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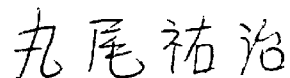
SCOPE OF WORK
FOR
THE STUDY
ON
THE SUSTAINABLE GROUNDWATER RESOURCE AND ENVIRONMENTAL
MANAGEMENT
FOR THE LANGAT BASIN IN MALAYSIA

AGREED UPON BETWEEN
THE MINERALS AND GEOSCIENCE DEPARTMENT MALAYSIA
AND
THE JAPAN INTERNATIONAL COOPERATION AGENCY

Kuala Lumpur, December 16th, 1999



Mr. Chen Shick Pei
Director-General,
Minerals and Geoscience
Department Malaysia



Dr. Yuji Maruo
Leader of the Preparatory Study
Team,
Japan International Cooperation
Agency



I. INTRODUCTION

In response to the official request of the Government of Malaysia, the Government of Japan decided to conduct a study for the sustainable groundwater resource and environmental management for the Langat Basin in Malaysia (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of Malaysia.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

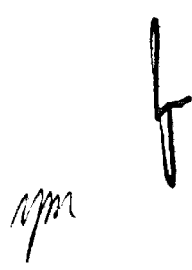
The objectives of the Study are:

1. to formulate a sustainable groundwater resource and environmental management plan (hereinafter referred to as "the Management Plan") for the Langat Basin;
2. to establish a monitoring system and Geographic Information System(GIS) to support the Management Plan;
3. to formulate a human resource and institutional development plan for the implementation of the Management Plan and to be able to utilize the Management Plan for other basins; and
4. to pursue technology transfer to counterpart personnel in the course of the Study.

III. STUDY AREA

The Study will cover the entire Langat Basin (about 1,800km²).

However the areas for groundwater models will be confirmed at the later stage.



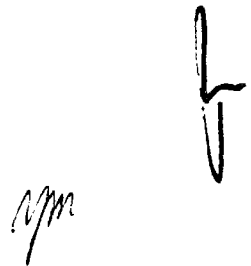
IV. SCOPE OF THE STUDY

Phase I: Baseline Study

1. Collection, review and analysis of related data and information on:
 - (1) Natural conditions (topography, geology, hydrology, hydrogeology and meteorology, etc.);
 - (2) Socio-economic condition (population, public institution, agriculture, commerce, industry, etc.);
 - (3) Land use and vegetation;
 - (4) Well inventory and water use;
 - (5) Institution, legislation and regulation concerning water resource and environmental management;
 - (6) Related development plans and policies; and
 - (7) Other relevant data and information.
2. Topographical and geological reconnaissance.
3. Hydro census (well data, amount of daily abstraction, piezometric level and water quality of existing wells).
4. Establishment of observation well network.
5. Establishment of level survey network for land subsidence.
6. Hydrological investigation of wetland environment.
7. Water demand forecast.

Phase II: Field investigation

1. Geophysical exploration.
2. Core drilling, sampling of clay sediments, compaction tests.



3. Test well drilling, electric logging, pumping test, installation of piezometer, water level recorder and data logger.
4. Observation of pore fluid pressure and groundwater level.
5. Simultaneous measurement of groundwater level and water quality.
6. Designing of GIS.

Phase III : Formulation of the Management Plan

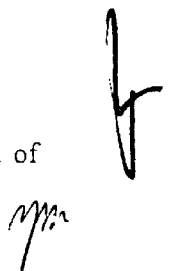
1. Establishment of GIS.
2. Development of groundwater models (water balance study, estimation of groundwater potential, prediction of groundwater level and estimation of land subsidence, prediction of sea water intrusion, contaminant transport study).
3. Formulation of the Management Plan.
4. Formulation of a groundwater resource monitoring plan.
5. Formulation of a human and institutional resources development plan.

V. SCHEDULE OF THE STUDY

The Study will be carried out in accordance with the tentative schedule as attached in the Appendix 1. The schedule is subject to modification if the necessity arises during the course of the Study and mutually agreed upon by both Parties.

VI. REPORTS

JICA shall prepare and submit the following reports in English to the Government of Malaysia.



1. Inception Report:

Twenty five (25) copies in English at the commencement of the first field survey in Malaysia. This report will contain the schedule and methodology of the Study as well as outline of the field survey.

2. Progress Report (1):

Twenty five (25) copies in English at the beginning of the second field survey. This report will summarize the findings of the first field survey.

3. Interim Report:

Twenty five (25) copies in English at the beginning of third field survey.

4. Progress Report (2):

Twenty five (25) copies in English at the beginning of the forth field survey. This report will summarize the findings of the third field survey.

5. Draft Final Report:

Twenty five (25) copies in English at the beginning of fifth field survey. The Government of Malaysia shall submit its comments within one (1) month after the receipt of the Draft Final Report.

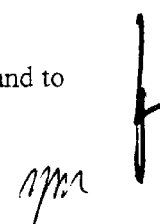
6. Final Report:

Fifty (50) copies and fifty (50) copies of CD-ROM in English within two (2) months after the receipt of the comments on the Draft Final Report.

VII. UNDERTAKINGS OF THE GOVERNMENT OF MALAYSIA

To facilitate the smooth conduct of the Study, the Government of Malaysia will take the following necessary measures subject to the laws and regulation in force in Malaysia;

1. To inform the members of the Study Team of any existing risk in the study area and to take any measures deemed necessary to secure the safety of the Study Team;

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2. To ensure the necessary entry permits for the Study Team to conduct field surveys in Malaysia and exempt them from consular fees;
3. To exempt the members of the Study Team from taxes and duties, as normally accorded under the provision of Malaysian General Circular No.1 of 1979, on equipment, machinery and other materials brought into and out of Malaysia for the conduct of the Study;
4. To exempt the members of the Study Team from Malaysia income tax on their official emoluments in respect of their period of assignment in Malaysia in connection with the conduct of the Study, but the Government of Malaysia shall retain the right to take such emoluments into account for the purpose of assessing the amount to be applied to income from other sources;
5. To provide necessary facilities to the Study Team for remittance as well as utilization of funds introduced into Malaysia from Japan in connection with the conduct of the Study;
6. To secure permission for entry into private properties or restricted areas for the conduct of the Study;
7. To provide the Study Team with medical services when needed but the expenses will be chargeable to members of the Study Team;
8. To provide the Study Team with available data, maps and information necessary for the execution of the Study;
9. To make arrangements for the Study Team to take back to Japan the data, maps and materials connected with the Study, subject to the approval of the Government of Malaysia, in order to prepare the reports;
10. To appoint counterpart personnel to the Study Team during the study period;
11. To provide the Study Team with suitable office space with clerical service and necessary office equipment in Kuala Lumpur;
12. To provide the Study Team with adequate means Local transport for official travel only;
13. To bear claims, if any arise, against the members of the Team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the member of the Japanese survey team; and
14. To nominate the Minerals and Geoscience Department Malaysia to act as the counterpart agency for the Study and also as the coordinating body in relation to other relevant governmental and non-governmental organizations.



VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures;

1. To dispatch, at its own expense, the team to Malaysia; and
2. To pursue technology transfer to counterpart personnel in the course of the Study.

IX. CONSULTATION

JICA and the Minerals and Geoscience Department shall consult with each other in respect of any matter that may arise from or in connection with the Study.



Tentative Schedule

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Fiscal Year	1999	2000												2001												
Month	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
Work in Malaysia	<div><div></div><div></div><div></div><div></div></div>																									
Work in Japan	<div><div></div><div></div><div></div><div></div></div>																									
Report	▲ IC/R						▲ P/R(1)						▲ P/R(2)						▲ IT/R						▲ DF/R	▲ F/R

IC/R : Inception Report
P/R : Progress Report
IT/R : Interim Report
DF/R : Draft Final Report
F/R : Final Report

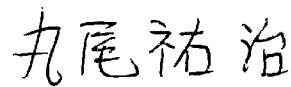
MINUTES OF MEETINGS
ON
SCOPE OF WORK
FOR
THE STUDY
ON
THE SUSTAINABLE GROUNDWATER RESOURCE AND
ENVIRONMENTAL MANAGEMENT
FOR THE LANGAT BASIN IN MALAYSIA

THE MINERALS AND GEOSCIENCE DEPARTMENT MALAYSIA
AND
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Kuala Lumpur, 16th December 1999



Mr. Chen Shick Pei
Director General,
Minerals and Geoscience Department
Malaysia



Dr. Yuji Maruo
Leader of the Preparatory Study
Team,
Japan International Cooperation
Agency

1. Introduction

In response to the request from the Government of Malaysia, the Preparatory Study Team (hereinafter referred to as "the Team") of the Japan International Cooperation Agency (hereinafter referred to as "JICA") visited Malaysia from December 6th to December 24th, 1999 to discuss the Scope of Work (hereinafter referred to as "S/W") for "The Study on the Sustainable Groundwater Resource and Environmental Management for the Langat Basin in Malaysia" (hereinafter referred to as "the Study").

A Meeting to discuss the S/W was held at the Minerals and Geoscience Department Malaysia Headquarters (hereinafter referred to as "JMG") on 8th December, 1999. The list of attendees at the Meeting is shown in Appendix I. The Team also carried out field visits, accompanied by members of JMG, to the study area in the Langat Basin and held a series of technical discussions with JMG from 9th to 14th December, 1999 (Appendix II). Members of the Team will continue further technical discussions and data-gathering until 23rd December, 1999.

The Minutes of Meeting have been prepared to elaborate further the S/W agreed upon between JMG and the Team.

2. Project Committee

Both sides agreed that the Committee shall be called the Committee for JICA Development Study on Groundwater Resources (in short, the "Project Committee") and the Chairman shall be the Director-General of JMG. The Committee shall meet when the Inception, Interim and Draft Final Reports are to be presented, and at other times when necessary. Both sides also agreed on the Committee's Terms of Reference as attached (Appendix III).

3. Study Title

Both sides agreed that the title of the Study would be "The study on sustainable groundwater resource and environmental management for the Langat Basin in Malaysia" as described in the S/W.

4. Study Area

Both sides agreed that the Study Area would be the Langat Basin (about 1,800 sq. km), Selangor, in Malaysia as described in the S/W. Although the area for groundwater models will be confirmed at a later stage, hydrogeological study will be concentrated in the alluvial aquifer area of the Basin. Malaysian side requested to undertake groundwater study and modelling in both the hard rock and alluvial aquifer areas. The Team will convey the



request to JICA headquarters.

5. Scope of the Study

- (i) Both sides confirmed that the baseline study will include Initial Environmental Assessment (IEA) related to the Study and identification of potential pollution source will be included in the hydro census study.
- (ii) During pumping tests, water sampling at periodical intervals will be collected. The samples will be analyzed for their physical and chemical parameters.
- (iii) Water-level recorders will be installed on the observation wells for continuous measurement.
- (iv) A network of bench-marks will be established to study land subsidence in the alluvial aquifer area.
Malaysian side requested to install land subsidence meters in the vicinity of well fields where large amount of water is being extracted.
- (v) Both sides confirmed that electric resistivity survey and electromagnetic survey (TDEM) will be employed in the alluvial aquifer area.
- (vi) Both sides confirmed that about 10 clay sediment samples for the consolidation tests and also about 10 test drillings, which will be developed as observation wells, will be conducted in the alluvial aquifer areas.
- (vii) Current relevant databases and the existing Geographic Information System (GIS) in JMG will be reviewed and improved upon.
- (viii) Malaysian side requested that recommendations on groundwater treatment, in particular of excessive iron, in the study area be made.
- (ix) A contaminant transportation model will be introduced in the study.

6. Schedule of the Study

Both sides agreed that, barring any unforeseen circumstances, the Schedule as described in the S/W will be adhered to.

7. Reports

Malaysian side requested that as an output of the Study, the Final Report should also touch on operationalising the recommendations made.

The number of various reports required to be submitted is shown in the S/W. It was agreed that field data as well as the Final Report will be presented in electronic format and CD-ROM.

It was also agreed that the Final Report can only be released to the public after the



presentation of the Final Report to the Government of Malaysia.

8. Undertakings of the Government of Malaysia

Certain restricted topographic maps and aerial photographs can only be provided to the Study Team after obtaining the necessary approval from the relevant Malaysian authorities. JMG will provide office space with necessary facilities to the Study Team in JMG's headquarters, geophysical survey equipment such as electric resistivity and electro-magnetic meter (TEM) and as well as two 4WD vehicles for use by the Study Team.

9. Undertakings of JICA

Equipment necessary for the Study shall be provided.

JICA will mention in their contracts with successful bidder regarding the security nature of restricted documents such as Malaysian topographic maps and aerial photographs.

10. Consultation

Periodic consultations will be held by both sides to resolve any issues arising.

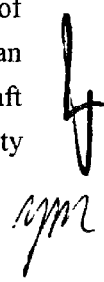
11. Counterpart Training

Japanese side mentioned that one person per year will be generally accepted in the program of counterpart training in Japan.

Malaysian side requested that, in line with human resource development plan, more Malaysian counterpart personnel be sent to Japan for training in view of the fact that several agencies will participate in the Study.

12. Seminar

Malaysian side requested that JICA hold two workshops and a seminar as a means of reporting the findings and the recommendations made by the Study Team to the Malaysian Committee and the Government of Malaysia. The seminar would be held when the draft Final Report is submitted to the Project Committee. The Team recognized the necessity and promised to convey the request to JICA Headquarters for positive consideration.



LIST OF ATTENDEES

(Malaysian side)

Chen Shick Pei	(Chairman)	-	Minerals and Geoscience Department Malaysia (JMG)
Chu Ling Heng		-	Minerals and Geoscience Department Malaysia (JMG)
P. Loganathan	(Secretariat)	-	Minerals and Geoscience Department Malaysia (JMG)
Saim Suratman	(Secretariat)	-	Minerals and Geoscience Department Malaysia (JMG)
Zaidi Daud	(Secretariat)	-	Minerals and Geoscience Department Malaysia (JMG)
Zulkifli Md. Hassan		-	Economic Planning Unit (EPU)
Rasali Osman @ Yusof		-	Economic Planning Unit (EPU)
Namimah Hashim		-	Economic Planning Unit (EPU)
N. Balasubramanian		-	Ministry of Primary Industries (KPU)
Hussain Moh		-	Ministry of Primary Industries (KPU)
Roslan Zakaria		-	Public Works Department, Water Supply Branch (JKR)
Mustaffa Hj. Mohd.		-	Selangor Waterworks Department (JBA)
Muhamad Zin Mohamed		-	Department of Environment (JAS)
Zulkifli Abdul Rahman		-	Department of Environment (JAS)
Mohd. Nazan Awang		-	Minerals and Geoscience Department Selangor

(Japanese side)

Yuji Maruo (Leader)	-	Preparatory Study Team, Japan International Cooperation Agency (JICA)
Masami Mizuguchi (Member)	-	Preparatory Study Team, Japan International Cooperation Agency (JICA)
Taketo Kuroki (Member)	-	Preparatory Study Team, Japan International Cooperation Agency (JICA)
Shigeru Ono (Member)	-	Preparatory Study Team, Japan International Cooperation Agency (JICA)
Takeshi Sagae (Member)	-	Preparatory Study Team, Japan International Cooperation Agency (JICA)



APPENDIX II

LIST OF ATTENDEES FOR TECHNICAL DISCUSSIONS FROM MINERALS AND GEOSCIENCE DEPARTMENT MALAYSIA (JMG)

- | | | |
|----------------------|---|---|
| 1. Jamaludin Othman | - | Head of Geophysics Section |
| 2. Seet Chin Peng | - | Head of GIS Section |
| 3. Kwan Tai Seong | - | Head of IT Section |
| 4. Mohd. Nazan Awang | - | Director of JMG Selangor |
| 5. Saim Suratman | - | Head of Urban and Environmental Geology Section |

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Terms of Reference
JICA Development Study on Groundwater Resources Committee

Study topic:

'The Study for the Sustainable Groundwater Resource and Environmental Management for the Langat Basin, Malaysia'.

Terms of reference:

1. Finalise and endorse scope of work for the study
2. Provide necessary counterpart personnel and supporting staff
3. Facilitate data collection related to the study
4. To monitor the progress of the study on a periodical basis as required
5. Recommend necessary actions to ensure the smooth implementation of the study and to resolve any issues
6. Ensure smooth transfer of technology from the foreign experts to Malaysian counterparts
7. To receive and approve periodical reports submitted for the Project by the study team, and
8. To table the findings of the study to the government and to make recommendations for follow-up action.



PROFORMA FOR PROJECT-TYPE CO-OPERATION

1.0 TITLE OF PROJECT

**A STUDY ON SUSTAINABLE GROUNDWATER RESOURCE
AND ENVIRONMENTAL MANAGEMENT FOR THE LANGAT
BASIN, MALAYSIA.**

2.0 BACKGROUND

Outside the Klang Valley (where urban centres like Kuala Lumpur, Petaling Jaya and Klang are located), future development will be directed towards the Sepang area in the Langat Valley where the Kuala Lumpur International Airport, the Putrajaya Federal and Administrative Centre and the Cyberjaya are sited. The population in the Klang-Langat Valley is estimated to have grown from 2.0 million in 1980 to 2.7 million in 1990 and by the year 2000, it will have a population of about 3.3 million (JICA, 1981). With such a phenomenal growth in population, there is a corresponding increase in water demand. The water demand for 1998 is projected to be about 450 mgd but the five treatment plants at Sg. Langat, Cheras, Ampang, Semenyih and Bt. Nanas in the Klang-Langat Valley could only provide about 290 mgd.

This problem is compounded by the recent drought caused by the El Nino effect resulting in most of the water treatment plants working at only about 60% to 80% capacity. As such, residents in the Klang-Langat Valley have experienced serious water shortages and rationing has to be implemented during the dry period. To alleviate the water shortage problem, the Selangor Water Supply Department has resorted to abstracting groundwater as an alternative source.

Recent investigations carried out under the Seventh Malaysia Plan by the Geological Survey Department in the Olak Lempit-Teluk Datuk area near Banting showed that there is a large groundwater storage.

The Langat Basin, which encompasses the Olak Lempit-Teluk Datuk area, has an areal extent of about 1815 km² and the alluvial aquifers of Olak Lempit have the potential to be

developed as sources of groundwater to supplement the surface water supply for the Klang-Langat Valley. Presently three groundwater wellfields are located in Olak Lempit-Teluk Datuk, Banting, Selangor that is west of the Multimedia Super Corridor (MSC). The Wetland Sanctuary (known as Paya Indah) is located upstream of these wellfields.

The purpose of the project is to formulate the methodology and action plan to ensure the sustainable exploitation of the groundwater resource in the Langat Basin. This groundwater resource exploitation and environmental management plan will help maintain a sustainable groundwater supply to supplement water needs of the Langat Valley without triggering off undesirable environmental problems such as excessive lowering of groundwater level, ground subsidence, drying up of the nearby wetlands and seawater encroachment. The project will also focus on the monitoring of the quality of the groundwater to ensure that the public will continue to enjoy unpolluted, uninterrupted, safe and clean groundwater supply.

This proposed study has the full support of the Public Works Department of Malaysia (see Appendix 1) and is in consonance with the strategies of the broader national water utilisation and management strategies and the objectives of the groundwater policy (Appendix 2).

3.0 OBJECTIVES

The main objectives of the investigation are:

- (i) To establish a sustainable groundwater resource and environment management plan for the Langat Basin.
- (ii) To develop a monitoring and information system to support the management plan.
- (iii) To develop a human resource and institutional development programme for the sustainable implementation of the groundwater resource and environment management plan and to be able to utilise this programme for other basins.
- (iv) To receive technology transfer from foreign experts.

4.0 PROJECT DESCRIPTION

The project area for the sustainable groundwater management¹ that include environmental management² will cover the entire Langat Basin. The project area is about 1815 km² (Figure 1) and will include undertaking of the following:

- (i) Drilling of three deep wells (each measuring 112 mm piezometers in diameter) up to a depth of 100 m. Multi-level piezometers will be installed in each well for the study of pore pressure, groundwater level, quality variation and to collect water samples for contamination studies.
- (ii) Geophysical studies on possibility of seawater intrusion
- (iii) Surface settlement plates will be installed at about 10 to 15 locations to monitor the ground settlement
- (iv) A study on the groundwater potential of the basin will be carried out using modelling techniques
- (v) A study on the effect of groundwater abstraction on the environment, including the wetlands near Banting
- (vi) A study on the basin recharge and water balance components within the basin
- (vii) To establish a geological/hydrogeological model
- (viii) To establish baseline of environmental condition, including quality of groundwater

¹ *Sustainable groundwater management* is defined as groundwater management that enables the use of groundwater as a resource for a long time

² *Environmental management* is restricted to issues related to groundwater such as seawater intrusion, possible subsidence and lowering of groundwater level as a result of groundwater abstraction, and potential contamination from agricultural, industrial and other human activities.

Figure 1 . Location of the Langat Basin



- (ix) To establish safe yield of groundwater in terms of quantity as well as quality
- (x) To establish a basin development plan
- (xi) To have technology transfer
- (xii) To formulate a human resource and institutional development programme

5.0 PREVIOUS STUDY

The Geological Survey Department had conducted geophysical investigations and hydrogeological studies in the Banting area from 1994-1995 under the Lembah Klang – Kuala Langat Integrated Geoscience Project. Thirty-two exploration holes were drilled and results showed that fresh, good quality groundwater can be found in and around the Brooklands Estate in Teluk Datuk.

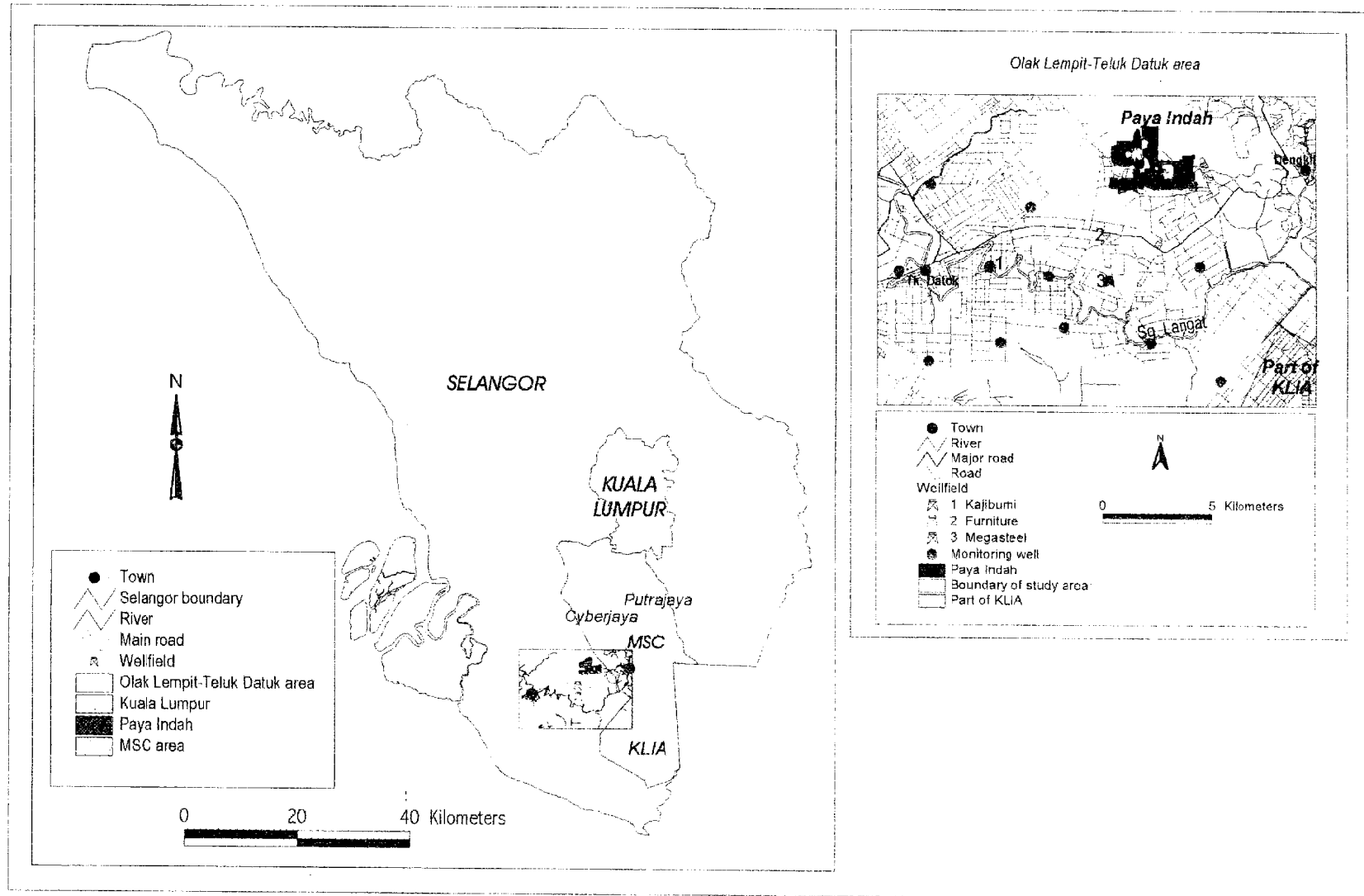
The Olak Lempit-Teluk Datuk area in Banting, Selangor has been shown through the Geological Survey Department Malaysia's (GSD) groundwater exploration work to have a significant and efficient aquifer system. Subsequently, three wellfields were developed in the area. The capacities of the wellfields are shown in Table 1 below:

Table 1: Capacities of present wellfields in Olak Lempit-Teluk Datuk

Wellfield	Location	Number of wells	Capacity (m ³ /d)	
			Min	Max
Megasteel Factory	Brookland Estate	4	27600	40900
Kajibumi (GSD)	Brookland Estate	4	9000	9200
Furniture Factory	Olak Lempit	2	6700	8900

Currently, the Megasteel Factory pumps 27,600 m³/d of groundwater and utilises it for factory consumption as well as for public water supply as groundwater from one of the wells in this wellfield is channelled to the public water supply network. The pumping capacity of the wellfield would be increased to full capacity of 40,900 m³/d once the factory is operating at maximum capacity in the near future. The Kajibumi (GSD) wellfield is currently being commissioned as part of the public water supply source in the area. The location of the Olak Lempit-Teluk Datuk and MSC is shown in Figure 2.

Figure 2: Location of MSC and Olak Lempit-Teluk Datuk area



GSD has also constructed a number of basic monitoring wells and settlement plates to monitor the fluctuation of the groundwater levels and its quality, including possible ground settlement near these wellfields. A preliminary groundwater flow modelling for the Olak Lempit-Teluk Datuk aquifer is being carried out to simulate the effect of the groundwater withdrawals on the surrounding areas. Through this proposed project, new appraisal techniques can be procured to further refine the modelling technology.

A number of housing developments and supporting industries for the MSC and Megasteel factory have been planned within the vicinity of the wellfields. In relation to these developments, more groundwater is expected to be abstracted from the proposed study area (Langat Basin) as a supplementary supply for the urban water supply system to relieve the pressure of over-dependence on the surface water source. Existing and future developments in the area are expected to depend on groundwater as a supplementary source for uninterrupted water supply, for which there is a possibility of more wellfields being built. It is imperative that proper baseline data be acquired through this proposed study to guide proper exploitation and management planning for the future.

6.0. PARTICIPATING AGENCIES

The Geological Survey Department Malaysia³ (GSD) of the Ministry of Primary Industries will be the lead agency and will be assisted by three other organisations, namely the Department of Environment (DOE) of the Ministry of Science, Technology and Environment, the Geology Department of the University of Malaya (UM) and Selangor Water Supply Department. The proposed committees to guide and monitor the implementation of this project are shown in Appendix 3. The main functions of the GSD are included as the Appendix 4.

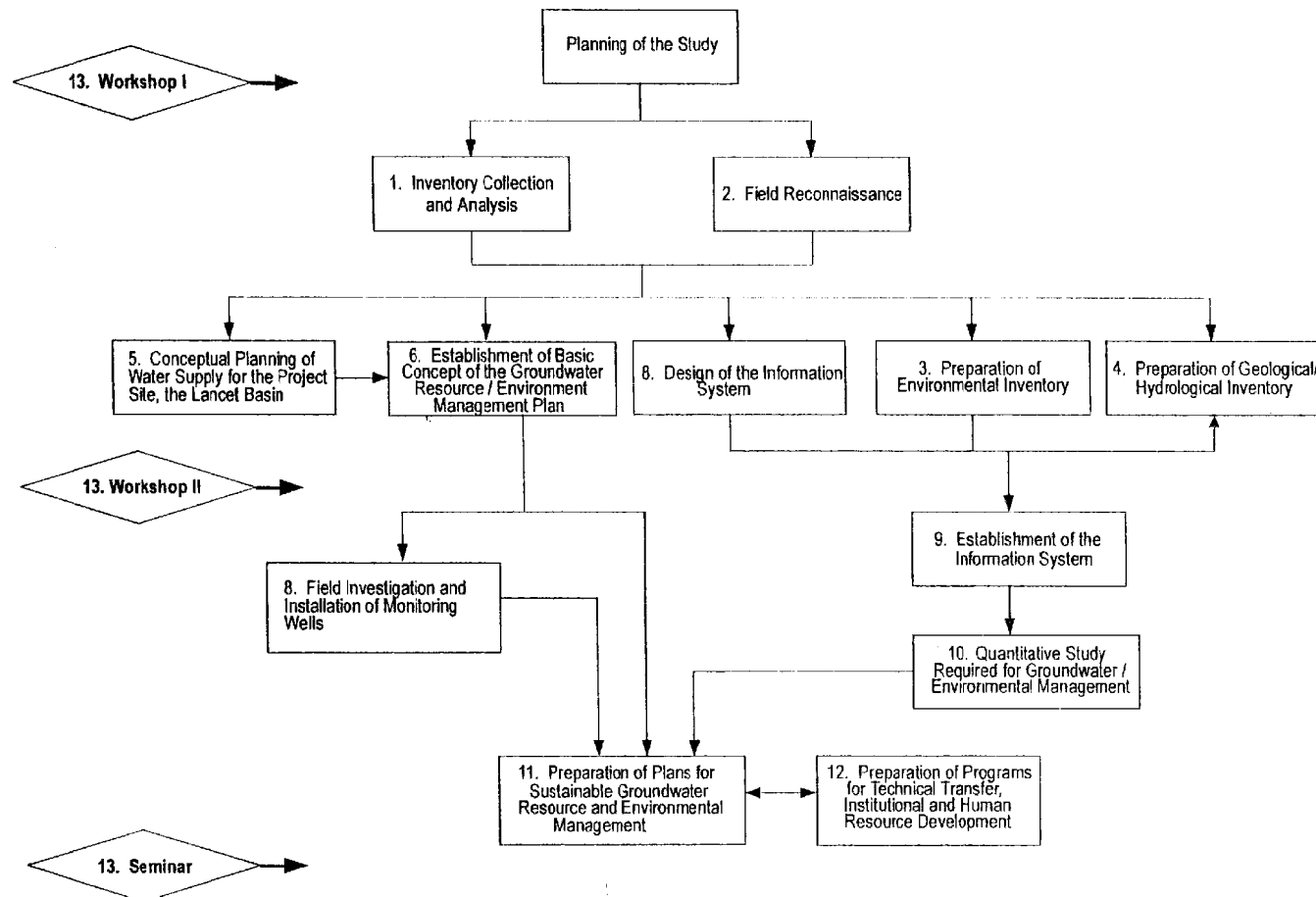
³ Geological Survey Department will be merged with the Mines Department into a new entity named the Department of Mineral and Geoscience.

7.0 SCOPE OF WORK

The scope of work of the project will include the following (Figure 3):

1. Inventory and analyses
 - (a) Studies on the topography, geology, hydrogeology, meteorological conditions and river systems in the project area
 - (b) Studies on landuse and vegetation cover of the project area
 - (c) Studies on the distribution of existing wells and their production capacities in the project area
 - (d) Identification of the potential groundwater pollution sources
 - (e) Evaluate of the water requirements in the study area
 - (f) Studies on the base line groundwater quality
 - (g) Studies on the institutional and legal aspects of water resource and environmental management
2. Field reconnaissance

Figure 3: Flow Chart of the Study



3. Preparation of environmental inventory

The study includes the review of current and future problems.

4. Preparation of geological/hydrogeological inventory

The study will cover logs of boreholes and wells as well, as other geological, hydrogeological and geotechnical information

5. Preparation planning of water supply for the Langat Basin.

The study will cover the present state of water supply, the future water demand and the use of groundwater as a supplementary source

6. Establishment of basic concepts of the groundwater resource/environment management plan.

This will entail the establishment of targets, direction and scope of the groundwater resource/environment management plan.

7. Design of the information system.

An evaluation of the existing information systems will be made and an integration plan for groundwater and environment databases will be formulated.

8. Field investigation and installation of monitoring wells.

This will include the boring and geophysical logging of 3 deep wells and the installation of multi-level piezometers. Groundwater samples will be collected for contamination studies and pore pressure will be studied for monitoring the aquifers.

Geophysical studies comprising Transient Electromagnetic, Resistivity and Gravity surveys will be carried out to study the extent of seawater intrusion.

Settlement plates will be installed in 10 to 15 locations to monitor the settlement rate of the basin.

The geology of the wetlands and the effects of groundwater abstraction on the wetlands will be studied.

The existing wells in the area will be studied and the groundwater potential in the project area will be reviewed.

9. Establishment of the information system.

A groundwater and environmental information system will be prepared and basin geological/hydrological, and environment maps will be produced

10. Quantitative study required for groundwater/environment management

Quantitative analyses and modelling of the basin characteristics such as basin recharge and water balance, and quantitative prediction for groundwater contamination will be made. A study on the groundwater potential using modelling techniques will be carried out.

11. Preparation of a sustainable groundwater resource and environmental management plan.

A plan for sustainable groundwater resource and environmental management will be produced. Plans for mitigative measures such as recharge of wells and cleaning of pollutants, a monitoring programme, and a public education programme will also be prepared.

A cost-benefit analysis of the management plan will also be carried out.

12. Technical transfer and institutional and human resource development.

A programme for technical transfer and human resource development will be instituted.

13. Workshops and seminars.

As a means to disseminate information and to monitor the progress of the project, two workshops, one at the start and another half way through of

the project will be conducted. A seminar will be held at the end of the project.

14. Reports.

An inception report at the start of the project, periodical progress reports, a mid-term interim report and a final report will be prepared.

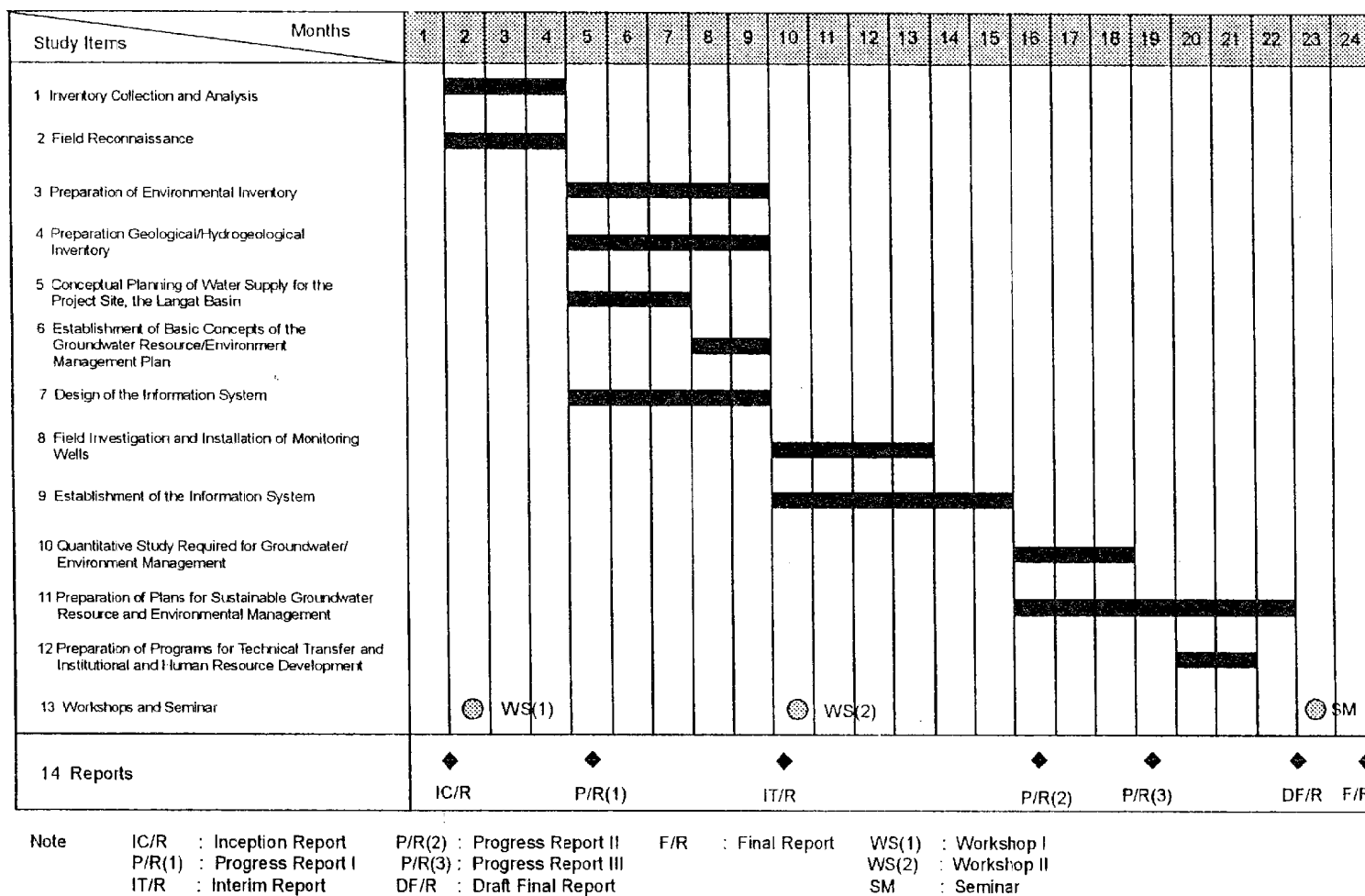
8.0 PROJECT IMPLEMENTATION

The project is expected to last for two years (Figure 4).

The first year of the project will involve the following:

1. Inventory collection and analysis
2. Field reconnaissance
3. Preparation of environmental inventory
4. Preparation of geological/hydrogeological inventory
5. Conceptual planning of water supply for the Langat Basin
6. Establishment of basic concepts of the groundwater resource/environment management plan
7. Design of information system
8. Field investigation (which will continue into the first month of the second year)
9. Establishment of the information system (which will continue into the third month of the second year)

Figure 4: Study Schedule of the Project



The second year of the project will involve the following:

10. Quantitative study required for groundwater/environment management
11. Preparation of plans for sustainable groundwater resource and environmental management
12. Preparation of programmes for technical transfer, institutional and human resource development.

In addition, workshops will be held at the start and towards the end of the first year of the project. A seminar will be held at the end of the project.

9.0 RESOURCES SUPPLIED BY THE HOST COUNTRY

9.1 Manpower

The list of the local officials involved in the project is shown in Table 2.

Table 2: List of local experts

Designation	Number	Agency	Time involved (month)
Counterpart leader	1	GSD	10
Hydrogeologist	1	GSD	10
	1	UM	10
Geologist/Engineering geologists	2	GSD	10 each
Environmental geologist	1	GSD	10
Groundwater and soil pollution specialist	1	GSD	10
GIS personnel	1	GSD	10
Database personnel	1	GSD	10
Ecologist	1	DOE	10
Water supply engineer	1	JBA	10

9.2 Equipment and vehicles

The Geological Survey Department will provide two four-wheeled drive vehicles for the project. Geophysical survey equipment (Transient Electromagnetic Measurement, Gravity and Resistivity Equipment) will be provided by the Geological Survey Department.

9.3 Laboratory analyses

The Geological Survey Department will undertake analyses of groundwater.

9.4 Office space

The Geological Survey Department in Kuala Lumpur has sufficient space for the foreign experts. One room will be provided for them to work in.

9.5 Local cost estimates

The local contribution for each year is estimated at RM80,000. These costs are for field allowances of (RM40,000 per annum), supplies and maintenance of vehicles (RM20,000 per annum), and chemicals for laboratory tests (RM20,000 per annum) as shown in Table 3.

Table 3: Estimated Local Cost

Item	1999	2000	Total
Allowances	RM40,000	RM40,000	RM80,000
Supplies and maintenance	RM20,000	RM20,000	RM40,000
Chemicals for laboratory tests	RM20,000	RM20,000	RM40,000
		Total	RM160,000

10.0 FOREIGN ASSISTANCE REQUIREMENTS

10.1 Expertise

A list of foreign experts required for the project is shown in Table 4.

Table 4: List of foreign experts

Designation	Number	Time involved (months)
Team leader	1	10
Hydrogeologist	1	7
Water resources engineer	1	3
Geologist/Engineering geologist	1	7
Environmental management planner	1	10
Groundwater and soil pollution specialist	1	5
Environmental monitoring specialist	1	5
Ecologist	1	3
Regional planner/Landuse planner	1	3
GIS specialist	1	10
Database specialist	1	7
System engineer	1	7
Training and technology transfer specialist	1	7
Socio-economist	1	3

10.2 Equipment and vehicles

The foreign experts will hire 2 vehicles (4 wheeled-drive) for the project. Specialised equipment, computer hardware and software, field monitoring equipment shall be provided by the foreign experts as and when necessary upon the recommendation of the experts.

10.3 Foreign cost estimates

JICA will provide a sum of about USD2.8 million for the project. A breakdown of the contribution is shown in Table 5.

Table 5: Foreign contributions

Item	Cost (US Dollar)
Fieldwork (inclusive of drilling, installation of piezometers, study of basin recharge, water balance study of basin, ecological & geophysical studies)	310,000
Equipment	300,000
Experts' fees	1,860,000
Travelling claims for foreign expert	200,000
Preparation of report	100,000
Training of local counterparts	30,000
Total	2,800,000

10.4 Training

Training for local officers involved in the project will be provided as and when recommended by the foreign experts. The training may involve on-the-job training in Japan.

11.0 PROJECT OUTPUT

The project will result in the formulation of a sustainable groundwater resource and environment management plan for the Langat Basin that can be applied to other basins as well. A comprehensive report with thematic environmental and geological/hydrogeological maps of the Langat Basin will be produced.

The project will also set up a monitoring system for the exploitation of the groundwater resource and for the environment management of the Langat Basin.

An up-to-date environmental and geological/hydrogeological database will be acquired by the Geological Survey Department.

An institutional and human resource development plan for sustainable implementation of the project and for other basins will be formulated.

12.0 BENEFITS AND JUSTIFICATION

The project will set down methodology, action plan and activities to ensure the sustainable exploitation of groundwater resources in the Langat Basin, and avoidance of over abstraction. The groundwater resource and environmental management plan, the implementation of which will help maintain a sustainable groundwater supply to supplement water needs of the Klang-Langat Valley without triggering off undesirable environmental problems such as ground settlement, lowering of groundwater level, including that of the nearby wetlands, and inland seawater encroachment. The project will also monitor the quality of the groundwater to ensure that the public will continue to enjoy unpolluted, uninterrupted, safe and clean potable groundwater.

There will be technological transfer from the foreign experts to the local counterparts and with the development of a human resource development plan, the local counterparts will be able to continue with the sustainable management of the Langat Basin and this technology can be applied to other areas in Malaysia.

2. 調査対象地域の概要

2-1 一般概要

マレーシアの首都クアラルンプール及びその周辺地域では、急激な都市化・工業化が進行している。特にクアラルンプールから新しい国際空港（KLIA）に至る地域は Multimedia Super Corridor（MSC）と呼称され、情報テクノロジー産業誘致のための地域である Cyber Jaya や、新しい首相官邸と首相公邸を中心とした新しい政治の中心である Putra Jaya という街づくりが進行中である。このため、急激な水需要の伸びによる水不足、水質汚濁を含む都市環境の悪化が懸念されている。

水不足に対応するため、セランゴール州では代替を地下水資源に求め、既に一部の工場では、工業用水として地表水から地下水利用にシフトしつつあるが、地下水の無計画な利用は、地盤沈下、地下水 n 塩水化、地下水位の低下による湿地帯の枯渇等の深刻な環境問題を引き起こすおそれがある。また、実態は正確に把握されていないが、クアラルンプール及びその周辺地域では、工場、ごみ処理場等からの排水、あるいは錫鉱跡地からの有害物質による地下水の汚染が懸念される。

これに対しマレーシア政府は、第7次開発計画を修正し、当地域での地下水資源開発及び環境保全対策を最重点項目とするとともに、既に同計画のもとで一次産業省地質調査所は地下水資源開発調査、科学技術環境省環境局は地下水汚染調査を開始している。しかしながら、両調査は各々の目的に沿う方向での現状把握に留まり、また相互間の連携はとられていない。このため、持続可能な地下水資源の利用と安全な地下水を供給するためのバランスのとれた横断的・総合的な地下水資源/環境管理計画の立案が急務となっている。

2-2 自然状況

熱帯雨林気候で気温湿度ともに高い。一年を通して気温は摂氏 21 から 32 度、湿度は 80 % 程度である。年間降雨量は 2000 から 2500 mm。クアラルンプールでは一般に 11 月はじめから 2 月半ばまでが雨季（モンスーンシーズン）とされているが、マレー半島東海岸に比べて雨季・乾季はそれほど明瞭ではなく、一年を通して雨量が多い。

対象地域を流れるランガット川は、上流ではほぼ南南西に、中流で西に向きを変えて流れ、マラッカ海峡に注いでいる。既存の土地利用図 1995 年版を見ると、土地被覆の概要は次のとおりである。

- 上流域 : 森林（全流域の 1/5 程度）
- 中流域 : ゴム林とオイルパームの混在した中に都市開発が見られる
- 下流域 : オイルパームが大半を占め、その中に大きな湿地が広がる

開発が進んでいる中下流はもともと油ヤシとゴムのプランテーションが広がっている地域である。

2-3 社会・経済状況

東南アジアの中心に位置するマレーシアは、マレー半島とボルネオ島の一部、サバ、サラワクから成

り立っている。人口はマレーシア全体で約2, 200万人、マレー系、中国系、インド系そして多数の部族に分けられる先住民で構成される多民族国家である。マレーシアの首都はクアラルンプールであり、その人口は250万人である。

政治は議会民主制立憲君主制となっており、国土は政治的権力を持たない。

マレーシアの国内総生産(GNP)は1995年でUS\$78,000million、1人あたりのGNPとしてUS\$3,890であり、1985年から1995年までの成長率は平均で6.8%であった。1997年半ばから始まったアジア通貨危機では、さすがにその影響を大きく受け、1998年にはマイナス成長を記録した。しかしながら1999年には早くもそのダメージから脱出し、2から4%の成長を記録するものと期待される。

マレーシアは豊かな天然資源に恵まれ、伝統的に資源の輸出で外貨を稼いできた。石油、天然ガス、錫、天然ゴム、やし油などの一次産品は、今でも外貨獲得の大きな担い手であることに変わりない。しかし、20年ほど前から強力で押し進めてきた工業化政策が実を結び、GNPに対する貢献度は、現在製造業部門が他を圧して第一位となっている。また、サービス業の成長も著しく、産業構造が先進工業国並みになりつつある。

2-4 水文・地質

ランガット川はマレー半島の脊梁山脈西面、クアラルンプール北東のウルランガットにその源を発する。水源付近の山々の標高はおよそ1000mである。ランガット川はその後山岳地帯を南に下り、カジャン、バンギの丘陵地帯を徐々に西に進路を変えながら通過する。さらにカンボンデンキル付近から平野部に入って西に進路を取り、時に大きく蛇行しながら進み、マラッカ海峡へと注いでいる。ランガット川流域全体の広さはおよそ2000平方キロメートルである。

水源付近の山地の基盤層は、マレー半島の脊梁山脈を形成する花崗岩類であり、チェラス付近の丘陵部まで続いている。カジャン、バンギ周辺の丘陵地帯を形成している地層は、ケニーヒルフォーメーション、カジャンフォーメーションと呼ばれる変成を受けた堆積岩層であり、頁岩、片岩、泥岩を主体としている。花崗岩類を含めこれらの基盤岩上部は、通常相当の深度まで激しく風化し土砂化している。この強風化によって土砂化した部分の厚さは典型的に十から数十メートルに及んでいる。

平野部には沖積層のゆるい砂層、軟弱粘土層が堆積している。これらの土層は、山地・丘陵地の岩、土が削られ運ばれて堆積したものであり、その厚さは一般に海岸地域で非常に大きく、厚さ100mに達する場所もある。