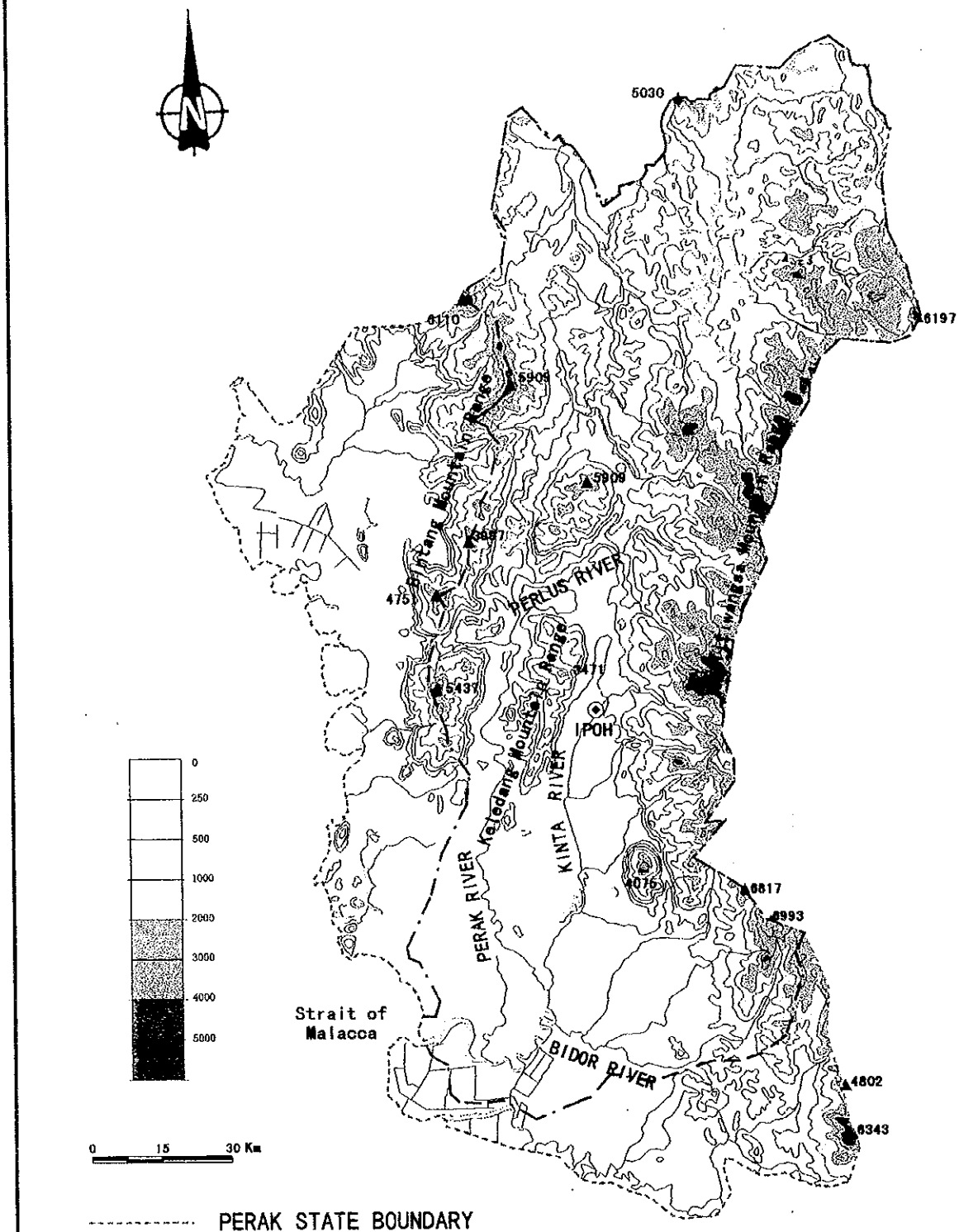
*FIGURE*

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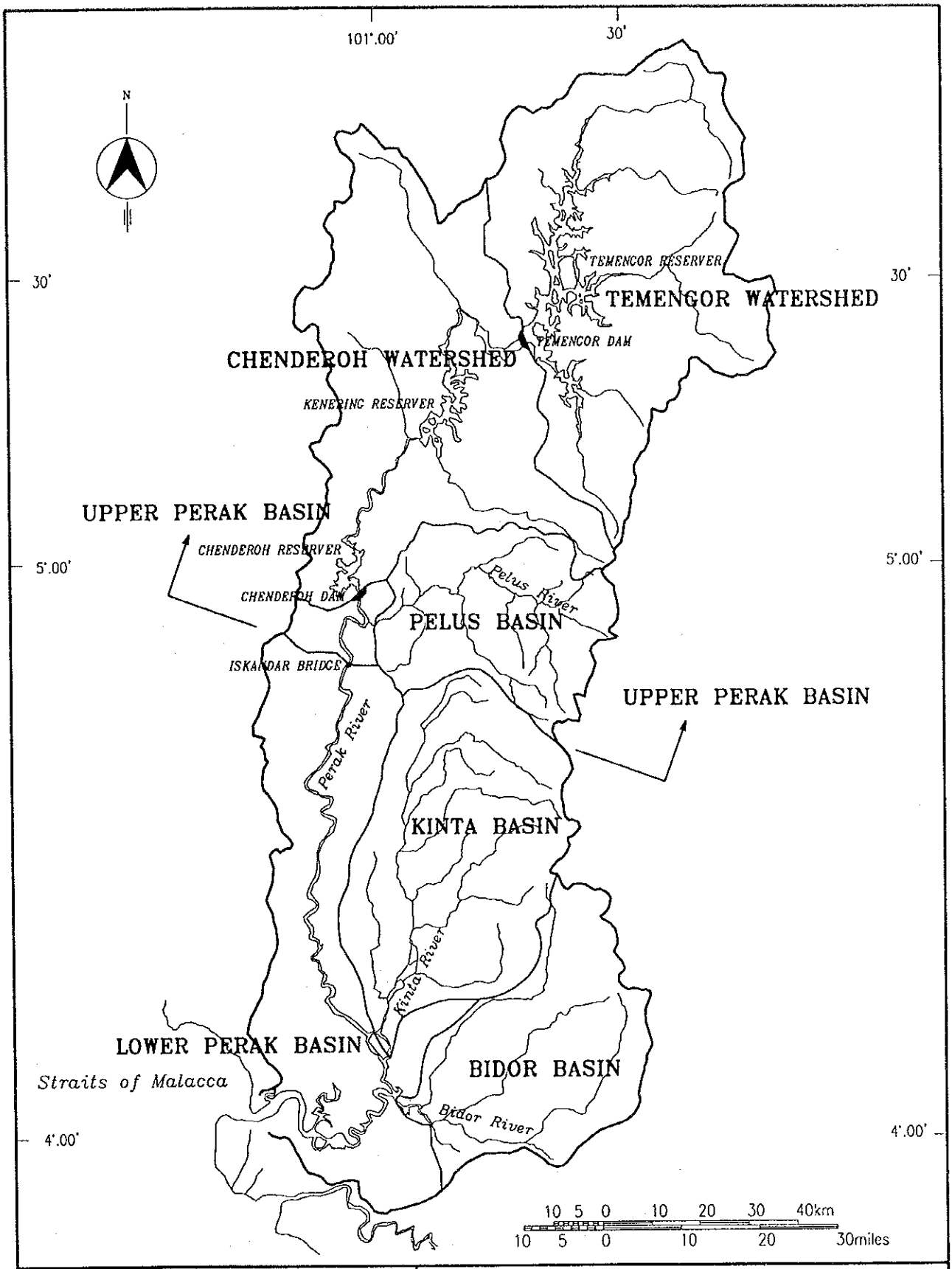
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-1 TOPOGRAPHIC MAP OF PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

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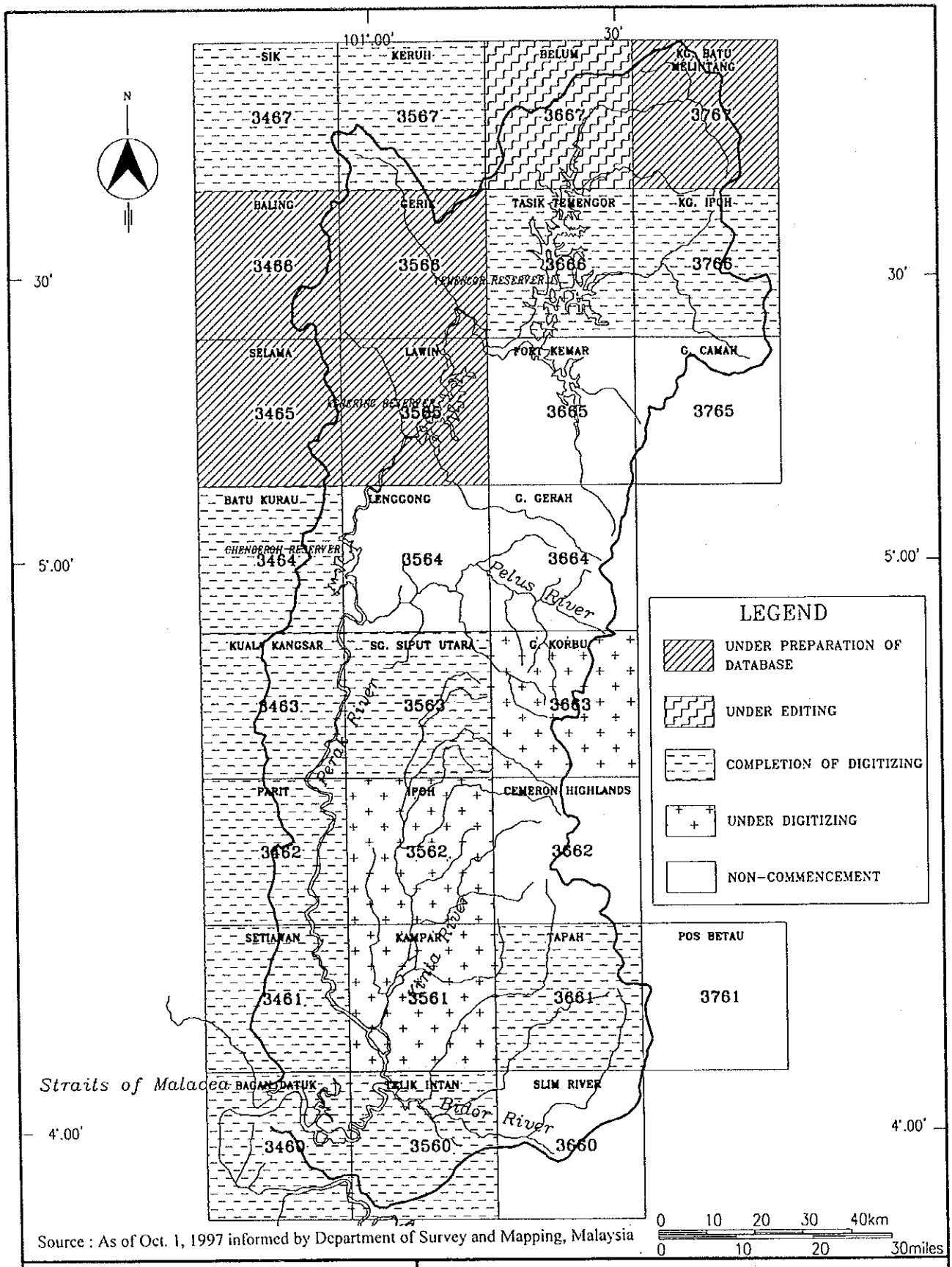
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA<br>JAPAN INTERNATIONAL COOPERATION AGENCY | Fig. III-2 DIVIDE OF PERAK RIVER BASIN |




Source : As of Oct. 1, 1997 informed by Department of Survey and Mapping, Malaysia

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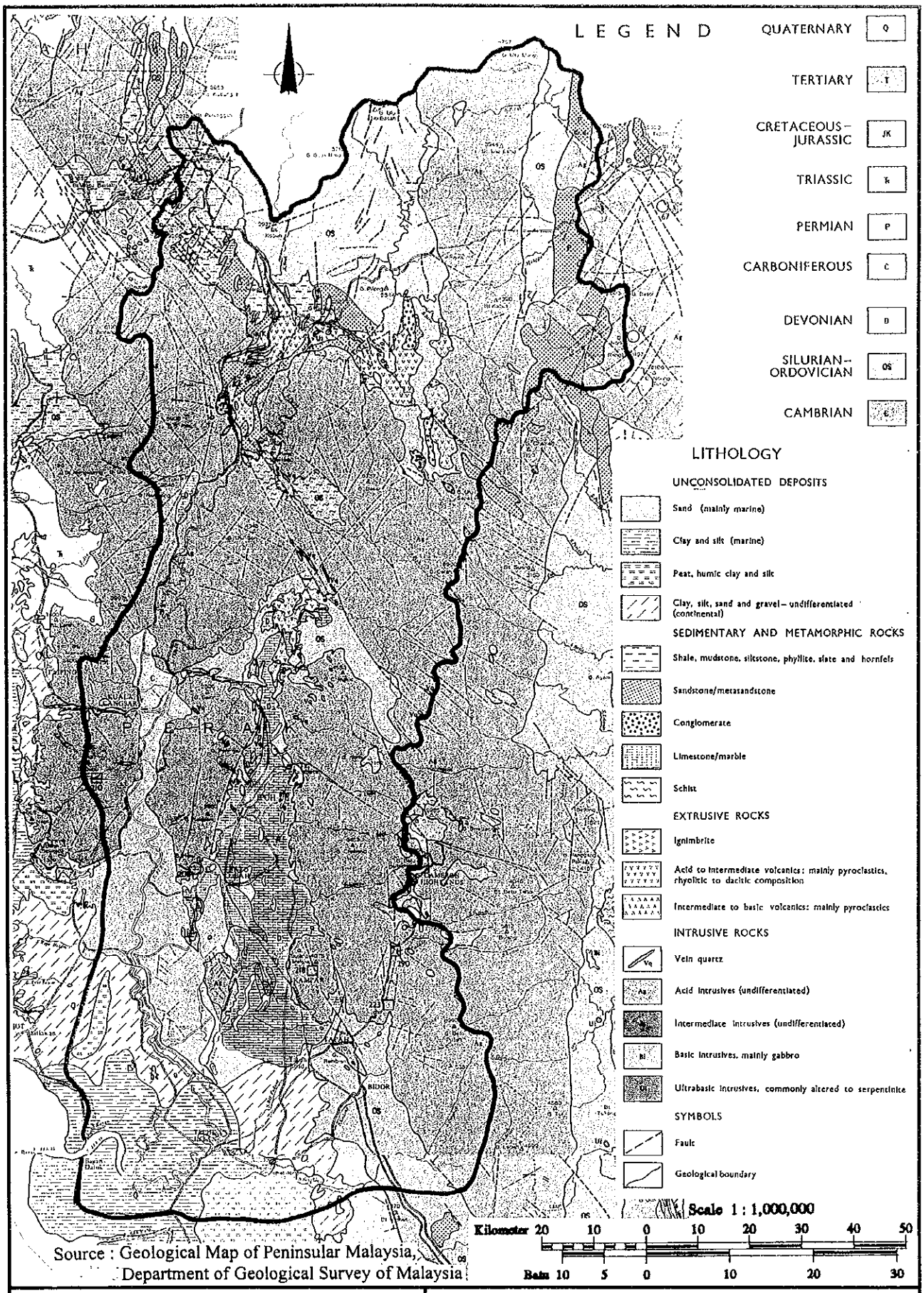
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA<br>JAPAN INTERNATIONAL COOPERATION AGENCY | Fig. III-3 PROGRESS OF DIGITIZING WORK OF 1:50,000 TOPOGRAPHIC MAP |




Source : Geological Map of Peninsular Malaysia, Department of Geological Survey of Malaysia

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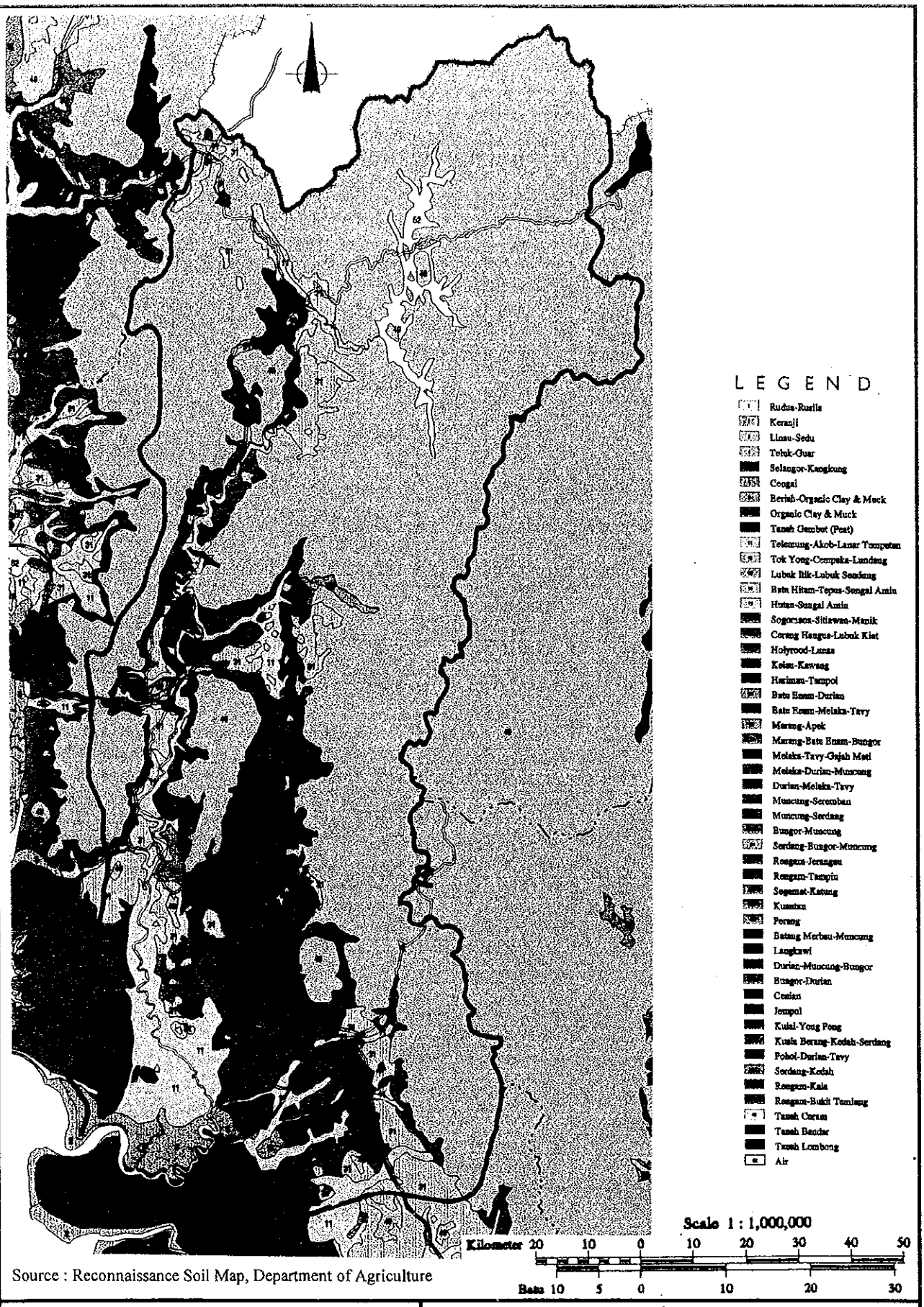
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-4 GEOLOGICAL MAP OF PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




Source : Reconnaissance Soil Map, Department of Agriculture

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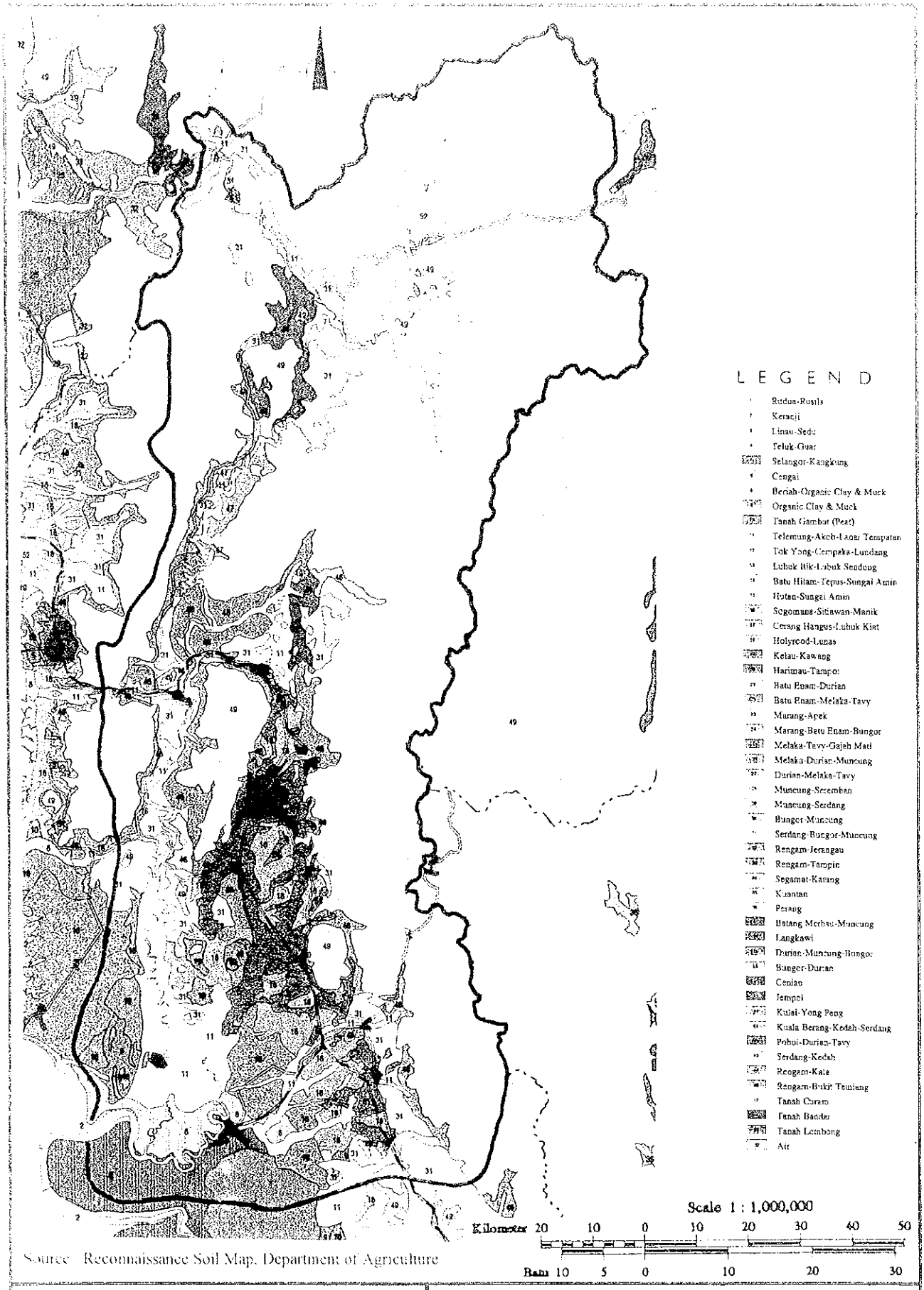
|---|---|
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-5 SOIL COVER OF PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

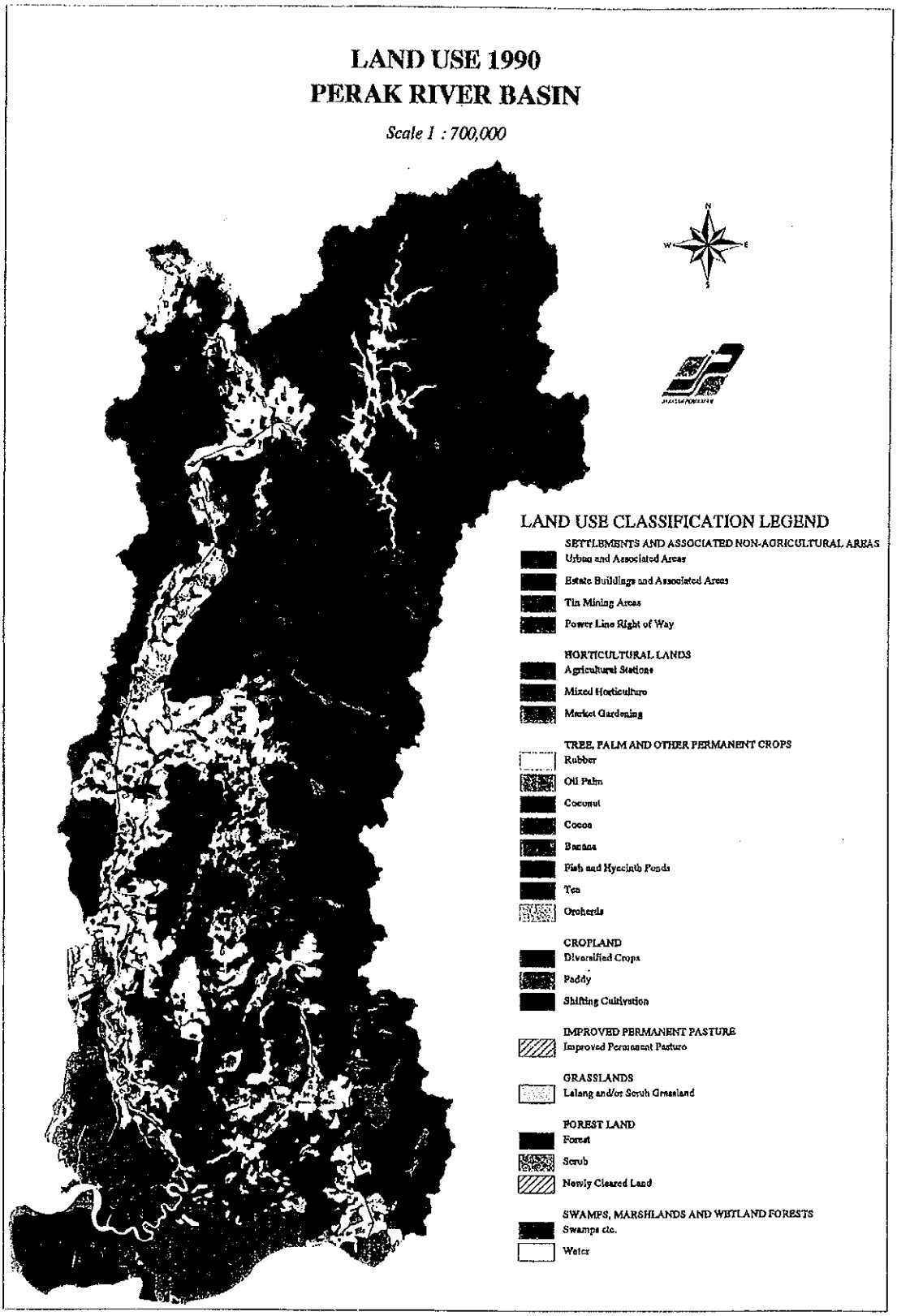



Source : Reconnaissance Soil Map, Department of Agriculture

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

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. III-5 SOIL COVER OF PERAK RIVER BASIN




Source : Department of Agriculture

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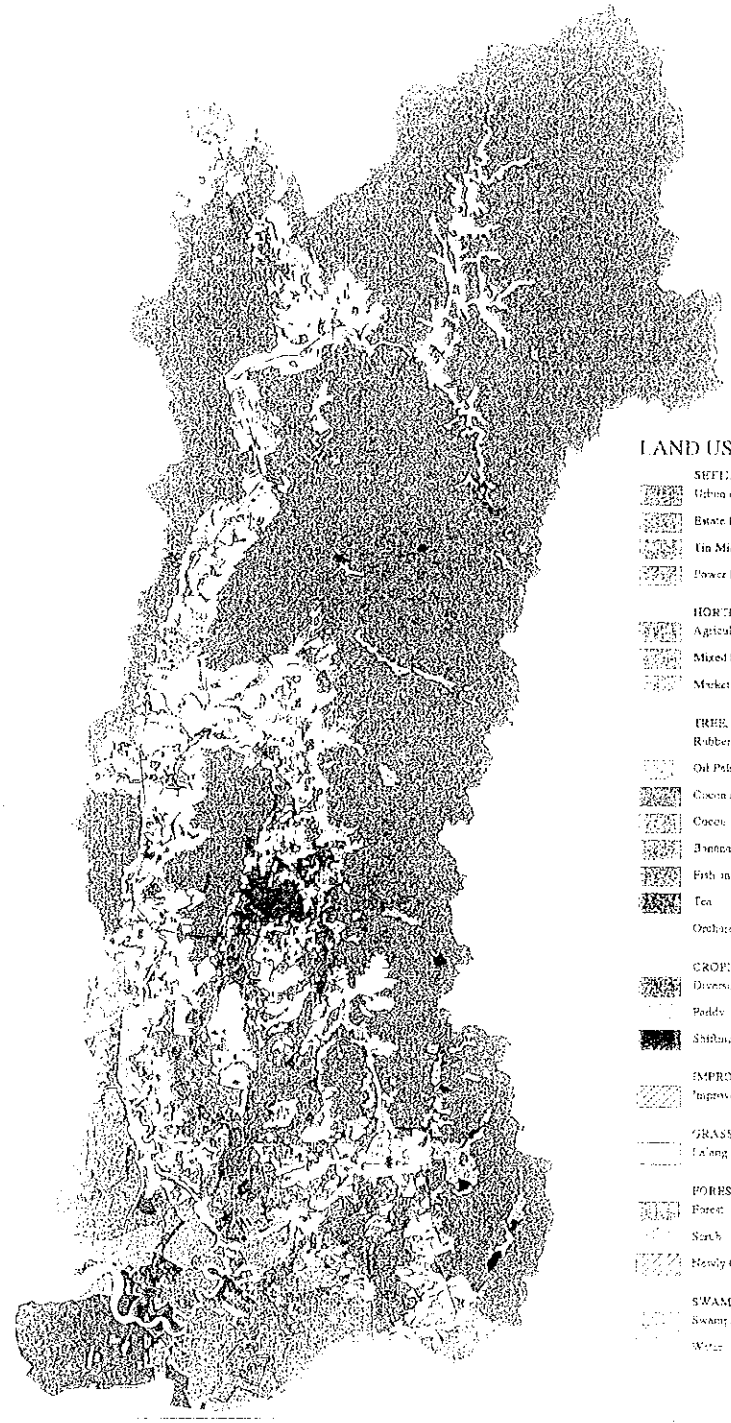
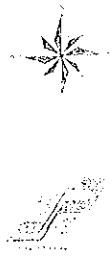
|---|---|
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-6 LAND USE OF PERAK RIVER BASIN IN 1990 |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

# LAND USE 1990
# PERAK RIVER BASIN

*Scale 1 : 700,000*





## LAND USE CLASSIFICATION LEGEND

SETTLEMENTS AND ASSOCIATED NON-AGRICULTURAL AREAS
- Urban and Associated Areas
- Estate Buildings and Associated Areas
- Tin Mining Areas
- Power Line Right of Way

HORTICULTURAL LANDS
- Agricultural Stations
- Mixed Horticulture
- Market Gardening

TREE, PALM AND OTHER PERMANENT CROPS
- Rubber
- Oil Palm
- Coconut
- Cocoa
- Banana
- Fish and Livestock Farm
- Tea
- Orchards

CROPLAND
- Diversified Crops
- Paddy
- Shifting Cultivation

IMPROVED PERMANENT PASTURE
- Improved Permanent Pasture

GRASSLANDS
- Lalang and/or Scrub Grasslands

FOREST LAND
- Forest
- Scrub
- Newly Cleared Land

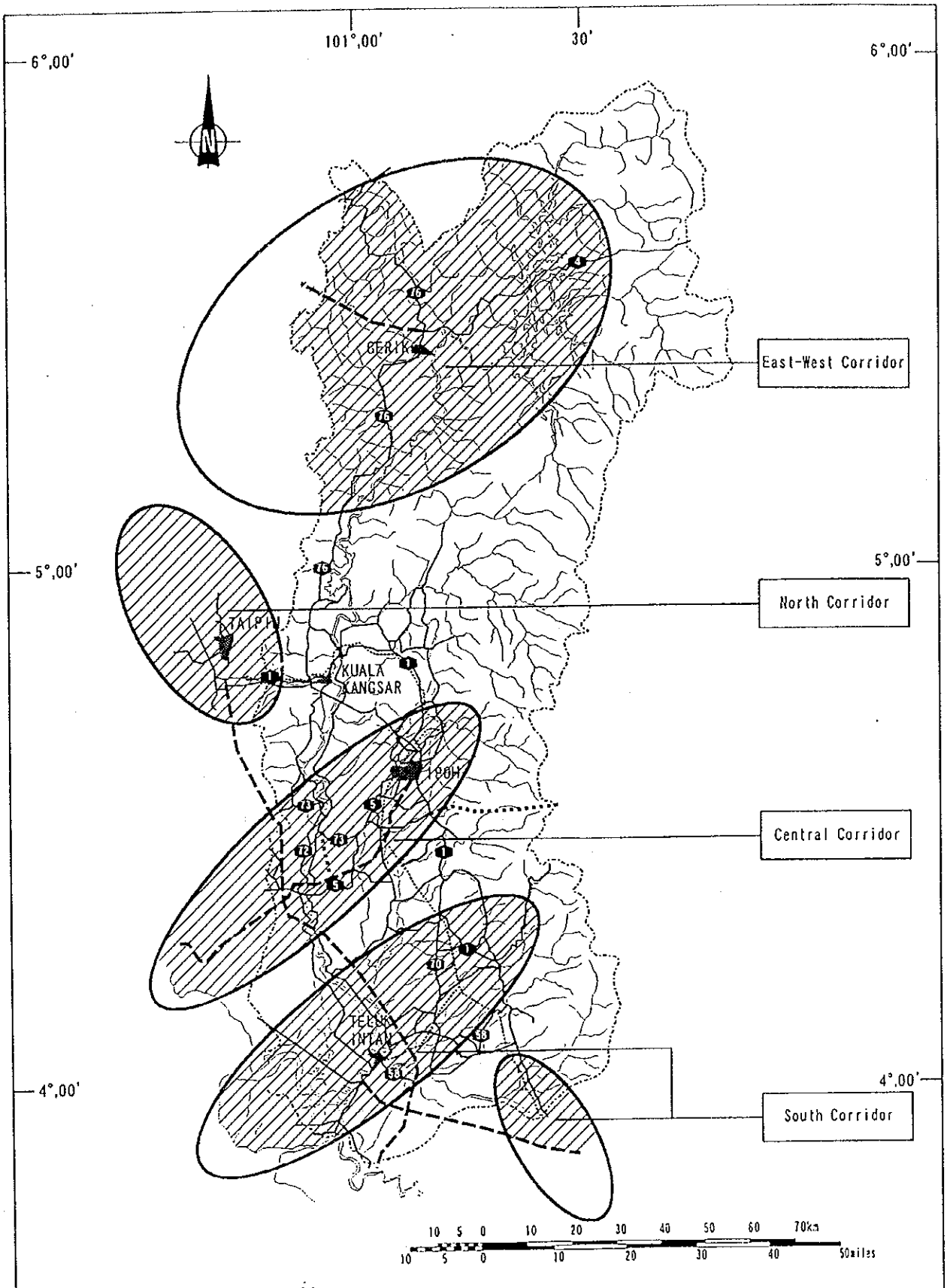
SWAMPS, MARSHLANDS AND WETLAND FORESTS
- Swamp etc
- Water

Source : Department of Agriculture

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

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. III-6 LAND USE OF PERAK RIVER BASIN IN 1990




Source : Perak Menjanjikan Emas, 1996

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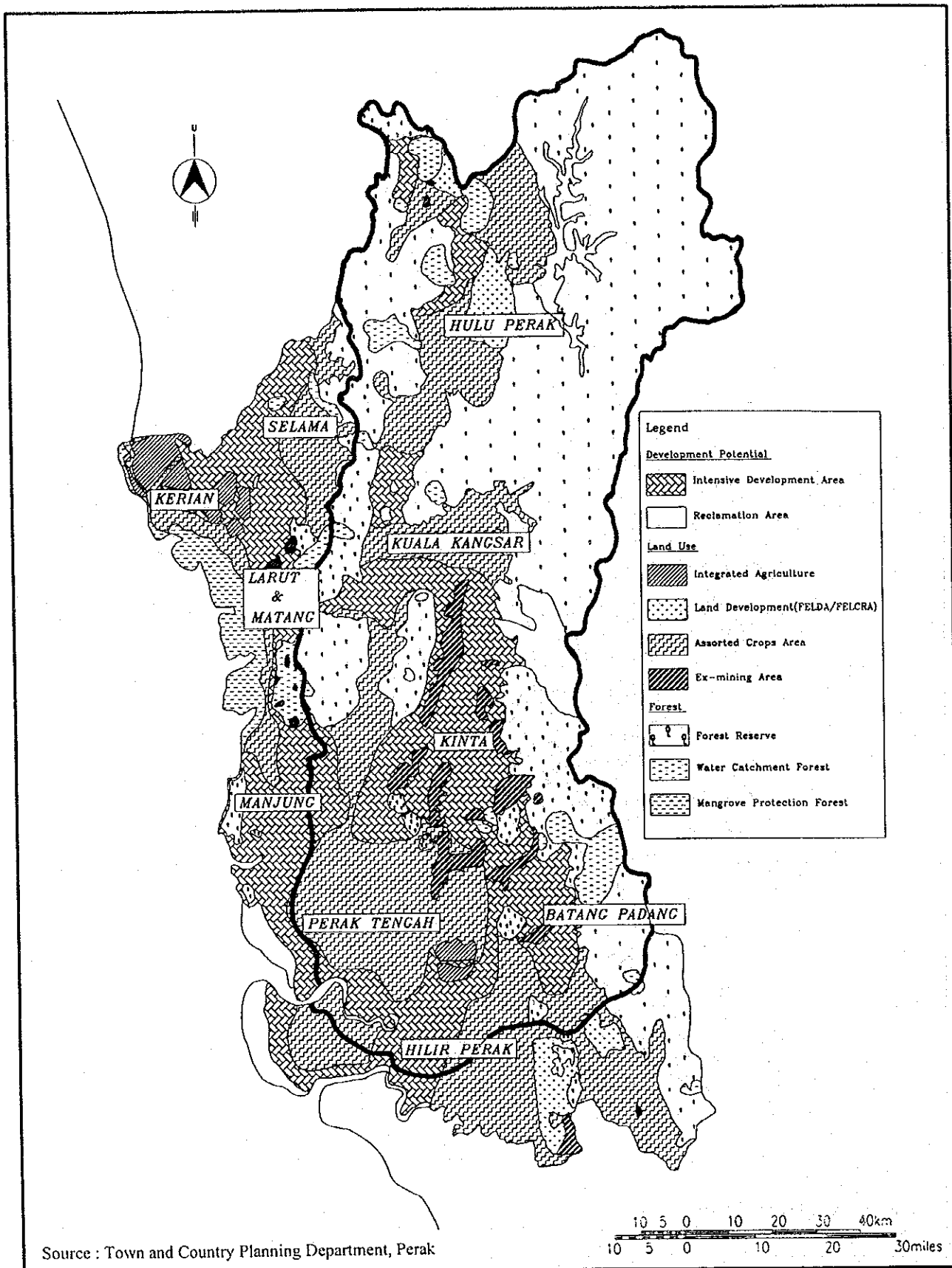
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-7 STRATEGIC DEVELOPMENT CORRIDOR IN PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

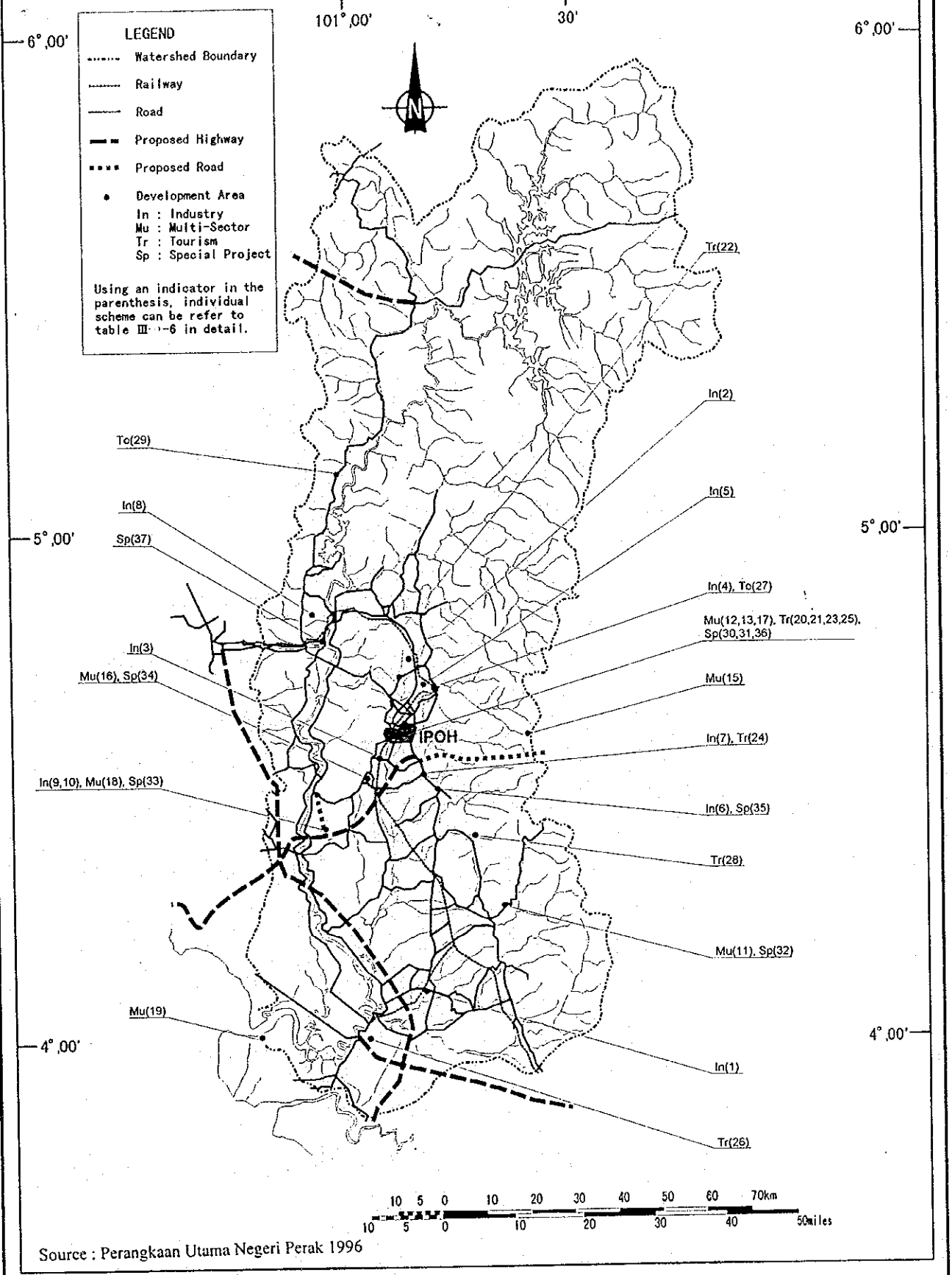



Source : Town and Country Planning Department, Perak

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

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. III-8 FUTURE LAND USE PLAN IN PERAK RIVER BASIN




Source : Perangkaan Utama Negeri Perak 1996

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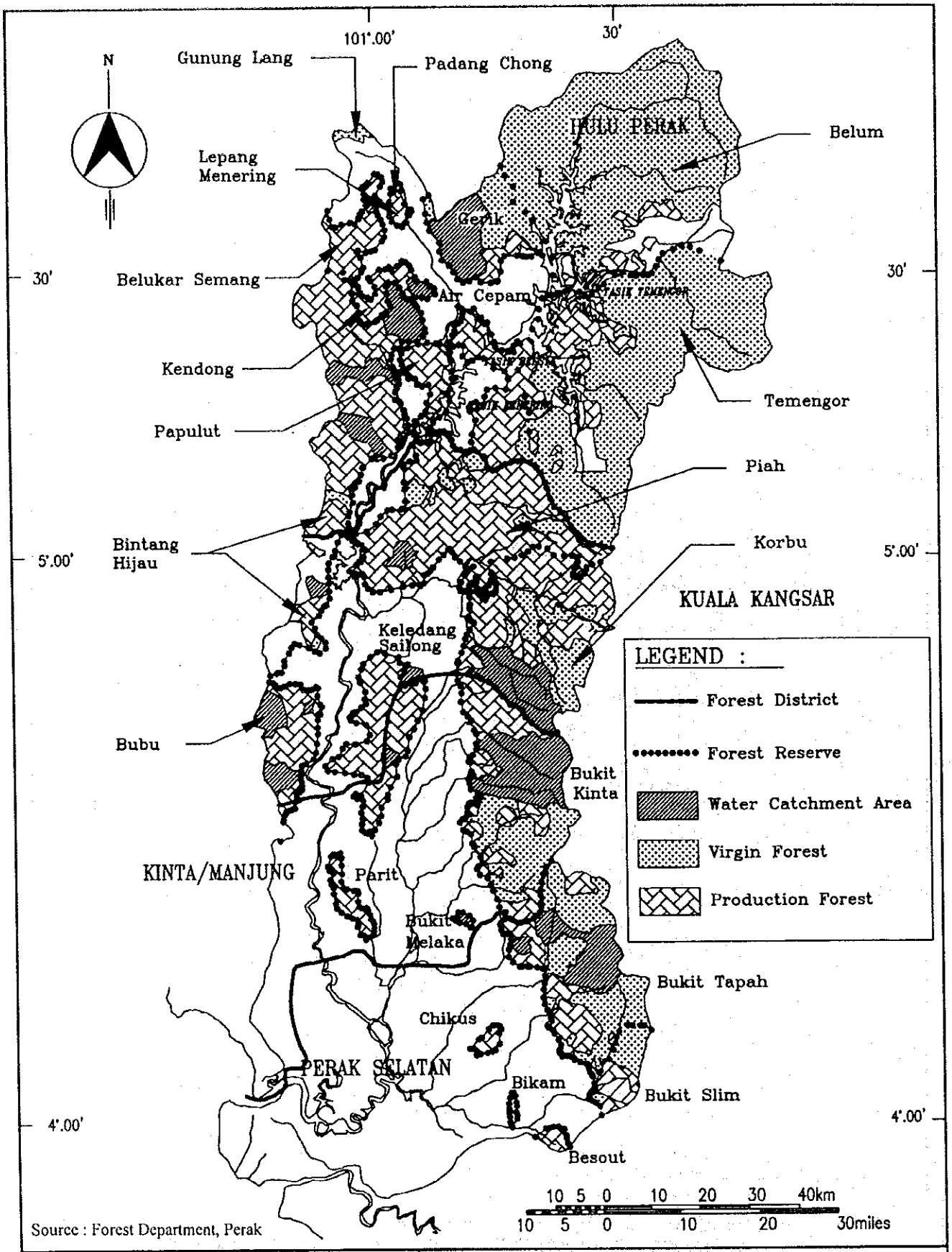
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-9 MAJOR DEVELOPMENT SCHEMES IN PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |

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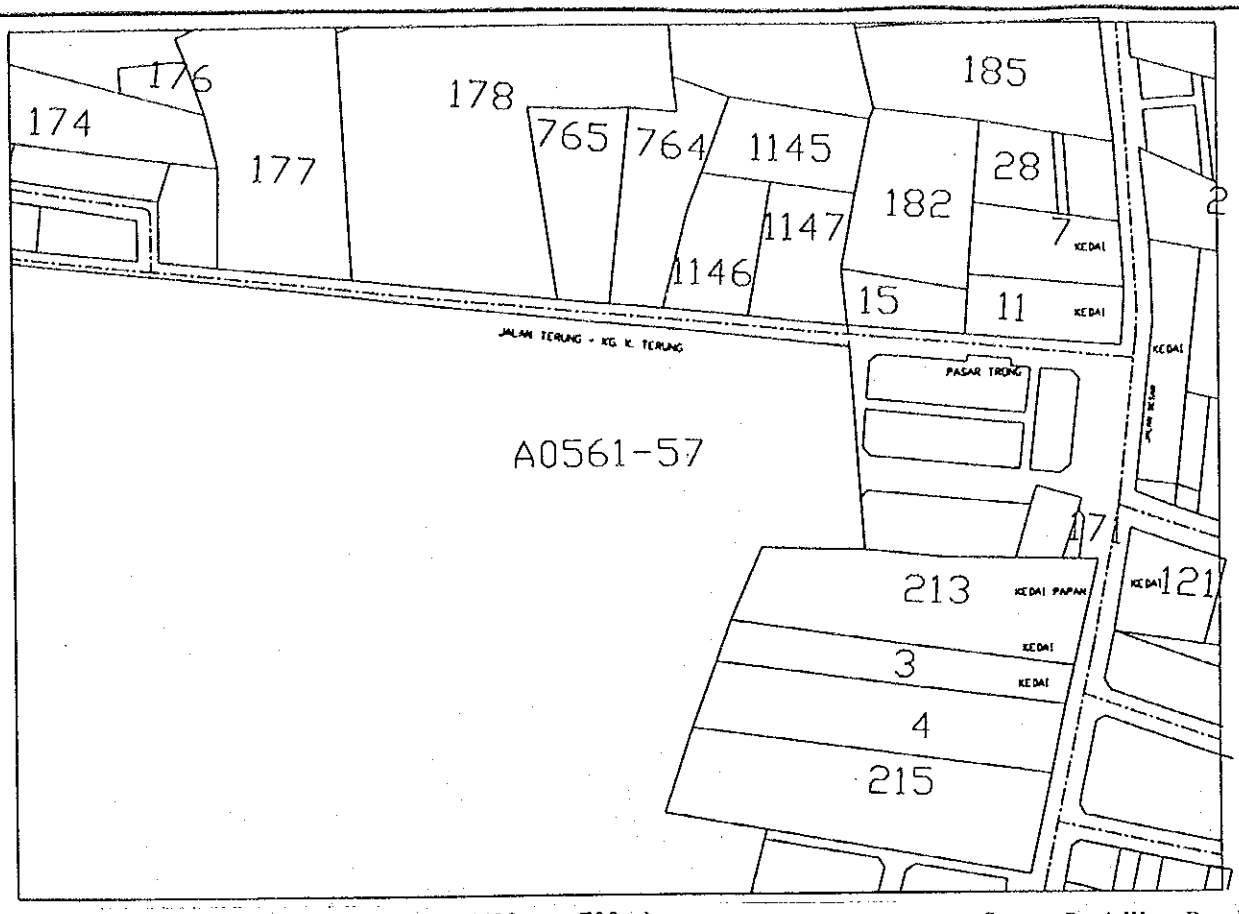
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-10 FOREST RESERVE AND CLASSIFICATION IN PERAK RIVER BASIN |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




**PIXEL OF CADASTRAL MAP (500 m x 700m)**

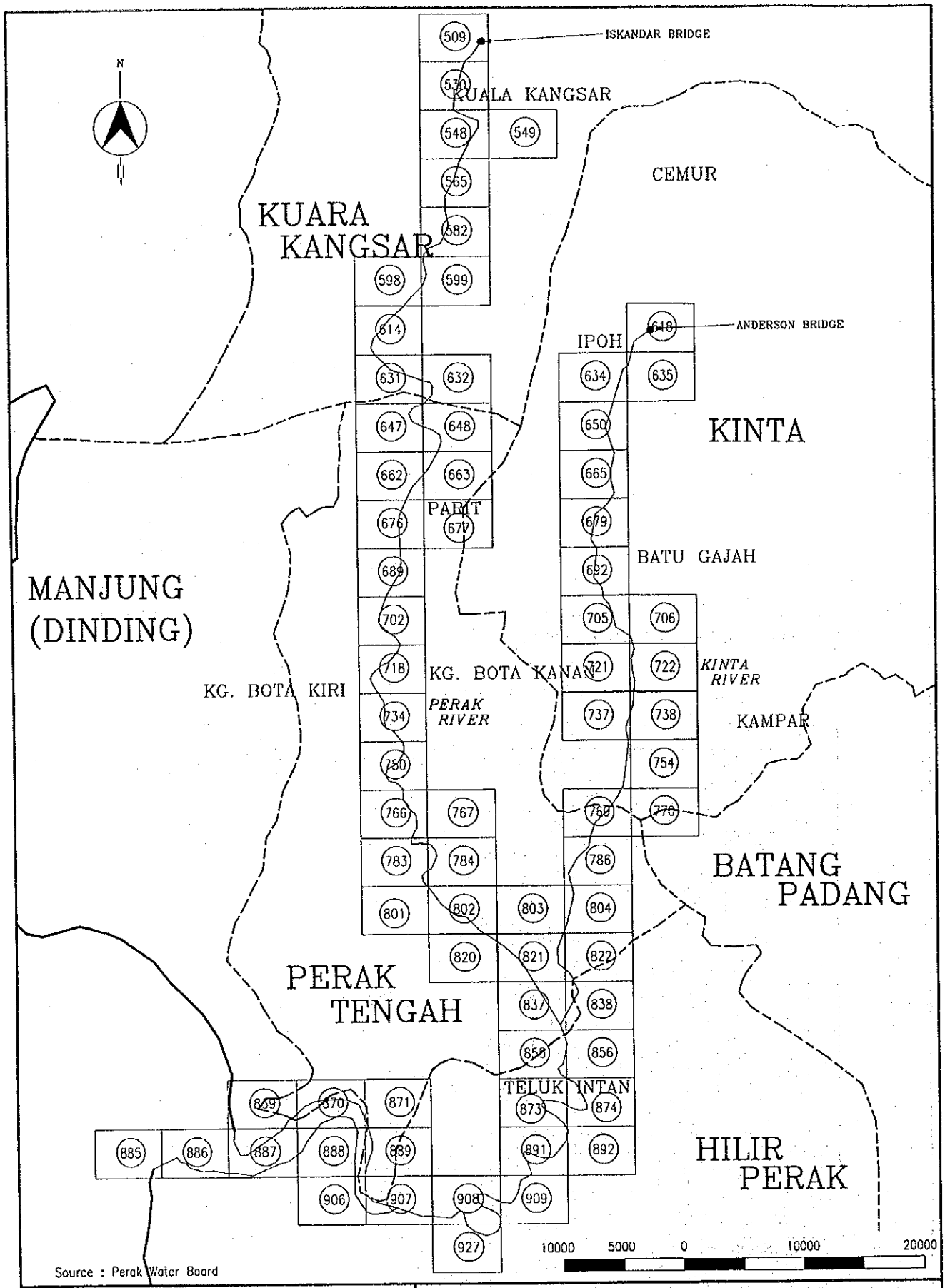
Source : Perak Water Board

**Attributes of Land Parcels**

| No. | Attribute | Explanation |
|---|---|---|
| 1 | UPI | Parcel-key (it consists of the following eight attributes.) |
| 1-1 | Negeri | State Code |
| 1-2 | Daerah | District Code |
| 1-3 | Mukim | Sub-District Code |
| 1-4 | Seksyen | Section Code |
| 1-5 | Kod Lot | Lot Code |
| 1-6 | Apdate | Date when parcel was created |
| 1-7 | Kuluasan | Area of Land Parcel |
| 1-8 | Unit | Unit of Measurement |
| 2 | Nombor Lot | Lot Number |
| 3 | Jenis Hakmilik | Type of Title (Grant, Lease, etc.) |
| 4 | Nombor Hakmilik | Title Number |
| 5 | Tarikh Daftar | Registration Date of Title |
| 6 | Tempoh Pajakan | Duration of Lease |
| 7 | Kategori Tanah | Category of Land Use |
| 8 | Syarat Nyata | Expressed Condition Imposed on Land Use |
| 9 | Sekatan Kepentingan | Restriction on Land Usage |
| 10 | Cukai Tanah | Yearly Land Tax (RM) |
| 11 | Status Tanah | Land Status |
| 12 | Bilangan Pemilik | Number of Persons/Organizations Owing the Land |
| 13 | Urusan | Department of Land and Mines |

Source : NaLIS Secretariat

| | |
|---|---|
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-11 CADASTRAL MAP AND ATTRIBUTES |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




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

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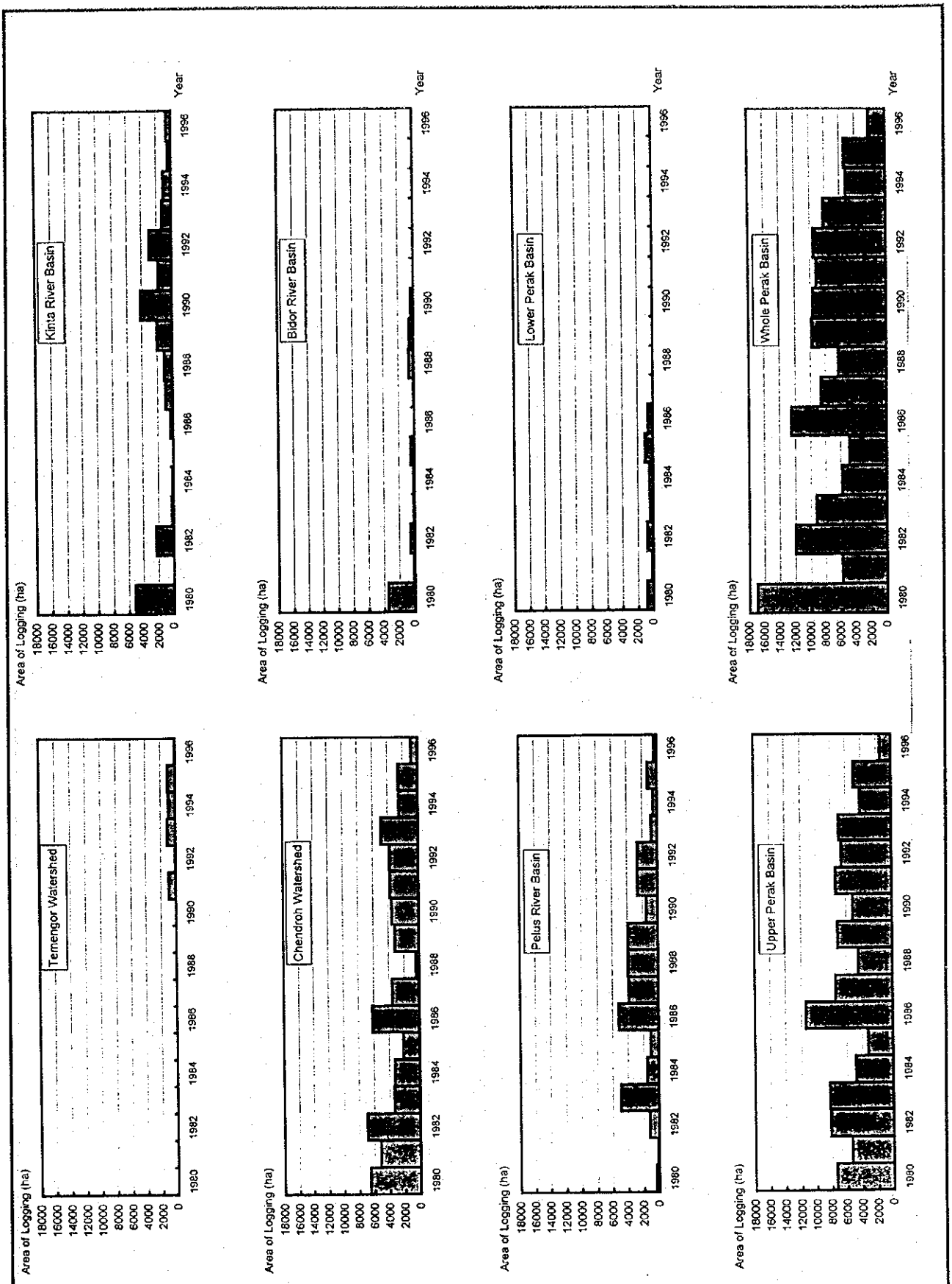
Fig. III-12 RIVER RESERVE STRETCH AND RELATED CADSTRAL MAP INDEX




Data Source : Rancangan Tebangan, Bagi Negeri Perak Darul Ridzuan, Forest Department, Perak

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

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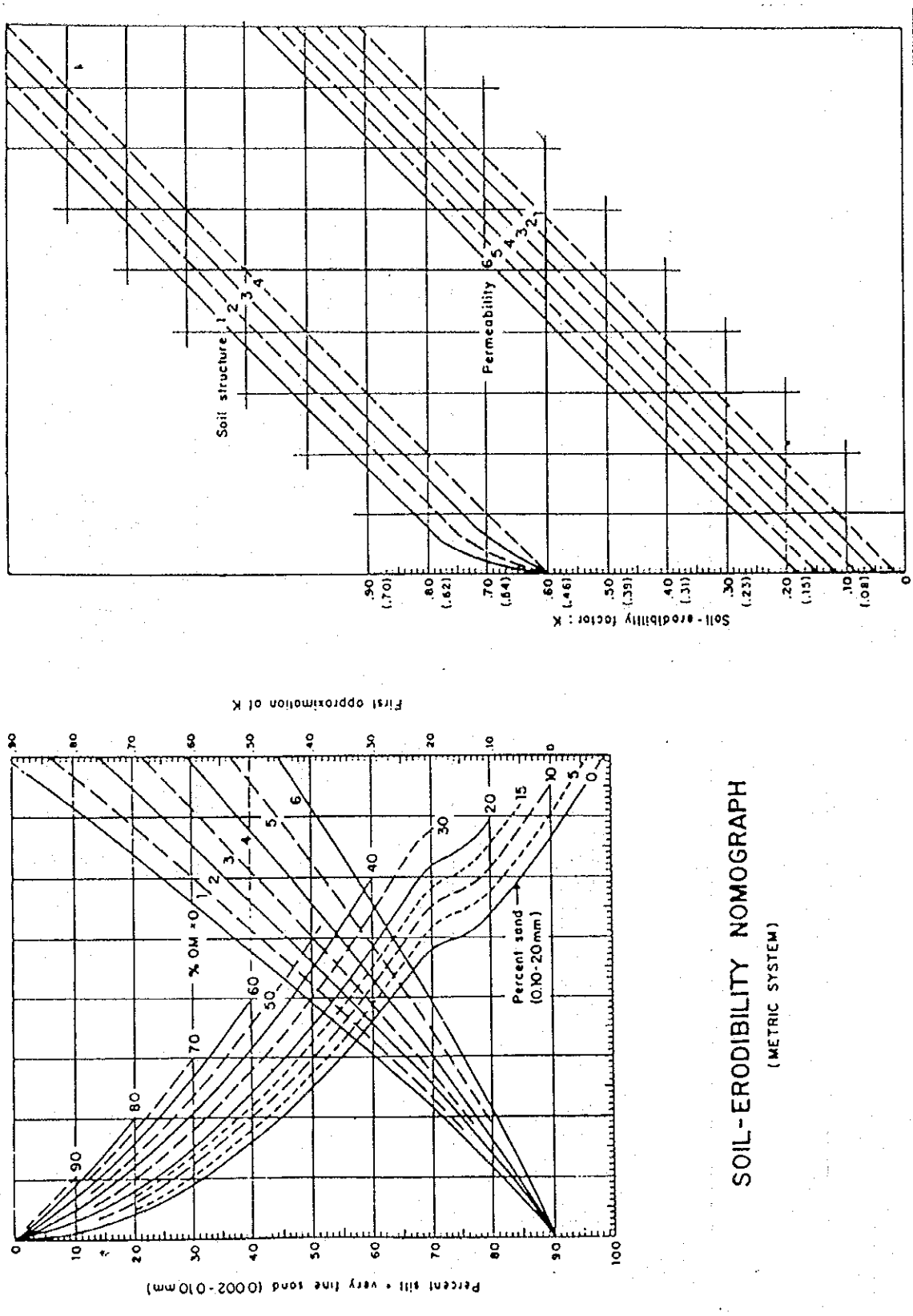
Fig. III-13 HISTORICAL CHANGES OF LOGGING VOLUME IN SUB-BASIN OF PERAK RIVER




Source: A Soil Erodibility Nomograph for Farmland and Construction Site, Vol. 26, Journal Soil and Water Conservation, 1971

| | |
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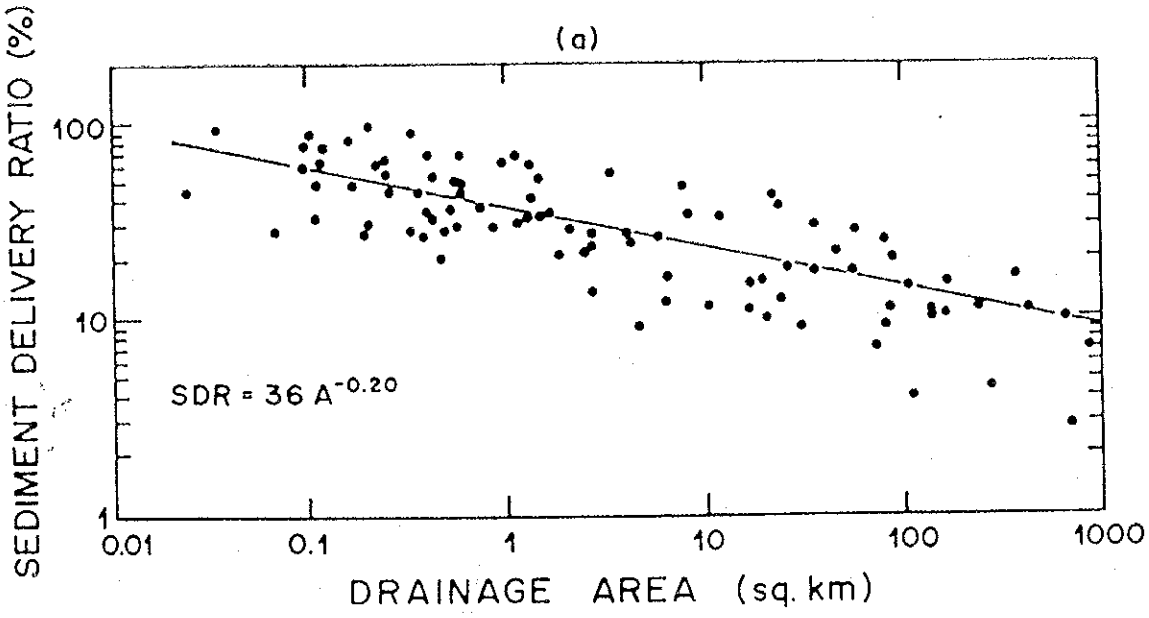
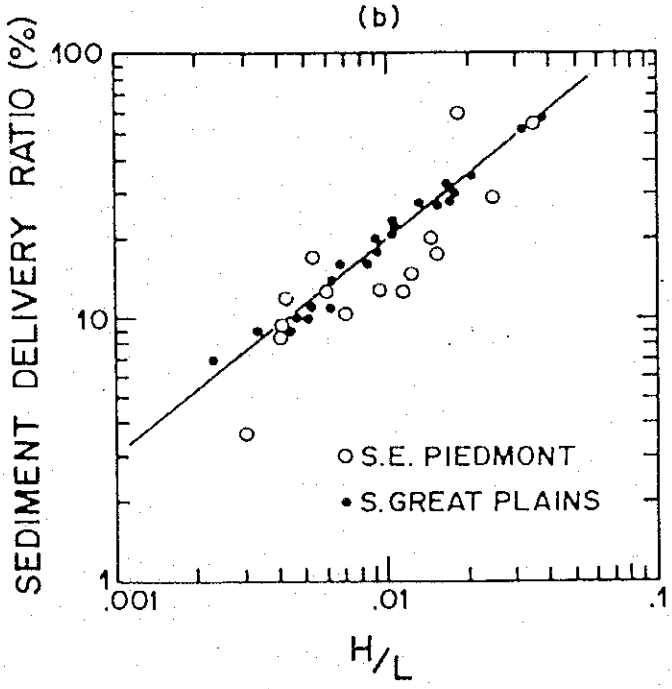
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-14 SOIL ERODIBILITY NOMOGRAPH |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |



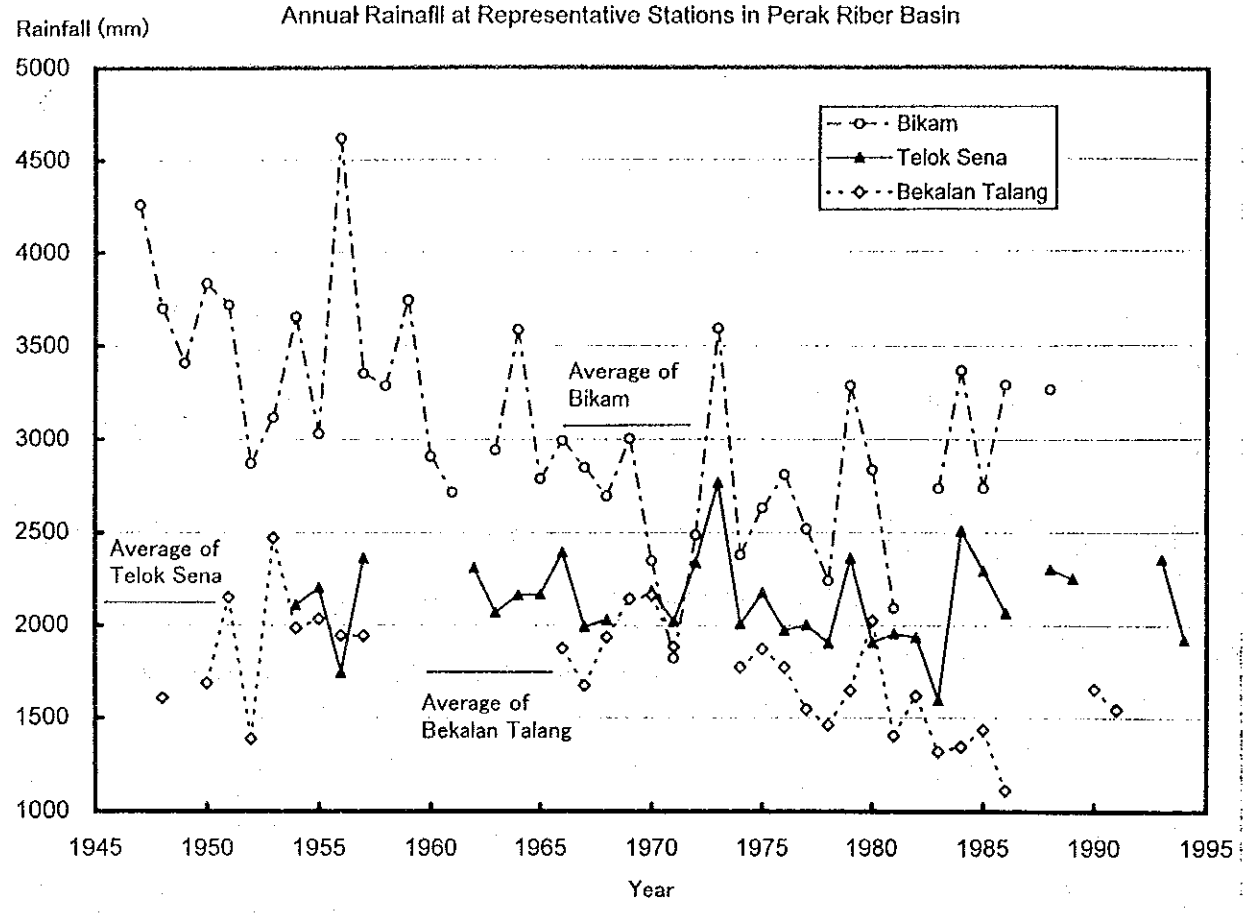

(a) Relation of Sediment Delivery Ratio to Catchment Size




(b) Relation of Sediment Delivery Ratio to Catchment Relief (H) and Mainstream Length (L)

Source: Sediment Source Areas, Delivery Ratios and Influencing Morphological Factors, International Association of Scientific Hydrology Publication 59, 1962

| | |
|---|---|
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-15 SEDIMENT DELIVERY RATIO |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




Annual Rainfall

| Year | Rainfall Station 4012143 Bikam | 4209093 Telok Sena | 4708084 Bekalan Talang | Year | Rainfall Station 4012143 Bikam | 4209093 Telok Sena | 4708084 Bekalan Talang |
|---|---|---|---|---|---|---|---|
| 1947 | 4260.8 | | | 1972 | 2487.8 | 2338.7 | |
| 1948 | 3701.9 | | 1607.2 | 1973 | 3592.3 | 2766.8 | |
| 1949 | 3409.8 | | | 1974 | 2382.5 | 2006.4 | 1772.7 |
| 1950 | 3836.8 | | 1686.8 | 1975 | 2632.1 | 2175.5 | 1872.8 |
| 1951 | 3720.8 | | 2149.7 | 1976 | 2811.0 | 1974.0 | 1772.2 |
| 1952 | 2872.7 | | 1390.0 | 1977 | 2520.0 | 2002.5 | 1546.3 |
| 1953 | 3117.8 | | 2471.4 | 1978 | 2241.8 | 1904.0 | 1461.4 |
| 1954 | 3656.4 | 2109.1 | 1984.2 | 1979 | 3286.7 | 2363.5 | 1647.6 |
| 1955 | 3031.2 | 2200.3 | 2032.7 | 1980 | 2836.1 | 1907.8 | 2024.8 |
| 1956 | 4617.8 | 1743.4 | 1943.1 | 1981 | 2093.3 | 1955.2 | 1405.5 |
| 1957 | 3351.2 | 2363.4 | 1942.7 | 1982 | | 1934.8 | 1618.0 |
| 1958 | 3287.0 | | | 1983 | 2737.0 | 1594.5 | 1319.0 |
| 1959 | 3744.6 | | | 1984 | 3369.0 | 2508.0 | 1346.0 |
| 1960 | 2907.4 | | | 1985 | 2739.0 | 2295.0 | 1437.0 |
| 1961 | 2716.4 | | | 1986 | 3294.5 | 2067.0 | 1112.5 |
| 1962 | | 2310.3 | | 1987 | | | |
| 1963 | 2944.0 | 2069.1 | | 1988 | 3269.0 | 2301.5 | |
| 1964 | 3585.3 | 2162.8 | | 1989 | | 2251.5 | |
| 1965 | 2791.7 | 2166.2 | | 1990 | | | 1654.0 |
| 1966 | 2993.1 | 2396.1 | 1876.0 | 1991 | | | 1543.5 |
| 1967 | 2849.2 | 1992.8 | 1673.3 | 1992 | | | |
| 1968 | 2697.0 | 2029.7 | 1935.9 | 1993 | | 2355.5 | |
| 1969 | 3002.2 | | 2142.6 | 1994 | | 1923.0 | |
| 1970 | 2349.7 | 2184.4 | 2162.8 | 1995 | | | |
| 1971 | 1821.6 | 2021.6 | 1884.4 | 1996 | | | |
| | | | | Average | 3065.6 | 2136.7 | 1747.2 |

Note: Annual values in the blanks consist of missing data in some parts.

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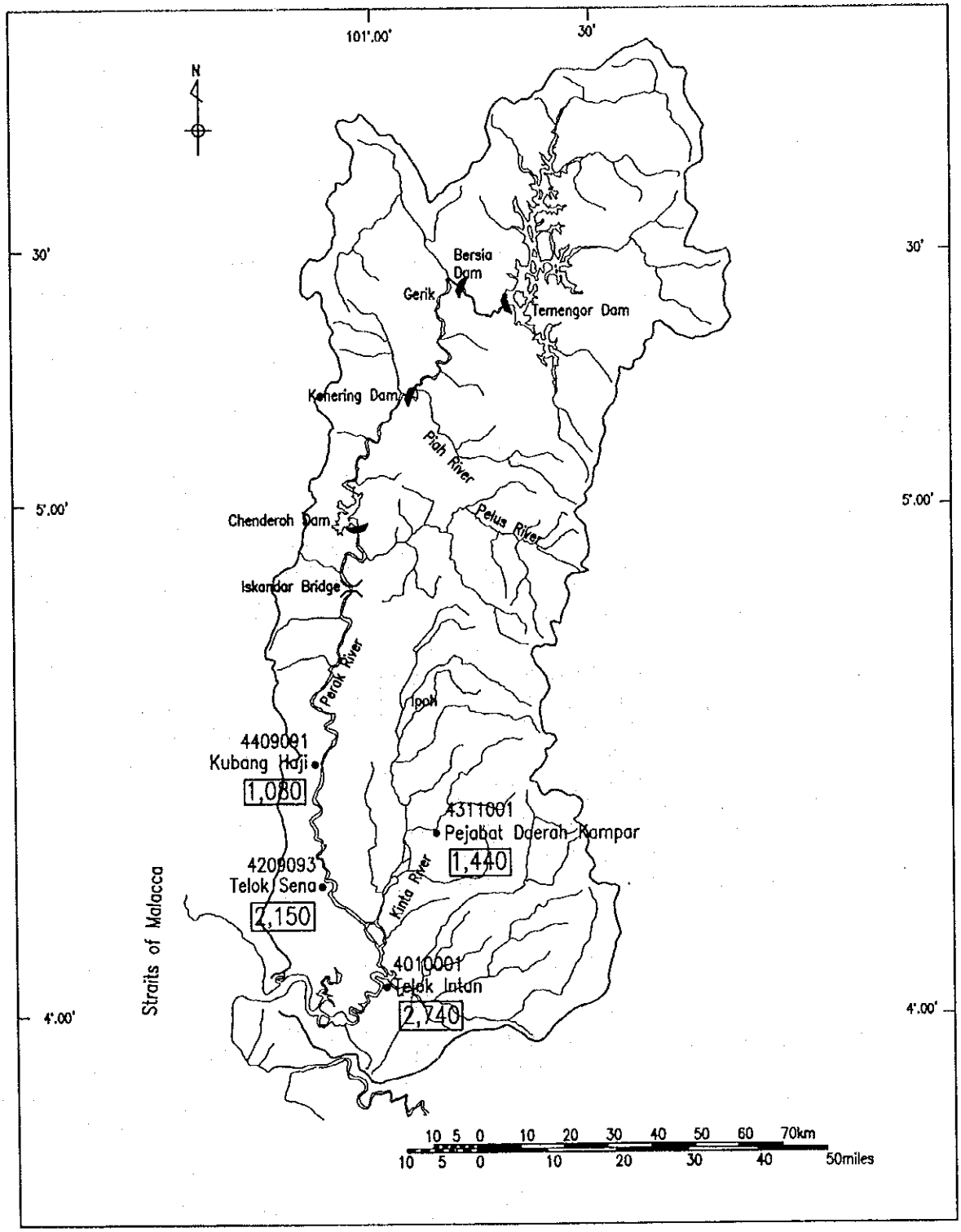
Fig. III-16 ANNUAL RAINFALL SERIES AT REPRESENTATIVE STATIONS

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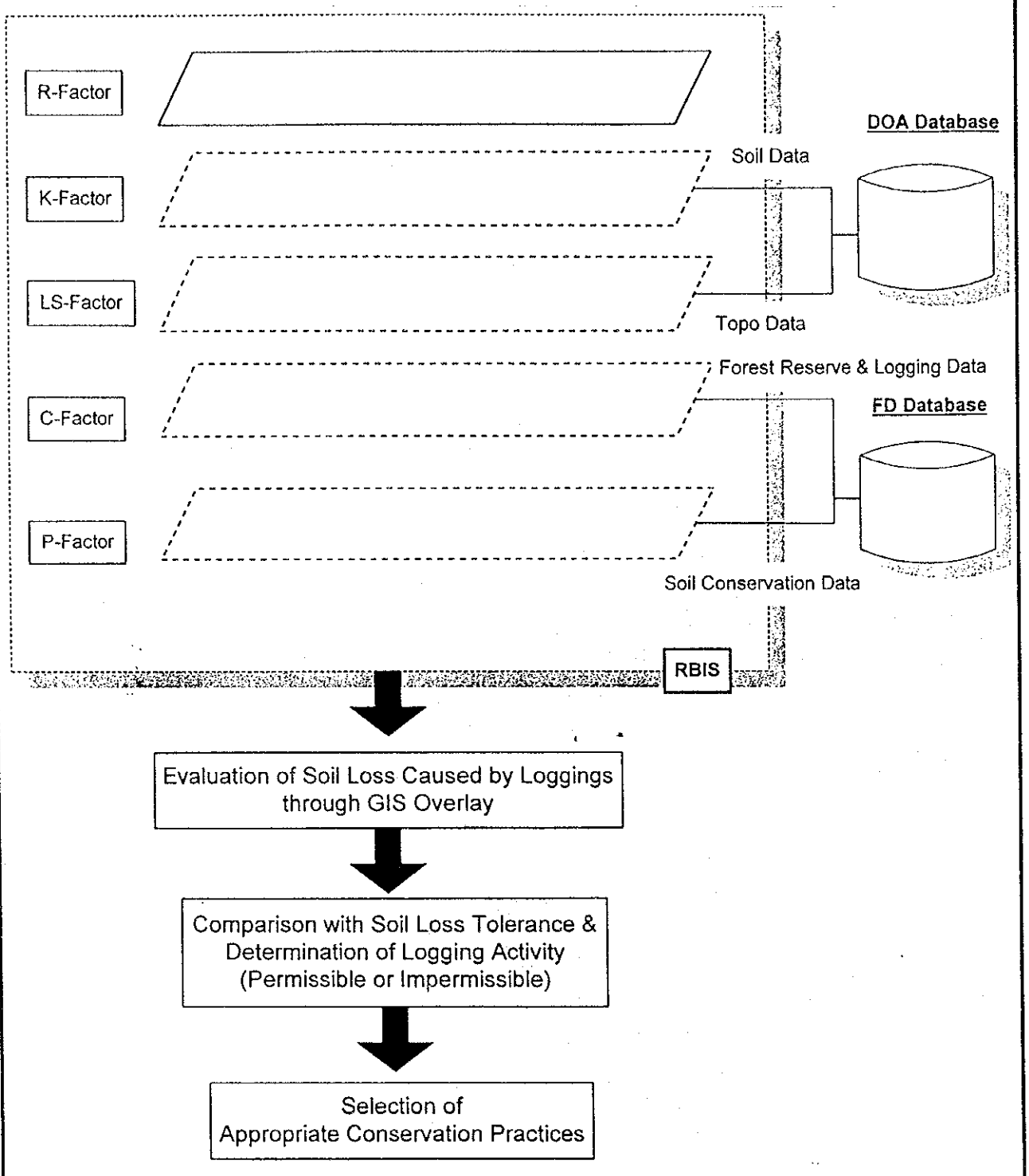
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA | Fig. III-17 ESTIMATED ANNUAL RAINFALL FACTOR |
| JAPAN INTERNATIONAL COOPERATION AGENCY | |




| | |
|---|---|
| THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA<br>JAPAN INTERNATIONAL COOPERATION AGENCY | Fig. III-18 CONCEPT OF FUTURE RBIS UTILIZATION FOR EROSION CONTROL |

# *SECTOR IV*

# *RIVER BASIN INFORMATION SYSTEM*

SUPPORTING REPORT

SECTOR IV

RIVER BASIN INFORMATION SYSTEM

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# CHAPTER 1 INTRODUCTION

This Supporting Report, Sector IV, River Basin Information System, presents the River Basin Information System (RBIS), including the investigation on the presently existing system, the RBIS master plan, the design and development of the Operational System, and the results of technology transfer to Malaysian counterpart personnel.

Chapter 2 describes the present river related information system in Malaysia, then draws out the issues on the present system.

Chapter 3 describes the master plan of River Basin Information System, known as the RBIS.

Chapter 4 describes the design of the Operational System, including detail specifications of system hardware and software.

Chapter 5 describes the development of the Operational System, giving the detail system application image and the operation.

Chapter 6 describes the results of system technology transfer to Malaysian counterparts, including the contents of the On-the-Job training.

# CHAPTER 2 PRESENT RIVER ASSOCIATED INFORMATION SYSTEM

At the first stage of the study, the existing river related information system in Malaysia was investigated. It was found that many information systems controlled by the various government agencies are related to river basin management and almost all of the information systems are running as stand-alone. After the investigation, the JICA study team defined the issues on the present information system in Malaysia. This will be useful to do the design of the futuristic plan of River Basin Information System (RBIS).

## 2.1 Real-time Information System

According to the investigation on the Perak river information system, a telemetry system used as a real-time information collection system was built by the Department of Irrigation and Drainage (DID) in 1974. The system consists of one terminal station, two repeater stations and ten gauging stations (two rainfall stations, five river stage stations and three rainfall and river stage stations). The terminal station can real-timely receive the data from other stations and provide the information to the river managers by a simple user interface. All the telemetry stations are presented in Sector I, Hydrology. In this Sector IV, the terminal station is presented. It includes two subsystems; namely, the telemetry master controller system and the data management system.

### 2.1.1 Telemetry Master Controller System

This subsystem is equipped with a CD-6000 Front End Processor (FEP), radio and modem, Liquid Crystal Display (LCD) and a power supply unit. The CD-6000 FEP, as the master controller, plays a major role to collect, process and transmit the data to the data management system. The communication between the terminal station and the gauging stations are through radios and dial up modems. The terminal station is the data concentrator calling the gauging stations, recording the gauged data and time, and saving the data in memory every hour.

The system sends a calling command to a remote station through the radio transmitter set, and upon receiving the calling command, the remote station sends the data through the radio set. The terminal station in the standby mode receives the signal. At the same time, the master controller CD-6000 displays, prints and stores the results. The existing memory of the CD-6000 master controller can save four (4) days' data. When the data management system starts up, the data can be automatically read into the data management system via a serial communication port.

### 2.1.2 Telemetry Data Management System

The data management system contains a HP personal computer installed with the software called "TeleWin32". The Operating System for the computer is the Windows 95, and the software of TeleWin32 consists of the following three applications: (1) TeleWin32 Server, (2) TeleWin32 Event Logger, and (3) Telemetry Application.

The TeleWin32 Server is the communication interface reading the data from the memory of the CD-6000 master controller at the rate specified by the user application (called "TeleWin32 Event Logger"). The TeleWin32 Server itself starts to search and store the data only when the user application calls it. Then, the data is transferred to the application. The TeleWin32 Event Logger is designed to get the data from the master controller through the TeleWin32 Server, and save the data into a transaction database in Microsoft Access format.

The Telemetry Application is an application for displaying database built by the TeleWin32 Event Logger into a user-friendly format. Through this application, the database is displayed on various screens presenting maps, tables, and graphs, etc.

## 2.2 Non-real Time Information System

Various government agencies currently operate their data information systems that are closely related to river basin management work. The details of such existing information systems have been clarified.

### 2.2.1 DOA GIS System

The Department of Agriculture (DOA) has established a GIS system processing land use and soil maps covering the whole country. This system applies several UNIX machines, digitizers and plotters as well as the GIS and the RS (Remote Sensing) software. All of the hardware in the system are linked together by a Local Area Network (LAN). This system was established in 1981 and upgraded three times till 1993 as below:

| Year | Hardware | Operational System | Software |
|---|---|---|---|
| 1981 | General Data | AOS/VS | COMPIS |
| 1988 | Microcomputer | MS-DOS | Terrasoft,SPANS |
| 1993 | Hewlett Packard | UNIX | ARC/INFO, ERDAS |

The reasons for upgrading the hardware and software are as enumerated below:

(a) The General Data computer with COMPIS software was abandoned in 1988, because the operation of the hardware took much time having a very slow response and at the same time, the manufacturer did not support the software.

(b) In the late of 1980's, intensive technology development on the hardware as well as the GIS and RS software was made and, at the same time, the IBM Microcomputer supported by the MS-DOS system became the main stream of personal computer usage. Due to the conditions, the DOA started to use the IBM Microcomputer supported by the MS-DOS system.

(c) In 1990's, the UNIX workstation with a huge capacity of hardware prevailed, facilitating the processing of large GIS database and larger scale of resolution on satellite image. The UNIX workstation also contributed to the reliability and high speed of network communication. The system users started to use the ARC/INFO and ERDAS as the most eligible GIS and RS software for such large scale of data processing. Under such circumstances, the DOA applied the UNIX workstation (Hewlett Packard), and software of the ARC/INFO and ERDAS in 1993.

The list of hardware and software currently used by the DOA is as given below.

Database Server (1 unit)

| | | | |
|---|---|---|---|
| Name | HP9000 | Maker | Hewlett-Packard |
| Model | 750 | CPU Type | PA-RISC |
| Memory | 64MB | CPU Speed | 76.7 MHz |
| Hard Disk | 3.9GB | Network | TCP/IP |
| Monitor Size | 19 inch | Resolution | 1280x1124 |

GIS and the RS Analysis Workstations (2 units)

| | | | |
|---|---|---|---|
| Name | HP9000 | Maker | Hewlett-Packard |
| Model | 720 | CPU Type | PA-RISC |
| Memory | 32 MB | CPU Speed | 57.9 MHz |
| Hard Disk | 420 MB | Network | TCP/IP |
| Monitor Size | 19 inch | Resolution | 1280x1124 |

Client Microcomputers (3 units)

| | | | |
|---|---|---|---|
| Name | Compaq | Maker | Compaq |
| Model | | CPU Type | Intel 486 |
| Memory | 8 MB | CPU Speed | 50 MHz |
| Hard Disk | 170 MB | Network | TCP/IP |
| Monitor Size | 14 inch | Resolution | 640x480 |

Digitizers (2 tables)

| Name | Calcomp | Maker | Calcomp |
|---|---|---|---|
| Type | Mechanical Lift | Size | A0 |

Plotters (2 Units)

| Name | HP 650, HP 750C | Maker | Hewlett-Packard |
|---|---|---|---|
| Type | InkJet (Mono, Color) | Size | A0 |

GIS, RS and other DB software

| Item | Description |
|---|---|
| GIS DB | Software: ARC/INFO, Maker: ESRI, Modules: GIS Basic (3 units), TIN Module (1 unit), Network Module (1 unit) |
| RDBMS | Software: Oracle, Maker: Oracle |
| RS | Software: ERDAS Imagine, Maker : ERDAS |

### 2.2.2 FD GIS system

The Forest Department Peninsular Malaysia (FDPM) started to use computers in forestry application from 1970's with the use of microcomputer to process pre/post-felling inventory data. In 1986, FDPM initiated the National Forestry Information System (NFIS) for managing location data and resource monitoring through the RS technology. In 1989, FDPM updated this system to a Local Area Network for GIS and RS system. The NFIS was divided into three major parts, namely Management Information System (MIS), Geographic Information System(GIS) and Image Processing System(IPS). All of the software and hardware used in each system are listed below.

MIS System

| Item | Description | Item | Description |
|---|---|---|---|
| Database Server | HP9000/835 | RAM | 24 MB |
| HD | 1.34 GB | OS | UNIX |
| Backup 1 | 2.0 GB DDS/DAT | Backup 2 | Magnetic Tape Driver |
| Clients | 17 sets of Microcomputer | Output | Line Printer |
| Database | Oracle | | |

GIS System

| Item | Description | Item | Description |
|---|---|---|---|
| GIS Database Server | HP9000/715 | RAM | 32 MB |
| HD | 2.0 GB | OS | UNIX |
| Backup | 2.0 GB DDS/DAT | Input | 2 Calcomp digitizers (A0 size) |
| Clients | 2 sets of HP9000/710, 720 Microcomputer | Output | HP DeskJet A0 size plotter |
| Database | Arc/Info | | |

IPS System

| Item | Description | Item | Description |
|---|---|---|---|
| Analysis Machine | HP 486/33 | RAM | 8 MB |
| HD | 2.0 GB | OS | MS-DOS |
| Backup | Magnetic Tape Driver | Output | A4 size Sony Tektronix Color Printer |
| Software | ERDAS | | |

According to the investigation, it was found that in addition to the above NFIS, the project for establishment of the Integrated Forest Management Information System (INFOMIS) is ongoing, and the necessary system devices have been installed at the FDPM. The Asian Institute of Forest Management (AIFM) installed the system devices. The configuration of the INFOMIS is as follows.

INFOMIS System

| Item | Description | Item | Description |
|---|---|---|---|
| GIS DB Server | HP9000/715 | RAM | 32 MB |
| HD | 2.0 GB | OS | UNIX |
| Backup | 2.0 GB DDS/DAT Driver | Input | Calcomp 9500 A0 size table digitizer |
| Software | Arc/Info, Arc/View, ERDAS | Output | HP LaserJet IV Printer, HP DesignJet650C A0 size color plotter |

Many GIS data have been collected by the system, such as topographical map, national forest inventory map and wildlife map. The data can be used through an in-house LAN. To give some progress information to the public, FDPM even made a web homepage for introducing the system.

### 2.2.3 DID Hydrological Data Bank

DID is the main agency which gauge rainfall and river stage/discharge. DID further carries out regular suspended sediment measurements at river stage and discharge stations in conjunction with discharge measurement. 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 by the EDP system, the processed data are stored into the Hydrological Data Bank System set up in the DID Hydrology Division.

The Hydrological Data Bank was built in 1974. The system included the following two database servers and several clients:

| Item | Description |
|---|---|
| Server | Data General UNIX Workstation AV8500 |
| Client | MS-DOS personal computer |
| Database Software | TIDEDA (Non-geographic RDBMS, made in New Zealand |

The system is linked by a local area network providing the services through printing out of the text data or exporting of the text data into digital form. As described in Subsection 2.1.1, the "Hydrological Information System" is being developed as a sort of interface to upgrade the present data processing system in the data bank, but its completion time is still indefinite.

### 2.2.4 Department of Wildlife and National Parks

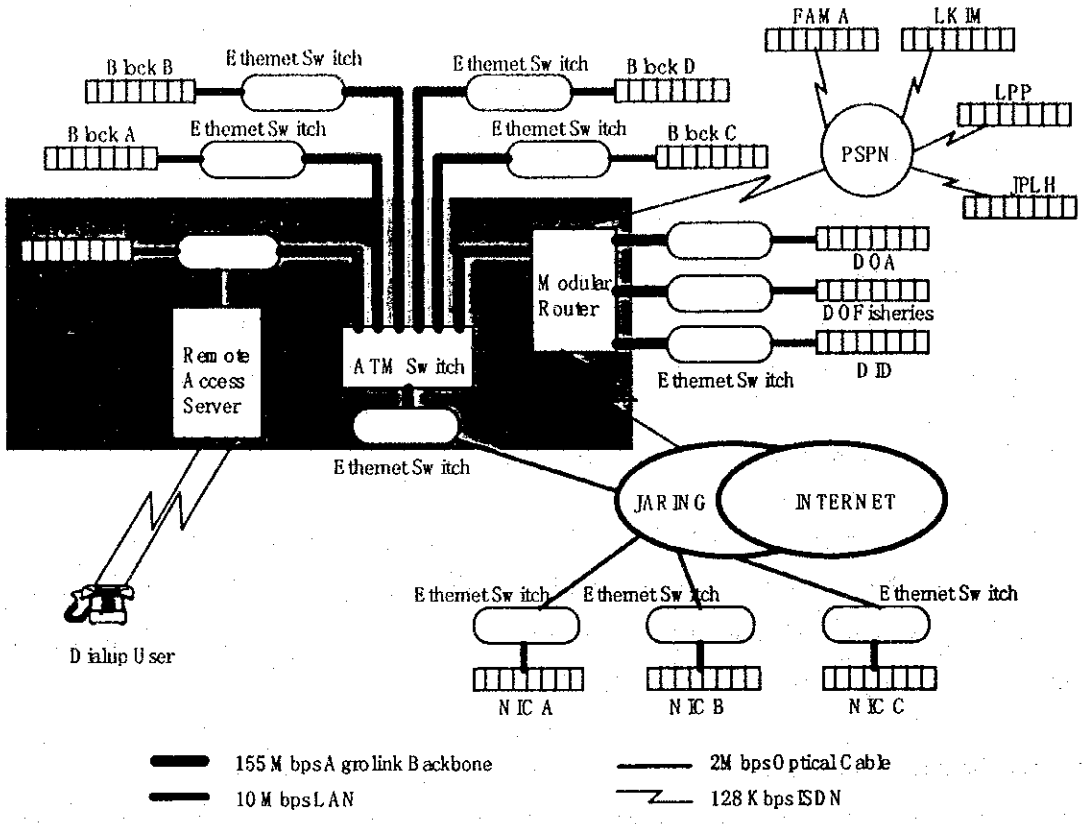
The Department of Wildlife and National Parks is in charge of the survey of fauna and flora in the river. This Department is now developing a database system to digitize the results of survey. The system is a compact GIS system for managing the protection area database. The data include the boundary of protection area and protected plants, animal list, etc.

Since the data volume is not big, the system applies the personal computer as major hardware solution. All computers are linked together by LAN for easy data transfer in-house. The main computer model adopted HP machine. For database input and management, the PC Arc/Info was selected. The PC Arc/View was also selected for viewing the database and producing output maps. The hardware and software used by the system are shown below.

| Item | Description |
|---|---|
| Hardware | HP Microcomputer, Intel Pentium133 |
| Software | PC Arc/Info, PC Arc/View |

### 2.2.5 AGROLINK Network System

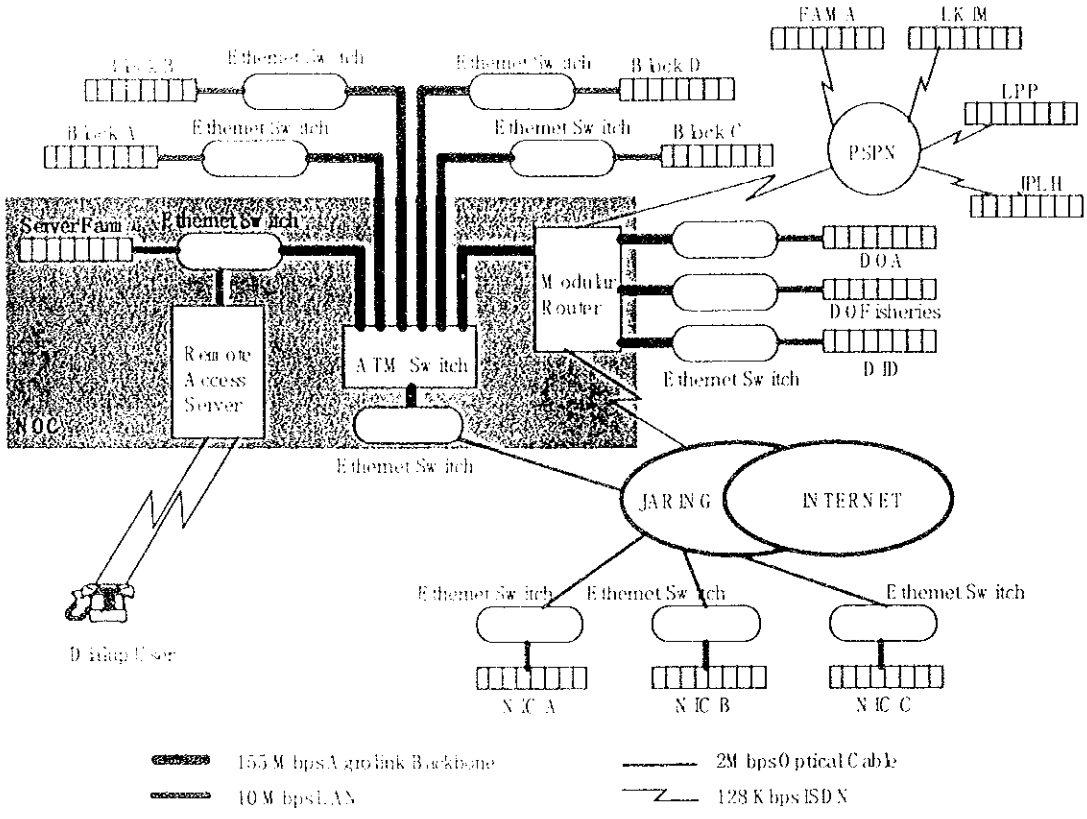
The Ministry of Agriculture (MOA) has embarked on a project to establish a national agricultural information network called AGROLINK to link up the computers of agricultural organizations in November, 1995. The configuration of the whole network is as illustrated below.




The heart of the network is located at the computer center of the Ministry of Agriculture. This network operation center (NOC) manages the overall operation of AGROLINK, allocating the internet protocol (IP) addresses, and setting the standards for inter-operability and inter-connectivity of equipment and software in participating organizations.

The most important part of the NOC is the 155 Mbps AGROLINK Backbone. It is controlled by a Asynchronous Transfer Mode Switch (ATM Switch). When the data is transferred to this ATM Switch, it is automatically distributed into ATM cells. Each of the cells includes a header that shows the data's destination. Then, the ATM Switch automatically selects the data transmission line of optical cable which leads to Virtual Path (VP) or Virtual Channel (VC) according to the data volume. This data transfer system provided by the ATM Switch, realizes safety and high quality data transmission. The AGROLINK Backbone supports the server farm, Remote Access Server (RAS), Blocks of MOA, and a Modular Router. The Server Farm provides several types of Internet Servers, for instance, WWW, FTP, SMTP, etc.

Two digital lines are connected from NOC to a nationwide network for delivery and transport of multi-protocol data. These two lines doubly ensure the system transmission. The network uses the existing public switched telephone network and facilities of the Malaysian Institute of Microelectronics (MIMOS) through its joint advanced research integrated

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networking (JARING). The AGROLINK network has several network information centers (NICs) at the state and district levels, which can directly access to the JARING nodes through high speed data lines. When the agencies not under the AGROLINK network wish to access to JARING nodes, they need to first access to the nearest NIC using leased or dial-up lines.

The users of AGROLINK are classified into the six (6) groups which have different link methods to AGROLINK as enumerated below.

| User Name | Location | Link Method | Speed in Maximum |
|---|---|---|---|
| MOA Users | MOA Building, Block A, B, C and D (Inside MOA Building) | Directly link with AGROLINK Backbone | 10 Mbps |
| Public Users | Personal Users located in Kuala LumpurL | Dialing up with RAS | 64 Kbps, (20 lines) |
| FAMA, LKIM, LPP, JPLH Users | Out of ISDN Connections | HK Satellite PSPH communicate with Modular Router | 128 Kbps |
| DID, DOA, DOFisheries | MOA Area | Directly link with AGROLINK Modular Router | 10 Mbps |
| State Users | Out of KL | Link with NIC | 2 Mbps |
| Other Government Users | All over the country | Link with JARING | 2 Mbps |

The AGROLINK has already linked three NICs in the states of Penang, Johor and Selangor where communication through the network is available among the offices under MOA such as DID, DOA, Department of Fisheries, FAMA (Federal Agricultural and Marketing Authority), LPP (Farmers organization authority), LKIM (Fisheries Development Authority), and JPLH (Pepper Marketing Board). Moreover, the AGROLINK is going to link other 15 NICs within the seventh Malaysia plan (1996-2000). Thus, the AGROLINK is expanding as JARING is extending its coverage in the whole country, and will be finally formed as a part of an integrated Malaysian information network providing services to other government agencies and the private sector.

### 2.2.6 Other Government System

(1) TNB Database System

TNB also collects hydrological data usually at 2 months interval. The data are forwarded to the TNB Hydrology Section for centralized processing. On receipt, the data are stored in TIDEDA format (same as in DID Hydrology Division) in the

Hydrology Section, Engineering and Project Development, Generation Division. However, details of available hydrological information were not clarified and shall be subject to a further study.

(2) DOE GIS System

The DOE is the main agency for overall water quality monitoring on the Perak River. 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 in Federal DOE. Federal DOE is also developing a GIS database system for managing the water quality data through mapping software. The system consists of UNIX workstation, Windows PC and ArcInfo, ArcView software. All of the hardware are linked by a Local Area Network.

(3) DSMM Digital Map System

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. As in other developing countries, Malaysia is also accelerating development of digital maps. Therefore, the DSMM and DSMP implemented the GIS system and in-house LAN to handle the digital mapping work. DSMM uses the GINIS software made by Norway and OpenVMS computer system. To compare with DSMM, the DSMP uses the UNIX workstation and ArcInfo software.

(4) PWB MAP System

The Perak Water Board carries out water sampling and tests on river water. The purpose of PWB is, however, only to monitor the water quality for domestic and industrial water supply and, therefore, the monitored data are judged to little contribute to the river management works. However, PWB digitized the cadastral map into a CAD system. The system consists of stand-alone windows machine and AutoCAD software. All the digital data can be exported to the GIS database system.

## 2.3 Summary of Existing Systems

During the study, it was found that there are twenty (20) agencies that develop information systems related to river basin management and their system configuration (refer to Tables IV-1 and IV-2). The results of the clarification are as described below.

### 2.3.1 Operating System (OS)

Interview survey was carried out with the fourteen (14) agencies that have developed an information system related to river basin management. Among them, 12 agencies apply the UNIX as computer operating system (refer to Table IV-1) and 11 of these use the Local Area Network (LAN) and/or Wide Area Network (WAN).

The UNIX contains a customized function to connect the computer machine (the mini-computer or workstation) with networks (LAN and WAN) without requiring any additional application software for the network connection. The UNIX has been the standard OS in the engineering field for a long period, accumulating various kinds of applicable software for technical calculation. From this background, UNIX has dominant and different characteristics from other OS such as MS-DOS and MS Windows that are used mainly for office works.

### 2.3.2 System Software

Almost all agencies related to the mapping work have developed or are going to develop a Geographical Information System (GIS) for their particular purposes. Among the agencies interviewed during the study stage, 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 (refer to Table IV-2). 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 the UNIX machine (client-server system) and the ArcView on the 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.

### 2.3.3 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 telecommunication company in Malaysia has made the following visions to provide advanced telecommunications services by the year 2005:

(a) 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);

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

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

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

The growth in the number of installed public telephone lines between 1990 to 1996 is shown in Table IV-T-3. The present annual average growth of telephone lines is about 14%, and the total telephone lines 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:

(a) Integrated Services Digital Network (ISDN)

(b) Digital Leased Line

(c) 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 (refer to Table IV-T-4). The Binariang Sdn. Bhd operate the satellite network by MESAT.

In parallel with the above expansion of telecommunication infrastructures, the nationwide communication network system is also being set up by various government agencies. The first government wide area network called AGROLINK was established by the Ministry of Agriculture (MOA) 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. At present, the optical fiber cable under the AGROLINK links all of the departments of MOA located in Kuala Lumpur and the State of Penang. It is also scheduled to link, through access points, with all states within several years.

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. IV-1). The federal government agencies under MOA need to apply the linkage AGROLINK to NOC, and state agencies to NIC.

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

### 2.3.4 Perspective of Existing Information System

The following items are recognized, through the above study, as the perspective of the existing information systems related to the river basin management:

(a) A majority of the government agencies apply the UNIX as the master machine, and the PC as a low end client machine for their information management system.

(b) The digitizer and plotter are used as the most common input and output devices. Moreover, the digitizer and the plotter are the products of Calcomp and HP, respectively.

(c) The dynamic technology development on the computer hardware has progressed; for example, the computer CPU speed has increased from less than 100 MHz before 1995 to over 200 MHz at present. Under such conditions, the hardware capacity of the existing information system is deemed to be left behind as compared with the updated prevailing capacity.

(d) The Arc/Info database software is widely used as the solution for GIS database management in Malaysia, as well as all over the world.

(e) All of the information in the existing systems are transferred within the extent of Local Area Network (LAN) providing the information only to in-house users. Thus, none of the existing systems so far investigated applies a Wide Area Network (WAN) using Intranet and/or Internet.

(f) The existing telemetry system in DID Perak is equipped with a HP personal computer (called "TeleWin32 Server") and TeleWin32 applications which were upgraded in the middle of 1997 and could be availed of to provide all necessary real-time information for the Operational System. However, the system is not covered by the wide area network and, therefore, could not transmit/disseminate the information to the various users.

(g) The AGROLINK network as a wide area network, could be linked to various types of government as well as public users, and will be useful as a part of the data dissemination system for the objective Operational System.

# CHAPTER 3 MASTER PLAN OF RIVER BASIN INFORMATION SYSTEM

## 3.1 Proposed System Network

The objective River Basin Information System (RBIS) is composed of sub-systems that have a sequential process of data collection, data transmission, data processing and dissemination. Such an overall system could be established through various components including the system network plan, the system design, and the institutional setup plan. Among these plan components, the system network plan is the most fundamental and important issue for determination of the system. From this viewpoint the optimum system network plan was studied through the comparative study on alternative plans.

### 3.1.1 Alternative System Network Plans

Among the necessary information for the system described in Sectors I, II and III, the river monitoring information and the map information have the most massive data volume. Database management on such non-real time information is presently centralized at the federal level. On the other hand, the actual river basin monitoring and management works are generally decentralized to the state levels. Moreover, the real-time information for flood prevention works is solely managed at the state level without any linkage to the federal level. In due consideration of these present conditions, the following basic concepts were given for selection of the alternative system network plans:

(a) The important issue on the non-real time database management is how to allocate the different functions to the federal and state levels in the proposed system network. In other words, the alternative system network plans for the non-real time information will include the centralized type of system on the federal level, the decentralized type of system to the state level, and their intermediate types.

(b) As for the real-time information, all alternative system network plans will give the principal function of management to the state level. The difference among the alternative plans is the procedure of linking such real-time information to the federal level.

(c) The Perak river basin is the objective river basin for the proposed system in this Study. However, the proposed RBIS plan is formulated to orient the future nationwide expandability of the system.

In line with the above principles, the following six (6) alternative system plans were selected (refer to Fig. IV-F-2):

(1) Alternative System Network Plan-1

This system is characterized by the centralization of non-real time information to the federal level. As for the real-time base information, however, all management works are undertaken independently on the state level without any linkage to the federal level. Thus, this alternative plan is oriented to the current situation of information management. The database server machine for the non-real time information is placed solely at the federal level, while the real-time data processing system is at the state level.

Under this Alternative Plan-1, the server machine at the federal level could meet the future nationwide expansion of the system without any additional server machine. Thus, this alternative plan minimizes the system investment cost as well as the maintenance cost and the number of system operators under the nationwide expansion of the system. The effectiveness of the system can also be identified in easy accessibility to the database. On the other hand, the data transmission and access speed largely depends on the networking data transfer capability. In addition, the federal level could not monitor the real-time information so that no coordination is undertaken at the federal level for flood management as well as drought management.

(2) Alternative System Network Plan-2

The configuration of the non-real time database system is the same as Alternative Plan-1. The difference is the linkage of real-time information from the state level to the federal level. Alternative Plan-2 could maintain the same advantages as those of Alternative Plan-1 and, in addition, Alternative Plan-2 enables the federal level to monitor the real time information on river flow discharge.

On the other hand, Alternative Plan-2 requires a telemetry data server machine as well as a data transmission device to link the real time information from the state level to the federal level. Moreover, Alternative Plan-2 will require a higher network data transmission capability than Alternative Plan-1, due to the necessity of transmission of real-time information from the state level to the federal level.

(3) Alternative System Network Plan-3

This Alternative Plan-3 assumes that the server-machine is placed at the state level, and a series of data collection, data processing and data dissemination is entirely managed by the state level both for non-real time and real-time information. This alternative also assumes that the federal level has the database client machines to monitor for non-real time only, but does not undertake any data management works. Under this alternative, the state level could simultaneously execute the present actual river basin management works and the necessary data management works.

Thus, Alternative Plan-3 will be the real job-site oriented approach to enable the actual executing body to have an immediate response to the information. However, the digitizing works on the river monitoring information and the map information is presently being undertaken at the federal level and hardly shifted to the state level. Moreover, when the nationwide expandability of the system is projected, the server machines need to be scattered to each state causing higher installation and maintenance cost for the system associated with the increased number of system operators. This Alternative Plan-3 also has the same defect as Alternative Plan-1 in monitoring the real time information at the federal level.

(4) Alternative System Network Plan-4

The configuration of the non-real time database system is the same as Alternative Plan-4. The difference is the linkage of real-time information from the state level to the federal level. This Alternative Plan-4 has the same advantages as Alternative Plan-3. Moreover, under this alternative, the federal level will have the telemetry data client machine and could monitor real-time information. However, Alternative Plan-4 will have the fatal defect, same as Alternative Plan-3.

(5) Alternative System Network Plan-5

In this Alternative Plan-5, database server machines for non-real time information will be installed at both the federal and state levels sharing the information management work. However, the real-time information is solely managed at the state level without any linkage to the federal level. Since the management for the non-real time information could be shared by the federal and state levels according to the particularities of the information, the data digitizing and processing works could be more efficiently made as compared with the other alternatives. However, the

exchangeability of the geographical information is extremely difficult between the state and the federal level due to the huge data volume and the complicated data structure. Thus, the nationwide integration of information is extremely difficult leading to the little future expandability of the system. Moreover, since server-machines are installed at both the federal and the state levels, the installation and operation cost for the system is higher than the other alternatives, and will remarkably increase the number of system operators as the system expands to the nationwide scale. The federal level could not also monitor the real-time information like Alternative Plan-1 and Plan-3.

(6) Alternative System Network Plan-6

The configuration of the non-real time database system is the same as Alternative Plan-5. The difference is the linkage of real-time information from the state level to the federal level. Alternative Plan-6 could be an improvement of Alternative Plan-5 in the aspect of monitoring of real time information at the federal level. Alternative Plan-6 contains the same fatal disadvantages as Alternative Plan-5 in the aspect of management of non-real time information.

### 3.1.2 Optimum System Network Plan

The advantages and disadvantages of the alternative plans have been examined, and Alternative Network System Plan-2 is preliminary proposed as the optimum system from the following viewpoints:

(a) The decentralized system network represented by Alternative Plan-3 and Plan-4 will have the fatal defect in integrating the nationwide information related to the river basin management works;

(b) Alternative Plan-5 and Plan-6 will require a higher cost for system installation/operation and a larger number of system operators as compared with the other alternatives, particularly when the system expands to the nationwide scale. Moreover, the geographical information regarded as the essential information for the river basin management could not be integrated into one unified database.

(c) Under Alternative Plan-1, the federal level could not monitor the real-time information. The real-time information will be essential for the flood

management (the forecasting and warning), the drought management (the water allocation during a drought period) and the water quality control. Such management works are closely related to the dam operation controlled by the TNB at the federal level. To execute an appropriate and effective coordination between the river basin management body and TNB, the monitoring on the real-time information is indispensable for the federal level. Moreover, the necessity of the interstate water allocation may arise during a drought period, and the coordination for such water allocation will be required at the federal level. From these viewpoints, Alternative Plan-2 that has a function of real-time monitoring is preferable.

(d) Alternative Plan-2 will require a higher data transmission capability as well as communication cost than Alternative Plan-1 due to the necessity of transmission of real-time information from the state to the federal level. However, this issue will be cleared in the future by the optical fiber network that is going to expand throughout the country and realize the great and high speed data transmission capacity. Moreover, the government network AGROLINK will connect the optical fiber line between Kuala Lumpur and Ipoh by the end of 1997. The tentative use of this AGROLINK could also be considered to support Alternative Plan-2.

### 3.2 System Devices

Several years ago, the personal computer could process only textual and numerical information through word processors and spreadsheet programs. In recent years, however, the personal computer has remarkably increased its performance, enabling it to process images scanned from maps/drawings and even multimedia information such as the dynamic visual and audible information. The personal computer has also come into wide use due to the remarkable price reduction.

The recent communication infrastructure is also undergoing a dynamic qualitative improvement and quantitative expansion in Malaysia. As seen in the "Multimedia Super Corridor Plan", the high-speed optical fiber communication network is going to be the main communication line in the country. Moreover, the satellite communication system is being made practicable since the Malaysian East Asia Satellite (MESAT-1) was launched in 1996.

In line with the development of the personal computer and the communication infrastructure, field gauging and/observation devices could now provide a dynamic visual and audible

information of the field on real-time base. Such multimedia information will provide actual images of disaster condition to enable prompt and appropriate action on them. The recent technology also enables extensive and systematic river basin gauging works through the development of gauging facilities such as the radar rainfall gauge and the automatic water quality gauging devices.

In the RBIS, futuristic system devices are proposed in due consideration of potential technology development so as to set up the long-term objective of the River Basin Information System in Malaysia. The details of the proposed systems are as described below.

### 3.2.1 Monitoring Device for Field Visual Information

The recent multimedia technology enables monitoring of dynamic visual and audible scenes of a remote field by the industrial television (ITV). The ITV had been initially developed to monitor the industrial production line and therefore called as "Industrial Television". The ITV system consists of a television camera installed at the field sites and optical fiber cable installed between the television camera and the remote office. The optical fiber cable is indispensable for the ITV due to the necessity of transmitting the dynamic scene of the field. The major disadvantages of the ITV are such that the monitoring points are fixed at the location of the television camera, and a high investment cost accrues from the installation of the optical fiber cable. The ITV is, however, deemed to be useful in particular to monitor the flood conditions or the illegal activities along the river such as dumping of garbage and effluent from the pollutant sources. From these points of view, the ITV system is proposed as a part of the futuristic monitoring system for the RBIS. The number of ITV cameras in the proposed system is assumed to be ten (10) spots in the river basin.

The recent technology on the multimedia communication system has also produced the portable information terminal (PIT) that transmits the digital data and images of the field scenes through the public telephone line from the field to the offices. The PIT could not provide the dynamic scenes of the field unlike the aforesaid ITV, but the cost of PIT is much cheaper than ITV and the PIT could take the field data at flexible points. As an example of possible usage of PIT for the river basin management, a river inspector keeps a PIT and connects it to his cellular phone so that he could report the actual field conditions to the management office on real-time base. Such function of PIT is deemed to be useful particularly in the following aspects of river management work, and a set of PIT is proposed as one of the monitoring facilities for the RBIS:

(a) The inspector could input the hydrological data read from the gauging chart into PIT, and send it to the river management office;

(b) The inspector could send the images of the field taken by the digital camera through PIT; and

(c) The inspector could send the results of his inspection in the form of a predetermined checklist through PIT.

### 3.2.2 Input Devices for Non Real-time Information

The RBIS will input the non-real time data such as the maps/drawings and the attribute data (the alphabetical and/or numeric data). In view of viability of the updated technologies, the following hardware and software are proposed as input devices of the RBIS:

(1) Input of Maps and Drawings

Maps and drawings have been conventionally input by means of the digitizer. However, the digitizer takes much time and manpower in data input works. Moreover, the input accuracy by the digitizer will depend much on the skill of the operator. To minimize such disadvantages, attempts are recently being made to read maps and drawings by scanner and convert them to digital data using the software of raster/vector transformation. Such input measure could contribute to the dynamic improvement in the aspect of less input time, less operation skill and high accuracy of input data. The major disadvantage of the input measure is addressed to the high purchase cost of scanner and software of transformation, particularly when the system applies a large-scale scanner and a higher quality of software. Such purchase cost is however expected to decrease with the intensive demand for map information as seen in the wide use of car navigation and CAD. From these viewpoints, the scanner supported by the software of raster/vector transformation is proposed as the input device for the RBIS.

(2) Attribute Data

To realize less manpower and higher accuracy of input works on the alphabetical and numeric data, the automatic reading method will certainly take over the conventional key-in method in the future. In this connection, the Optical Character Reader (OCR) is proposed as the most eligible hardware for automatic reading. Current OCRs can

accurately read more than 90% of alphabetical and numeric data and their use is being made practicable.

### 3.2.3 Data Processing Devices

The following software and hardware are proposed to analyze and process the non-real and real-time information:

(1) Software for Processing of Non Real-time Information

The RBIS will process the mapping data as well as the alphabetic and numeric data, and the most eligible software for processing of such information is the Geographic Information System (GIS). The GIS has both graphic and database functions so as to simultaneously process the mapping information and its attribute information.

Since the GIS could manage various mapping information as separate independent layers, it will be easy to present various river basin characteristics by overlaying the layers such as land use, topography, flood inundation area and watershed boundary. Through the presentation of various characteristics of the river basin, the GIS can clarify the important interrelations between the river gauging data (river discharge, water quality, etc.) and land development/conservation conditions (urban/industrial development, deforestation, etc.). At the same time, the GIS could display the digitized map information on a desired scale and/or focus on a specific area. The GIS also will enable easy access to the desired map information and to easily update and/or retrieve the information. Thus, the GIS can provide the essential information for the river basin management operations.

As described in Chapter 2, most of the government agencies apply the GIS running on UNIX workstations. In due consideration of such prevailing use and the aforesaid preeminent function, the GIS is proposed as the principal software for the RBIS.

(2) Software for Processing Real-time Information

The river basin information system will analyze and process the radar rainfall data, the automatic water quality gauging data and the river stage data. All objective real-time information, in particular, the radar rainfall and water quality gauging data will require expert computer programs to analyze and calibrate the gauged data and to estimate the actual rainfall depth and the water quality value.

Presently, no ready-made application software such as the aforesaid GIS is applicable to such expert programs. Instead, the expert program is set up beforehand by the supplier of the gauging equipment and developed by the users of the equipment according to their own convenience.

(3) Hardware for Processing Non-real Time Information

The data processing method is in general classified into the following two items:

(a) The mainframe processing method where all data are managed by a centralized computer; and

(b) The distributed processing as represented by the client/server system (C/S) where data are stored by the server machines and distributed to the client machines.

As shown in Table IV-5, the client/server system is superior to the mainframe system in extendibility and in cost efficiency. Such superiority of the C/S is attributed to the recent dynamic functional improvement and the lower prices of the personnel computers. Due to such superiority, the C/S is applied to the RBIS.

The private personal computers widely prevailing could be used as the client machine. As for the server machine, the UNIX machine is selected as the optimum hardware in due consideration of the following conditions:

(a) Most of the government agencies in Malaysia apply the UNIX machine as the main server;

(b) The machine contains the standard operating system to connect the computer network system;

(c) The machine does not depend on vendors;

(d) Connection between different models is easy;

(e) Most Internet server programs are developed on the premise of the UNIX machine and most Internet servers are running on the UNIX machine; and

(f) A large-scale network usually applies the UNIX machine as the server.

The server machines are placed at the federal and state operation rooms. The data management work will be divided into the real-time data management and the non real-time data management. The non-real time data management is further made separately for the flood management, the water resources management, the river environmental management and the watershed management.

The Master Plan proposes several server machines that will have an exclusive task for each of these management works, to effect on the future substantial increment of data management works. Such server system could also avoid the concentration of user's access on one server machine, and increase the efficiency of system operation.

The Master Plan also proposes several servers to control the traffic of data supplied from the servers and the Internet information. The number of server machines are as proposed below:

| Name of Server | Purpose of Server | Number of Servers |
|---|---|---|
| Communication Server | Communication control for information supplied from the servers | 2 (one each for federal and state levels) |
| Web Server | Control of Internet information | 2 (one each for federal and state levels) |
| GIS Server | Supply of mapping data | 1 (at federal level) |
| Flood management Data Server | Supply of non-real time data related to flood management | 1 (at federal level) |
| Water Resources Management Data Server | Supply of non-real time data related to water resources management | 1 (at federal level) |
| River Environmental Management Data Server | Supply of non-real time data related to river environmental management | 1 (at federal level) |
| Audio Control Server | Control of the display data at the system operation rooms | 2 (one each for federal and state levels) |

(4) Hardware for Processing Real-time Information

The real-time information covers the radar gauge rainfall data, the telemetry data for rainfall, river stage, water quality and the visual field scenes. Among the information, the telemetry river stage data require simple processing such as conversion of river stage to river discharge, so that the UNIX workstation at the state operation room could be applied as the telemetry data sever. The visual information is also processed by the same telemetry data sever. Moreover, the telemetry data server distinguishes the radar gauge rainfall data and the point telemetry rainfall data and

transmits them to the exclusive computer machine for radar gauge analysis. Likewise, the server will transmit the telemetry water quality data to its exclusive computer machine for analysis.

The radar gauge rainfall data as well as the telemetry data of water quality require a huge and continuous processing work, and the capacity of the UNIX workstation will not be applicable to such work volume. From these viewpoints, two (2) exclusive computers are placed at the state operation room to analyze and process the radar rainfall gauge and water quality.

### 3.2.4 Data Dissemination Devices

The dissemination device will distribute various information such as gauging data, sounds and pictures comprehensively according to different types of users. The proposed dissemination devices for these users are as described below:

(1) Display Device in System Operation Rooms

Setup of the system operation rooms is preliminarily proposed at the federal and state levels to manage the objective information. All real-time and non real-time information could be accessed through the client machine placed at the system operation rooms. In addition, the audio machine is proposed to display the visual and sound information of the fields on a large screen. Such audio machine will facilitate the common understanding of all members in the system operation rooms particularly on the disastrous conditions of the field and to make an appropriate instruction and/or determination on the disaster management. The proposed audio machine consists of projector, display, recorder and audio control server.

(2) Dissemination to Related Government Agencies

All of the real-time information as well as non-real time information are transmitted through the Internet to the personal computer at the government offices. Such on-line dissemination will be made through the exclusive optical fiber network so that all information including the dynamic visual scenes of the field could be distributed. The government agencies could also obtain the non-real information stored by CD-ROM. In case of such off-line dissemination by CD-ROM, particular application software needs to be developed beforehand to access the information stored in CD-ROM and installed in personal computers at the government agencies.

(3) Dissemination to Public Users

The dissemination system is principally the same as the aforesaid exclusive system for the related government agencies. The on-line dissemination is, however, made through the public telephone line, therefore, dynamic visual information is hardly disseminated. Moreover, some information would not be open to the public and such control of communication will be made by the aforesaid Web Server. Likewise, the public users can obtain information through the CD-ROM but confidential information against the public users is not stored in the CD-ROM.

### 3.2.5 Data Transmission Devices

There are various data transmission devices classified into the radio wave lines and the ground cable lines. The radio wave lines include the multiplex radio wave line, the telemetry line and the satellite line, while the ground cable lines are the optical fiber line and the telephone line. Among these devices, the optical fiber line is selected as the optimum trunk line of data transmission for the objective river basin information system in view of the following points:

(a) Among the transmission devices, the optical fiber line could promise the best quality and reliability of transmitted data.

(b) Only the optical fiber line could transmit the dynamic visual information.

(c) As proposed in Telecommunication Vision 2020, the optical fiber network is going to cover the whole country of Malaysia by the year 2020.

The optical fiber line is a ground cable line, therefore, it has the possibility to be cut off. To cope with any failure of the trunk line, a backup trunk line will be required in the futuristic river basin information system. In this connection, the satellite communication line is proposed as the optimum back up transmission device in consideration of the following points:

(a) Among the transmission devices, the satellite has the second largest data transmission capacity next to the optical fiber line and could transmit all objective information other than the dynamic visual information; and

(b) The satellite communication system is going to prevail in Malaysia as seen in the Telecommunication Vision 2020 and also in the fact that the Malaysian East Asia Satellite (MEASAT-1) was launched in 1996.

The above trunk line will connect the operation centers at federal and state levels as well as the related government agencies. In addition to transmission by this trunk line, the real time gauging data is transmitted through the telemetry radio wave and/or the public telephone line to the server machine. Data dissemination using Internet will also be made through the public telephone line.

### 3.2.6 Overall System Devices

In line with the optimum system network described in Section 3.1.2 and the above proposed system devices, the overall system is preliminarily designed as shown in Fig. IV-3. In the system, eleven (11) UNIX workstations are installed as the data server and/or interface server. In addition, two (2) computer machines are installed at the state operation room to analyze and process the gauged radar rainfall and the telemetry water quality.

Among the eleven (11) workstations, seven (7) are at the federal operation center; i.e., four (4) as the non-real time data server and three (3) server machines as the interface for communication control. Likewise, four (4) workstations will be placed at the state operation room, one as the real-time data server and the others as interface server.

The exclusive optical fiber network will connect the operation rooms at the federal and state levels and the related government offices. Public users can also access the system through the Internet. Through this network, both the real time and non-real time information could be transmitted.