specified by DOE. The water sampling by DOE is, however, not associated with the discharge measurement. Under such conditions, although the concentration of quality items could be well estimated, the quantitative pollutant loads could not be clarified. Accordingly, it is deemed necessary to set

up several unified points for water sampling and river discharge gauging with the coordination between DOE and DID, the competent authority for discharge gauging.

4.2 Information on Field Survey

DID is the competent agency to undertake the river channel survey, monitor the river morphology (sedimentation, erosion, meandering), and/or facilitate river channel management. However, longitudinal profile and cross-section surveys of a substantial stretch of the Perak River have not been carried out by DID since the 1970s. DID presently carries out only periodical spot cross-sectional surveys at river discharge gauging stations and/or river intake points. Moreover, many of the channel survey results before 1970s have been scattered and lost. To retrieve conditions, an attempt should be made to resume regular river channel surveys and, at the same time, establish a data management system for the results of the channel survey.

The State DID also carry out flood damage survey in every major flood. The results of flood damage survey are compiled as annual flood damage report and submitted to the Federal DID. The report contains the hydrological data observed at the gauged stations and the flood damage data collected from the field survey in every major flood.

The annual flood damage reports since 1950s have accumulated to a tremendous volume and are very useful to know the actual flood conditions and to facilitate further flood mitigation works. However, many of the reports at both Federal and State DID have been scattered and lost. Such unfavorable condition may be attributed to the lack of staff to well arrange such extensive collection of reports and the difficulty of filing the reports with various sizes of flood maps.

The Department of Wildlife and National Parks (DWNP) surveys the gender, size, location and habitat of aquatic wildlife such as fishes, terrapins and crocodiles in the Perak river basin, recording them in the GIS database. The objective river stretch for the survey is selected as the natural reserve area every three years, and the survey thereof is made two times a year.

The freshwater fishes tend to inhabit the upper reaches from Teluk Intan in the river basin. The major habitats of fishes in the Perak River are as shown in Fig. 4-5. The crocodiles also inhabit around the confluence of the Perak and Kinta rivers. The number of crocodiles has, however, remarkably diminished due to the water pollution from Kinta River, and the crocodiles in Perak River are currently specified as rare species.

The Department also specify the following four protected areas in the Perak river basin, and the animals to be protected in the area (refer to Fig. 4-6).

Name/Place	Area (ha)	Year Gazetted	Responsible Agency	Protected Animals & Plants
Batu Gajah Bird Reserve	4	1952	DWNP	Birds
Bota Kanan Tuntung Reserve	6	1993	DWNP	Terrapin
Chior	689	1903	DWNP/FD	
Sungkai	2,468	1921	DWNP	Deer

DWNP: Department of Wildlife and National Parks; FD: Forest Department

4.3 Information on River Management

There are various information related to river management. The major ones are as presented below.

(1) Information on Flood Mitigation

The state DID and the tin mining companies have carried out and proposed various structural measures for flood mitigation including channel improvement, construction of perimeter bund, and flood diversion channel as given in Tables 4-2 to 4-3 and Fig. 4-7. The design flood level adopted for these structural measures are 25-year return period for the Perak River and 5 to 100-year return period for the Kinta River. The detailed information on these structural measures are currently kept by the DID districts office, and integration of such information is indispensable in order to figure out the entire flood mitigation works in the basin and to formulate the consistent and optimum flood control plan based on the information on the exiting flood control structures.

In addition to the above flood mitigation structures, there exist four (4) hydropower dams. Among the four (4) existing dams, Bersia, Kenering and Chenderoh have little flood regulation effects due to their limited dam reservoir capacity. However, Temengor Dam has by far a larger flood regulation effect than the other dams. The information on the detailed structural features as well as the reservoir operation rules for these dams are kept by TNB.

(2) Information on Water Supply

There are eleven (11) intake facilities for irrigation and thirty-two (32) intake facilities for domestic and industrial water along the main stream of the Perak River

(refer to Tables 4-4 to 4-5). These intake facilities fulfill the water demand of several service areas as shown in Tables 4-6 to 4-7 and Figs 4-8 to 4-9. The information on the detailed structural features of these intake facilities as well as their objective supply is separately kept by DID for irrigation and PWB for domestic and industrial water supply.

(3) Information on Bridges

There are twelve (12) trunk bridges crossing over the Perak River and its tributaries (refer to Fig. 4-10). The bridges are ten (10) federal bridges, one (1) highway bridge and one (1) state bridge. The information on the structural features of these bridges are, however, separately stored by the Federal Government, the Plus (the privatized firm controlling the highway) and the State Government. Thus, no integrated information source on the bridge structures is available, causing difficulties in obtaining the overall information for the river basin.

(4) Information on River Sand Mining Activities

There are 36 sand mining sites along the Perak River between the Kenering Dam and the river mouth (refer to Fig. 4-11). The Department of Land and Mining issues annual licenses for sand mining. The mining records are, however, dispersed in its district offices.

(5) Information on Ecotourism and Riverside Park

Yayasan Perak organizes ecotourism in the Perak River, furnishing information on the ecotourism attractions (refer to Table 4-8). The local authority also manages the riverside parks. Information such as those related to river environment will be useful to facilitate public awareness on the river and regarded as one of the important information for the proposed river basin information system.

4.4 Basin Land Information

The following maps and plan are required as major information sources for the watershed management of the Perak river basin:

Items	Major Objectives to Clarify
Land Use Map	Present land use conditions in the entire river basin
Forest Conservation Map	Non-logging and logging areas in the upper reaches
Soil Map	Soil condition in the basin including condition of soil erosion and production of basin sediment runoff
Geological Map	Geological condition in the basin
Topographic Map	Topographic condition in the basin
Cadastral Map	Landowner and detailed classification of land use
Structural Plan	Urban and industrial development plans particularly in the flood prone area

Identified during the study period are fifteen (15) kinds of maps prepared by ten (10) government agencies and they could cover all the necessary map information listed above. The digitizing work on most of these existing maps are either in progress or completed (refer to Table 4-9).

Among the agencies related to the mapping work, the Department of Survey and Mapping, Malaysia (DSMM) as well as the Department Survey and Mapping, Perak (DSMP) are specialized in developing maps. Therefore, the accuracy of their maps is fully guaranteed, particularly, in terms of globular projection and accuracy of coordination.

However, other agencies put a higher priority on the expression of attribute information on their maps rather than accuracy. As a result, their maps do not have a standardized globular projection and coordination, giving the low map accuracy. The digitizing of such unreliable map information will require a complex process. The base maps first need to be developed from those prepared by DSMM/DSMP and then the attribute information are transformed to the base map.

Almost all agencies related to the mapping work have developed or are going to develop a Geographical Information System (GIS) for their particular purposes.

CHAPTER 5 EXISTING RELEVANT INFORMATION SYSTEM

5.1 Data Processing System

The following were identified as the prevailing hardware and application software for data processing in Malaysia.

(1) Hardware

Among the agencies interviewed, twelve (12) agencies apply the UNIX as the data processing device (refer to Table 5-1). All information in the existing systems other than the system of the Fishery Department are transferred within the extent of Local Area Network (LAN) providing the information only to in-house users. Thus, most of the existing systems do not apply a Wide Area Network (WAN) using Intranet and/or the Internet.

The UNIX has been the standard OS in the engineering field for a long period, accumulating various kinds of applicable software for technical calculation. Moreover, the UNIX contains a customized function to connect the computer machine (the mini-computer or workstation) with networks (LAN and WAN) not requiring any additional application software for the network connection.

(2) Application Software OS such as MS-DOS

Among the agencies interviewed, ten (10) agencies apply the Geographical Information System (GIS) as the main application database program. Among them, seven (7) agencies use the Arc/Info software. The Arc/Info can run on all of the UNIX machines and is compatible with the remote sensing data. Several agencies such as DOA, DOE and the Forest Department develop the mapping database using a combination of the Arc/Info and the remote sensing data due to the said compatibility.

The GIS requires, in general, a huge memory capacity of the processing machine and, therefore, usually applies the client-server system. The above Arc/Info is for use of the client-server system. To minimize the required memory for the GIS processing, the application programs ArcView and MapInfo have been developed and could be used by a single desktop computer. The editing functions of these software are quite limited as compared with the Arc/Info. Since ArcView and Arc/Info have been

developed by the same manufacturer and compatible with each other, the DID Hydrology Division, DOE and the Forest Department apply Arc/Info on their UNIX machine (client-server system) and the ArcView on their personal computer.

In addition to the above GIS, some agencies use the application software for database called "Infomix" and "ORACLE". According to the interview survey, however, these database software had been applied before the GIS prevailed, and continues up to the present. Although desirable, it is difficult to convert the present database to the GIS due to budgetary constraint.

5.2 Data Transmission System

In view of the objectives of Vision 2020 defined by the Government of Malaysia in 1991, Telekom Malaysia which is the biggest telecommunications company in Malaysia has made the following visions to provide advanced telecommunications services by the year 2005:

(1) To increase the telephone penetration rate from the current 10 per 100 population to 40-45 per 100 population (in terms of telephone line from 1.6 million in 1990 to 11.3 million by 2005);

(2) To improve internal productivity and efficiency through the effective use of updated technology;

(3) To offer more value-added information services including the establishment of a nationwide Integrated Services Digital Network (ISDN); and

(4) To establish an effective and comprehensive optic fiber network linking Peninsular Malaysia, Sabah and Sarawak.

The present annual average growth of telephone lines is about 14%, and the total telephone line is assumed to reach 12.5 million by the year 2005 based on the average growth. In addition, the Telekom Malaysia now offers the following telecommunications services for all major cities in Malaysia:

(1) Integrated Services Digital Network (ISDN)

(2) Digital Leased Line

(3) Analog Leased Line

The Malaysian East Asia Satellite (MEASAT-1) was launched in January 1996 as the first stationary telecommunications satellite of Malaysia. The purpose of this satellite is to realize sophisticated telecommunications services such as satellite TV and multimedia data transmission. In addition to the MESAT-1, launching of other eight (8) satellites are scheduled.

In parallel with the above expansion of telecommunication infrastructures, the nationwide communication network system is also being set up by various government agencies. The Ministry of Agriculture (MOA) established the first government wide area network called AGROLINK and started operation in 1995.

The AGROLINK is for common use of all departments of MOA so as to minimize the network construction cost and telecommunication cost and also to effectively exchange information among the related agencies. Presently, the AGROLINK links all departments of MOA located in Kuala Lumpur and the State of Penang by the optical fiber cable. It is also scheduled to link, through access points, to Perak State and other four states within fiscal year 1997. Moreover, the linkage of AGROLINK for all states will be completed by fiscal year 1998.

The Network Operation Center (NOC) at MOA in Kuala Lumpur is responsible for the whole AGROLINK administration, and the Network Information Center (NIC) at the State government is responsible for managing network equipment and user registration (refer to Fig. 5-1). The Federal government agencies under MOA need to apply the linkage of AGROLINK to NOC, and state agencies to NIC.

The system of AGROLINK is protected by firewall from illegal invasion on the network. All server machines at NOC are, however, open to the legal public users of Internet. Public users can easily get information to access and browse the Homepage.