

**ENVIRONMENTAL PLANNING FOR
SUSTAINABLE WATER USES
- A CASE STUDY ON THE DEVELOPMENT
OF CATCHMENT MANAGEMENT
PLANS IN MALAYSIA**

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**This thesis is submitted in fulfilment of
the Degree of Doctor of Philosophy in Town and Country Planning**

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Abstract

The thesis explores the role of Catchment Management Planning [CMP] in promoting sustainable water uses within a river catchment and develops a framework and procedures whereby CMP could be implemented in Malaysia. The study links the concepts of sustainable development and the principles underlying the sustainability of water uses, which are explicit throughout the thesis, with land use, water resources, environmental planning and management controls, using the river catchment or basin as the basis of the framework for water resource management.

The mismatch between the intended uses of river water and the prevailing water quality condition of rivers arises from conflicts of interest and can be attributed to the lack of land use and water resource management and control. The thesis emphasises the essential elements of integrating the concept of sustainable development into planning and management activities, while advocating the need for a multidisciplinary and integrative approach to catchment water quality management.

The thesis describes the research framework and methodologies, and analyses the concept of sustainable development, the environmental policy for Malaysia, and the land use, water resource and environmental planning and management systems within the Malaysian context. The use of GIS in this area of spatial planning has been very promising, and the thesis demonstrates the functional capabilities of GIS in the identification of pollution problems and problematic areas through water quality modelling and approaches to decision making; this forms the basis for recommended actions in the proposed plan. The plan proposals, which are based on a holistic approach towards sustainability, contain: strategies for improving river water quality through source control and minimising impacts of land use development, while sustaining beneficial river uses; components of planning decision making and implementation; the functions, recommended format and framework for the Malaysian CMP; and opportunities and needs for further research.

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GLOSSARY OF ACRONYMS

BOD	Biochemical Oxygen Demand
CMP	Catchment Management Plan
COD	Chemical Oxygen Demand
DID	Drainage and Irrigation Department
DMS	Department of Meteorological Services
DoA	Department of Agriculture
DOE	Department of Environment, Malaysia
DOE(UK)	Department of Environment (United Kingdom)
DoF	Department of Fisheries
DoLM	Department of Land and Mines
DoPW	Department of Public Works
DoTCP	Department of Town and Country Planning
DoVS	Department of Veterinary Services
DoWS(NS)	Department of Water Supply (Negeri Sembilan)
EA	Environment Agency, England and Wales
EIA	Environmental Impact Assessment
EPU	Economic Planning Unit (Federal)
EQA	Environmental Quality Act, 1974 (Act 127)
EQC	Environmental Quality Council
FD	Forestry Department
Felda	Federal Land Development Authority
GD	Geological Department
GIS	Geographical Information System
GOM	Government of Malaysia (Federal)
GoNS	Government of Negeri Sembilan (State)
IAPG	Inter-Agency Planning Group
LEAP	Local Environment Agency Plan
Mardi	Malaysia Agricultural Development Institute
MGD	Million Gallons per day
MPS	Municipality of Seremban
N.S.	The State of Negeri Sembilan
NDC	National Development Council (Federal)
NEP	National Environmental Policy
NGO	Non Governmental Organisation
NH ₃ N	Ammoniacal Nitrogen
NLC	National Land Code, 1965
NRA	National River Authority, England and Wales
NRWW	Ngoi-ngoi River Water Works
OPP	Outline Perspective Plan
PTG(NS)	Land and Mines Office (Negeri Sembilan)
PWTW	Pantai Water Treatment Works
SEPU	State Economic Planning Unit
SIC	State Investment Committee
SIRIM	Standards and Industrial Research Institute Malaysia.
SLWTP	Linggi River Water Treatment Plant
SS	Suspended Solids
STW	Sewage Treatment Works
SWSA	State Water Supply Authorities
TCPA	Federal Town and Country Planning Act
TIN	Triangulated Irregular Network
TRWW	Terip River Treatment Works
TVA	Tennessee Valley Authority, United States
U.S.L.E.	Universal Soil Loss Equation
WQO	Water Quality Objectives
WQR	Water Quality Region

CHAPTER 1

INTRODUCTION

1.1 PREAMBLE

Environmental issues have become a central concern in recent years especially after the Earth Summit at Rio in 1992. One of the resolutions accomplished and adopted at the Earth Summit was Agenda 21, which revealed elaborate strategies and integrated programme measures to halt and reverse the effects of environmental degradation and to promote environmentally sound and sustainable development. Since then, sustainable development has been entwined along with all sorts of management and planning, particularly those that are related to the exploitation and preservation of the natural resources. In fact, the concept of sustainable development offers a management style which emphasises integrated management of natural resources and the concern of meeting not only the needs of the present generation but also those of the future.

Action to deliver Agenda 21 and the 27 principles of the Rio Declaration on Environment and Development has been undertaken by the Government of Malaysia along with many other nations in the world. This has been reflected in many of its policies, strategies and actions covering the various aspects of planning and management at all levels of government departments and agencies. Consequently, the

principles behind sustainable development will be explored in my approach to management of the water environment and help to achieve the sustainability of this vital resource.

Rivers have been recognised as a most indispensable source of water supply but this vital water source has become threatened more than ever in recent years due to rapid development programmes to meet the needs of the growing population with little regard to its sustainability. Realising this critical situation, it is therefore necessary for appropriate actions to restore the river conditions be planned and implemented, so as to sustain the various uses of the river. Although Malaysia is a country with abundant rainfall, it may eventually experience water supply shortages to meet the growing demand because of polluted water sources and insufficient flow for abstraction, if constructive programmes to sustain the resource is not given a priority. Various approaches on the ways in which the river system can be best managed, such as river basin management, watershed management, catchment management or river conservation, have been introduced. Basically, these approaches have similar objectives although they may vary in terms of the level to which they apply. Nevertheless all of them recognise and manage the river system as a single water resource unit.

Erickson (1995) sets out that these sorts of management and planning are inherently concerned with land use issues and their impact on catchment interests including river water quality and biological diversity. The interaction between the different processes involved in land use activities on a river basin or catchment scale should enable a quantitative assessment be made (Newson, 1992), in order to identify problem areas and finding ways to resolve them.

The benefits of river management and planning are many, among which it would lead to water quality improvement and in turn ensure clean and safe water supply, induce fisheries conservation and promote the use of river as an amenity. Further dimensions shall be explored to integrate the conservation aspects of water environment into land

use planning and control through a structured approach of Catchment Management Planning.

Several principles under Agenda 21 support the approach of Catchment Management Planning, especially in Principles 4, 10, 11 and 15 as follows:

- * Principle 4: Environmental protection must be an integral part of the development process.
- * Principle 10: Environmental issues are best handled with the participation of local communities. Individuals should have access to information on the environment and activities which may affect it and be able to participate in the decision making process.
- * Principle 11: Environmental standards, management objectives and priorities should reflect the local environmental and developmental context.
- * Principle 15: The precautionary approach should be widely applied.

A number of countries including England and Wales, Canada, France, and Australia have implemented Catchment Management Planning [CMP], and the approach is becoming popular in resolving conflicting planning issues and helps to promote sustainability of the water environment. The concept of CMP is also consistent with the proposal made in the Second Outline Perspective Plan (1991-2000) for Malaysia, which sets out that "adequate attention will be given to the protection of the environment and ecology so as to maintain the long-term sustainability of the country's development" and in the Third Malaysia Plan (1976-1980) which aimed "... to balance the goals for socio-economic development and the need to bring the benefits of development to a wide spectrum of population ... against the maintenance of sound environmental conditions." Whilst in the Seventh Malaysia Plan, a policy statement related to Catchment Management Plan has been explicitly stated as " ... watersheds will need to be protected to ensure that their potential use is not jeopardised."

Catchment Management Planning carries the element of integration. It will bring about the intended sectoral integration of water resource in terms of flood defence, pollution control, conservation and numerous other benefits including fisheries, recreation and navigation. The CMP could be extended to the local planning authorities and the local authorities responsible for implementing development programmes within the local area. For example, development of urban areas has an effect on water in several ways but development has rarely been halted for water consideration reasons. CMP will help to guide planners on how to manage development with minimal damage to water resources.

This research focuses on the development of Catchment Management Planning in Malaysia, and the use of Geographic Information System [GIS] as an integration to Catchment Management Planning. Although GIS is new in the field of catchment management in Malaysia, it has been successfully used in many fields of river basin management in other places. It is anticipated that Catchment Management Planning could be a useful piece of work that promote a sustainable water resource in Malaysia, through this research.

1.2 PROBLEM DEFINITION

1.2.1 Predicament of Development Process

The Seventh Malaysia Plan (1996-2000) in stating the future challenges facing the nation during its implementation period, recognises that for sustainable development to be achieved, it should not rely on awareness for the preservation of environment alone but most important is to integrate environmental considerations in the economic and social development process. Aspects of environmental protection in project development are sometimes not given equal priority to the projects themselves, even if they are not totally ignored. The extent of the problems posed on the environment were often known at a much later stage when Environmental Impact Assessment

[EIA] study is completed while some projects proceed despite neither their EIA studies were completed, nor the necessary approvals were obtained.

While in some instances, the EIA studies have been conducted at a much later stage although the requirement clearly indicates that no prescribed activity shall proceed before obtaining the approval from Department of Environment on the EIA report. This can create a difficult situation especially when an EIA study shows that the proposed site to be unsuitable for the prescribed activity while remedial measures could be expensive if not impossible.

The Catchment Management Planning procedure is aimed not only to provide guidance on the actions for responsible agencies to undertake according to their roles, but also to guide investors and to provide them with sufficient information before they resort to heavy investment. Similarly, to all other parties whether they may be the authorities responsible for managing the sources of water supply for abstraction, the development agencies searching for suitable location for their projects, the environment regulatory agency to enforce the legislation on the protection of water quality; the local authorities in siting the best location for river improvements or the promotion of recreational sites, etc., all will have access to adequate information about the condition of any part of the catchment before any action or investment is made. The present situation is not so, thereby causing the responsible agency like the Department of Environment been bogged down with many queries regarding new proposed sites for development projects from all parties including the investors and the local authorities.

With the rapid pace of industrial and economic growth, some States experience the problem of water supply stress. In addition, the clearing of hill land areas has led to the encroachment of upland watersheds, and the resulting sedimentation impedes the development of adequate water flows in rivers. Water loss due to mismanagement of upstream catchment areas continued to be a problem. As such, efforts were made to introduce the watershed-management concept into the planning and development of

water resources in order to ensure a sustainable supply of water and to maintain their long-term viability.

1.2.2 Current Water Crisis

The incidence of drought in Malaysia for several months from January 1998 has reached a critical level in April 1998, resulted in water shortages especially in the water stress areas throughout the country, and the situation is expected to continue until the approach of the monsoon season. The severity of the situation led all the involved parties to focus their attention towards resolving the issue and to turn for favour from water-rich states. The Federal Government in an effort to win over its role to co-ordinate the management of water supply for years with no success, has at last obtained the consent from all the State Governments, due to the existing situation on water crisis. This is not surprising as the problem of co-ordinating is also an issue (Erickson, 1995) when it involves political jurisdiction not only among states but even at local townships level.

“The Federal Government will take over the management of inter-state water distribution under a long-term plan to overcome future shortages.
.. the Cabinet approved the formation of a National Water Council”
(The Star, 2/4/98)

Nevertheless, solutions to the crisis will take some time, as the formation of the National Water Council itself will need an amendment to the constitution in order to provide the necessary power to the Council in discharging its role, and any infrastructure required for inter-basin water transfer will take quite a while before it can be ready to serve. Proposals such as to place water catchment and reserves under the jurisdiction of the Federal Government will also require amendments to the constitution as matters relating to water are under State jurisdiction. The steps towards achieving this at present are still unclear as the States themselves will need some time to determine appropriate policies before proceeding into inter-state water distribution

(The Star, 17/4/98). Meanwhile, the situation seems to worsen, where it was reported on the followings:

“Thousands of residents in Klang, Subang Jaya, Sepang and Ulu Langat have been told to prepare for water supply disruptions as the level at the Semenyih Dam is dropping. In later development, water-rich Pahang announced a rescue plan to provide piped water to critical states like Selangor and Negeri Sembilan through an ambitious multi-billion ringgit project.” (The Star, 5/4/98)

“Water supply to all districts in Negeri Sembilan will be rationed beginning Friday (10/4/98).” (Utusan Express, 8/4/98)

“Severe water rationing will be imposed in the entire Klang Valley if the water level in the dams continue to drop in the next four months” (Utusan Express, 9/4/98)

“As the authorities argue over who should be blamed for the water crisis, many residents in the Klang Valley have been living like nomads in search of water.” (The Star, 9/4/98a)

“A total of 702 areas will be affected in the water rationing exercise involving more than 1.8 million people in the Klang Valley” (The Star, 17/4/98a)

A report by the Institute of Engineers Malaysia states that “the problem in the Klang Valley is not because there is no water but the priceless commodity is wasted through losses of non-revenue water and consumers habit of using plenty of water ...” (Utusan Express, 4/4/98). One of the policies worth considering in the implementation of inter-basin water transfer, is as suggested by the Prime Minister Dato’ Seri Dr Mahathir Mohamad that “states could sell water because it was a commodity like tin or oil” (The Star, 17/4/98b).

All these suggest that the vital resource should be better managed not only to help overcome the present water shortages and prevent a recurrence of water crisis, but also for the community well being as a whole through all the benefits that can be tapped from the river system.

Thus far, the Government has taken several initiatives through various programmes such as the river clean-up and “*Love Our Rivers*” campaign. The Klang River 10-year Clean-up Programme which started in 1992 focuses to improve the Klang River

(which flows through the Capital City Kuala Lumpur, in the Klang Valley Region) through its 9 main activities including: river alignments and installation; debris collection; desilting; beautification; resettlement of squatters; piggery wastes treatment; rehabilitation of fish life; public education and awareness and water pollution control (DOE, 1994a). The “*Love Our Rivers*” campaign introduced by the Drainage and Irrigation Department [DID] in collaboration with the Department of Environment [DOE] in 1993, involves 6 main tasks and these are: river adoption by the State; organising expedition activities by boat along the selected river stretches; education and awareness; river beautification; symposium; and, river watch activities (DOE, 1994a).

However, the most crucial step that should be taken is to produce a strategic plan that will identify problem areas and finding appropriate solutions to the problems through a comprehensive management plan for all the catchment areas to ensure the sustainability of water in the long-term. It is important that such plan should be proactive in nature and should be able to withstand situations resulting even from an effect of climatic change.

1.2.3 Public Complaints

The number of complaints received reflect the current dissatisfaction with the general river water quality in the country. Incidence of water pollution complaints in 1993 is 252, (of which: 52 percent are due to industrial activities, 7 percent due to animal husbandry, 7 per cent due to mining / siltation, 6 per cent due to sewage disposal, and, 28 percent due to other sources (DOE, 1994a), as compared to 59 in 1986 (with 46 percent due to industrial activities, 20 percent due to animal husbandry, 11 percent due to mining and siltation, 2 percent due to sewage disposal and 21 percent due to other sources (DOE, 1987)). This calls for a concerted effort to ensure that the status of river water quality improves over the years although the sources of pollution continue to increase in their numbers.

1.3 RESEARCH QUESTIONS

This background and context leads to several broad research questions:-

1. Has the concept of sustainable development been integrated in the approach towards environmental planning and management in the country?
2. Is the present system adopted in land use planning adequate to support sustainable water use in Malaysia? In what way do development plans consider the carrying capacities of the environment segment and pollution control strategies?
3. Could a sustainable water use be achievable under the present water resource planning and management in the country?
4. Is Catchment Management Planning suitable for implementation in Malaysia?
5. In what way could Geographic Information System [GIS] be applied to guide planners and decision makers through CMP in the identification of areas susceptible to high impact risk for appropriate mitigating measures to be taken?
6. What sort of CMP format should be best adopted and is the present institutional framework sufficient to handle the implementation of CMP?

1.4 RESEARCH AIMS AND OBJECTIVES

Aims

This study is intended to set out the components necessary for an integrated catchment management planning approach and to develop a format of Catchment Management Plan in Malaysia that can be used throughout the country for proper river management.

Objectives

The following will be the objectives of the study:

- i) To study the planning components that contribute towards the sustainability of the water environment;
- ii) To correlate the land use activities and its impact on water quality;
- iii) To assess the achievements of meeting the water quality objectives;
- iv) To propose an integrated catchment management plan for Malaysia;
- v) To suggest linkages for proper implementation within the planning framework and the institutional arrangement in Malaysia.

1.5 RESEARCH METHODOLOGY

1.5.1 The Research Process

This research on Catchment Management Planning in Malaysia will be based on exploratory research and there will be no testing of hypothesis. Some references to the approach used in Catchment Management Planning in England and Wales are made in developing the CMP for Malaysia, as at present, Malaysia does not have one. The research process will involve 6 stages as described below and illustrated in Figure 1.1. The stages involved in this thesis are:

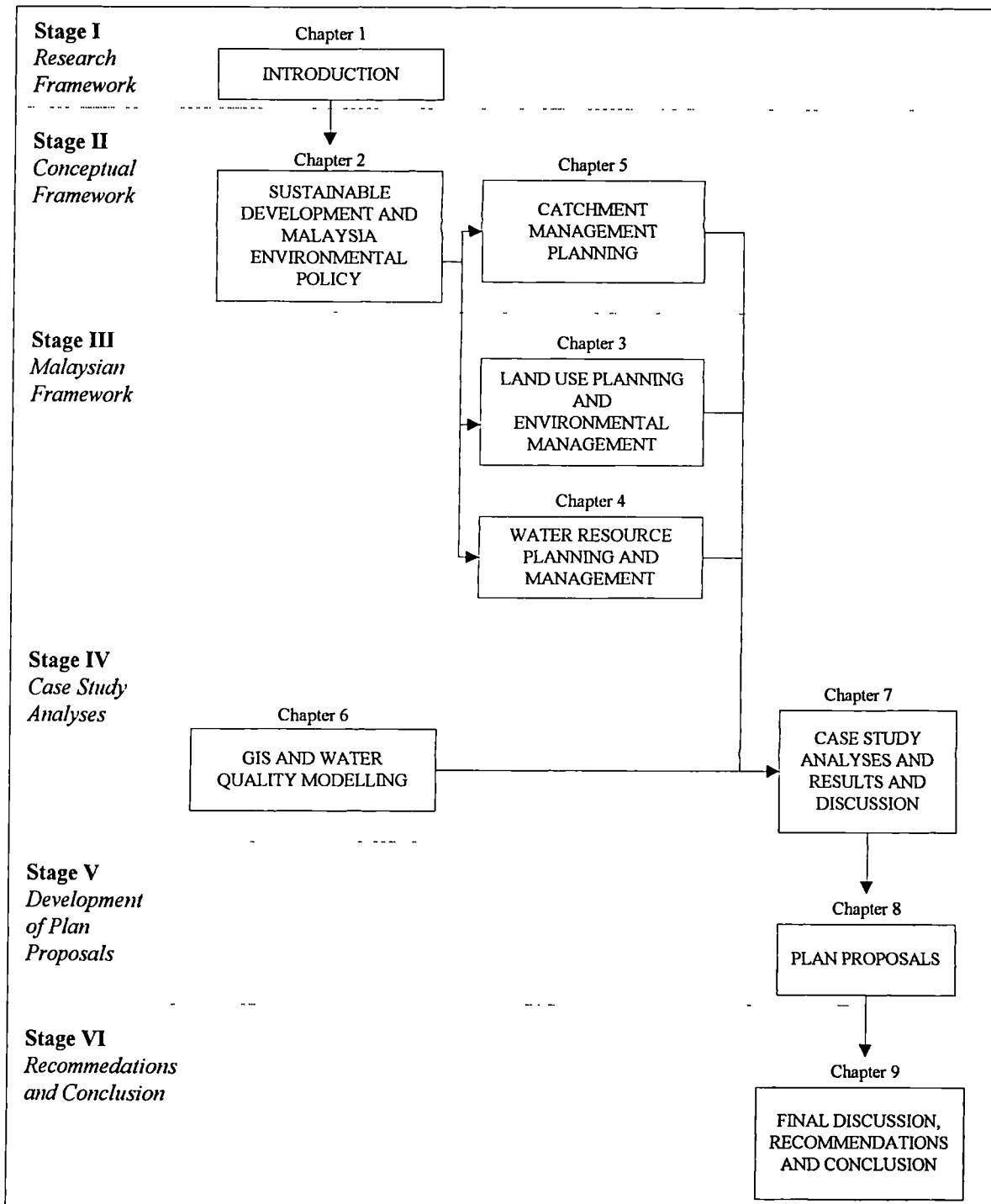


Figure 1.1 Research Methodology for Development of Catchment Management Plan for Malaysia

First/Preliminary Stage	Describes the research framework.
Second Stage	Describes the conceptual framework.
Third Stage	Describes the Malaysian framework.
Fourth Stage	Research context and analyses of case study.
Fifth Stage	Development of proposal for Malaysia.
Final Stage	Recommendations and conclusion of the research.

The preliminary stage basically outlines the introduction to river Catchment Management Planning, the problems that prompted the needs for proper management of water as the vital resource to ensure its sustainability. This stage also detailed the aims and objectives, the scope of the research, the research methodology and the content of this thesis.

The second stage emphasises further literature review and analysis of the concepts of sustainable development, and the sustainability of water use as well as the principles to develop and achieve the implementation of the subject so far on a global perspective and having global significance. It also comments on the need for an environmental ethic in order to bring about sustainable development. The situation in Malaysia, which has developed her own national policy on environment, has been examined on its capability to integrate the concept of sustainable development and turn it into a reality. The national environmental policy for Malaysia is also examined to focus on the key issues that would help to uphold the concept of sustainable development. The examination of these concepts is expected to yield key conceptual issues in the form of philosophies, principles and links between concepts that justify and provide the framework and basis for further analyses in the succeeding stage.

This stage examined the experiences of Catchment Management Planning particularly in England and Wales and the nature of the plans being produced in promoting a good water environment. This examination serves to built up the conceptual framework of

the study. Analyses at this stage mainly involved the review of literature particularly on the various catchment management plan reports, including the consultation report, the action plan and the annual review of several river systems. The task of analysing the catchment management plans is expected to highlight various issues that help determine the scope and format of catchment management plan to be developed for Malaysia.

The third stage examined the efforts made in the Malaysian land use planning system, environmental planning and management, water resources planning and management and water quality monitoring and management to derive the necessary components that are essential for the formulation of the integrated catchment management plan in Malaysia. In analysing the strengths and shortcomings that may have implications on the operation capability and effectiveness of the plan to be proposed, a review of existing resources which include policy, planning, legislation, institutions and information are also carried out. The performance of the systems was analysed in relation to their roles in ensuring the sustainability of the water environment. This task was undertaken through government-document analyses and literature reviews.

The fourth stage involved case study analyses using the Geographical Information System [GIS] modelling technique. The output from the GIS modelling technique is expected to yield the key issues that can be associated with the action plan within the catchment management plan proposal (this will be further elaborated in research methods).

The fifth stage synthesised the key conceptual issues and the Malaysian catchment issues on top of utilising the results obtained in the fifth stage, to propose the integrated catchment management plan for Malaysia. Based on this synthesis, a set of general proposals for actions was developed. This stage also sets the implementation framework where the plan proposal can be made into a reality after considering all the key issues identified at stage three. The proposal to be made will be based on the key conceptual links established in the earlier stages.

The sixth stage summarises the responses to the research problems, sets out several recommendations for further research and development, and finally draws conclusion on the research study.

1.5.2 Research Methods

This research will be based on the following methods:-

- Literature review and analyses.
- Government-document analyses.
- GIS application and modelling.
- Case study analyses.
- Proposing an integrated plan.

1.5.2.1 Literature review and analyses

This method is intended to set out the philosophical base and principles and to establish the underlying concepts which justify and will contribute to the development of this research. Fundamental concepts related to sustainable development and Catchment Management Planning emphasised especially under the second and fourth stages are gathered from literature review. The approach and methodology development, the assumptions made and the procedures that contribute to the development of the proposals are based on literature review.

1.5.2.2 Government-document review and analyses

As laid out in the third stage which involved the review of the current planning system and water and environmental planning and management in Malaysia, these were mostly based on the review of Government reports and documents. These are in the form of annual reports, project reports, technical reports, various pieces of legislation's and proposals for government actions, master plans, structure plans and conference papers and seminar papers. Some of these documents include:

- legislation of particular relevance such as the Environmental Quality Act, 1974 (Amendment, 1985) and the regulations made under the Act; Town and Country Planning Act, 1976 (Amendment, 1995); Water Enactment, 1929 and Water Act, 1989, and other legislation's related to water management which are mentioned in Chapter 4.
- plans such as Drainage Master Plan; Sewerage Master Plan; Structure Plans for Seremban and Port Dickson.
- documents such as: National Water Resources Study; Development of the Proposed Interim Water Quality Criteria and Standards for Malaysia; and, the Soil characteristics study by Department of Agriculture, etc.
- Maps (for GIS modelling), especially land use map; topographical maps; reconnaissance soil map and environmental sensitive area map.

From the perspectives of England and Wales which made up significant portion of Chapter 5: documents related to catchment management and planning produced by the Environmental Agency for England and Wales and the former National River Authority; Guidance paper produced by the Department of Environment United Kingdom, are the main sources of information that contribute useful pieces of information pertinent to the research subject. The published documents are cited in the reference list.

1.5.2.3 GIS application and modelling

The main purpose of this method is to explore the application of GIS in defining problems and problem areas that are in need of attention and help in deriving an action plan to resolve the uprising issues within the catchment. In doing this, the vulnerability of the resource under study is then associated with the various influencing elements and the impacts on the resource are predicted based on the various scenarios. The

application of GRID ARC/INFO GIS package has prove useful in analysing various inputs from sources identified in the above sections as well as data gathered from the Department of Environment through its records and publications and other available literature relevant to the water resource management in Malaysia. Input of data for GIS database was made using dbase IV software and these data were later imported to ARC/INFO as INFO files. Detailed description on the methods is given in Chapter 6. For validation purposes, comparison was made between predicted results and the actual values. The collated water quality monitoring data from the Department of Environment have been used to represent the actual values since they were gathered on a regular and consistent basis with high quality assurance. The modelling technique used provides the understanding on the complexities attached to the applications and help to learn about the benefits offered by the system. The benefits and shortcomings of modelling using GIS help in addressing the plan proposal recommended in this research.

1.5.2.4 Case study analyses

A case study on the catchment modelling of an area in Malaysia was conducted to present a real world model that illustrates the phenomenon under study. Basically, the potentially sensitive areas or areas of high risk to withstand development stress are compiled and analysed, in addition to the information regarding the generation of pollution load that may have impact on the water quality within the catchment area. Both non-point and point sources are considered under the assessment of the pollution loading. The modelling for the case study area was conducted using GRID ARC/INFO as describe above. The proposed interim water quality criteria and standards for Malaysia (DOE, 1988a) was used in assessing the achievement of the water quality objectives along the river stretches within the catchment area. The Linggi River catchment was selected as a case study area because of the uniqueness of the river system in serving the population within and outside the river basin area, in two districts, as a source for domestic and industrial water supply. Besides this, the river system has been polluted due to rapid development taking place within the Seremban Municipality area, which is located upstream of the water abstraction point.

1.5.3 Limitations

Several types of data which are essential for modelling the non-point source of pollution and specific to the case study area, were not available, hence, the author has searched for data that closely resemble the local situation. Data such as those required for the analyses of local soil characteristics (to obtain the K factor), and the crop cover (C) factor are not available for the study area and this to some extent may have some influence over the results of the modelling process. Whilst in other cases, available data were insufficient to produce good estimates such as for rainfall erosivity for area under study and the river discharges. However, the author has, through the review of several reports, come out with the nearest figures that resemble the local situation. In so doing, modelling of the case study area was able to be carried out using the best available piece of information.

1.6 ORGANISATION OF THE THESIS

This chapter has described the definition of problems, research questions, the research aim and objectives, the limitations and how they were addressed and the development of research methods used to answer the identified research objectives. This final section outlines the thesis structure.

Chapter 2 creates a context within which the research has focused, be conducted, analysed and discussed. The chapter provides the concept essential for the conduct of this research and the necessity for sustainability for water use to be achieved. The chapter also elaborates on the Malaysian environmental objectives, its policy on environment and set out the role and commitment of the environmental control agency in the pursuit for a sustainable development.

Chapter 3 reviews the Malaysian framework on land use planning and the environmental and management, describing the Malaysian planning system at various levels (i.e. at the national, regional, state and local levels), the development control enforced and the nature in which environmental management are undertaken in maintaining a conducive environment possible for the realisation of sustainable development. The chapter also sets out the institutional arrangements in planning framework and discussed on the relationships between land use planning process and the sustainability of water resources.

Chapter 4 reviews the Malaysian framework on water resource and environmental planning and management, provides the background of water resource in Malaysia and the control aspects of water pollution, elaborates on the water quality management aspects and the setting of water quality objectives and water pollution control. The chapter touches on various aspects of legislation and institutional framework in Malaysia which is essential in the understanding of the mechanism that would possibly allow the setting of new procedure for the implementation of programmes related to sustain the water environment; the proposed national water policy for Malaysia; the planning and allocation of water resources; the existing land use and water quality relationships; and, the control of land use activities to improve the river water quality.

Chapter 5 is the central focus of the thesis, where it reviews the background history of Catchment Management Planning, highlights the importance of an integrated catchment planning and management and attempts to associate development plans and CMP with emphasis made to link both the plans in order for a better appreciation of CMP. The chapter also sets out the scope of CMP for England and Wales that could be a useful source of reference to be explored especially by those countries engaging in intensive programmes to restore clean water so as to cater for the increasing demand like in Malaysia. The chapter further explains on the introduction of the Local Environment Agency Plan [LEAP] and its relation to CMP, and sets out their approaches to catchment and local environmental management planning. The chapter

has also produces the scopes of CMP for Malaysia based on the experience gained from the approach as practised in England and Wales.

Chapter 6 reviews in detail the basics of Geographic Information System [GIS], its applications and progress achieved so far. The chapter describes on the GIS processes and the building of databases necessary for the research. This chapter elaborates on the water quality modelling technique developed using GIS technology with the aim of identifying problem areas associated with the case study analyses. Several aspects related to the methodology of the study has been presented in this chapter and these include model development for the study and modelling modules involve in the technique. The core of the study however, is describes under the section on ‘development programmes under different environmental control scenarios’. This chapter also describes the various options tested using the designed models and these are divided into 3 categories: no environmental control; weak environmental control; and strong environmental control. While for each category, several case scenarios were assumed to predict the possible future conditions.

Chapter 7 comprises the sections on case study analyses, results and discussions of the modelling results and contribute to the basis of discussion for the proceeding chapters. The case study is presented starting with the background information of the study area and these are based on information derived from several government-document analyses, analytical results of collated data, and digitised maps from GIS applications. The beneficial uses identified in this chapter determine the desired water quality objectives of a particular river stretch. This chapter also defines the sources of pollution and makes an assessment on the prevailing water quality condition at the various river stretches. The emphasis in this chapter lies in section 7.6 and beyond, where it presents the results from the applications of water quality modelling using GIS techniques, giving several illustrations of output maps and verification of predicted values with that of the actual values based on data obtained from DOE. Based on the assumptions made on the various categories of environmental control, as elaborated in Chapter 6, the courses of action to be selected are tested using the model in GIS applications to produce an output in the form of the best option for actions to

be recommended, apart from identifying the issues that need to be tackle under the plan proposal for action in Chapter 8.

Chapter 8 deals specifically on proposal development for Malaysia based on the outcome of the case study analyses in Chapter 7. This chapter includes a discussion on action proposal to achieve a sustainable water use with particular reference to the Linggi Catchment. It also examines several shortcomings of EIA procedure in development project screening. The plan of actions were divided into three main areas within the catchment area and these are: the water management zone; the catchment buffer zone; and the developable land unit zone. The chapter in discussion on the policies, legal framework, institutional requirements for CMP that relates to the plan of actions, calls for the strengthening of some policies to ensure that CMP are well receive and could be set to work within the Malaysian situation.

Chapter 9 summarises the responses to the research questions as identified in Chapter 1. This is the final chapter of this thesis, and the chapter sets out several recommendations for further research and development, and ends with a final conclusion on the research study.

CHAPTER 2

SUSTAINABLE DEVELOPMENT AND THE MALAYSIAN ENVIRONMENTAL POLICY

2.1 INTRODUCTION

Sustainable development has become one of the most widely used terms and has been extensively debated since its popularisation from the World Conservation Strategy to Rio via the Brundtland Report. The underlying essence of the concept is complex, owing to the various definitions given to the theme. It should however be clear whether the policies as well as the actions of agencies are necessarily well adapted in responding to the needs and demands of sustainable development. As indicated in Principle 1 of Agenda 21, human beings are the centre of concerns for sustainable development and are entitled to a healthy and productive life in harmony with nature.

This chapter explores the concept of sustainable development, the key component of the concept and the principles of sustainability. These principles are analysed in light of sustainable water development. The chapter examines the major cause of environmental concern. It sets out the scope of the National Policy on Environment and the role and programmes of the regulatory agency in Malaysia. This thesis emphasises the need to pervade the concept of sustainable development in policy making, while actions implemented should be consistent with the principles underlying the concept. Emphasis is given in discussing the integrating and co-

ordinating roles in environmental management and planning for sustainable development.

2.2 DEFINITION

The word “*sustainable*” is derived from Latin *sus-tene*, meaning to uphold. “*Sustainable*” can also mean supporting a desired state of some kind. It therefore refers to an act or process which is capable of being upheld or defended (de Varies, 1989).

“*Development*”, on the other hand, is a notion infused with the idea of progress and based very much on material improvements. There are many forms in which development could take place. If human progress were to be achieved at the expense of destroying the environment or any of its components, and ultimately the resources on which development depends, then such development lacks legitimacy and is against the concept of sustainability.

According to Pearce (1990) there has been no consensus as to the meaning of sustainable development. The concept of sustainable development has been widely debated and in most cases tailored towards the existing conditions of individual countries, its needs and aspirations and treated flexibly enough to account for changes. This can be seen from a number of definitions as listed below.

“... development that meets the need of the present without compromising the ability of future generations to meet their own needs. ... a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations” (World Commission on Environment and Development, 1987)

“Sustainable development means that per capita utility or well-being is increasing over time; ... Sustainable development means that a set of development indicators is increasing over time.” (Pearce, Markandya and Barbier, 1989)

“... a vector of desirable social objectives; that is, it is a list of attributes which society seeks to achieve or maximise...(and) ...this vector might include:

- * increase in real income per capita;
- * improvements in health and nutritional status;
- * education achievement;
- * access to resources;
- * a ‘fairer’ distribution of income;
- * increases in basic freedoms.

... Sustainable development is then a situation in which the development vector does not decrease over time. ... Sustainability (can also) be defined as the general requirement that a vector of development characteristics be non-decreasing over time, where the elements to be included in the vector are open to ethical debate and where the relevant time horizon for practical decision-making is similarly indeterminate outside of agreement on intergenerational objectives” (Pearce, Barbier and Markandya, 1990)

From the above definitions, development is a change leading to improvement or progress. Pearce, Markandya and Barbier (1989) state that an “extremely important way of incorporating emphasis on the environment into sustainable development is to ensure that people’s preferences for environmental quality are properly accounted for.” This is because “development” implies change that is desirable and whatever constitutes development needs to satisfy social goal (Pearce, Barbier and Markandya, 1990). Hence policy attention must be as much on environmental variables as it is on economic growth.

Basically, sustainable development can be summarised as consisting of the following foundations and on which this thesis is based:

- concerns about meeting the needs of the present and at the same times making sure that the needs of the future generation are not jeopardised;
- per capita utility or well being increased over time;
- achieve the desired social objectives; and
- having a situation where development vectors do not decrease over time.

Further, for sustainable development to become implemented in reality, criteria comprising 3 major dimensions need to be satisfied, which are namely: ecological; social; and economic factors.

2.3 PRINCIPLES OF SUSTAINABILITY

The earlier concept of sustainable development as put forward by the World Conservation Strategy in 1980 was as a means of integrating economic development with environment. This earlier concept provides little intellectual or practical guidance as to how the principles of sustainable development might be put into practice, when and by whom. The Brundtland Commission in 1987 (the first definition under section 2.2) introduced sustainable development as an approach to development where we should leave the next generation a stock of quality of life assets no less than those we have inherited. The assets here may include human, man-made artefacts and natural capital. The concept rejected the then dominant argument that economic growth and environmental quality were mutually exclusive and its principles replaces the principle of maximising utility that governed the conventional framework of development.

Since at the present time the framework of sustainable development is still in its initial stages of development, therefore not all the elements have been generated. Nevertheless, the Brundtland formulation of sustainable development has several strengths among which: (i) it places the linkage between environment and development at the top of the global agenda, and (ii) it has stimulated an important body of work on sustainability.

Some arguments have surfaced implying sustainable development as a shift from exploitation to conservation (Blowers, 1992) and indeed this should effectively be the nature of development that is to be brought forward. Activities which rob or imperil future generation should be withdrawn to reflect the efforts to work with nature whilst ensuring the long-term sustainability of available resources.

The Club of Rome's Limits to Growth in 1972 suggested that any mix of economic growth (measured by rising real per capita incomes) and improved environmental

quality will involve a trade-off, that is, more environmental quality meant less economic growth, and vice versa (Meadows, 1972). A more recent approach suggests the potential complementary of growth and environment. However in reality both approaches, according to Pearce, Markandya and Barbier (1990), are unlikely to be correct based on the following reasons: (i) environmental quality would improve economic growth; (ii) sustainable development shifts the focus from economic growth as narrowly construed in traditional attitudes to economic policy (where it places emphasis on development rather than growth, and on quality of life rather than real incomes alone); (iii) sustainable development accepts that there must be some rational trade-off between narrowly construed economic growth and environmental quality; (iv) sustainable development accepts that in the past, economic-growth has been measured by some misleading indicators, such as Gross National Product [GNP] or Net National Product [NNP].

Water, though regarded as a vital natural asset, is most vulnerable to abuse on a global scale (Newson, 1992). Even in the article no. 3 in the European Water Carter, it is stated that to pollute water is to harm man and the other living creatures which are dependent on water. Obviously the use of water in development programmes has proved a powerful influence. Newson (1992) further sets out that competing demands for water between water supply for domestic and industrial uses may come to clash with the commitment of water resources to irrigation for rapidly growing towns and cities. In which case a wise choice needs to be made based on priorities and in consideration of long-term water sustainability.

On balance water need to be valued accordingly. Pearce, Markandya and Barbier (1990) state that if something is provided at a zero price, more of it will be demanded than if there was a positive price. Therefore it is an important principle that resources and environments serve economic functions and have positive economic value. Environmental components, such as water, can be valued “correctly” and their correct values can then be integrated into economic policy. Nevertheless, it should be bear in mind some environmental capital is so valuable that it should be protected and not subject to a trade-off against man-made capital.

With so much attention devoted to development, spending to meet the increasing demand for clean water in terms of supply now seems to be growing and in large quantities and often has to be provided speedily. These spending do not only include for the networks of supply pipes and sewers, but also the treatment works and probably for the purpose of storage such as reservoirs and dams. Moreover the cost of treatment could vary very much depending on the quality of raw water at the point of abstraction. All these show that such infrastructures and their services are essentially collective in the benefits they offer, and to assess such benefits might be difficult. Even the benefits of water-supply networks or projects to improve sanitation would be difficult to price as factors like value for better health or lower mortality may not be dependent on safer water supply alone.

While the general sustainability stance maintains the need to look at stock capital, the strong sustainability stance is preferred over weak sustainability in the sense that it advocates that special attention be paid to the environment (Pearce et. al., 1993). It is therefore realistic to suggest that the stock of natural capital should not decline over time; that is, there should be no net environmental damage in the long run and this, according to Pearce et. al. (1993), is a requirement under a strong sustainability rule. There should therefore be a shift in the relative position of the ecological capital stock that favours a strong sustainability stance.

The general principles for a strong sustainability stance comprises the aspects of conservation, precautionary approach, maintaining ecological capital stock, efficient resource utilisation (within threshold limits) based on holistic approach, enforcing source control, conducting monitoring and implementing waste minimisation. The explanation of these principles are summarised in Table 2.1. It also forms the basis of a framework for this thesis, relating development of catchment management plan in ensuring the sustainability of water environment, particularly in terms of water quality.

Table 2.1. General Principles for a Strong Sustainability Stance¹.

General Principles	Preference / Status	Basis	Remarks
(a) CONSERVATION	Preferred	"Prevention is better than cure" and Protection is better than re-creation.	This is the principal element of sustainable development.
(b) PRECAUTIONARY	To be applied in any decision making	This will serve to meet the design safety factor and reinforcing the principle of conservation based on those already in existence will be better than what might be created.	In order to preserve the perceived appropriate balance of benefits and cost of development. ³
(c) ECOLOGICAL CAPITAL STOCK	To be kept constant or increased	Unless the idea that natural stock can be replaced by human knowledge and man-made assets need to be accepted.	Renewable resource should be used within limits of carrying capacity. ⁴
(d) EFFICIENT UTILISATION	To be incorporated	Technical advancement should improve the efficiency (such as for eternal preservation of fossil fuels) and reduce the disadvantages of their use until such time as technology finds replacement energy source.	Non-renewable resources should be used wisely and sparingly. ⁴ First stage of any water resource scheme development to stress on this principle. ⁵
(e) THRESHOLD	To be enforced	Environmental carrying / absorptive capacities	The limit helps protect the ability of environment resources to meet the functions we rely upon, beyond which the carrying capacity begins to decline. ⁶
(f) HOLISTIC APPROACH	To be implemented	It will assist in determining threshold values and provide information over the adequacy of the present stock, while reinforcing the need for application of the precautionary principles.	
(g) SOURCE CONTROL	To be more efficient	Intergenerational equity implies an aerial limit and source control can be important in the fields of energy, transportation and water resources.	(c) and (e) together applied to both donor and receptor catchment in the case of inter-basin water transfer. Principle (g) aims for self-sufficiency within catchment. ²
(h) MONITORING	To be improved in techniques and reliability	investment involving ecological change should ideally be carried out incrementally to assess the accuracy of the prediction of change, and in any case monitored to allow adaptive management be applied.	Properly-designed monitoring programme should be the rule and not the exception. ⁷
(i) WASTE MINIMISATION	To be adopted to improve environmental quality	Products which cannot be returned safely to the environment need to be minimised, 'recycled', and allow return of high-quality effluent from a sewage-treatment works above the point of abstraction.	The concept of integrated pollution control (IPC) applies.

¹ Requiring at least the protection of critical capital and maintenance of the overall stock of capital with special attention to the natural environment.

² Adapted and modified from Gardiner, J. (1994b).

³ Hardy and Lloyd (1994).

⁴ Scottish Natural Heritage (1993).

⁵ McIntosh (1993).

⁶ Boon (1991).

⁷ McLaren (1996).

While the policy framework for the achievement of sustainable development, as pointed out by McLaren (1996), should be reflected by following key component:

1. Accountability and transparency and accompanied by free access to information and rights for participation;
2. Co-ordination of policy and the integration of environmental and economic goals; and,
3. Target setting with specified timetable, reflecting the environmental capacity, and supported by a regulatory framework within which appropriate measures can be taken to achieve the target and to monitor them.

2.4 SUSTAINABLE WATER ENVIRONMENT

Water is a vital natural asset which is often exposed to abuse (Newson, 1992) and has been identified as critical capital (Dubourg, 1995). Thus, the state of water environment is something that many people feel more relevant and much closer to them. There are two main reasons for this: (i) they indeed inhabit their local river basin and are directly involved in some of the impact on the basin; (ii) the water environment provides vital parts of their own life-support systems (Kinnerseley, 1994).

The roles of water in society are almost as numerous as society's activities. Water provides society with a medium for assimilating and dispersing substances which are by-products of domestic, industrial and agricultural activity though not all of which are essential. It also provides a source of inputs into the economy where water is used for industrial production, cooling and irrigation. Nevertheless the fresh water environment is strongly influenced by the nature of land use. Whatever decisions are

made over land use will have repercussions either directly or indirectly on the water environment.

There are suggestions that for a better appreciation of this essential (but becoming scarcer) resource, appropriate values must be attached to it. Pearce (1986) states that depletion of an exhaustible natural resource typically has two cost components, that is, (i) direct costs of extraction; and (ii) user-cost element where the user cost element is the foregone benefit in the future of using a unit of the resource now. However this may not be the case for renewable resources where the user cost appears to be irrelevant, since the use of a unit of the resource now does not preclude a unit of use later, given that the resource renews itself. Only as the stock of the resource decreases, there may be a rise in harvesting cost. For sustainable use rates, where harvest is in excess of sustainable yield, there is a user cost because the non-sustainable management of a renewable resource will reduce the future availability of the resource.

In the case of fresh water, sustainability requires that the value of its capital stock should not decline over time, that is, there should not be net environmental damage (deterioration in water environment) in the long run. If not properly managed, current fresh water use may impose costs upon future generations whether it may be direct (i.e. via lower health standards from increasing pollution), or indirect (in terms of opportunities forgone) and for water sustainability to happen such effects should not be the case.

As a basis for sustainability, the conservation strategy for the water environment according to the conservation rules proposed by Turner (1988) would serve as useful guidelines:

Conservation Rule One: Maintenance of the regenerative capacity of renewable resources, and avoidance of excessive pollution which could threaten biospherical waste assimilation capacities and life support systems.

Conservation Rule Two: Guidance of technological changes in an indicative planning process such that, wherever physically possible, switches from non-renewable to renewable resources (stock and flow variants) are fostered.

Conservation Rule Three: Utilisation of the growing body of scientific data on geological and geochemical processes in order to formulate a 'phasing' policy for the use of non-renewable resources. In principle, the aim should be to move gradually over time from relatively scarce to less scarce resources.

By and large, in terms of water quantity, the demand for water continues its relentless rise; it is critical that the issues of sustainability be associated with the future demand for water. The encouragement of economy in use and having an effective water distribution system need to be initiated and implemented by the authority with the aim of reducing consumption of water. When a place is stricken with situations of water crisis, suggestions to proceed with the inter-basin water transfer are often heard. All parties get themselves busy to put such proposal to practice as a quick solution to the problem in hand without much deliberation. However, it is necessary that the ecological and environmental effects of inter-basin transfer are fully researched before such proposal is implemented. On the other hand, the issues of sustainability for water quality are to ensure that our drinking water, rivers and aquifers are properly protected.

Hence sustainable development introduces a proactive approach which is based on the concept of prevention rather than cure. This approach should represent a major part in regulating natural resources management including water resources and the environment. Moreover, water also provides other benefits including aesthetical values. It was cited that many cities are founded by rivers owing to their location by (and often facing) the rivers because water portray their attractiveness within the urban setting.

“...the Parliament building in Budapest stands besides the Danube like the British one at Westminster. Bangkok has among the most fascinating of riverside setting provided by the busy Choa Phya, in Paris, Notre Dame looks all the more striking for being on its small island in the midst of the city, the Nile represents almost the history

of Egypt; and India has rivers at the heart of its religion.”
(Kinnersley, 1994: p.113).

The situation has changed slightly over the years in a number of societies of the west and recently in the developing world where rivers are treated as open sewers for transporting waste discharges and often only the backyards were left to face the rivers.

2.5 ENVIRONMENTAL ETHICS AND THE TRAGEDY OF THE COMMONS

Basically the environmental predicament facing most countries has been attributed partly to the lack of an environmental ethic. Ethics are the moral beliefs and rules about the right and wrong. Although most members of the public were not fully aware, thinkers particularly in the developed societies soon started to realise the needs for environmental ethics that would correct existing irresponsible attitudes towards the environment. Such attempts started very early, that is around the late eighteenth century and proceed until today. Joma (1991) listed some of these attempts as follows: John Muir (1867), called for “the right of all the rest of creation”; Albert Schweitzer (1915): “reverence for life”; Liberty Hyde Bailey (1915): “ethical consideration of the holy earth” and Aldo Leopold (1940’s): “a land ethic”; Charles Birch and John Cobb: “the rights of life”; Eugene Hargrove: “the right of the solar system and the universe”, and Arnes Naess: “deep ecology” or ecological egalitarianism”. All of them brought forward almost the same theme, that is, an ethic to save the earth which is also fundamentally the concept of the future and they are utopian and in a way their approaches are radical.

Nevertheless these advocates do not project in a pragmatic manner in the sense that ethics alone cannot fulfil the real needs of man’s life on earth. However, their “radical” change in attitude towards the environment will pioneer the path for correction with the hope of achieving a better environment.

Resource problems are often raised due to the so-called 'tragedy of the commons', a situation presented by Professor Garrett Hardin, where he discussed a situation in relation to population and pollution (Hardin, 1968). Hardin described that each user of commonly owned resource will maximise his own self-interest and ignore the effects of his actions on other users (the 'crowding' externality) and the user cost of the consumption (the 'intergenerational' externality). This is a problem having no technical solution as they were driven by greed. It is because of the greed to maximise the exploitation of natural resources - which we consider highly as "public domain" or "common property" regardless of the adverse consequences.

Hardin presented a situation of a pasture which is open to all. Each commoner will try to keep as many cattle as possible on the commons but constraints such as shortage of capital and diseases will keep the number of animals grazing on the common below its carrying capacity. However there will come a time where the carrying capacity were reached and it would inevitably become unstable and thereby would lead to over-grazing. Each commoner who is able to add a cow, would do so because of the benefits he would gain from the rearing and the selling. Further, the cost of feeding on the common pasture will substantially fall on the other commoners whose cattle would lose some grazing. Therefore they will keep on adding further cattle when the cost of adding them keeps on falling on the rest of the community, thus resulting in the cumulative damage to the resource capacity of the common, which in this case, is through overgrazing.

In parallel, the deterioration of river water quality could be attributed to the discharge consent which is permitted until the situation may no longer be enough to sustain the river water capacity. The river capacity can be equivalent to grazing pasture, an activity which it is to the community's benefits may continue indefinitely but within specific limits. Therefore defining and monitoring such limits is essential to avoid overloading. Nevertheless river pollution is an even more difficult limit compared to the case of the historic grazing of the common because its effects may not show up. When overload occurs, it may be impossible to trace all sources contributing to the problem as it may come from very far upstream or it may even be locally discharged.

It is therefore crucial to be vigilant in operating the sharing within limits because without it those who always comply with all the limits will not get credit while those who exceed may be hidden from public disapproval. To achieve such a state of openness and vigilance in ensuring sustainable water resources, water has to be properly planned and managed in an integrated and holistic manner.

“Water resources must be planned and managed in an integrated and holistic way to prevent shortage of water, or pollution of water sources, from impeding development. Satisfaction of basic human needs and preservation of ecosystems must be the priorities; after these, water users should be charged appropriately.

By the year 2000 all states should have national action programmes for water management, based on catchment basins or sub-basins, and efficient water-use programmes. These could include irrigation of water resource with land-use planning and other development and conservation activities, demand management through pricing or regulation, conservation, re-use and recycling of water.” (The Local Government Management Board, 1992).

The environmental role and the responsibility of planners is obvious. Planners have the obligation to ensure that decision makers are fully informed about all the environmental consequences of development policies or projects. In so doing, planning can contribute towards preventing further degradation of the natural environment in the field which influences it most, that is, in decisions on the location, scale, kind and timing of development. Planning must, therefore be anticipatory and proactive.

In a wider context, the ethical element should be inculcated within the corporate levels and individuals. For all companies, the sustainability issue helps them to seek actions that take into account this dimension in all activities they are dealing with. While the issue of sustainability for individuals is to be informed about the environmental issues and to be concerned with actions in their everyday lives by weighing the balance between the economic and environmental issues in all their decision (Clarke, 1994).

2.6 NATIONAL POLICY ON ENVIRONMENT IN MALAYSIA

In achieving sustainable development, therefore an approach endeavouring to bring about a more balanced utilisation of resources in a careful manner is essential, with emphasis placed on development with conservation. Such initiatives will ensure the benefits gained through development are not negated by environmental damage.

Among the fundamental principles which are of concerned to the community that requires proper environmental planning in development, include:

Conserving the carrying capacity of supporting human life

This is a basic requirement for consideration especially in land use planning with the main aim of achieving sustainable development. The need for clean air, clean water, food and for shelter is fundamental to human survival. For example, water supplies everywhere should be protected as a scare resource vital to human life; and high-grade agricultural land should be retained as a natural resource for the highest long-term value to society.

Human well-being

People pay more attention to the environments which are close to them and have immediate impact on their lives or support their daily activities. It is therefore important that precautions are taken to maintain the environment which benefit them while ensuring their well-being, and to do so within the constraints of the local environment, economic and social characteristics.

Cultural Diversity

Cultural diversity should be maintained while aiming to provide people with the environment that support their way of life.

Rationale Resource Utilisation

The earth's resources, either renewable or non-renewable, must only be exploited with great care. For example, land once built over, it cannot be returned to the original state of high-quality agricultural land for many centuries and has to be accepted as a lost natural resource.

The four fundamental principles above are supportive of the strong sustainability stance as summarised in Table 2.1, and they are among the major elements to be given due consideration under the environmental objectives for Malaysia.

2.6.1 National Environmental Objectives

It is since the Third Malaysia Plan (1976-1980) period that environmental policy objectives been emphasised, where it states "... to balance the goals for socio-economic development and the need to bring the benefit of development to a wide spectrum of population ... against the maintenance of sound environmental conditions." The increase concern over the growing incidence and severity of environmental problems (Table 2.2) during the last decade of rapid development has led the government to reaffirm its commitment in the protection of the environment and ecology in order to maintain the long-term sustainability of development. It is also evident that most of the concerns are related to the essential resources that are important to the community, where they made up about 40 per cent of the problems raised; which include land (22 %), air (11 %) and freshwater (7 %).

In the Second Outline Perspective Plan [OPP2] (1991-2000) it was pointed out that "adequate attention will be given to the protection of the environment and ecology so as to maintain the long-term sustainability of the country's development". Whilst in

Table 2.2 Malaysia: Common Problems Identified by the Environment Interest Groups, 1984-1985.

Aspect	Problem	Interest group Identifying Problem	
		No.	Per cent
Legislation and Administration	Citizen Representation in EQC*	2	
	Enforcement	1	
	Environmental Quality Act	2	
	Federal-State Relations	2	6
Air	Acid rain	2	
	Air Pollution	4	
	Ambient Air Quality Standards	2	
	Haze	1	
	Heat Island	1	
	Lead in Atmosphere	2	11
Energy	Energy Resources Management	2	
	Nuclear Energy	2	4
Fishery	Depletion of Fisheries Resources	3	
	Fishermen's Income Reduction	2	
	Over Exploitation of Fisheries	1	6
Freshwater	Chemicals in Surface Water	2	
	Domestic Sewage in Surface Water	2	
	Droughts	1	
	Flash Floods	3	7
General	Ground water Depletion / Contamination	1	
	Industrial Effluents in Surface Water	2	
	Pig Waste	2	
	Rural Portable Water Supply	1	
	Siltation of Surface Water	3	
	Surface Water Depletion	1	
	Surface Water pollution	4	
	Data / Information Dissemination	2	
	Dislocation of Aborigines	2	
	Environmental Education	2	
	Environmental Impact assessment	2	
	Flora, Species Reduction	2	
	Parks and Recreation Areas	2	
	Research	1	
	Rural Poverty	1	
	Public Transport	1	25
Health	Occupational Health	2	
	Occupational Health Law (Co-ordination)	2	
	Rural Medical Facilities	1	5
Land	Deforestation	2	
	Forest Management	1	
	Loss of Habitat (Terrestrial)	4	
	Mangrove Destruction	2	
	Mining Land Rehabilitation	1	
	Quality of Agricultural Land	2	
	Soil Erosion	4	
	Soil Management	1	
	Soil Waste Management	3	
	Wildlife Species Reduction	4	22
Marine	Beach Erosion	2	
	Coral Reef Destruction	2	
	Marine Pollution	2	6
Noise	Noise	2	
	Noise Regulation	1	3
Pesticides	Pesticides Act	1	
	Pesticides, Use	1	2
Toxic & Hazardous Waste	Hazardous Waste Management	2	
	Toxic Chemicals in the Environment	2	3
Total		108	100

* Environmental Quality Council

Source: Abu Bakar, 1992.

the First Statement in Malaysia's Vision 2020 specifically emphasised that " ... in the pursuit of economic development, Malaysia will also ensure that invaluable natural resources are not wasted, the land must remain productive and fertile, the atmosphere clear and clean, the water unpolluted, the forest resources capable of regeneration, able to yield the needs of the national development. The beauty of land must not be desecrated: for its own sake and for its economic advancement." (after Abu Bakar, 1994a).

The commitment shown by the Federal Government is not restricted only at the national level. The Langkawi Declaration on the Environment, which Malaysia initiated at the Commonwealth Heads of Government Meeting (CHOGM) in October 1989, reinforced Malaysia's commitment to the global plan of action aim at arresting possible environmental degradation and promoting environmentally-sound and sustainable development.

These policy statements on environment reflect serious efforts on the side of the Government to fulfil its responsibility and strong commitment in managing all the resources in a manner that considers the welfare of future generations, as embraced within the context of sustainable development. For this to happen, the economic, social and environmental aspects will have to be well integrated into the development process. It is only with the improvement in environmental quality and efficient utilisation of resources will it ensure the efforts to improve our living standards do not compromise the needs and welfare of future generation.

2.6.2 Policy On The Environment

Malaysia has her own National Policy on the Environment (GOM, 1996) which carries the aims of promoting economic, social and cultural progress through environmentally sound and sustainable development. The policy outlines the following objectives: (i) to achieve a clean, safe, healthy, and productive environment for both the present and the future generations; (ii) to conserve the country's unique

natural resources and diverse cultural heritage with effective participation by all; and, (iii) to promote the lifestyles and patterns of consumption and production consistent with the principles of sustainable development.

These objectives, in general, contain the basic elements of sustainable development as discussed in section 2.2 above, when considered together with the seven inter-related and mutually supporting principles identified below and the anticipated follow up action to the policy.

- Stewardship of the environment;
- Conservation of nature's vitality and diversity;
- Continuous improvement in health, safety and the quality of the environment for sustained human development;
- Integration of sustainability in all development decisions;
- Commitment and accountability;
- Rational and efficient use of natural resources; and
- Active participation in the community of nations.

The Seventh Malaysia Plan (1996-2000) states that a plan of action is to be drawn up to operationalise the different aspects of the National Policy on the Environment, with the focus given to providing a framework for an integrated approach to development, enhancing the effectiveness of the regulatory and institutional framework, recommending suitable mitigation measures, improving environmental education, communications and awareness, and training programmes as well as incorporating environmental considerations in resource management and development planning.

In the process of achieving such targets the strengthening of institutional framework would be a requisite in order to provide adequate capacity to undertake planning, regulatory and enforcement functions, training and education as well as research and

development. Emphasis has been placed on an integrated and preventive approach. Where decision are usually made either at Federal, State or Local Authority level, the integration of environmental consideration should be considered as a matter of priority.

The policy statements, with a wide ranging scope, in essence would be concerned not only with pollution control but, would extend to the management and control of other subjects such as soil and water conservation, flood control, wildlife, national parks, cultural aspects, aesthetic values, health, recreation and tourism, education and town and country planning. The planning and implementation of all development programmes will therefore have to be geared towards interpreting these policies into a reality. To make this happen, environmental planning must become the basis for all development decisions if the natural environment is to be conserved and people's environmental needs met.

This policy also manifests significant recognition of an integrated development approach as a means of accomplishing an effective and suitable environmental strategy. Such integrated development approach entails the incorporation of an environmental dimension into the development approach right at the base level; through the enlargement of the existing machinery for planning to take account of environmental factors in the planning process, and simultaneously, to shift from the traditional methodology and approach of project evaluation adopted by development planners and decision makers that are based purely on economic considerations.

2.6.3 Framework Of Environmental Planning For Sustainable Development

Malaysia has three tiers of government, namely the federal, state and local authority. The functions and responsibilities of the federal government are listed under the in the Ninth Schedule of the Federal Constitution and these encompass eight (8) main areas, i.e., external affairs, defence, internal security, civil & criminal law, federal citizenship, finance, trade, commerce and industry; and federal government

machinery. Although there is no mention specifically on environment under the Federal Constitution, a number of items which are related to the subject of environment could be used to control development programmes in the country either at Federal, States or the local level (Table 2.3).

It is at the Federal level, that the Ministry of Science, Technology and Environment is currently the principal ministry in charge of environment. The Department of Environment under the Ministry, which was set up since 1975 after the Environmental Quality Act 1974 (Act 127) [EQA] was adopted, is the principal agency involved in environmental protection and management (this will be further discussed towards the end of this section).

The State governments also have their roles clearly defined within the Federal Constitution. Amongst its important areas of jurisdiction are: land, forest, local government and water, etc. Because the States have control over land, forest, water, and other landbase resources, they have a very powerful role in the final approval of projects.

The third tier of government is the local authority, which is incorporated under the Local Government Act, 1976 for Peninsular Malaysia. The local government is responsible for local authority administration of areas gazetted by each state government. These include several important aspects of environmental management, provision of municipal services, and public health. Local authorities, by virtue of the Local Government Act (1976) have the power to deal with local level environmental problems. Furthermore, under the Local Government Act, 1976, local authorities are empowered to deal with all kinds of pollution arising from within their jurisdiction. In addition, the local authorities play the main role in providing services to the population within their respective areas.

The three-tier government to some extent has posed difficulty and hinders the smooth implementation of programmes for sustainable development in one way or the other, as each level of government having legislative and administrative competence in

Table 2.3 Malaysia: Matters Relevant to Environment Under the Constitution.

List	Item	Subject
I. Federal	8	Trade, commerce and industry, including: i) Industries, regulation of industrial undertakings. j) Development of mineral resources; subject to item 2(c) of the State list. k) Factories; boilers and machinery, dangerous trades. l) Dangerous and inflammable substances.
	9	Shipping, navigation and fisheries, a) Shipping and navigation on the high seas and tidal and inland waters. b) Ports and harbours foreshores. c) Maritime and estuarine fishing and fisheries, excluding turtles.
	10	Communications and transport, a) Roads, bridges, ferries and other means of communication if declared to be federal by or under federal law. b) Railways, excluding Penang Hill Railway. c) Airways, aircraft and their air navigations; civil aerodromes; provisions for the safety of aircraft. d) Mechanically propelled vehicles.
	11	Federal Works and power, including: b) Water supplies, rivers and canals, except those wholly within one State or regulated by an agreement between all the States concerned; production, distribution and supply of water power. c) Electricity, gas and gas works; and other works for the production and distribution of power and energy.
	14	Medicine and health, including sanitation in the Federal Capital including, c) poison and dangerous drugs.
	20	Control of agricultural pests; protection against such pest; prevention of plant diseases.
	24	Federal Housing
II. State	2	Land (except with respect to Federal Territory), including: a) Land tenure. b) Permits and licenses for prospecting for mines, mining leases and certificates.
	3	Agriculture and Forestry (except with respect to the Federal Territory)
	4	Local Government outside Federal Territory a) Local government services. b) Obnoxious trades and public sources in local authority areas. c) Housing and provision of housing.
	6	State works and water. c) Subject to Federal list, water (including water supplies; rivers and canals); control of silt; riparian rights.
	12	Turtles and riverine fishing.
	15	Ports and harbours in Sabah and Sarawak.
III. Concurrent	3	Protection of wild animals and wild birds; National Park.
	4	Animal husbandry.
	5	Town and country planning except in the Federal Capital.
	7	Public health, sanitation (excluding sanitation in the Federal capital) and the prevention of diseases.
	8	Drainage and irrigation.
	9	Rehabilitation of mining land and land which has suffered soil erosion.
	13	Production, distribution and supply of water power in Sabah and Sarawak.

Source: LRB (1995a).

specific fields, and their actions can sometimes contribute to environmental degradation. This, therefore, requires effective co-ordination and willing co-operation so that available resources are deployed to good purposes and without duplication of efforts.

As provided in the EQA, an Environmental Quality Council (EQC) was set up to deliberate environmental issues on a comprehensive basis. The council comprises representatives from several government departments, the private sector and non-governmental organisation (NGOs) plays an advisory role. Whilst the EQC has no power to co-ordinate policy formulation, planning and implementation, it nevertheless, provide a platform which in some way or the other may influence decision making process within the agencies involved in the council.

The effectiveness of the Department of Environment as a regulatory agency to conduct its role in the interest of environmental protection and enhancement has been negated by a number of problems that pose some obstacles and thereby slow down the process to incorporate the necessary measures that would sustain environmentally sound development.

These concerns include problems such as lack of resources and capacity of the existing machinery, the needs for advance information system, lacks of incentives and lacks of commitments on the part of the private sectors. Nevertheless, the Malaysian Government has been committed to resolve these issues with suggested measures as in Table 2.4, to remove such obstacles that resist the process of achieving a sustainable development.

At the same time, DOE has engaged in various aspects of environmental planning and management that influence decision making process, within the government machinery as well as in business sector, in the determination to put the concept of sustainable development right to the very core of development programmes and project implementation. DOE involves in a number of functions / tasks including: pollution control; environmental quality monitoring; post audit and monitoring

environmental-related project; conducts pre-siting evaluation & granting approval for project implementation; reviews of environmental impact assessment reports; provides environmental inputs / advice to other governmental bodies; developing guidelines to minimise adverse impact of growth and development; promotion of environmental education to raise public awareness; initiates natural resources assessment & accounting; reviews and adjusting sectoral policies according to regional / state / district / local priority. Table 2.5 shows the functions carry out by the Department of Environment Malaysia. It is also critical that the preservation of the environmental components should be undertaken in maintaining the environment carrying capacity and this should be explicitly mentioned in the task of promoting sustainable development.

Table 2.4 Malaysia: Issues Towards Achieving Sustainable Development and the Remedial Measures.

Issue	Suggested Remedial Measure
Lack of resources and capability in the existing machinery to implement environmental programmes	The relevant agencies should be provided with adequate staff and resources to plan, implement and monitor resource-based projects based on the sustainable development concept - including the need to create environment officer's post and environment units in State and Local Authorities.
Inadequate research and data for effective management information system [MIS] on the environment.	Enhancing the technical capability in research on environmental issues, including the creation of a National Environmental Data Bank [NEDB]
Need to enhance co-ordination among Federal, State and Local agencies pertaining to environmental issues.	<ul style="list-style-type: none"> • Reinforce existing Federal-State and inter-departmental collaboration on environmental activities. • Promote a closer co-operation between local NGOs and government agencies.
Lack of incentives to promote environmentally sound technology.	<ul style="list-style-type: none"> • Provide incentives for environmentally friendly technology and 'green' products, and to impose levies of environmentally hazardous products and technology. • Initiate the setting up of 'Green Fund' contributed by the private sector to promote environmental activities with tax exemption.
Lack of commitment by the private sector to promote environmental programmes	Multinationals and other enterprises in the country should adopt a code of conduct based on the UN Centre on TNCs - Criteria for Sustainable Development Management.

Source: summarised from Anon (1990) pp. 9 & 17-18.

Table 2.5 Department of Environment: Functions / Tasks in Promoting Sustainable Development.

Time Frame	Strategy	Task
Present	Curative Measures	<ol style="list-style-type: none"> 1. Pollution Control 2. Environmental Quality Monitoring 3. Environmental-Related Project Implementation 4. Post Audit and Monitoring <ul style="list-style-type: none"> • Sewerage and Sewage Treatment • Solid Waste Management • Toxic and Hazardous Waste Facilities • Common Wastewater Treatment Facilities • Inspection/Testing/Repair facilities • Reafforestation • Flora and Fauna Rescue Programmes
	Specific Preventive Measures	<ol style="list-style-type: none"> 1. Environmental Impact Assessment 2. Pre-siting Evaluation & Approval 3. Written Permission 4. Guidelines 5. Environmental Inputs / Advice <p>20 categories of major development projects Small industrial projects (those not subjected to EIA) Approval prior to installation of wastewater treatment and pollution control equipment. Activities not subject to EQA, 1974. In the preparation of Master Plans, Structure Plans, Local Plans, etc.</p>
	Long-term Preventive Measures	<ol style="list-style-type: none"> 1. Environmental Education 2. Public Awareness 3. Dissemination of Environmental Information 4. Natural Resources Assessment & Accounting 5. Long-term Monitoring

Table 2.5 Department of Environment: Functions / Tasks in Promoting Sustainable Development.

Time Frame	Strategy	Task
cont. Future	Minimising adverse impact of growth and development	<ol style="list-style-type: none"> 1. Pollution control at source; 2. Control of pesticide residue; 3. Check on use, misuse, abuse and overexploitation of natural resource; 4. Control of growth in critical area; 5. Rehabilitation of degraded lands and other natural resources.
	Resolving and reconciling the diverse and conflicting environmental, demographic, economic and natural resource use issues.	Review sectoral policies and implementation.
	Integrating environmental considerations in decision-making, proper resource accounting and pricing, conservation of biodiversity, promotion of environmental education, public participation.	<ol style="list-style-type: none"> 1. Environmental factors; 2. Technical considerations; 3. Economic feasibility
	Formulating environmental and development strategies for every sector and its related activities. Adjusting the policies and programmes according to regional / state / district / local priority.	Review their respective policies, programmes, projects, and activities.

Source: Abu Bakar (1990).

2.7 CONCLUSION

The main focus of the subject of sustainability is that it will benefit present generations while maintaining its potential to meet the needs and aspirations of future generations. The concept of sustainable development also covers the scope of maintenance of the regenerative capacity of renewable resources. Sustainable development can be taken as a methodology, having a normative goal, posing as a model for planning and it forms a strategy involving purposeful management of the environment. Sustainable development may also be summed up to denote well-being increased over time, while it strives to achieve the desired social objectives; and at the same time ensuring the development vectors do not decrease over time.

Lessons from the situation described in the “tragedy of the commons” indicates that unless the environment and all actions that contributing to its change are properly planned and managed, the aim of achieving the desired sustainability of resources will not be successful. Our concern now is how has this global ‘green wave’ influenced the planning profession. The ethics element definitely has an influence over which action will be taken in which the impacts of these actions can either be positive or otherwise. Ethic reflects the idea of fairness, justice and rights of other users.

A review of the environmental objectives for Malaysia, indicates that the willingness on the part of the government is evident. The stated policy on the environment, by and large, contains the essential principles of sustainable development. Nevertheless, it is pertinent that the mechanism to interpret the underlying concept into reality exist and be further strengthened, apart from the necessary actions in producing a clear plan to work with.

The key elements with respect to sustainable development and the Malaysian Environmental Policy are therefore as follows:

- The “tragedy of the commons” results when the carrying capacity of environmental resources are ignored.
- The nature of development to be expected needs to fulfil the criteria of sustainability while paying special attention to the environment.
- Sustainable development requires the application of binding principles in policy as indicated in Table 2.1. Strong sustainability requires a quantum change in approach to natural resource capital and this needs to be manifested through the relevant policies.
- The components of accountability, integration and target setting that are currently weak hinder the achievement of the desired forms of sustainable development.
- The establishment of the Malaysian National Environmental Policy, which is meant to uphold the concept of sustainable development, will need every support necessary for its success; this includes adequate capacity building in the implementing agencies; resolving the problem of co-ordination; and improving the commitment of the public and private sectors.
- The achievement of sustainable development relies on the effectiveness of the planning system and the policies formulated to ensure the sustainability of natural resources.

CHAPTER 3

LAND USE PLANNING AND ENVIRONMENTAL MANAGEMENT

3.1 INTRODUCTION

Planning has been seen as a promising approach in upholding the concept of sustainable development, as it serves as a “future-oriented problem-solving process” (Glasson, 1975). This is because planning involves a translation of knowledge to action in managing environmental change as well as social change (McEvoy and Dietz, 1977). The produced plan should then represents an entity that aims to make decision systematic (Faludi, 1987) and involve strategic choice (Friend and Hickling, 1987).

It is pertinent that planning processes at all levels, which influence the overall use of resources and having significant impact on the environment, be closely examined on its role within the perspective of sustainable development.

There are various approaches adopted in environmental planning and management, and these are in the forms of prevention, abatement, control of pollution and the enhancement of the environment. The land use planning process itself can be considered as a form of environmental planning and it carries the preventive approach the helps to avoid adverse consequences on the environment. Moreover, the process

has an important link in influencing the process towards a sustainable development. The approach of protecting the natural resources and the environment through land use planning is not new. However, the ways and extent to which today's land use planning approaches support the efforts of achieving a sustainable development need to be further examined.

This chapter examines the planning process in Malaysia with the central focus on Negeri Sembilan, where the study area is located. Negeri Sembilan is located within a potentially strategic region for rapid development in the very near future. This chapter attempts to analyse the component within the land use planning and environmental management process that influence the fate of water resource so that concrete Catchment Management Plan could be derived with the aim of sustaining the water uses within the catchment.

3.2 MALAYSIAN PLANNING SYSTEM

3.2.1 National Planning

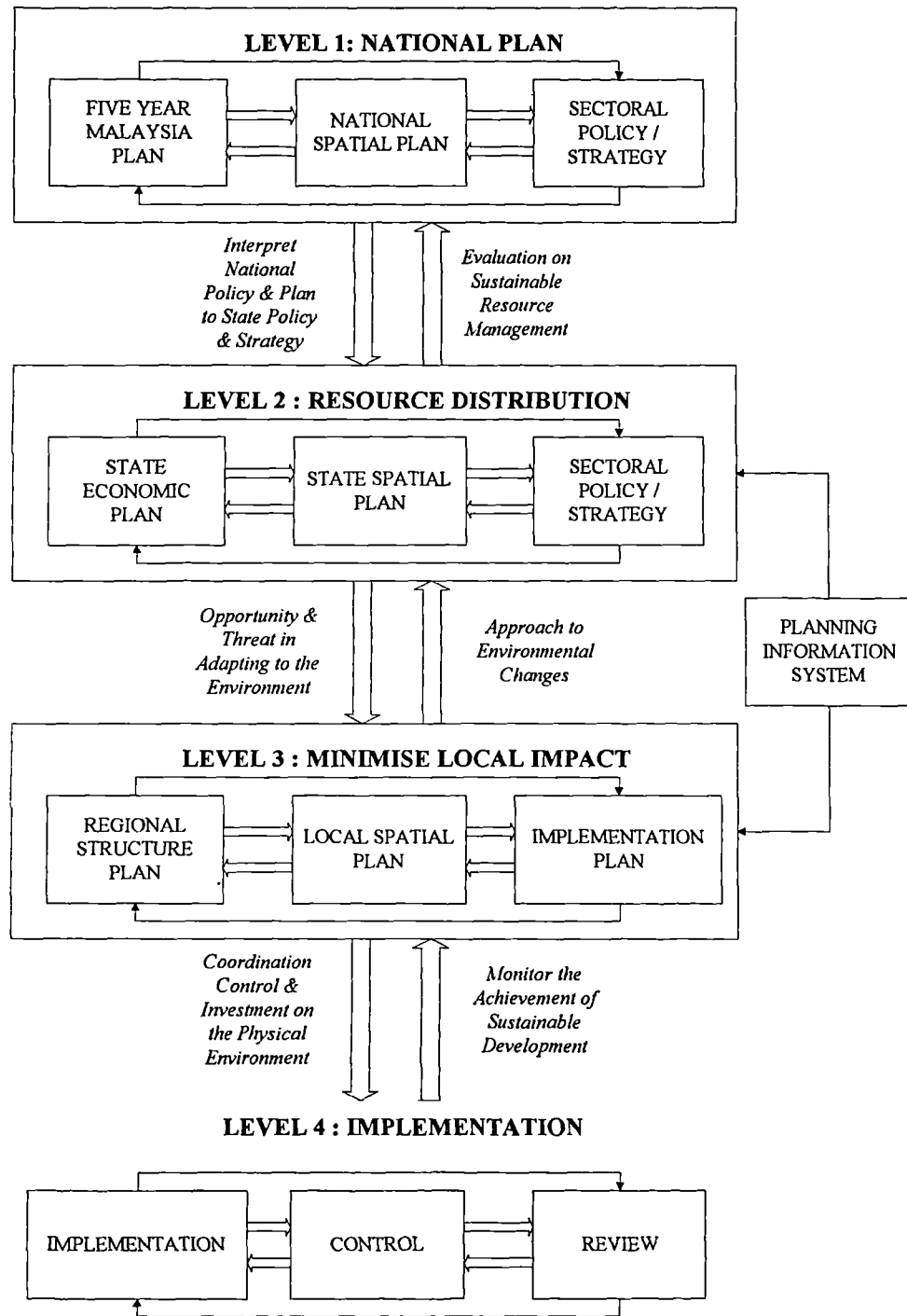
There exist different levels of plans in Malaysia as reflected by the various levels of government and as described in Chapter 2, namely the Federal, State and the Local Authority level. Specific plans in the form of socio-economic plans and sectoral development plans, are produced to guide in the development of the nation, region, state or the local area (Table 3.1). The relationships between the various plans are best illustrated in Figure 3.1 where the Five Year Malaysia Plan and the Outline Perspective Plan, regarded as the National Plans, provide the necessary guidance and direction for policies and strategies for other plans at the lower levels in the planning system hierarchy. From the period 1970 onwards, two outline perspective plans covering the period 1971-1990 and 1990-2000 and seven five year national plans have been prepared. These plans were prepared by the central agency of the Federal Government.

Table 3.1 Peninsular Malaysia: Various Types of Plan in the Planning System.

Levels of Government	Plan	Nature of Plan
Federal	National Outline Perspective Plan Five Year Malaysia Development Plan	Socio-economic
State / Regional	State Economic Development Plan State Indicative Plan Sub-regional Physical Plan	Socio-economic / sectoral Socio-economic & spatial plan
Local	District Development Plan Structure Plan Local Plan	Development project identification. Strategic land use plan. Local land use plan.

The Second Outline Perspective Plan (1991-2000) [OPP2] which embodied the National Development Policy [NDP], sets the broader objectives, strategies and targets that guides development of the nation. Further elaboration of the strategies and programmes and projects designed aimed to achieved the objectives of the NDP were presented in both the Sixth and the Seventh Malaysia Plan.

The Sixth Malaysia Plan (1991-1995) underscored the approach towards achieving the NDP where it emphasised on “prudent management of natural resources and the ecology as well as preservation of natural beauty and clean environment are important to improve the quality of life for the present as well as future generation” (GOM, 1991). As natural resources are becoming more scarce in addition to the growing concerns over environmental degradation, the needs for efficient resources utilisation become very essential. The Seventh Malaysia Plan (1996-2000) has taken an approach that emphasises on the integration of environmental considerations into the economic and social development process to ensure a sustainable development and this has place the government policy towards the right direction in consonant with the understanding made at Rio in 1992. Point 4 of the Rio Declaration made at the UN Conference on Environment and Development in 1992, which states that “in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it (after Bishop et. al., 1995).



Source: DoTCP (1996).

Figure 3.1 Peninsular Malaysia: Levels of Planning Under the Malaysia Planning System

The national objectives, strategies and targets provide the guidance on all matters related to planning and development for the benefits of the present community without depriving those of the future generation. Table 3.2 shows the strengths and weaknesses (shortcomings) in the Five Year Malaysia Plan, since the Third Malaysia Plan, in providing the opportunity for further enhancement of the environmental management activities that will lead the way towards sustainable development. It has been shown that many improvements have been made in the two most recent national plan (i.e. the Sixth and the Seventh Malaysian Plans) documents in terms of issues presented in relation to environmental management compared to the earlier documents. Their contents include several new activities. The Seventh Plan has explicitly focused on sustainable development and the needs for an integration process to be established in order to achieve the aims of sustainable development. This thesis recognises such initiatives as crucial and of significance because it has given proper directions in guiding the nations development not only to serve the needs of the present but also the future generations. This provides better clarity for planning as well as implementing agencies to act consistence with the policies which have been endorsed in the official document.

The Federal agency responsible for co-ordinating the socio-economic planning and undertaking economic analysis is the Economic Planning Unit [EPU] under the Prime Minister's Department. The EPU acts as the secretariat for the National Development Planning Council [NDPC], an inter-agency committee comprising the civil service heads of all major Ministries and chaired by the Chief Secretary to the Government (Figure 3.2). The NDPC in turns reports to the National Economic Council [NEC], a committee of the Federal cabinet under the Chairmanship of the Prime Minister.

3.2.2 Regional Planning and Development

The national objectives for regional development as outlined in the National Development Policy [NDP] and Vision 2020, are aimed to balanced the income distribution, health facilities, utilities, recreational, housing and other socio-economic

Table 3.2 Malaysia: The Strengths and Weaknesses in the Five Year Malaysia Plan on Issues Related to Environmental Management Planning and Management.

Malaysia Plan	Period	Strength	Weakness
Third	1976-1980	<ul style="list-style-type: none"> • A substantial Chapter devoted to development and the environment was included, and this Chapter is considered striking as it relates to the National Economic Policy. • Assurance given that environmental improvement and protection would receive the full attention of the government in the planning and implementation of programmes (pp. 218-227). • It provides a broad and holistic approach of environmental issues proposed by the plan document which discussed problems related to the discharge of undesirable waste products and also covered problem arising from development of land and other resources. 	<ul style="list-style-type: none"> • No financial allocation for proposed activities. • absence of bonding requirements on public development projects / programmes to incorporate environmental dimensions into the projects / programmes planning, design and implementation. • Federal-State co-operation still remained difficult to operationalise, whilst allocation of resources remain within the purview of the States.
Fourth	1981-1985	<ul style="list-style-type: none"> • DOE was provided with increased resources to carry out its pollution control activities • DOE reported considerable success in reducing pollution load in the agro-based industries. 	<ul style="list-style-type: none"> • No Chapter on environment, although the Plan was marked by various new strategies of development including regional development, growth of new townships, industrial estates development and integrated agricultural development. • Failure to integrate environmental consideration in major sectoral issues.
Fifth	1986-1990	<ul style="list-style-type: none"> • Reinstatement of a Chapter on environment. • The Plan reaffirmed that the priority of the government to achieve a balance between environment and development. • The report stressed that priority would be given "to conservation strategies and efforts that strengthen the existing regulatory machinery, particularly at the State and local government levels through the development of uniform rules with variable standards as well as through joint and well co-ordinated enforcement" (p:279). • Indication made to formulate a National Conservation Strategy to provide the framework for comprehensive resource management and utilisation. • Greater Federal-State levels co-ordination between policy-formulating and programme-implementing agencies become more pronounced. 	<ul style="list-style-type: none"> • Little success in Environmental Impact Assessment as a complementary tool for environmental assessment in addition to pollution control, although much has been rely on the procedure for development planning, project implementation to incorporate the relevant environmental dimension.

Table 3.2 Malaysia: The Strengths and Weaknesses in the Five Year Malaysia Plan on Issues Related to Environmental Management Planning and Management.

Malaysia Plan	Period	Strength	Weakness
Sixth	1991-1995	<ul style="list-style-type: none"> • Chapter on environment included with substantial discussion on progress with the management of the environment. • All Public institutions will be required to collaborate and co-operate with DOE and effectively integrating the environmental considerations in the planning and implementation of their programmes and projects. • DOE has been strengthened to enable to play a “<i>developmental role</i>” as well as to be more effective in enforcement. 	
Seventh	1996-2000		<ul style="list-style-type: none"> • Sustainable Development is explicitly mentioned in the Plan with specific section devoted to it. • The Plan emphasised on economic, social and environmental aspects to be integrated into the development process, in improving the environmental and ensuring a more efficient utilisation of resources. Whilst environmental concern is to be integrated into land use planning to ensure that land is properly utilised and watershed and catchment areas to be protected. • Chapter on Environmental Management is included with several institutional mechanisms and programmes put in place to combat environmental pollution as well as conserve natural resources. • Active participation in international fora including those promulgated at the United Nations Conference on Environment and Development (UNCED), and promoting partnership in the North and the South in combating global environmental deterioration. • Emphasis on the continued measures by taking appropriate actions to ensure that development is sustainable and balanced, with environment and conservation considerations as the key for integration with development planning.

opportunities. The regional development strategy in Peninsular Malaysia, as outlined in the Sixth Malaysia Plan, identified the development phases and function for each region. The strategy involves four main regions as described in Table 3.3.

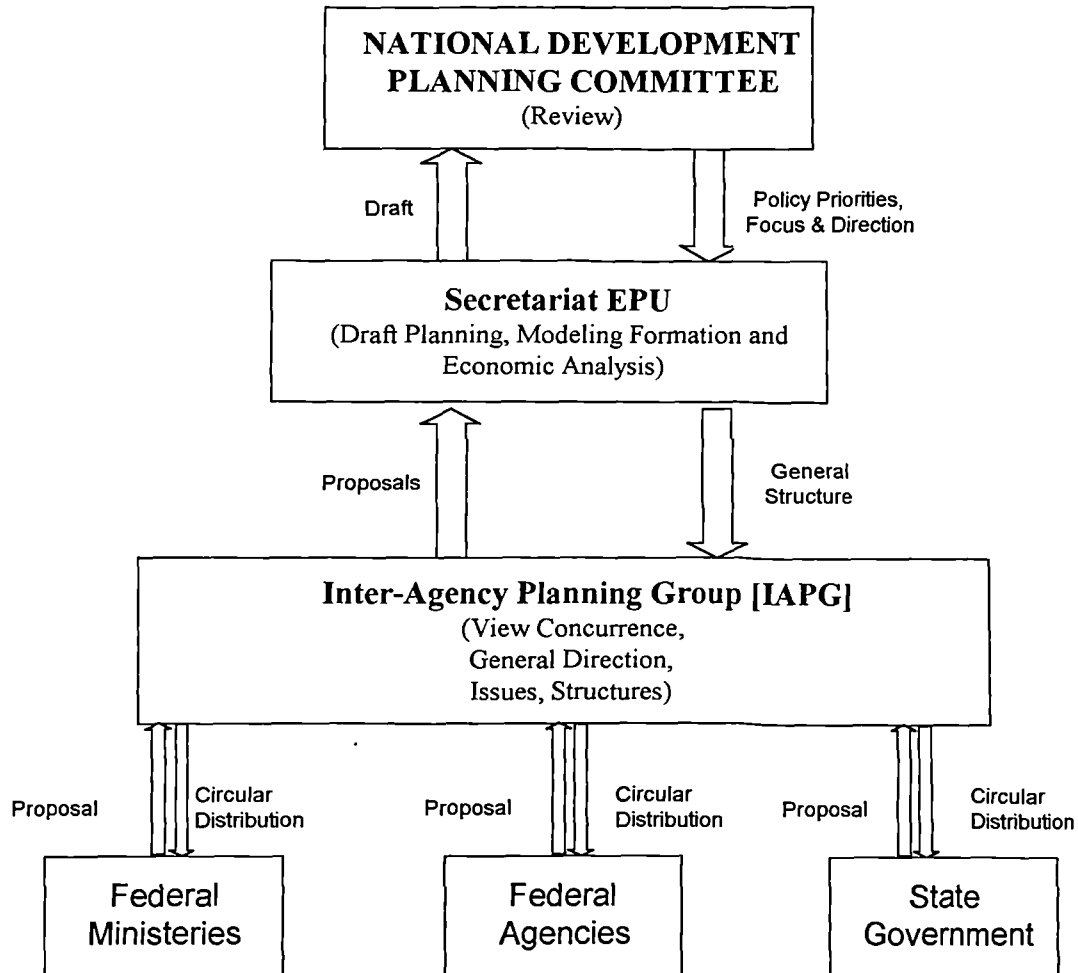


Figure 3.2 Malaysia: Flowchart of Development Planning Process.

In planning for regional development, there has been a shift in the planning level from the traditional procedure of planning based on states boundaries to that based on regions. In the Fifth Malaysia Plan, an appropriate mechanism was established to promote closer co-ordination of development activities among States and at the regional level. In addition, strengthening of the information base pertaining to the structure of regional and State economics was made in order to shape regional development programmes that would benefit member States as a whole. Spatial plans

were prepared as part of these efforts to identifying the priority location of economic activities that suit the resource endowments of the area. Nevertheless, the plans lack a basis for integrating environmental considerations into their development processes (IAS, 1992).

3.2.3 State Planning

At the State level, the State Economic Planning Units (SEPUs), under the State Secretariat Offices, handle all matters related to local development and are responsible for promoting the integration of agency proposals for development in local areas. The SEPUs in turn, report to the State Action Committees which are under the Chairmanships of the Executive Heads of State (i.e. the 'Menteri Besar's / Chief Ministers). Planning undertaken at this level mainly focuses on the socio-economic aspects of development programmes. So far, none of the SEPUs has a separate division or unit which has the responsibility to deal with environmental issues. In fact, Anon (1992) highlighted the needs for such units to be established in light of a growing concern on the integration of environmental consideration in planning process. The SEPU of Negeri Sembilan has made an initiative along the line when a State Environmental Master Plan (the first at State level) was produce in collaboration with the Department of Environment, to provide general guidelines for the development process.

The Town and Country Planning Act, 1976, Amendment (1995) provides for the establishment of the State Planning Committee - also chaired by the Executive Heads of State which, among other functions, shall promote the conservation, use and development of all lands in the State and advise the respective State Government with regard to it.

The State government may also formulate rules as provided under Section 17 of the Town and Country Planning Act, 1976, in the preparation of the development plans.

Table 3.3 Peninsular Malaysia: Regional Planning and Development under NDP

Region	State	Function of Development Plan
Central	Selangor, Negeri Sembilan, & Melaka	This is the most advanced region with very rapid development where Klang Valley is the most influential area. The main function of the Central Regional Strategy is to spread out the urban development away from the Capital City, Kuala Lumpur, and existing National Regional Centres to the existing towns in the vicinity, especially Seremban and Melaka. For Negeri Sembilan, the towns of Port Dickson and Kuala Pilah become the State Sub-Regional Centres.
North	Perlis, Kedah, Penang & Perak	The main function of the Northern Regional Development Strategy is to extend urban structure to the North up to Kedah and Perlis, where the towns of Alor Setar and Kangar will be developed as Regional Development Centres under Phase II of the regional Development Plan.
South	Johor	Emphasis under the Southern Regional Development Strategy involves the development of Johor Bahru City to become the National Regional Centre for Southern Peninsular Malaysia, while Muar, Kluang and Segamat as State Sub-Regional Centres.
East	Kelantan, Trengganu & Pahang.	The strategy will be to established an integrated urban area / township with Kuantan serving as the National Regional Centre for Eastern Peninsular Malaysia, while Kota Bahru and Kuala Trengganu will become the State Regional Centres.

Source: DoTCP (1995).

“The State Authority may make rules for the better carrying out of the purposes of this Part [i.e. Development Plans] or for prescribing anything that may be, or is required to be, prescribed under this Part.” (LRB, 1995b)

One of the States having implemented this, is Negeri Sembilan. The Town and Country Planning (Structure and Local Plans) Rules for Negeri Sembilan which is a State regulation was formulated and made effective in 1981. It is under this rule that the scope detailing the form and contents of the Structure Plan and administrative procedure to its publication is made.

As in the case of Negeri Sembilan, its development growth especially at the Central Regional Centre - Seremban - is expected to reach the optimum level by the turn of the millennium. All the while, development of the Central Regional Centres in the region had been proceeding with the growth axis directed towards the Klang Valley. Such development growth is expected to reach the optimum level by the turn of the millennium. However, a second growth option - pointing south of the Klang Valley region is later anticipated to become the major development option. The Kuala

Lumpur - Seremban corridor is anticipated to benefit from the spill over from the Klang Valley. The main function of the Central Region Development Strategy, hence, to disperse development from the Klang Valley to the Kuala Lumpur - Seremban Corridor.

Such development strategy will help to alleviate overconcentration particularly in large cities and to avoid the undesirable consequences like urban congestion, increased transportation costs, squatters and other social problems. However, such development pattern is best guided by a national policy on urbanisation (Malaysia has yet to formulate one), where the policy can provide the basic framework for a more organised urbanisation process and well-integrated rural-urban development linkages.

3.2.4 Local Planning

As targeted, development plans were expected to offer a real opportunity that contribute towards a sustainable development and growth (DOE(UK), 1993) in the United Kingdom, while the approach in Malaysia should be worked out along the same line of action.

“ ... One major responsibility is to ensure that development plans are drawn up in such a way as to take environmental considerations comprehensively and consistently into account. In this way environmental improvement can be plan-led, and individual development decisions taken against an overall strategic framework that reflect environmental consideration.” (DOE(UK), 1992a)

This calls for the effectiveness of land use planning to be re-evaluated in light of sustainable development, where such evaluation can be designed to contribute to the process of policy development and review. Development plans in the form of Structure Plans and Local Plans only encompassed a certain fraction of the land area, although they cover significant portion of the urban land use. Often areas outside the coverages of structure plans and local plans were normally left out and to be determined through the committees at the state level such as presented in Figure 3.3.

The needs for a much more comprehensive land use master plan would be considerably crucial particularly in avoiding haphazard development.

From the outset, planning should be concerned with the protection of land as a fundamental environmental resource which, with the other resources, helps sustain life on earth. Changes in land use, whether through urbanisation or deforestation may destroy or impair the productive capacity of soils and contribute to environmental change. The role which planning has to play in the protection and enhancement of the environment is to control land use and development. Structure plans and district-wide local plans in England and Wales are intended to provide a forward planning and policy framework against which specific proposals may be judged and infrastructure an investment program prepared (Kirby and Carrick, 1985) and they represent an approach to a problem. These can be seen in Table 3.4, where the various plans, particularly at the local level, envisage to deal with the issues of protecting the water environment.

There exist a two-tier development plan system at the local level in Malaysia, which is very much similar to the planning system in England and Wales (Table 3.4). The provision for the preparation of development plan is contained in the Federal Town and Country Planning Act, 1976 of Malaysia. The Act requires a Local Authority (LA), as the local planning authority to produce: (i) a general Structure Plan, in the form of policy statement and general proposals for the areas under its jurisdiction, and (ii) a more detailed Local Plan, if it thinks desirable, in the form of detailed Zoning Plan or Action Area Plan for any part of its area.

The strength of Federal Town and Country Planning Act, 1976 lies in its ability to promote national, regional and state policies to be translated into physical space at the local level. The Act introduces a new planning system consisting of development plans on which all physical planning is to be undertaken. The development plans comprise a Structure Plan and Local Plan. The differences in the two are: while the Structure Plan deals with structural issues and has to be submitted by the local planning authority to the State Planning Committee for approval, the Local Plan deals

with local physical layouts which have to conform with the approved Structure Plan but it only need to be approved at the local planning authority level.

The Town and Country Planning Act, 1976 was amended in 1995, to further streamline the legislation and policy of town and country planning in Peninsular Malaysia. In particular, the Town and Country Planning (Amendment) Act, 1995, emphasises on environmental management in planning, such as conservation of topographical features and trees. This is taken as a positive steps in consonant with the government policy on sustainable development and environmental conservation, and the integration of government policies discussed above, in the operations of all its agencies.

3.2.4.1 Structure Plan

The Structure Plan in Malaysia, contains the broad long range policies that look beyond the period within which land allocations and site definitions can be made. The emphasis is on the written statement which includes reasoned justifications of the policies and general proposals which are included in the Plan. Section 8(3) of the Town and Country Planning Act, 1976 states that the draft Structure Plan of an area shall be a written statement:

- a) formulating the policy and general proposal of the local planning authority for the development and use of land in that area, including measures for the improvement of the physical environment, the improvement of communication and the management of traffic, etc.;
- b) stating the relationship of those general proposals for the development and use of land in the neighbouring areas that may be expected to affect that area; and,
- c) contains such other matters that may be prescribed by the State Planning Committee.

Table 3.4 England and Wales: Development Plans With Issues and Objectives for Water Environment Protection.

Development Plan	Level of Coverage	Content and Scope ¹	Issue & Objective Related to Water Protection
Structure Plan Unitary Development Plan (UDP) Part I	Strategic / County - Non-Metropolitan - Metropolitan	<ul style="list-style-type: none"> Provide the strategic policy framework for planning and development; Ensures that the provision for development is realistic and consistent with strategic guidance; Secures consistency between local plans for neighbouring areas. 	<p>Issue The degree of consideration and protection should be given to agriculture, forestry and the environment.</p> <p>Objectives</p> <ul style="list-style-type: none"> To protect and enhance the environment as far as practicable. To resist allocation of land for development which will lead to a deterioration of water quality. To resist development which will result in adverse impact on the environments due to excess surface water runoff. <p>The requirements for water protection is provided in ²:</p> <ul style="list-style-type: none"> the Guidance Notes for local planning authorities on Methods of Protecting the Water Environment through Development Plans published by the NRA. DOE (UK) Circular 30/92 - Development and Flood Risk. DOE Circular 9/95 - General development Order consolidation 1995. PPG 23 Planning and Protection Control.
Local Plans / Part II of UDPs	District or National Park Metropolitan County	<ul style="list-style-type: none"> Set out policies and specific proposals for the use of land, within the strategic framework of the structure plan; Set out the local authority's policies for the control development; Make proposals for the development or use of land and to allocate land for specific purposes; and May include proposals for action areas. 	<ul style="list-style-type: none"> to resist proposals for new mineral workings whose impact on surrounding to have detrimental effect on existing water abstraction, river flow, lake levels or natural habitat. not to consent for mineral workings in flood plains Permission may be exceptionally be granted if it was satisfied that flood compensation was provided. ³
Minerals Plans / Part II of UDPs	Local / District Metropolitan County	<ul style="list-style-type: none"> Set out the authority's policies for the supply of minerals, within the strategic framework of the structure plan, and the required degree of environmental protection associated with development; Indicate areas where provision is made for mineral working and the disposal of mineral wastes and areas to be safeguarded for future working; and Set out the development control criteria for consideration applications for mineral working, and requirements for the restoration of such sites. 	<ul style="list-style-type: none"> to resist proposals for new mineral workings whose impact on surrounding to have detrimental effect on existing water abstraction, river flow, lake levels or natural habitat. not to consent for mineral workings in flood plains Permission may be exceptionally be granted if it was satisfied that flood compensation was provided. ³
Waste Plans / Part II of UDPs	Local / District Metropolitan County	<ul style="list-style-type: none"> Set out detailed land use policies for the treatment and disposal of waste, within the broad strategic framework of the structure plan; Must complement the Waste Disposal Plans (prepared by waste regulation authorities under the Environment Protection Act 1990) which considers the types and quantities of waste arising in the area, the availability of disposal facilities, suitable locations, and the planning criteria likely to apply, including geological, hydrological and other considerations. 	<ul style="list-style-type: none"> Disposal of waste within flood plain to be restricted to inert waste only. ³

Source: ¹ Hashim (1994), p.55.

² EA (1997b).

³ NRA (1994), p.20 & 22.

Whilst Section 8(4) of the Town and Country Planning Act 1976 states, “that the Structure Plan shall have regard:

- a) to current policies in respect of the social and economic planning and development and the environmental protection of the State and the Nation;
- b) to the resources likely to be available for the carrying out of the proposal of the Structure Plan; and,
- c) to such other matters as the committee may direct it to take into account.”

In summary, the functions of the Structure Plan will encompassed the following for it to meet its main objectives: (i) to interpret national and regional policies; (ii) to establish aims, policies and general proposals; (iii) to provide the framework for local plans; (iv) to indicate action areas; (v) to provide guidance for development control; (vi) to provide a basis for co-ordinating the decisions of a wide range of government agencies; and (vii) to bring the main planning issues and decisions before the public and the State Planning Committee.

3.2.4.2 Local Plan

A Local Plan may be prepared by the local planning authority for any part or the whole area within its jurisdiction. The Local Plan, however, need to conform to an approved Structure Plan which has come into effects for the particular area as required under Section 12(8) of the Town and Country Planning Act, 1976. It is the purpose of the Local Plan to detailed out and interpret the strategic and spatial implication of Structure Plan while presents the local and spatial implications of national policies and objectives on social and economic changes. Section 12(3) of the Town and Country Planning Act, 1976, described the Local Plan “shall consist of a map and a written statement and shall:

- a) formulate, in such detail as the local planning authority thinks appropriate, its proposals for the development and use of land in the area of the local plan, including such measures as the local planning authority thinks fit for the improvement of the physical environment, the improvement of communications, and the management of traffic; and,
- b) contains such matters as may be prescribed or as the committee may in any particular case specify.

3.2.5 Public Participation

Public participation is a unique feature and a component of the preparation of development plans in Malaysia. It is a statutory requirements of the new development plan as prescribed by the Town and Country Planning Act, 1976. The nature and processes of public participation in Malaysia, involved:

- a) *Publicity* under Section 9(1) of the Town and Country Planning Act, 1976 which states: “When preparing a draft Structure Plan for its area and finally determining its content for submission to the Committee the local planning authority shall take such steps as will in its opinion secure: (i) that publicity is given in its area to the report of survey under Section 7 and to the matters that it proposes to include in the plan; and, (ii) that persons who may be expected to desire an opportunity of making representations to the local planning authority in respect to those matters are made aware that they are entitled to, and are given in opportunity of doing so.”
- b) *Public Involvement* (Participation) as provided under Section 9(1)(b) that any persons are entitle to make representations to the local planning authority in respect of those matters proposed to be included in the plan. It is further provided that the local planning shall consider every representation made within the prescribed period to it. This forms one of the major components prior to the approval of the draft Structure Plan.

- c) In any case there is an *objection*, the act provides (as prescribed under Section 9(2), 9(3) and 10(3), that public be notified of the draft Structure Plan and given the opportunity to make objections to the plan.

3.3 DEVELOPMENT CONTROL

Planning becomes meaningless if without proper control imposed upon development activities taking place, as it will later be subjected to numerous criticism and what matter most is the adverse consequences with negative externalities resulted from any departure from the earlier plan.

In Malaysia, the provision under the Town and Country Planning Act, 1976, Amendment 1995, in controlling polluting sources was in placed whereby planning permission may be withhold or certain conditions may be imposed to any consent. The Act also carries provision which enable pollution control clauses to be incorporated in planning agreement between the developer and the planning authority.

As a useful guide, the planning authorities may include within the development plans strategic policies on pollution and the environment to serve as a framework for decisions on individual projects.

Bruce and Heal (1984) suggested that in land use planning, one of the primary questions which need to be satisfied, while making certain that no adverse consequences arise in the future, is that it should include a checking mechanism as to see "Are the decisions working?". Basically, this acts as a check and balance mechanism and monitoring activities remain as an important component of the planning process evaluation. However, such auditing rarely happens and it will lead to massive clean up work to be done by the enforcement agencies involved, when problem arises.

Planning may be viewed as a preventive approach towards pollution by spatial separation of incompatible land uses, for example, residential or similar sensitive development, and industrial plants from which the discharge of polluting matter is inevitable. Although in certain cases, such separation of incompatible land uses is not practical, certain limits could be imposed in terms of the volume of discharge or the amount of pollution load from the polluting development by the planning authority. In this way the planning process ensures the sustainability limit or the environmental carrying capacity is kept within control.

In preparing the development plan, physical environment were taken to include not only the land use policies but also policies to protect or improve the environmental quality. It is wise that local planning authorities consider to provide justification in their plans on issues related to: (a) how environmental consideration had been taken into account in the formulation of their policies; and (b) the relationship of the policy and general proposals to other measures for reducing pollution. The local planning authority based on their discretion would normally consider to include such measures in the case of their local plans. By and large, control of environmental pollution contributes to the social well-being and should become a legitimate objective of land use planning.

Hence, as set out by Miller and Wood (1983), planning can serve as a means of indirect but nevertheless effective control by preventing the encroachment of polluting source into an environmentally sensitive land uses, and in a sense avoiding incompatible land uses. Consideration on land use changes should only be permitted provided the degree of its impact be limited to a certain acceptable amount within the carrying capacity of the local environment. Such direct form of pollution control is also provided in the physical environment planning in the Federal Town and Country Planning Act, 1976, Amendment 1995, in Malaysia, and the provision may be utilised by the local planning authorities when new development is anticipated. The measure is considered as essentially proactive in nature rather than retrospective.

The Federal Town and Country Planning Act, 1976 also provides the means of development control where it requires that “no person, other than the Local Authority, shall commence, undertake or carry out any development unless Planning Permission in respect of the development has been granted to him by the Local Planning Authority, or unless the intended activity / work / change of use falls, explicitly into the list of exemption”. It is obvious that development may be refused, if not justifiable. In fact, as expressed by Kirby and Carrick (1985) development control is a key part of purposive planning even if it is reactive rather than proactive in character.

The amendment to the Town and Country Planning Act in 1995, further strengthened its control on development activities. It brings into regulation a much stringent set of development control as well as evaluation, such as the requirement for Development Proposal report to be submitted along with layout plans during applications for planning permission.

Land development is also controlled at the state level through the Technical Committees which function as a *one stop agency* to process and co-ordinate applications for land conversion before any approval being granted by the Land Office (Figure 3.3). It is at this stage that development control may be imposed for undesirable activities or incompatible land uses. It is not until in the recent years that DOE, the agency responsible for the protection of the environment, has been made a member to the committee in some states, while others regard the department role in the committee as merely advisory in nature. For instance, DOE is an invited member of the committee as shown in Table 3.5, i.e. the department will be invited if the cases to be considered contain matters of relevance to the environment (PTG(NS), 1992). Presumably, the acceptance of DOE to become a full member of such committee could ensure that environmental consideration in all department projects be strengthened.

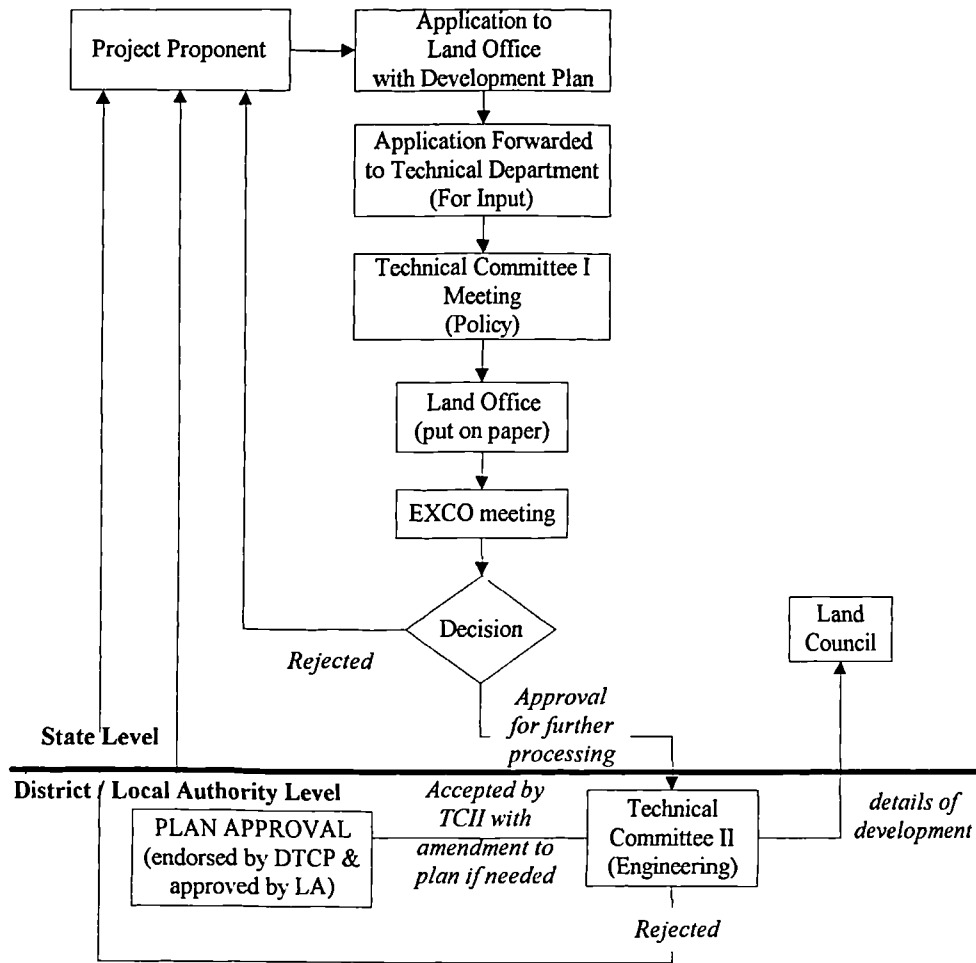


Figure 3.3 Negeri Sembilan: Committee for Processing Application for Land Conversion.

Table 3.5 Negeri Sembilan: Memberships of the Technical Committee I & II (as shown in Figure 3.3)

Agency	Technical Committee	
	I (State)	II (District)
Dept. of Land and Mines	Chairman	-
Land Administrator (Land Office)	Member	Chairman
Dept. of Town and Country Planning	Member	Member
Dept. of Public Works	Member	Member
Drainage and Irrigation Dept.	Member	Member
Dept. of Agriculture	Member	Member
Dept. of Health	Member	Member
Seremban Municipal Council	Member	Member
District Councils	Member	Member
<i>Dept. of Environment</i>	<i>Invited Member</i>	<i>Invited Member</i>
Syarikat Telekom Malaysia Bhd. (Telecommunication Co.)	Member	Member
Fire Dept.	-	Member
Local Authority	-	Member
Dept. of Water Supply	-	Member
Tenaga Nasional Bhd. (Power Generator)	-	Member
Petronas (National Oil Company)	-	Invited Member

Source: PTG(NS) (1992).

3.4 ENVIRONMENTAL MANAGEMENT

There is no mention made about “*pollution*”, “*pollution control*” or “*environmental protection*” in the Malaysian Constitution. But the legislation for environmental protection and pollution control has been made under the various matters or subjects that were specified in the Legislative List of the Constitution. All matters pertaining to land, water, agriculture, forestry, mining, soil erosion control, local government services (including solid waste collection and disposal; sewerage; and urban drainage) fall within the preview of the State, although some may be listed in the Concurrent List (LRB, 1995a).

On the other hand, activities posing major influence on the environment such as industrial development; water supplies and hydropower development; erection of boilers and machineries; and, the control on shipping, fall under the Federal legislation. Whilst the concurrent activities includes town and country planning, animal husbandry, public health and sanitation as well as drainage and irrigation.

The Environmental Quality Act, 1974 [EQA] itself is a Federal Act. Although the EQA appears to have wide-ranging powers of control, they do not extent into the resource sectors such as land, water and forest use and development.

On land matters, the Federal Government only has the power to legislate to the extent of ensuring common policies over it and a common system of land administration. The power is provided under Article 76(4) of the Federal Constitution. The most common example for this is the National Land Code [NLC], 1965. Nevertheless, the executive functions pertaining to land matters are vested in the States and the supreme authority in each state on any question of land administration is the Ruler-in Council or the State Executive Council (State EXCO), which is collectively responsible to the State Legislature (Abu Bakar, 1994a).

The State EXCO, which is the main political body with enormous executive power in deciding on land policy and any land matter, as long as the decisions made do not contravene Federal or State land laws or land policies agreed upon in the NLC. As shown in Figure 3.3, the Director of Land and Mines will advise the State EXCO on each application forwarded for consideration of the Technical Committee on land disposal. The State EXCO will have the most influential position to ensure the policies made on sustainable development be upheld by all the relevant agencies. Nevertheless, according to Abu Bakar (1994a), their powers may even reach the extent of overruling the advice tendered by the State's technical departments, including the Director of Land and Mines.

Definitely such decision would bear consequences on resources and the environment through land disposal including alienation, land sub-division and land conversion for the purpose of land development. It is even crucial, when decision made on land matters were sometimes not sought to DOE by the land office in the aspect of environmental considerations in the planning and implementation of their projects except the very late stage. If it was referred they were only applicable to a few categories of activities relating to land conversion prescribed in the Environmental Quality (Prescribed Activities) (EIA) Order, 1987. Any development decided, especially for hill land or hillside development, where erosion problem can be very severe or even disastrous (e.g. in the Highland Tower's incident, in 1993). This is of prime concern as it might risk public safety.

3.4.1 Scope Of Control Under Environmental Quality Act, 1974

The Environmental Quality Act, 1974 [EQA] is a Federal legislation which came into force on 14th March, 1974. The preamble of the Act states its main objective, i.e.:

“An Act relating to the prevention, abatement, control of pollution and enhancement of the environment, and for the purposes connected therewith.” (LRB, 1989)

The EQA was amended in 1985 to become the Environmental Quality (Amendment) Act, 1985, which include a new provision under Section 34A, that requires all prescribed activities to carry out environmental impact assessment [EIA], apart from to improve the overall effectiveness of the Act. The amendment Act was gazetted on 9th January 1986. The EQA also provides power to the Minister in charge of the environment to:

- specify the acceptable conditions for any emission or discharge of waste or the emission of noise into any area, segment or element of the environment. Restriction, provided under Sections 21-30, that may be imposed on pollution or discharge of pollutants that may affect the atmosphere, soil, inland waters, or Malaysia coastal waters;
- prescribe certain premises as prescribed premises, the occupation of which, is an offence without a license (Section 18);
- prescribe certain activities as prescribed activities which require that an assessment of the impact such activity will have or is likely to have on the environment (Section 34A);
- make regulations in respect to the prevention and to enhance the general quality of the environment (Section 51);

3.4.2 Environmental Quality Regulations

Several pieces of subsidiary legislation (regulations) to control the various forms of pollution related to water, soil and the atmosphere were introduced under the EQA. These regulations include,

- i) Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977;

- ii) Environmental Quality (Licensing) Regulations, 1977;
- iii) Environmental Quality (Clean Air) Regulations, 1977;
- iv) Environmental Quality (Compounding of Offences) Rules, 1978;
- v) Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Regulations, 1978;
- vi) Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979;
- vii) Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations, 1985;
- viii) Environmental Quality (Motor Vehicle Noise) Regulation, 1987
- ix) Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987;
- x) Environmental Quality (Scheduled Wastes) Regulations, 1989;
- xi) Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Order, 1989; and,
- xii) Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Regulations, 1989.

It is obvious that the earlier regulations set out under the EQA were targeted at the control of water pollution especially from the agro-based (i.e. palm oil and rubber) industries. Reduction of their pollution load was made successful, by means of licensing of the two prescribed industries, thereby providing close monitoring on the waste generation and discharges, while their discharges had to comply to generation-set of standards (this will be further discussed in the next Chapter).

3.4.3 Environmental Impact Assessment

Besides physical development control system, environmental planning which is the basic tool of planning, seeks to ensure that public interest is always accounted for in decisions regarding the use and development of land. Environmental planning has become a complementary approach towards sustainable development. Its role has increased dramatically with rising competition for scarce land, water and every other

resource, and the need to protect threatened environments. Environmental planning is applied to planning and management activities in which environmental factors are the central considerations (but does not exclude social, cultural or political factors), and is normally associated with the early phases of the planning process. Nevertheless, it is becoming apparent that it must also be part of the design, construction, and operational phases of projects.

Since 1st April 1987, EIA has been made mandatory in Malaysia for 19 categories of activities. Section 34A in which the requirement for EIA been made mandatory states that:

“Any person intending to carry out any of the prescribed activities shall, before any approval for the carrying out of such activity is granted by the relevant approving authority, submit a report to the Director General. The report shall be in accordance with the guidelines prescribed by the Director General and shall contain an assessment of the impact such activity will have or is likely to have on the environment and the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment.” (LRB, 1989)

The nineteen categories of prescribed activities include those related to agriculture, airport, drainage and irrigation, land reclamation, fisheries, forestry, housing, industry, infrastructure, ports, mining, petroleum, power generation, quarries, railways, transportation, resort and recreational development, waste treatment and disposal, and water supply. Another category was added later to include all types development on hill land of slope of 20° or more, which has been classified as the 20th category activities in the EIA Order 1987 (Amendment, 1995). Appendix A shows lists on the categories of prescribed activities defined either by quantum, project size and also those which with no unit of measurement.

The requirement for the 20th category put DOE on course to play a vital role in decision pertaining to hill lands development as well as its related public safety aspects. This is essentially important as steep slopes are more susceptible to any sort of disturbance and could easily cause environmental damages, not only at the

development site but it may extent also to the downstream areas of a particular catchment, thus affecting the river water quality.

It is the purpose of EIA, which is essentially an environmental planning tool, to prevent environmental problems due to development activities and at the same time it seeks to avoid costly mistakes either because of the environmental damages that are likely to arise during project implementation, or modification that need to be made in order to rectify the problem to make it environmentally acceptable. When being integrated into the existing planning system and decision making machinery, EIA can provide essential information towards making better decision. The requirement which has been subjected on the prescribed activities is aimed towards the adoption of the preventive approach and the precautionary principle as opposed to the curative action by entirely relying on the existing legislation.

The EIA procedure adopted in Malaysia comprises 3 major steps (Figure 3.4) namely Preliminary Assessment, Detailed Assessment and EIA Review, and is designed to follow the integrated project planning concept (Figure 3.5). Preliminary Assessment relates to the initial assessment of the impacts of the prescribed activities. Detailed Assessment needs to be undertaken for prescribed activities for which significant residual environmental impacts have been predicted in the Preliminary Assessment. The detailed report is required to be submitted for approval by the Director General of Environmental Quality prior to getting the approval by the relevant Federal or State Government authority for the implementation of the developmental project. Detailed assessment also needs to conform to the term of reference issued by an *ad-hoc* Review Panel appointed by the Director General of Environmental Quality. It is this *ad-hoc* Review Panel that will review the content of the Detailed EIA report and the Review Panel is chaired by the Director General of Environmental Quality.

The review of EIA preliminary assessment reports are carried out internally by DOE, while the detailed assessment reports are been reviewed by *ad-hoc* Review Panels set up by DOE and comprises the representation from various government agencies as well as the member of public. The recommendations from the review are transmitted

to the relevant approving authorities for their considerations before decision on the development project are made. At the completion of the EIA Detailed Assessment report review, a detailed assessment review document is issued by the review panel and the document normally includes contents covering: (1) Comments on the detailed assessment report; (2) Recommendations to the project proponent and the project approving authority including any specific conditions attached to the project approval; and (3) Recommendations for environmental monitoring and auditing.

The integrated project planning concept as recommended in the EIA procedure serves to minimise project delay and helps to improve its planning. It is recommended under the planning concept that as early as during the project identification stage, the need to conduct an EIA study is determined. If the project requires Preliminary Assessment, it need to be taken up in parallel to its Pre-feasibility Study stage. However, if there is a need for a Detailed Assessment, the study should therefore, be conducted as part of the Feasibility Study. Under the concept, the preliminary assessment and detailed assessment reports are reviewed simultaneously with the pre-feasibility and feasibility reports respectively, before a final decision on the project is made. Environmental monitoring is part of the requirement during project construction and project operation under the planning concept.

Table 3.6 shows the involvement of various parties for a proposed project and it is obvious that the final approving authority will determine whether or not a development project will be allowed to proceed. The project initiator with economic or sometimes socio-economic interests will have to ensure that all environmental requirements are met before setting out to take up the project. Often this is determined at the state *one-stop agency* committee meeting or on advise obtained from DOE officer at the Ministry of International Trade and Industries. It is at this stage, that the requirements are made known to the project initiator. The approving authorities referred here, as discussed above, comprise of the following bodies or agencies:

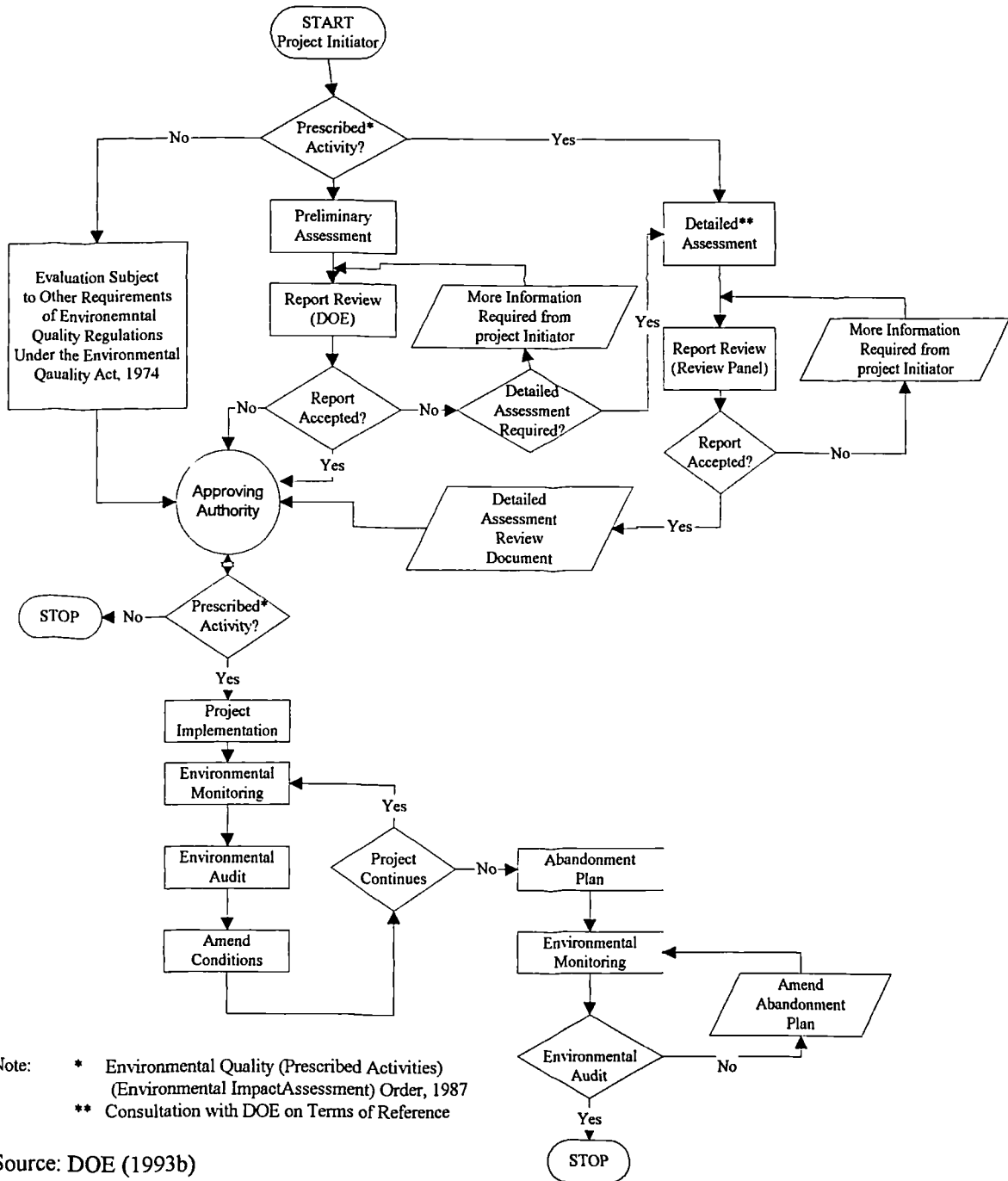
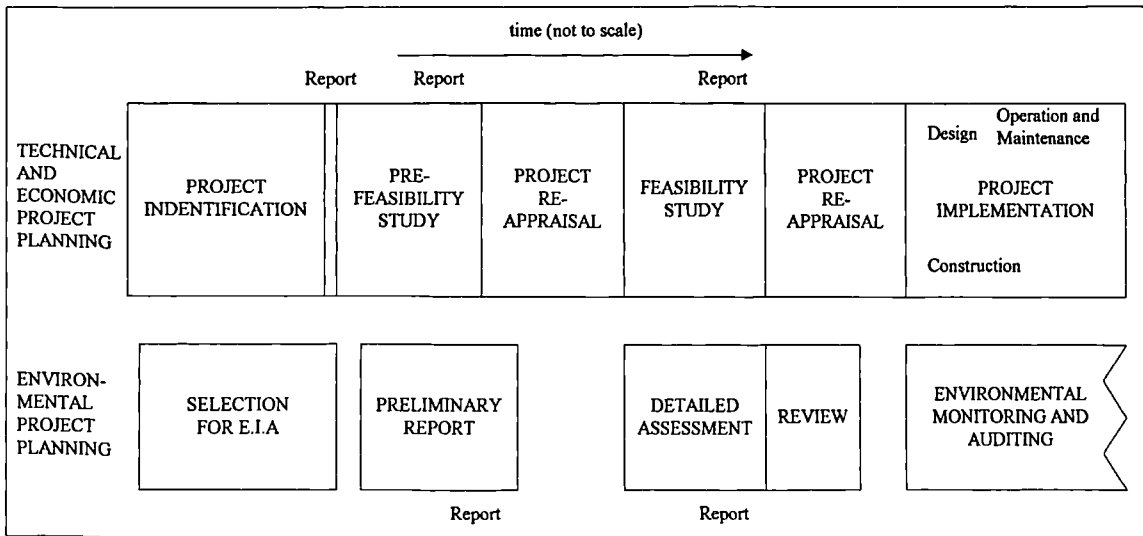


Figure 3.4 Malaysia: Outline of EIA Procedure.



Source: DOE (1993b).

Figure 3.5 Malaysia: Integrated Project Planning Concept Under the EIA Procedure

- The National Development Planning Committee (NDPC);
- The State Executive Council (EXCO) for State Government sponsored projects;
- The various Local Authorities or Regional Development Authorities with respect to planning approval within their respective area.

The protection of the environment requires commitment in order to achieve a sustainable development. Myerson and Rydin (1996) stated that, environmental assessment procedure may provides new material for decision-making process, but in itself, it does not ensure a higher level of environmental protection. Rather it depends on the ways in which the decisions are taken. Furthermore there may exist a danger in relying on procedural devices to achieve the task of resolving a potentially more fundamental tension between environment and development concerns.

On the whole, land use needs to be well-planned to ensure the ability of available land to meet future demands and as a resource for sustainable development. However,

ad-hoc decisions for land conversion which often occur despite having the structure plan and sometimes the local plan, reflects the shortcoming of the current land management system and this has to be rectified in order to meet the needs of the future and avoiding adverse impact on the environment.

Table 3.6 Role and Interest of Various Parties Involved in a Proposed Project

Group	Role	Interest
1. Project Initiator	Plan, develop and/or manage the project	Mainly economic (in the case of private sector) but socio-economic (in the case of public sector development)
2. Investor (lending agency and purchasers of land)	Investment in the projects	How impacts affect viability of project and liabilities to be incurred
3. DOE	Decision on EIA reports.	Extent of potential impacts and whether there are design solutions to mitigate impacts to acceptable levels.
4. DoTCP	Zoning and land use	Extent of impact the project has on land uses and adjacent developments.
5. Other Agencies: DID DoPW DoF DoA	Relevant inputs in respective areas of expertise.	Implications of proposed project on other projects or activities in which they have interest or wish to promote.
6. Approving Authority	Project Approval	Impacts are to be within acceptable levels with no significant residual issues.
7. Local Authorities	Zoning and development control.	Extent of impact the project has on land uses and adjacent developments.
8. Local Community	Relevant inputs for protection of local interest.	Impacts of project and how they affect the quality of life.

Source: Perunding Utama Sdn. Bhd. (1994), p.3-7.

3.4.4 Other Environmental Related Legislation

There are about 40 environment related pieces of legislation that exist in Malaysia (Appendix B). The purpose of their formulation is none other to promote and enforce sound practices in specific sectors. The legislation concerning resource utilisation are the earliest forms of environmental related legislation which came into force and it date back to the 1920's. These are directed towards the regulation of use and

exploitation of water, forest and minerals. Apart from legislation concerning resources, there is also legislation which is not concerning resources among the environmental related legislation. It was observed that most legislation related to resources is enforced by States although many are Federally legislated laws adopted by the States (e.g. forest, land and fisheries). Whilst for non-resource legislation's enforced by States and Local Authorities, they are aimed at achieving uniformity, in terms of enforcement of the law, among States (e.g. Street, Drainage and Building Act, 1974; Local Government Act, 1976 and Town and Country Planning Act, 1976).

On the one hand, problems arise because of the existence of fragmented legislation to deal with environmental matters, besides the EQA, and many overlapping areas of jurisdiction exist. While on the other hand, one State (i.e., the State of Sarawak) has even instituted its own piece of legislation (i.e., the Natural Resources and Environmental Ordinance, 1992) to deal with environmental, resource and pollution issues within the state. This could be very helpful as long as they complement each others efforts to ensure a sustainable environment, especially on matters pertaining to natural resources which are under the jurisdiction of the State. But in terms of environmental control and pollution abatement strategies, it is essential that uniformity in approaches among all the States be maintained.

Under this situation, it is clear that there is no one agency is responsible for overall environmental quality, except for the DOE. Nevertheless it should also be clear under the circumstances and areas where DOE is not empowered, e.g. in soil erosion or pesticides control, as there is a possibility that no one agency can be made accountable for the problem at the macro perspective. It appears very reasonable that the setting of an environmental division under the Federal Economic Planning Unit [Federal EPU] could function to foresee ways in ensuring proper delegation of power to handle cases of exceptional circumstances.

3.5 INSTITUTIONAL ARRANGEMENTS

The discussion above well indicates that environmental issues and problems often cut across the division of power between State and Federal Authorities, but Federal level objectives on environment may not be accorded similar priorities at State or Local Government level. The effectiveness in environmental management from the formal consensual planning process, where development applications are circulated for comments and recommendations, could be set to a minimum because of a variety of problems such as lack of co-ordination, different sets of objectives and priorities at the Local or State Government level; apart from many other problems such as inadequate manpower; and professional expertise. Under many circumstances most other agencies regard environmental matters as principally DOE's responsibilities and for the department alone to handle.

The fragmented view of the environment and consideration over environmental matters (as fragmented as the existing legislation's themselves), which many parties appear to have, results in lower priority being given, unless high and immediate environmental costs and serious negative impacts are involved, or if public outcry results from their activities. In the event of such happening, DOE will be a single main agency to turn to for assistance. Many States do not even have a dedicated environmental management unit to deal with environmental issues, and often the idea of environmental protection used to be treated as wasteful.

It is essential that the tools and mechanisms for the incorporation of environmental considerations in the planning process need to be supported at the very top level. The fundamental elements in the National Environmental Policy [NEP] once been realised, it would help the integration process at all level, but this needs to be initiated by the Federal and State Government agencies, to ensure that the development activities proceed in a sustainable manner.

As been acclaimed, the essence in achieving the desired planning is integration. However no calculus has been invented that satisfactorily facilitates integration.

Integration is usually a qualitative process rather than quantitative, and this remains a predicament in the planning process. Hence, integration almost always requires some sort of checking mechanism and to be evaluated to determine the relative importance and meaning of the results.

The mandate of the National Development Planning Council [NDPC] has expanded in 1993 in the move to ensure that environmental dimensions are well incorporated into development planning (GOM, 1996). This provides a co-ordination at the highest level among government agencies and its recommendation will be submitted to the National Economic Council for final decision to be made. This shows a clear sign of the initiatives taken by the Federal Government in promoting a holistic approach to the management of the environment and natural resources. The policies laid down in the Seventh Malaysia Plan provides many assurances by the Federal Government in its serious attempt to reduce the negative impact of land development.

To deal with the challenges ahead in land use planning, the Town and Country Planning Act, 1976 was amended in 1995 which incorporated in the amendments, measures on conservation of the environment which are required in all planning permission applications. The Department responsible for administering the Act, i.e., the Department of Town and Country Planning [DoTCP] serves to provide advisory and management services to the Federal, State and Local Authorities on the development activities, including development that contribute towards improving the environment.

The State Planning Committees, which are responsible for screening and approval of development plans at the State level, received an important role in charting the nature of development that stressed an emphasis on the conservation of the environment when dealing with all planning permission applications.

The Local Planning Authorities have an even greater role to contribute, because it is at this level that all the policies to meet the socio-economic objectives were interpreted into development plan and this include the incorporation of environmental

considerations that have to go along with the land use plan. For this reason, environmental and resource conservation as well as management considerations for natural and man-made resources are required to be included as an integral entity in the preparation of Structure and Local Plans.

The extent of incorporation of environmental dimension has to be comprehensive when dealing with planning at the local level. So much so, with such as the integration of soil conservation planning with physical development that would help to reduce soil erosion and hence improve the water quality if systematically undertaken. In practice, this may involved a review of the current legislation and guidelines governing land development. The core to this is the way the government influence the developers to incorporate environmental factors into the implementation scheme.

Effectively, the existing legislation could be further exploited with consideration of making amendments where necessary especially in the following legislation:

- National Land Code, 1965.
- Environmental Quality Act, 1974.
- Town and Country Planning Act, 1976.
- Uniform Building Bylaws, 1984.
- Housing Developers (Control and Licensing) Regulations, 1989.

Thus far, little have been explored with the National Land Code, 1965 [NLC] in terms of its application in environmental management. NLC has been used to guide the development trend in the country and has an influential role over land use planning. This piece of legislation is responsible for the classification of land uses, which fall under 3 broad categories namely: agriculture, industry and building. The State authority has the power provided under the NLC to change the designation of land use for development and proper land use planning and management. Section 62 of the NLC provide the necessary power to reserve State land.

The agencies responsible for providing access to information that forms the key elements towards better integration, include: National Land Information System [NALIS], Malaysian Centre for Remote Sensing [MACRES], the Department of Statistics, and all other government agencies and the government departments, universities and research institutes. Apart from NALIS, MACRES and the Department of Statistics, other bodies will provide access to information specific to their functions and responsibilities. A summary of the agency and the functions they provide are shown below:

Agency		Function
National Land Information System (NALIS) (<i>as proposed in the Seventh Malaysian Plan, para. 19.66</i>)	Land Capability Classification	To be the main source of land-related data and Capability Classification to be updated to facilitate land use planning. These information systems will be complemented by further development of remote sensing capabilities which will be utilised to evaluate the natural resource endowment efficiently and to better manage land resources.
Malaysian Centre for Remote Sensing [MACRES]	Real-time monitoring	This agency will provide real time monitoring of the environment, natural resources and land use through the use of satellite and other remote sensing sources.
Department of Statistics	Information system	To be the central depository for environmental statistics, where data will be compiled from all existing line agencies.
Other Government Agencies	Data collection and interpretation	<ul style="list-style-type: none"> • Routine monitoring programs in line with the departmental function and roles. • Established / Upgrade the various databases through an improve collection and information system. • Advisory in matters related to land use planning and water resources management. • To enforce the relevant provision under the various legislation.
Government Departments, the Universities and other Research Institutes	Research and Development	To undertake studies in the field of water resources catchment / watershed management.

Source: summarised from GOM (1996).

The agencies shown above are the existing organisations which contribute towards the exchange of information for the purpose of planning decision and their presence is of advantage to the planning institutions. This arrangement, as described in the Seventh Malaysia Plan, is intended to avoid duplication of effort in data generation and capturing when another agency has already handles similar piece of information which could be shared among the various users. The arrangement would lead to an efficient retrieval system on the basis of promoting integration for an effective decision making process.

3.6 LAND USE PLANNING AND WATER RESOURCES

The issues related to land use are many and extremely complex, and their impact may range from global to local levels. Owing to its complexity, many planners attempted to avoid impact issues for a long time. There are approaches such as the one suggested by Fabos (1985) which try to find ways to reduce or eliminate potentially negative impacts by sensible land use decisions. This thesis attempts to explore how a proper management of land use issue could ensure a sustainable water use within the designated area by understanding the probable impact of implementing certain land use decisions.

Land use development has an effect on water in several ways. Land use development taking place in the form of urbanisation process, agricultural, mining, and other infrastructural development purposes have given rise to much of the problem with respect to water resources. These sorts of land uses have taken up about 52 percent of the land area in Peninsular Malaysia. It is of no co-incidence though, that the occurrence of pollution problems are more closely associated with places especially on west coast Peninsular Malaysia (DOE, 1995a). Further, this part of the Peninsula is the most densely populated and highly developed compared to the east coast. Besides, the locations of urban areas are concentrated more on the western side of the Peninsular (ADB and GOM, 1986).

Such land use changes are brought about either plan-led or result from uncontrolled development. The rapid rate of urbanisation, primarily due to rural-urban migration, has resulted in the sprouting of squatter settlements and overloading the urban facilities. Urban facilities such as sewage treatment has become increasingly inadequate to cope with rising demand. As a result, a significant portion of discharges of partially treated domestic wastewater contain sewage. This has yet to consider the pollution impact on other segments of the environment which are facing similar threat due to the rapid rate of urbanisation. Similarly, the growth of industrial activities which occupy a reasonable portion of land especially in the west coast, are not only causing a huge increase in water demand for their processes but at the same time their existence are threatening the water resource due to the deleterious substances contained in their discharges.

In terms of planning policy, the author submits that reasonable coverage has been provided in setting out proper direction that aims towards sustainable water use in the country. Obviously there could be some sectors that will still require specific policy direction. What matters most is to interpret the existing policies into a reality through the planning process and specific designated area has to be established for the purpose of managing the implementation of the prepared plans. Hence, the inclusion of environmental consideration into land use planning need to be given a priority as been urged and emphasised in the Seventh Malaysia Plan.

“Efforts were also directed at maintaining the quality of the urban environment through the inclusion of environmental considerations in town and country planning and in land-clearing, upgrading of national sewerage system, and clean-up activities of the rivers. To alleviate the occurrence of urban flash floods due to excessive run-offs and siltation, several flood mitigation projects were implemented in urban centres ...” (GOM, 1996)

3.7 CONCLUSION

The planning process would be able to chart the scenario for the future with the concerns over the welfare of present and future generations and this has been a key issue in the process of achieving sustainable development. It calls for a proper integration of environmental considerations, and the incorporation of conservation and preservation principles, into the planning process in order to succeed. The land use planning procedure can be considered as one of the useful means whereby environmental consideration could be allowed to prevail in all development schemes. The provision for this has been accommodated through the amendment (1994) of the Federal Town and Country Planning Act (1976). Consequently, local development programmes are expected to proceed in a proactive manner without causing the impairment to the environmental quality and resulting in a cumulative adverse effects. Such damages, if they occur, will be long lasting and will be too costly for the community.

Efforts have to be made to mobilise the present planning system so as to be consistent with the concept and policy statements on sustainability and the various provision under the appropriate pieces of legislation. The policy statement on planning in the recent Five Year Malaysia Plan provides the impetus for proper integration of the sustainability concept in planning and operation in all government agencies. This is to be put into practice irrespective of their level of operation. Previous research indicated that the environmental component needs to be further strengthened in order to achieve a better land use plan. However, it is envisaged such a plan will still need to be supported with a complementary plan that would specifically deal with the interaction between land use planning, environmental management and water resources planning and management, with the intention of sustaining the water environment.

The key issues of the land use planning and environmental management process in Malaysia are therefore as follows:

- Sustainable development could be shaped through proper land use planning. Malaysia has an established planning structure but its approach needs to be more proactive and to employ carrying capacity arguments.
- The various levels of planning often expose inconsistencies in interpreting the national aims of achieving sustainable development; an effective mechanism to ensure co-ordination among the parties would serve a greater role in ensuring uniformity in their implementation.
- Development plans should integrate the concept of sustainability and emphasise environmental considerations and sustainable natural resource utilisation.
- Various strategies of environmental management are in place and are being implemented. However most of their accomplishments for sustainable development are undefined, which suggests that suitable indicators need to be established to serve the desired objectives.
- The principles of strong sustainability demand the type of environmental management which is far-sighted, proactive, holistic and integrated. Nevertheless there are constraints in the control of resources due to the existing institutional framework. Institutional matters need to be resolved through a credible authority to ensure the sustainability of natural resources for the well-being of present as well as future generations.
- Land use planning and development affects water resources in several ways. Therefore the relationship between the two should be understood and the extent of impacts needs to be closely studied so that meaningful action to bring about sustainable water use can be achieved.

CHAPTER 4

WATER RESOURCES MANAGEMENT AND PLANNING IN MALAYSIA

4.1 INTRODUCTION

Water resources are essential in sustaining human life and for the production of goods and services. Recognising this fundamental fact, Agenda 21 - a programme of action for sustainable development world-wide endorsed at Rio's Earth Summit in 1992 - includes in its proclamation under Principle 1 that man being at the centre of concern for sustainable development "is entitled to a healthy and productive life in harmony with nature" (UNDC, 1993). A healthy and productive living will require a clean and conducive environment.

In the pursuit of rapid development, it is necessary to ascertain that adequate supplies of water of good quality are maintained for the country's population, and development activities are implemented or allowed to discharge within the river carrying capacity. The unsustainable patterns of production and consumption should be eliminated or at least minimised as recommended under Agenda 21. Hence it is pertinent for a comprehensive assessment on the activities contributing to the present water quality be made.

This chapter attempts to explore the water management and planning aspects in Malaysia, while identifying the strengths and weaknesses of the existing legislation and institutional arrangements and to examine the opportunity these might have in contributing towards a sustainable water use in the country as a whole. The extent of impact of land use policies and plan of a local situation which have direct and indirect impact on the nations water resources is the central focus in this chapter. This chapter also examines the environmental policy and legislation available in Malaysia that helps to protect the nation's water resources and to find out the way for a proper planning of the water resources and land use in an integrated manner.

4.2 WATER RESOURCES IN MALAYSIA

4.2.1 Water Balance

Water resources comprise water that is of immediate and potential sources of benefits to the population. Water exists in a complex cycle where it passes from water vapour in atmosphere through precipitation upon land or water surfaces and later through the process of evaporation and transpiration, it will return into the atmosphere and so the cycle continues. That means water undergoes a temporary phase on the surface of land, in soil and underlying rocks before it is lost to the air or flow to the sea.

Water is available in abundance in Malaysia. Statistics show that 990 billion m³ are received through annual rainfall over the land mass of 330,000 km² (i.e. the total land area of Malaysia). In terms of rainfall distribution, the average annual rainfall is more than 2,000 mm in most areas (except for some parts of Pahang and Johor). It is more than 3,000 mm in the north-eastern part of Peninsular Malaysia, and the entire coastal areas of Sabah and Sarawak. In the mountainous areas of Sarawak, the average annual rainfall exceed 4,000 mm. On average the annual rainfall is 2,420 mm for Peninsular Malaysia, 2,630 mm for Sabah and 3,830 mm for Sarawak.

On balance, 60 percent of the total annual rainfall for the country, makes up the water resources, (i.e. 566 billion m³ meters as surface runoff and about 64 billion m³ as ground water recharge). Of the 566 billion m³ of surface runoff, 147 billion m³ occur in Peninsular Malaysia, 113 billion m³ in Sabah and 306 billion m³ in Sarawak (Table 4.1). The balance of 40 percent (i.e. about 360 billion m³) returns to the atmosphere in the form of evapo-transpiration (GOM, 1982b).

4.2.2 Water Resources Related Issues

There are several areas of concern relating to water resource that might have significant effects on the overall water use sustainability in the country. These areas of concern include (i) maintenance of low flow; (ii) preservation of water quality; (iii) development of adequate water supply; and, (iv) flood mitigation. Under certain circumstances, some of these areas of concern may need to be examined and dealt with together because of the interrelationship between them.

Table: 4.1 Malaysia: Hydrological Balance By State

State	Area (10 ³ km ²)	Rainfall	Surface Runoff	Groundwater Recharge	Evapo- transpiration	
Perlis	}	2	1	0	1	
Kedah	}	10.29	23	12	10	
Penang		1.04	3	2	1	
Perak		20.95	50	22	24	
Selangor & FT Kuala Lumpur		6.67	18	7	9	
Negeri Sembilan		8.23	14	5	8	
Melaka		1.65	3	1	2	
Johor		19.14	45	19	23	
Pahang		35.98	80	33	43	
Trengganu		12.95	43	22	19	
Kelantan		15.03	39	23	13	
Peninsular Malaysia		131.93	320	147	20	153
Sabah		73.70	194	113	14	67
Sarawak		124.45	476	306	30	140
Malaysia		330.08	990	566	64	360

Source: GOM (1982b), p. 99 & 101.

4.2.2.1 Maintenance of low flow

Over 90 percent of water resources in Malaysia occur in the form of surface water resources; consequently, surface water has been and will continue to be the main source of supply. Rivers perform the role of collecting surface water and conveying it through lands to the sea. In most cases it is from the rivers that water is abstracted or diverted for purposes of public water supply and irrigation as well as other uses. At the same time, rivers also provide for water transport, support fish life and form part of the eco-system.

Maintenance of low flow will ensure factors such as water depth, flow velocity, water quality, channel stability and the aquatic eco-system are kept as required for sustaining normal water uses and environmental quality. Such a minimum river discharge should obviously be specific to each particular river according to its natural conditions and water resources use and management requirements. The low flow maintenance efforts when employed would enable to sustain river uses such as navigation (for some large rivers), fish catch, operation and maintenance of intakes for water supply and irrigation, maintenance of facilities in the rivers, checking sea water intrusion, prevention of estuary clogging, conservation of groundwater, preservation of riparian lands and peoples' amenities.

At present, regulation of river flows in Malaysia, is performed under the provisions contained in the Water Act, 1929 (Amendment, 1989). This acts as a simple control of the resource since early days, and enables the sustenance of the river uses. Under the Water Act which is enforced in many states in Peninsular Malaysia, District offices issue water licenses to permit any private individual to divert water from a river for a certain permitted use of the water. The Mines Department also issue licenses for the diversion of water from rivers for mining purposes. However, such requirement for license is not imposed on government departments and its agencies. District officers and Inspectors of Mines would consult the Drainage and Irrigation Department and generally rely on the latter judgement as to whether or not further withdrawal of water will affect the existing users. Although the Drainage and Irrigation Department has

undertaken hydrological observation at a number of hydrological stations, the flow data available are inadequate to attain the accuracy in judgement (GOM, 1982b).

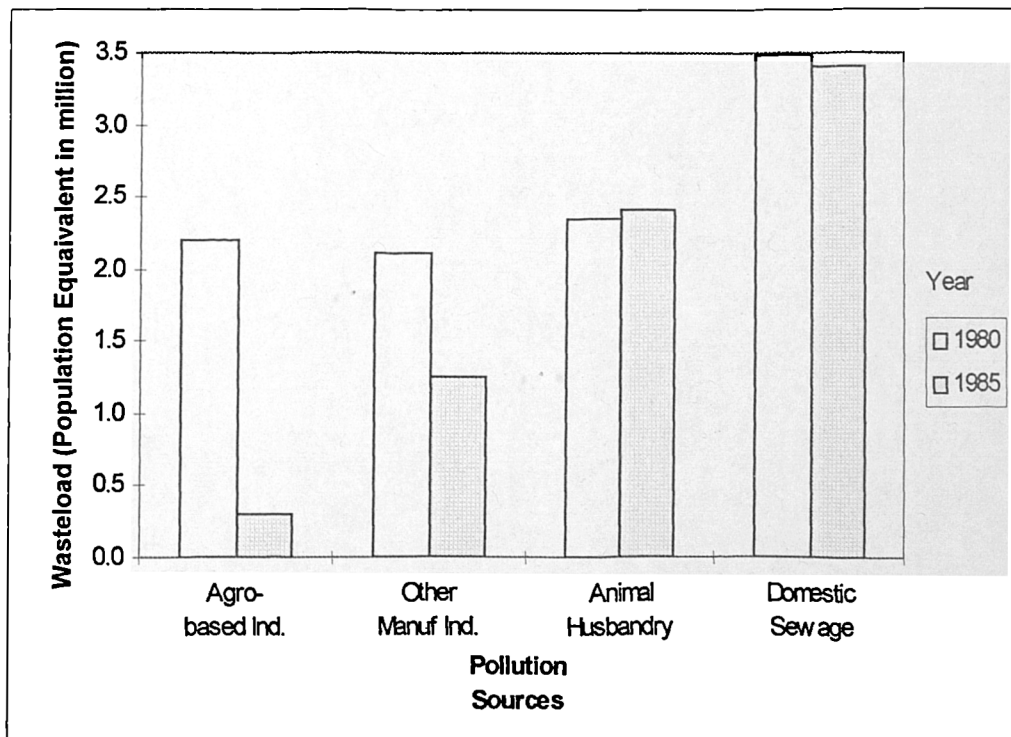
As water use increases more and more, the need for maintaining river flow becomes increasingly important to allow sufficient allocation of water to all legitimate users. Such low flow maintenance should be established for each river and will serve as an indicator of the allowable limit of water withdrawn taking into account all existing water use, the need to maintain operation of intake structures and other river facilities as well as hydrological and environmental conditions. Bagnati et. al. (1994) regards this as the threshold limit that need to be conformed with. As a requisite for this, it is necessary to maintain an inventory showing locations, purposes of water structures, quantities of all water withdrawals from a river so that a complete account of the water use can be made; whilst hydrological observation will need to be strengthened.

4.2.2.2 Preservation of water quality

The ever increasing use of water as a result of the growing population and growing manufacturing and processing industries has correspondingly increased the discharges of effluents and sewage into rivers and waterways. The wastewater needs to be sufficiently treated prior to its discharged in order to preserve the river water quality. Without increasing the present level of sewage treatment and in the absence of stringent control on industrial discharges, the pollution load discharged into rivers and waterways will increase markedly, thereby causing the pollution concentration in a number of major rivers to increase to the level that it will not only adversely affect the aquatic life but also will render river water unfit for use.

Domestic sewage, animal wastes and industrial effluents have been the main source of river pollution. In 1980, pollution load (in terms of organic load) from industrial sources accounted for 43 percent of the total load discharged into the rivers in Peninsular Malaysia, followed by domestic sewage which made up for 34 percent and animal wastes accounted for 23 percent. Measures to control the organic pollution in rivers include the installation of sewerage systems to treat domestic and industrial

sewage and treatment of industrial effluents and to some extent the treatment of animal wastes. The level of treatments have been continually improved to reduce the wasteload discharged. The situation in 1985 showed a marked improvements been observed in the industrial discharges particularly from the agro-based industries. Domestic sewage now ranked as the most polluting source accounting for almost half (46 percent) of the total organic (BOD) load discharged and it is followed by animal wastes (33 percent), whilst industrial wasteload accounted for only 21 percent. The wasteload discharged by type of sources between 1980 - 1985 is as shown in Figure 4.1.



Source: Modified from Harun (1994).

Figure 4.1 Peninsular Malaysia: Organic Pollution Loading, 1980 - 1985.

Large proportion of organic loads therefore originate from urban sewage and livestock farming as indicated in Figure 4.2 which cause a growing concern in more than two-thirds of the Malaysian rivers. In order to reduce the pollution concentration in rivers to an acceptable level, it is further necessary to construct centralised sewerage projects in cities and towns which are located along rivers and to treat the discharges from livestock farming activities. Another source category which causes deterioration in the river water quality is silt from soil erosion where the Department of Environment reported about two-thirds of the rivers in the country have high level of suspended solids.

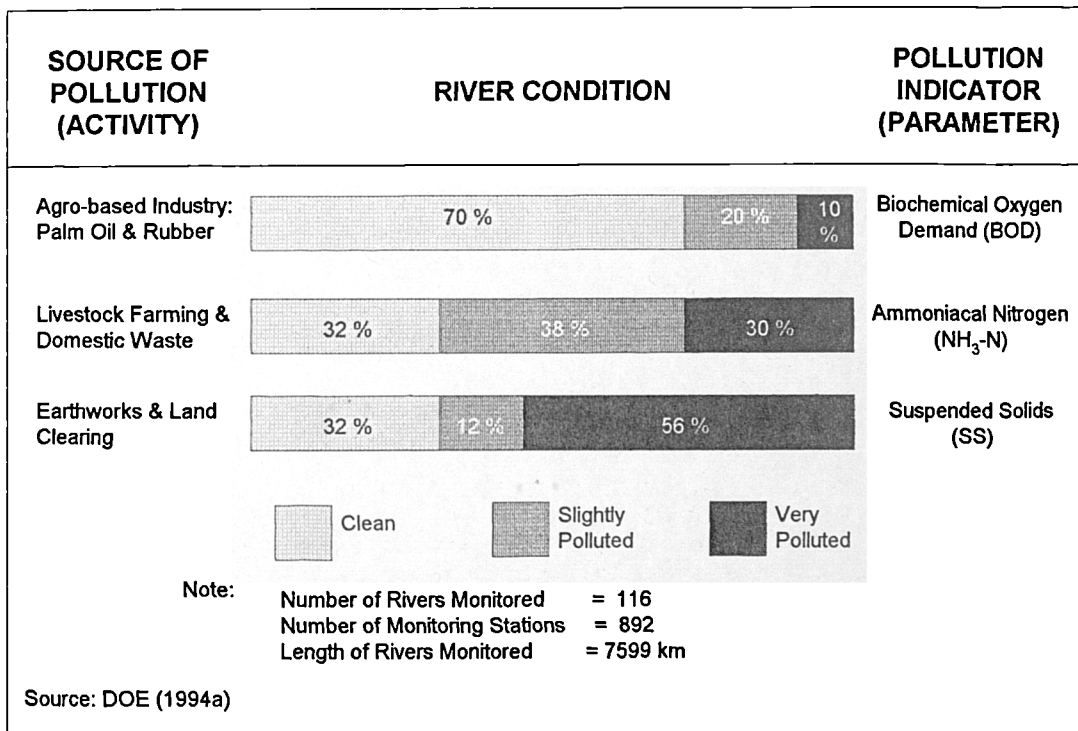


Figure 4.2 Malaysia: Status of River Water Quality Based on Activity, 1993.

Water pollution control in rivers has so far been improved to meet the appropriate standards which are set from the standpoint of public health and from the standpoint of conservation of environmental quality. However the control of water pollution seems to be more successful in terms of the reduction in agro-based industrial effluents compared to other sources of pollution. The sector has achieved a reduction

level of about 90 percent since the introduction of regulations to control their discharges in 1977-78.

Before 1993, the implementation and maintenance of sewerage facilities were undertaken by local authorities which impose a charge (sewage charge) for the use of public sewerage systems in the form of a surcharge to the water charge levied by a water supply agency. In addition, for the purpose of recovering operating expenditure and depreciation cost of sewerage systems, either an additional house assessment rate is levied or a part of the assessment rate collected is transferred for the purpose.

To ease the burden on the local authorities, the sewerage system for the whole of Peninsular Malaysia was privatised to the *Indah Water Konsortium (IWK)*. The privatisation of the facilities was carried out to ensure that the existing sewerage system could be further upgraded and refurbished while new facilities would be built to enhance the existing system. Where necessary it is expected that modern mechanically centralised sewerage treatment plants will be used. With better facilities in place, it was expected that organic pollution from domestic and animal waste would decline, thus helping to improve the river water quality. In fact, the government plan projected that by the year 2000, 79 per cent of the population will be served with modern sanitary sewerage services (GOM, 1996).

For new developmental projects, developers of housing and industrial estates are required to construct at their own expense the necessary sewerage systems or meet the cost for expanding existing public sewerage systems to serve the estates. Whilst in existing developments, the construction cost of trunk and branch sewers is either borne by the local authority or by individual users. The cost of house connection to a public sewer is borne by the house owner concerned.

4.2.2.3 Development water supply

Significant progress has been made in developing public water supply to provide domestic water to urban and rural areas so as to improve social well-being and to

supply water to support industrial development. The proportion of households served by (i.e. service factor of) public water supply in Malaysia is considered to be relatively high, and by the year 2000 (except for the rural areas in Sabah and Sarawak where for reasons of remoteness and the non-availability of suitable water source), it was anticipated that a service factor of 90 percent will be achieved (GOM, 1996). Not only does the public water supply serves domestic purposes but it is also able to meet the water demand from the industrial sector. However, some industries with intensive water consumption resort to private water sources to serve their own needs. With continuous urbanisation process, the demand for clean water is expected to rise rapidly.

Irrigation development functions to attain and maintain the desired level of self-sufficiency in food and to increase farmers' real income. Many irrigation projects were undertaken especially in areas with large proportion of agricultural land. The demand for water to irrigate land continues to increase, especially in places with extensive cultivated fields and frequently subjected to water stress conditions, in the pursuit of reaching the target of attaining self-sufficiency in food supply.

The increasing demand for adequate water of acceptable quality will, in one way or the other, pose some difficulties to the water authorities in the future because of the limitations in searching for new water sources due to their geographical locations, while the cost of water abstraction and treatment can be very costly.

4.2.2.4 Flood mitigation

In contrast to low flow problems, floods could threaten lives and damage property. Hence, flood control and mitigation is crucial to protect the public and reduce damages. More importantly, the flood mitigation programmes function to provide protection to the whole population of major flood incidences.

Significant flood damage has been experienced in many parts of the country. Flood events in the past were recorded with disruption of economic activities, human misery

and loss of life and property. Mitigation in the form of both structural and non-structural measures were taken to alleviate these problems. The former includes flood control dams, channel improvement, bypass floodway and the like while the latter includes restriction of development in flood-prone areas and resettlement.

4.2.3 Supply And Demand For Water

4.2.3.1 Historical development of water supply

Implementation of the water supply systems started in the Federated Malay States and in the Straits Settlements in the early 19th century. In 1804, the first formal arrangement for a water supply system in this country began in Penang serving a population of about 10,000 people, and Kuching (in Sarawak) had its first water supply in 1887 serving about 8,000 people then. However modern rapid gravity filtration plants were only introduced in this country in the 1930's, with the oldest treatment plants built to serve large towns i.e., Penang and Kuala Lumpur. Some of these water supply schemes such as the Waterfall Supply in Penang and the Ampang Impounding in Kuala Lumpur are still in service until today. The demand for water then was low and therefore there was not much problem in supplying water to the community. Even in the early days of water supply systems, routine samples of water were taken by the Health Department for chemical and bacteriological analysis.

All the major towns had treated water supplies even before the Second World War. During the period of war (between 1941 and 1945), little attention was given to maintain the water supply system which resulted most of the installations deteriorated in conditions. Whilst urban population had increased enormously with some towns having a population increase of as much as a 100 percent (DoPW, 1996). After the war, these installations were rehabilitated and new schemes were implemented to meet the growing demand for clean water.

By 1950, the country already had 100 treatment plants producing 195 thousand m³ per day and supplying treated water to a population of 1.15 million. Major developments, took place after the independence in 1957, with the completion of the first major scheme at the Klang Gates Dam and the Bukit Nanas treatment plant in 1959 and supplying the capital city of Kuala Lumpur. Subsequently, rapid progress was made under the various National Five Year Development Plans where particular emphasis were given on the development of various sectors including Water Supply and Health, which are essential for the national development. Larger schemes have been undertaken and presently (based on 1996 statistics) there are more than 477 treatment plants producing about 8.05 million m³ to cope with a population of about 18.04 million people (DoPW, 1996).

4.2.3.2 Present situation

There are a variety of purposes served by water in Malaysia as in many other countries. These uses include the consumptive water use which are largely for domestic water supply and irrigation and to some extent in the form of fish culture, mining and hydropower. Instream water uses include navigation and fish catch.

In 1990, the domestic and industrial water use was estimated to be 2.6 billion m³. It has been identified in the Seventh Malaysian Plan that the domestic and industrial water demand will increased by 42 percent between 1990 and 2000 to 3.7 billion m³ and the demand for irrigation water will grow to 10.4 billion m³ from 9 billion m³ within the period (GOM, 1996). The national trend of overall water supply capacity and water demand increase between the period of 1981 and 1996 is as illustrated in Figure 4.3.

The Seventh Malaysia Plan projected an increase in the water supply capacity from 9.5 million m³ per day in 1995 to 11.8 million m³ per day by the year 2000. This implies new sources for adequate water supply have to be developed in the not far future. It also predicted that any new water supply development may require heavy investment because of limited and remote sources, larger reticulation systems and

higher cost of treatment. Hence, all these factors necessitate the need to protect the watershed (catchment) areas from deteriorating, in order to ensure that their potential use are not jeopardised.

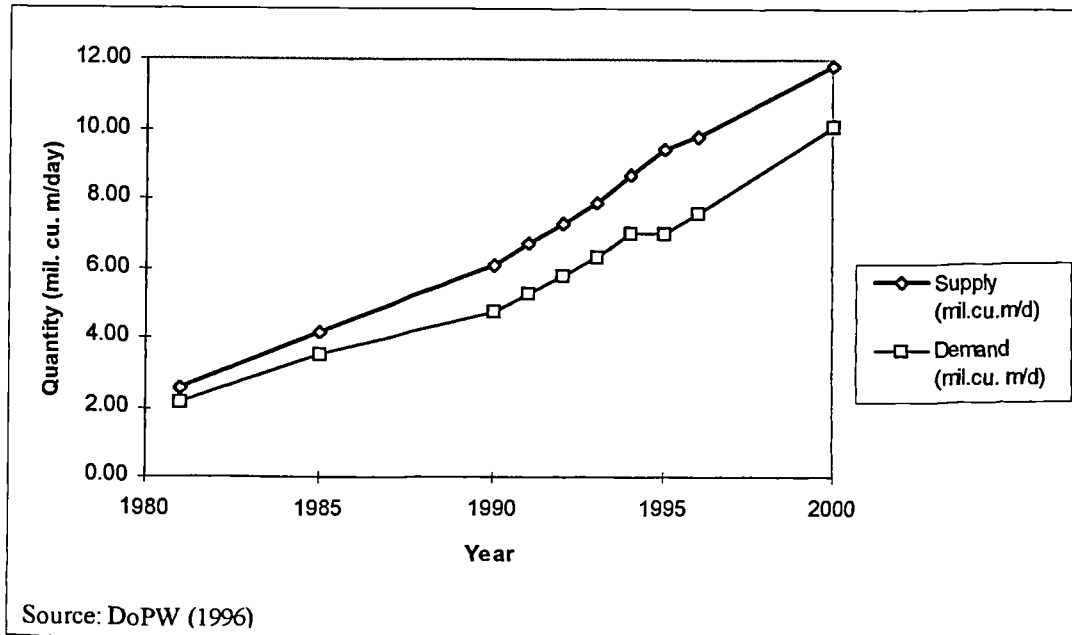
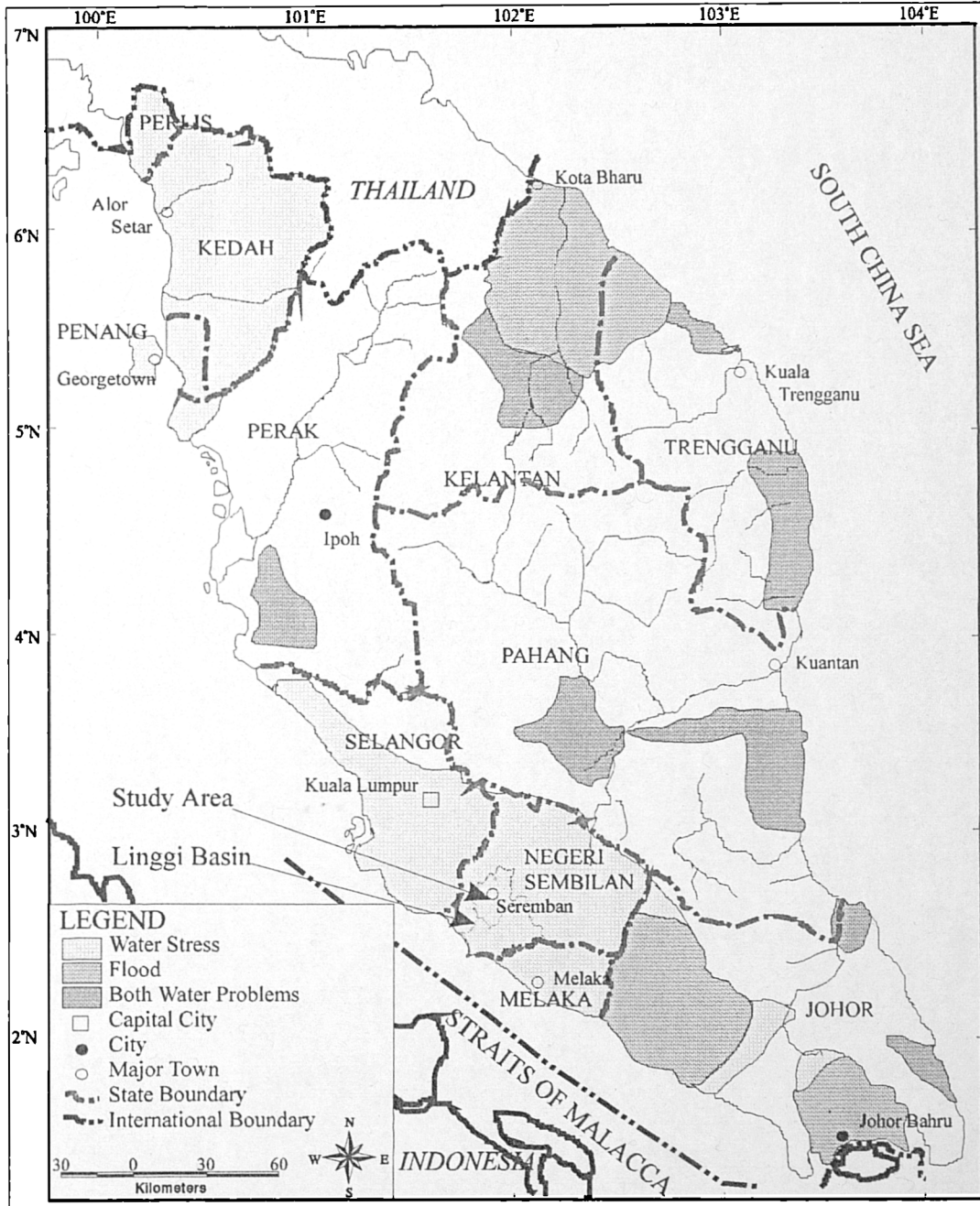


Figure 4.3 Malaysia: Water Supply Capacity and Water Demand, 1981 - 2000.

Some states are less fortunate than others because of their location within the water stress area of the country (Figure 4.4) and this situation poses another problem to meet the demand for clean water. Among the areas frequently hit with water supply shortages are the northern and central regions of Peninsular Malaysia.

In overcoming the problem, consideration is being given to explore the possibility of interstate and interbasin water transfers. Although the option is not new in terms of its concept, it would help to rectify the problem of uneven distribution of water resources, particularly among water stress states and to ensure long-term sustainability. In fact, initiatives are well under way to implement interbasin water transfer from the water-rich states such as Pahang to the critical water stress areas such as the Klang Valley region in Selangor and Kuala Lumpur. These are the areas worse hit by drought in 1998 which affected 1.8 million population.



Source: Welch and Keat (no date).

Figure 4.4 Water Problems in Peninsular Malaysia.

4.3 WATER POLLUTION CONTROL

4.3.1 Water Quality Management

Many views suggest that to establish an effective environmental management it will need a continuous implementation of environmental monitoring and the collection of environmental information (Holdgate, 1979; Sors, 1981). It is through the monitoring programmes that new or worsening environmental problems can be identified and early attempts can be made to rectify any disorder. Apart from the understanding of the local environmental problems, monitoring can shape the form of policies connected to the rising problem.

Similarly, water quality monitoring in Malaysia, which has been established since 1978, managed to lead the way in helping DOE to tackle specific issues concerning water pollution problems and thereby helps to improve river water quality. To-date there are approximately 600 water quality monitoring sites located in 95 river systems in the country that form a national network providing data at reasonable frequency of samples and number of parameters which in turn represent their status of water quality. The monitoring programmes include *in-situ* measurements of more than 6 parameters (i.e. turbidity, dissolved oxygen, salinity, temperature, pH and electrical conductivity) and laboratory analyses of as many as 30 other chemical and biological parameters. An estimated 3,600 samples were taken annually thereby generating over 70,000 water quality data each year (DOE, 1987a).

Because the demand for monitoring data is expected to grow significantly, on 1st January 1995, a national corporatised private body - *Alam Sekitar Malaysia Berhad* [ASMA] - has taken over the monitoring functions of DOE, and continues to operate the monitoring activities based on a concession agreement established between the Government of Malaysia [GOM] and ASMA (DOE, 1995b). The privatisation exercise is anticipated to provide an efficient environmental quality monitoring services for environmental management in the country where it involves the collation, processing and dissemination of environmental quality data via a national

environmental quality network and reporting system. The system comprises of manual and automated environmental quality monitoring stations of air and water quality, with DOE as its main client while other end users subscribing to the system include other government agencies, research institutions, industries and urban planners.

Besides DOE (and now ASMA), several other agencies are involved in monitoring river water quality. These agencies include the Department of Health (at public water supply abstraction point), the Mines Department (for discharges from mining activities), and the Geological Department (for groundwater quality).

4.3.2 Water Quality Criteria and Standards

The management of water quality solely through regulation and licensing of effluents discharges present some constraints. This is especially so in light of the cumulative pollutant loads which may eventually exceed the safe levels or the assimilative capacity of the rivers, despite the fact that effluent discharges into the rivers are in compliance with the stipulated standards. Hence, a complementary approach is likely to produce a more effective water quality management and planning.

In December 1984, the Department of Environment commissioned the Institute of Advance Studies, University of Malaya, to undertake a comprehensive consultancy study to review and develop water quality criteria and standards for Malaysia covering beneficial uses for domestic water supply, fisheries and aquaculture, livestock, recreation and agriculture. The final report, which is the Phase I of the study, was submitted on 28th May 1986. The first phase study has formulated the water quality criteria and interim water quality standards (where reference to this was made in this thesis) for various beneficial uses, comprising of conservation of the natural environment, domestic water supply, fisheries and aquaculture, recreational uses, livestock and irrigation. This specifies the water quality limits of the 5 classes of water sources in accordance to the highest attainable designated use or uses in each

class. These interim water quality criteria and standards for Malaysia, summarised according to their classification, are as follows:

Class I

Represents water bodies of excellent quality. Standards are set for the conservation of natural environment in its undisturbed state. Water bodies such as those in the national park areas, fountain-heads, and in high land and uninhabited areas come under this category where strictly no discharge of any kind is permitted. Water bodies in this category meet the most stringent requirements for human health and aquatic life protection.

Class IIA

Represents water bodies of good quality. Most existing raw water supply sources come under this category. In practice, no body contact activity is allowed in these water for the prevention of transmission of probable human pathogens. Another class of similar quality but not used for water supply is introduced and is referred to as Class IIB. The determination of Class IIB standards is based on criteria for recreational use and protection of sensitive aquatic species.

Class III

Defined with the primary objective of protecting common and moderately tolerant aquatic species of economic value. Water under this classification may be use for water supply with extensive/advanced treatment. The class of water is also defined to livestock drinking needs.

Class IV

Defined as water quality required for major agricultural irrigation activities which may not cover minor applications to sensitive crops.

Class V

Represents other waters which do not meet any of the above uses.

As rivers are the most important form of water resources in the country, DOE has initiated a programme to classify the various river basin through the second phase of the study in 1988 based on the recommendation of the Phase I. With this, six rivers (including Linggi River) were classified (DOE, 1990a). The second phase study involved two projects: i.e. (i) the quality assurance programme for environmental water quality monitoring; and (ii) the classification of rivers in Malaysia according to the various beneficial uses.

The phase III study of water quality criteria and standards, involved the review of the existing discharge standards, so as to complement the Phase I of the National Water Quality Criteria and Standards that have been formulated during the Phase I and Phase II Studies, and it was completed in December 1993 (DOE, 1993a). The study focused on the improvement, modification and strengthening of the standard requirements of the Environmental Quality (Sewage and Industrial Effluents) Regulation, 1979. The study recommended improvement to the existing standards including outlining practical approaches for setting up discharge standards.

The Phase IV study involved the classification of ten more major rivers according to their quality and beneficial uses of river water and the study was completed in November 1993 (DOE, 1994a). The ten river basins which have been chosen for classification in the study were Selangor River, Bernam River, Kelantan River, Trengganu River, Rompin River, Melaka River, Perlis River, Juru/Perai River, Sugut River and Sarawak River. Additional assessment parameters that were taken into account were biological, ecological and hydrological characteristics of the river basins as well as the land use and other socio-economic factors.

4.3.3 Water Pollution Control

4.3.3.1 Effluent discharge standards

The effluent discharge standards determine the quality of effluent discharge from pollution sources (either directly or via the effluent treatment plant) into watercourses.

This method is currently practice in Malaysia, and employed by the regulatory agency, DOE for the protection of the quality of the watercourses as well as their beneficial uses.

The effluent discharge standards have been practised widely in many countries over the years because of its simplicity, objectivity and ease of enforcement. Often the standards are regularly reviewed to achieve the objectives in the protection of the water bodies, as effluent loads increase with a growing socio-economy and the advances and availability of new treatment technology.

However, there is a shortcoming to this approach for pollution control because it tends to discourage water conservation practices. In fact, a reduction in discharge flow would consequently cause a rise in the concentration of the effluent. However, the polluters manage to bring their discharges to comply with the standards through dilution. This is the disadvantage of the standards which are merely based on concentration.

4.3.3.2 Wastewater discharge control regulations in Malaysia

The regulations in Malaysia introduced under the Environmental Quality Act, 1974 [EQA] to control effluent discharges include:

1. Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulation 1977 and Amendments 1982;
2. Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Regulations 1978 and Amendments 1981; and,
3. Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979.

The standards introduced for regulations (1) involves six generation of standards as shown in Table 4.2 with the final set of standards achieved in 1984. Regulations (2) produced the standards for latex concentrate wastewater discharges and SMR Block Rubber wastewater discharges and these are shown in Table 4.3 and Table 4.4.

Table 4.2 Malaysia: Palm Oil Mill Wastewater Standards.

Parameter	Standard	Standard	Standard	Standard	Standard	Standard
	A 1.7.78	B 1.7.79	C 1.7.80	D 1.7.81	E 1.7.82	F 1.7.84
BOD, 3-day, 30°C; mg/l	5,000	2,000	1,000	500	250	100(50*)
COD; mg/l	10,000	4,000	2,000	1,000	-	-
Total Solids; mg/l	4,000	2,500	2,000	1,500	-	-
Suspended Solids; mg/l	1,200	800	600	400	400	400
Oil and Grease; mg/l	150	100	75	50	50	50
Ammoniacal-Nitrogen; mg/l	25	15	15	10	150**	100**
Organic Nitrogen; mg/l	200	100	75	50	-	-
Total Nitrogen; mg/l	-	-	-	-	300**	200**
pH	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0
Temperature; °C	45	45	45	45	45	45
*	This additional limit is the arithmetic mean value determined on the basis of minimum of four samples taken at least once a week for four weeks consecutively.					
**	Value on filtered sample.					

Table 4.3 Malaysia: Latex Concentrate Wastewater Standards.

Parameter	1st Generation	2nd Generation	3rd Generation	Standards
	Standards effective on 1.4.80	Standards effective on 1.4.81	Standards effective on 1.4.82	effective from 1.4.83 and thereafter
pH	6 - 9	6 - 9	6 - 9	6 - 9
BOD, 3-day, 30°C; mg/l	450	300	200	100(50*)
COD; mg/l	1,500	1,000	500	300
Total Solids; mg/l	2,500	2,000	1,000	-
Suspended Solids; mg/l	1,000	800	250	150(100**)
Total Nitrogen; mg/l	450	350	350	300(60**)
Ammoniacal-Nitrogen; mg/l	350	300	300	300(40**)
*	This additional limit is the arithmetic mean value determined on the basis of minimum of four samples taken at least once a week for four weeks consecutively.			
**	As the target limit to be achieved as soon as possible in accordance with RRIM's recommendation based on research.			

Table 4.4 Malaysia: SMR Block Rubber Wastewater Standards.

Parameter	1st Generation	2nd Generation	3rd Generation	Standards
	Standards effective on 1.4.78	Standards effective on 1.4.79	Standards effective on 1.4.80	effective from 1.4.81 and thereafter
pH	6.0 - 8.0	6.0 - 8.0	6.0 - 8.0	6.0 - 8.0
BOD, 3-day, 30°C; mg/l	500	300	200	100(50*)
COD; mg/l	1,000	750	500	250
Total Solids; mg/l	1,000	1,000	1,000	-
Suspended Solids; mg/l	250	250	250	150(100**)
Total Nitrogen; mg/l	100	100	100	60**
Ammoniacal-Nitrogen; mg/l	800	70	70	40**
*	This additional limit is the arithmetic mean value determined on the basis of minimum of four samples taken at least once a week for four weeks consecutively.			
**	Value on filtered sample in accordance with RRIM's recommendation based on research.			

The discharge of sewage and industrial (other than the two major types of industry mentioned above) effluents are control by the Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979. Under these regulations two set of limits were stipulated for discharges of effluents into inland waters. The two set of parameter limits, namely Standard A and Standard B, are as shown in Table 4.5. Standard A represents limits for effluent discharging into watercourses upstream of public water supply abstraction point, while Standard B is meant for effluent discharges into watercourses downstream of public water abstraction. There is a provision in the Regulations which empowers the Director General of Environmental Quality to specify the acceptable conditions of discharge including the parameter limits of effluent with respect to any or all of the parameters as listed in the Fifth Schedule for parameters are not specified in the above lists (Table 4.6).

Table 4.5 Malaysia: Parameter Limits of Effluent of Standards A and B.

THIRD SCHEDULE				
ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS, 1979				
Regulation 8(1), 8(2), 8(3)				
Parameter	Unit	Standard		
(1)	(2)	A (3)	B (4)	
(i) Temperature	$^{\circ}\text{C}$	40	40	
(ii) pH Value	-	6.0-9.0	5.5-9.0	
(iii) BOD ₅ at 20 $^{\circ}\text{C}$	<i>mg/l</i>	20	50	
(iv) COD	<i>mg/l</i>	50	100	
(v) Suspended Solids	<i>mg/l</i>	50	100	
(vi) Mercury	<i>mg/l</i>	0.005	0.05	
(vii) Cadmium	<i>mg/l</i>	0.01	0.02	
(viii) Chromium, Hexavalent	<i>mg/l</i>	0.05	0.05	
(ix) Arsenic	<i>mg/l</i>	0.05	0.10	
(x) Cyanide	<i>mg/l</i>	0.05	0.10	
(xi) Lead	<i>mg/l</i>	0.10	0.5	
(xii) Chromium, Trivalent	<i>mg/l</i>	0.20	1.0	
(xiii) Copper	<i>mg/l</i>	0.20	1.0	
(xiv) Manganese	<i>mg/l</i>	0.20	1.0	
(xv) Nickel	<i>mg/l</i>	0.20	1.0	
(xvi) Tin	<i>mg/l</i>	0.20	1.0	
(xvii) Zinc	<i>mg/l</i>	1.0	1.0	
(xviii) Boron	<i>mg/l</i>	1.0	4.0	
(xix) Iron (Fe)	<i>mg/l</i>	1.0	5.0	
(xx) Phenol	<i>mg/l</i>	0.001	1.0	
(xxi) Free Chlorine	<i>mg/l</i>	1.0	2.0	
(xxii) Sulphide	<i>mg/l</i>	0.50	0.50	
(xxiii) Oil and Grease	<i>mg/l</i>	ND	10.0	

Note: ND - Not Detectable

Table 4.6 Malaysia: List of Parameters the Limits of Which to be Specified.

FIFTH SCHEDULE	
ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS, 1979	
Regulation 8(4)	
(i)	Ammoniacal Nitrogen
(ii)	Sulphate
(iii)	Chloride
(iv)	Cobalt
(v)	Colour
(vi)	Detergents, Anionic
(vii)	Fluoride (as F)
(viii)	Molybdenum
(ix)	Nitrate Nitrogen
(x)	Phosphate (as P)
(xi)	Polychlorinated Biphenyls
(xii)	Selenium
(xiii)	Silver
(xiv)	Beryllium
(xv)	Vanadium
(xvi)	Radioactive Material
(xvii)	Pesticides, fungicides, herbicides, insecticides, rodenticides, fumigants or any other biocides or any other chlorinated hydrocarbons.
(xviii)	A substance that either by itself or in combination or by reaction with other waste or refuse may give rise to any gas, fume or odour or substance which causes or is likely to cause pollution.

Table 4.7 Malaysia: Parameter Limits of Effluent Other Than of Standard A or B.

SIXTH SCHEDULE			
ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS) REGULATIONS, 1979			
Regulation 11(5)(b)			
	Parameter	Unit	Limit
(i)	Temperature	$^{\circ}C$	40
(ii)	pH Value	-	5.0-9.0
(iii)	BOD ₅ at 20°C	<i>mg/l</i>	400
(iv)	COD	<i>mg/l</i>	1000
(v)	Suspended Solids	<i>mg/l</i>	400
(vi)	Mercury	<i>mg/l</i>	0.10
(vii)	Cadmium	<i>mg/l</i>	1.0
(viii)	Chromium, Hexavalent	<i>mg/l</i>	2.0
(ix)	Arsenic	<i>mg/l</i>	2.0
(x)	Cyanide	<i>mg/l</i>	2.0
(xi)	Lead	<i>mg/l</i>	2.0
(xii)	Chromium, Trivalent	<i>mg/l</i>	10
(xiii)	Copper	<i>mg/l</i>	10
(xiv)	Manganese	<i>mg/l</i>	10
(xv)	Nickel	<i>mg/l</i>	10
(xvi)	Tin	<i>mg/l</i>	10
(xvii)	Zinc	<i>mg/l</i>	10
(xviii)	Iron (Fe)	<i>mg/l</i>	50
(xix)	Phenol	<i>mg/l</i>	5.0
(xx)	Sulphide	<i>mg/l</i>	2.0
(xxi)	Oil and Grease	<i>mg/l</i>	100

The Regulations also states the provision in which under acceptable conditions effluent discharges may be allowed to contravene, in accordance with the provisions of Section 25 (1) of the EQA. Apart from the parameters listed in Table 4.5, there is another set of parameter specified under the Sixth Schedule of the Regulations and is reserved for effluent permitted to be admitted to the sewerage system, where such system ready to receive industrial effluent is available (Table 4.7). Nevertheless, there are exceptions for certain sources of effluent discharges into inland waters where the Regulations do not apply and this is as listed in Table 4.8.

Table 4.8 Malaysia: List of Discharges to Which the Sewage and Industrial Effluent Regulations Do Not Apply

FIRST SCHEDULE
ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFFLUENTS)
REGULATIONS, 1979
Regulation 3

Subject to the provisions of regulation 6, these Regulations shall not apply to discharges of effluent into any inland waters from the following sources:

1. Processing of oil-palm fruit or oil-palm fresh-fruit bunches into crude palm oil, whether as an intermediate or final product;
2. Processing of natural rubber in technically specified form, latex form including prevulcanised or the form of modified and special purpose rubber, conventional sheet, skim, crepe or scrap rubber;
3. Mining activities;
4. Processing, manufacturing, washing or servicing of any other products or goods-
 - i. that produce effluent of less than 60 cubic metres (13,000 imperial gallons) per day;
 - ii. that the effluent of which does not contain those contaminants listed as parameters (vi) to (xvi) in the first column of the third Schedule;
 - iii. where the total load of biochemical oxygen demand of the effluent fixed at 20 degrees Centigrade for 5 days or suspended solid or both, shall not exceed 6 kilogrammes per day (concentration 100 milligrammes per litre);
 - iv. in any housing or commercial development or both of less than 30 units, without affecting the generality of 4 (iii).

4.3.3.3 Proposals for water quality-based effluent discharge standards

The third phase of the water quality criteria and standards study, recommended the use of water quality-based effluent discharge standards as an alternative water quality management approach. This proposes a new approach, which specifies the qualities of potential pollutants allowed in an effluent discharge as opposed to only their

concentrations. For this to take place, effluent discharge standards are set based on the water quality requirements or water quality standards for the watercourses, which means they are site specific. This thesis supports the use of the new approach as a means to vary the discharge limits according to the river stretches under consideration. However, further study in search for the best way of putting into practice need to be worked out, as the approach requires good data handling and management before they could be applied.

It will also mean that the concentration limits and the rate of discharge of effluents are to be based on the prediction of the dilution and assimilative capacity of the receiving water so that the river water quality standards will not be exceeded. This application calls for the use of the mathematical models to work out the limits for compliance. In some instances, the limits of discharge (both in terms of concentration and quantities) derived from water quality-based effluent discharge standards could be far more stringent compared with the earlier method, as currently practice. Under such circumstances, the dischargers will need to upgrade their treatment system capability to meet the new discharge limit, or reduce the amount of their wastewater to the watercourses.

The Phase II of the water quality criteria and standards, on the other hand, proposed the used of water quality standards where legal limits based on the water quality criteria as a means of control over river water quality. This thesis also supports the use of water quality standards as the river water quality objectives that need to be set at all river stretches.

Water bodies have a certain capacity to dilute and assimilate wastes received without affecting the water quality significantly. There has been an interest to shift away from the used of effluent discharge standards which had been developed to control the discharges of waste into these water bodies. The development of effluent discharge standards were based primarily upon technological attainability, economic feasibility, public needs and desires and even political influences (DOE, 1993a). In Malaysia,

there are several set of effluent discharge standards which have been established based on the receiving water as well as the type of sources.

4.4 LEGISLATION AND INSTITUTIONAL FRAMEWORK

4.4.1 Legislative Provisions

4.4.1.1 Legislation concerning water supply

Since independence in 1957, the jurisdiction and legislative powers in all aspects of water are distributed in accordance with the Legislative Lists of the Constitution between the Federal Government and the State Governments. The followings are the summary of the responsibilities as listed in the Federal List, State List and the Concurrent List.

- Federal List involves Hydropower, Navigation, Maritime Fisheries, Estuarine Fisheries (in the Concurrent List in the case of Sabah and Sarawak), Federal Works and Power including water supplies, rivers and canals except those wholly within one state or regulated by an agreement between States concerned.
- State List involves Rivers, Public Nuisances, Riverine Fisheries and Water (including water supplies, rivers and canals if they are wholly within one state or regulated by an agreement among the States concerned), control of silt and riparian rights.
- Concurrent List involves certain items that is within the jurisdiction of both the Federal Government and the State Governments. The items are Drainage and Irrigation, Town and Country Planning (except in the Federal capital), Public Health and Sanitation (excluding sanitation in the Federal capital) and the rehabilitation of land which has suffered soil erosion.

Matters relevant to water pollution are distributed among those three lists as described above. The legislation's that are of direct relevant to water sources and public water supply include:-

- Water Act, 1920 (Revised 1989)
- Geological Survey Act, 1974
- Environmental Quality Act, 1974 [EQA]
- Water Supply Enactment, 1955
- Safe drinking Water Act.

Water Act 1920 (Revised 1989)

The jurisdiction over matter related to water and rivers is clearly stated in the Water Act, 1929. Under the Water Act, 1920 (Revised 1989), the entire property in, and control of all rivers in any State is vested solely in the Ruler of such State, where it states "No person in any manner obstruct or interfere with any river except in all accordance with the terms of a license under this Act" (Water Act, 1920). A provision under the Act allow the issue of license to divert water from a river in any district for: (a) private or domestic purposes; (b) use in the cultivation of rice; and (c) industrial and other purposes, and it may be granted by the District Officer of such district with the approval of the State Authority.

The Water Act, however, only applies to the states of Negeri Sembilan, Pahang, Perak, Selangor, Melaka, Penang and the Federal Territory. For the other States there are similar provisions in the State Water Enactments.

Geological Survey Act, 1974

The legislation governing the abstraction of groundwater is the Geological Survey Act, 1974. The Act requires that any person who develops a well for the purpose of extracting water has to notify the Director General of the Geological Survey Department. Nevertheless, this requirement does not apply to any well which is less

than 30 feet (9.15m) in depth without reaching bedrock or yield less than 500 gallons (2.3 m³) of water per day and is used only for domestic purposes.

Environmental Quality Act, 1974 (EQA) - Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987

The EIA Order, 1987 requires a report on an assessment of the impact(s) on the environment from a prescribed activity to be submitted to the Director General of Environmental Quality for approval before proceeding with the project development. There is an understanding on this matter that the approving authority must not grant any permit or license for any project falling under the category of *prescribed activities* until an approval for the EIA report is given. The EIA Order (1987) (Amendment) 1995 listed 20 categories of activities as prescribed activities, and for any of the prescribed activities to be implemented an EIA report is required to be submitted to the Director-General of Environmental Quality for his approval before the project initiator can commence the physical works.

The following activities are "prescribed" under the Water Supply sector:

- a) Construction of dams, impounding reservoirs with a surface area of 200 hectares or more; and,
- b) Groundwater development for industrial, agricultural or urban water supply of greater than 4,500 cubic metres per day

Water Supply Enactment, 1955

The Water Supply Enactment, 1955 empowers the State Water Supply Authorities (SWSA) to supply water to domestic and trade consumers. This enactment also empowers the SWSA to lay water mains and distribution pipes across or under any street and through or under any enclosed land and providing reasonable compensation

for any damage done. This Enactment only applies to the States of Negeri Sembilan, Pahang, Perak and Selangor. For the other States there are similar provisions in the State enactments. However, in Johor the responsibility for public water supply has been handed over by the State Government to a private limited company, but the equity of this company is wholly owned by the State Government. *Syarikat Air Johor Sdn. Bhd.*, formerly the Johor Water Supply Department, was established under the provisions of the Water supply (Successor Company) Enactment, 1993. Concurrently, under provisions of the Johor Water Supply Enactment, 1993, a regulatory body, that is the Johor Water Regulatory Body, was established with the responsibility of enforcing the provisions of this enactment. Under this enactment, *Syarikat Air Johor Sdn. Bhd.* has to obtain a license to carry out the activities of public water supply. Recently on 2nd October 1995, the Kelantan State Government had privatised its public water supply activities to a joint venture company called *Kelantan Water (M) Sdn. Bhd.*

Safe Drinking Water Act

At the moment, there is no legislation on the safe water supply in Malaysia on its own. However the standards used at present is based on the WHO criteria standards. The Ministry of Health is in the process of drafting the *Safe Drinking Water Act* to control the quality of drinking water supplied to the public. The drafted Act is said to include of a provision on offences relating to the supply of drinking water which does not satisfy the standards to be specified. With such provision it is anticipated that the proposed legislative act will safeguard the quality of public water supply.

4.4.1.2 Legislative and statutory control over water pollution

A number of pieces of legislation are in place at both Federal and State levels to control the use of water resources and, in most cases, indirectly prevent detrimental effects on water quality through the control of land uses (Appendix B). The legislation that are related to the control of water pollution or the control of any activities that might give rise to water pollution problems include the followings:-

- ◇ Mining Enactments and Mining Rules, 1934;
- ◇ Forest Enactments, 1935;
- ◇ Environmental Quality Act, 1974 and its related Regulations/Order;
- ◇ Town and Country Planning Act, 1976;
- ◇ Water Act (Amendment) 1989.

Most of the legislation, until the Second World War, had been State legislation and each State enforced the rules and control accordingly within the area under their constitutional jurisdiction. Nevertheless, after 1960 a number of Federal legislative acts covering areas under the Federal or concurrent lists emerged which have some bearing on aspects of water pollution or even *specifically on water quality*.

The EQA has been the most important piece of legislation which addressed specifically on the subject of pollution and environmental quality. Eight out of twelve of the Regulations under the EQA are directly related to water pollution control for water quality improvements. The descriptions of this Act and the Regulations and Orders made under the Act are as discussed in Section 3.4.2. Nevertheless, the use of these regulations alone will not be able to contain the extent of problems occurring and threatening the environment, simply because of the fragmented nature of the existing legislation in addition to the number of agencies having their own role on various aspects of the environment, not to consider the level of government. Their success can only be achieved with concerted efforts made to integrate the environmental dimension into the development programmes.

In the pursuit to achieve the desired integrated efforts, DOE has come out with a number of guidelines (which serve as non-legislative control) formulated to complement legislative control under the Environmental Quality Act, 1974 [EQA]. The guidelines are developed to enhance and to support the implementation of EQA and its regulations. They were designed to facilitate industries, developers and planners to incorporate the environmental dimension into their projects (DOE, 1996). The guidelines include:

- Guidelines for the Prevention and Control of Siltation and Erosion;
- Guidelines on the Siting and Zoning of Industries;
- Code of Practice for the Disposal of Solid Wastes on Land;
- Guidelines for the Selection of Landfill Sites for Scheduled Wastes (Toxic and Hazardous Wastes);
- Guidelines for the Management and Disposal of Wastes in Downstream Petroleum Industries;
- EIA specific guidelines on groundwater and surface water supply, power generation and transmission lines, drainage and irrigation, fishing harbour, and land-based aquaculture, dams and reservoir, mines and quarries, hill station resorts, tourist facilities in national parks, tourist facilities on island in surrounding waters gazetted as marine parks, industries, municipal waste treatment and disposal, and toxic and hazardous waste treatment and disposal; and,
- Guidelines on the Disposal of Asbestos Wastes.

Direct and indirect control of pollution of rivers is not only exercised by the Department of Environment [DOE] but a number of other government agencies including Mines Department, Forestry Department, the Local Authority, State Water Supply Authority, and etc.

The Mining Enactments, which are State legislation and implemented in the tin mining States, include the provision to control the disposal of earth, sludge, dirt and mine tailings and purification of water used. Five years after the Enactment was enforced, the Mining Rules of 1934 were passed to provide for further control of mine discharge, namely, the imposition of a limit of 800 grains of solid matter per gallon (equivalent to 11,400 mg/l). Nevertheless the standards set was too lenient and the author is of the opinion that it is timely that stricter limits to be specified through an amendment to the Enactments. Another set of State legislation is the Forest Enactment, 1935, which primarily provides for the control of forest and the

declaration of forest reserves. This has indirectly led the way towards the protection of watersheds and the prevention of soil erosion.

Being in full control over land matters and rivers, the State Government therefore, has a profound role in ensuring that the various uses provided by the river system remains intact in the pursuit for rapid development. Unless the States are willing to adopt the proposed water quality criteria and standards, the implementation of such stream standards will not happen. The set of criteria will remain just as planning tools and will not be enforceable. Hence it is not surprising that, the Federal Government has voiced its concern on such issues and requested the State Government to play a much greater role.

“In order to improve the effectiveness of river systems management, the responsibility for river management is envisaged to be increasingly taken over by the State Governments, as in the case of Sarawak the Water Resources Council of Sarawak” (GOM, 1996)

“Appropriate mechanism need to be instituted to improve water resource planning and development of catchment and watershed areas to ensure adequate and clean water supply. Arrangements will be made at the Federal and State levels to determine the institutional, legal and financial mechanisms in carrying this out.” (GOM, 1996)

4.4.2 Water Resource Institutional Set-up

Since water supply matters under the Constitution are the responsibility of the States, the State Governments therefore, are responsible for the development, operation and maintenance of water supplies. This responsibility is exercised through either the State Department of Public Works [State DoPW], State Water Supply Department, State Water Board or the State Water Corporation/Company (Table 4.9). For example, in Penang and Melaka a water board was established in each state for undertaking public water supply projects. In Sarawak, the towns of Kuching and Sibul have their own Water Boards which are responsible for the water supply in the two towns and their environs. Miri, Limbang and Bintulu water supplies are managed by a

private company *LAKU*, while the rest of the areas in the State of Sarawak fall under the responsibility of the Sarawak State Water Supply Department.

The State Water Supply Authorities (SWSA) have been empowered to carry out the task of providing adequate public water supply in the respective states. Their responsibilities cover areas including: planning, financing, development, operation and maintenance of water supply. In discharging their duties the water authorities are required to undertake development works as well. The development aspect which have been entrusted upon them involves works such as dams construction, development of water treatment plants, trunk mains and service reservoirs, water supply distribution systems and connections to consumers, besides the operation and maintenance responsibilities the water authorities need to fulfil to ensure an efficient and satisfactory levels of service for the users.

Table 4.9 Malaysia: Water Supply Authorities / Institutions

Type	Organisation	Supply Area
Public Works Department	DoPW Labuan	Federal Territory of Labuan
State Public Works Department	DoPW Kedah	Kedah
	DoPW Perlis	Perlis
	DoPW Sarawak	Sarawak
State Water Supply Department	DoWS Selangor	Selangor & F.T. Kuala Lumpur
	DoWS Negeri Sembilan	Negeri Sembilan
	DoWS Trengganu	Trengganu
	Sabah Water Department	Sabah
	DoWS Pahang	Pahang
State Water Boards	Melaka Water Board	Melaka
	Penang Water Authority	Penang
	Perak Water Board	Perak
	Kuching Water Board	Kuching (Sarawak)
	Sibu Water Board	Sibu (Sarawak)
Corporatised / Privatised Company	<i>Syarikat Air Johor Sdn. Bhd</i>	Johor
	<i>LAKU Private Limited Co.</i>	Miri, Limbang and Bintulu (Sarawak)
	<i>Kelantan Water (M) Sdn Bhd</i>	Kelantan

Source: DoPW (1996).

Irrigation is another area which is essential in sustaining the production of sufficient food supply within the country. Thus far, the irrigation development has been guided

by the National Agricultural Policy and the responsibility for implementing irrigation programme goes to the Drainage and Irrigation Department. Development of hydropower has taken place to contribute to self-reliance in energy consistent with the National Energy Policy. *Tenaga Nasional Berhad*, an energy company, has been given the trust to ensure sufficiency in the generation of energy supply to meet the demand in Peninsular Malaysia under the privatisation programme.

4.4.3 Privatisation Programme in Water Resources Sector

4.4.3.1 Water supply

The approach upon which water development has been undertaken in Malaysia has changed in the recent years. Supply of water has been increasingly developed and managed by private operators to become independent of public fund. Several treatment plants in the country have so far been privatised and initiatives are under way to privatise the ones in Negeri Sembilan as well. The Department of Water Supply for the State Johor becomes the first state water authority to be corporatised in the country in 1994 in a step to privatisation of the water sector. While the privatisation of treatment plants helped the Government to reduce capital investment, its main purpose however, is to improve the efficiency in operation and maintenance of treatment plant and water distribution.

Even more crucial but central to the water sector is the protection and conservation of potential sources of fresh water and to improve the treated water quality through upgrading and rehabilitation of the existing water supply system. Improvement in efficiency should involve ways to avoid wastage in the distribution system and hence, reducing the operational cost. The responsibilities of improving the efficiency of water treatment and to raise the quality of water supplied remain the role of either the water authorities or the water companies for the area.

The progress made in the development of the water sector has influenced the rapid development in the industrial sector, and at the same time has been able to meet the public health and rural development objectives. With the privatisation of water treatment and supplies, the responsibility of ensuring an adequate quality and supply of water for consumption rests on the water companies. However the role of the government agencies will remain in terms of finding new sources and regulating the conduct of the water companies while ensuring that the population benefit from the privatisation process. At present there are two state water supply regulatory bodies, one in Johor (i.e. State of Johor State Regulatory Body) and the other in Kelantan (i.e. Kelantan Water Department). These regulatory bodies function to regulate the running of water supply company.

The recent initiatives by the Ministry of Health and the State Governments to draw up a piece of legislation on Safe Drinking Water (Berita Harian, 31/10/97), so as to ensure that treated water will achieve the required standard for drinking, seem very relevant in light of the incident of pollution at the Langat River in October 1997 (Utusan Express, 5/11/97). As more and more treated water is supplied by the water companies, such initiatives will help to monitor the quality of treated water so that it is safe to drink and complies with the standard set by the World Health Organisation.

4.4.3.2 Privatisation of sewerage projects

Privatisation of sewerage facilities have been made effective when 5,200 sewage treatment plants (STPs) in Peninsular Malaysia were taken over by a sewerage company, *Indah Water Konsortium* (IWK). The sewerage company now has the responsibility to operate and maintain the STPs and to make necessary arrangements with the local authority for taking over other new facilities, while ensuring that the discharged wastewater quality from all the STPs comply to the legislative requirements. In the preliminary bid for the sewerage privatise project, an agreement was made involving the take over of 1,800 STPs (Berita Harian, 24/3/98). Under this exercise, the workload and financial burden over the local authorities has enormously

reduced. Instead, the local authorities will have the ability to monitor the performance of the sole sewerage company in treating their wastewater discharges.

Some concern however, was raised as to the effectiveness of the take over, considering the large number of STPs to be operated and maintained by IWK under a single company. Several recent incidents which had caused public alarm where the water supply from a public waterworks at the Langat River Basin in Selangor had been contaminated with high level of ammonia and had be shut down for few days. Apparently the source of pollution was found to originate from the STPs located upstream of the waterworks abstraction point. Therefore, it has now become the responsibility of the sewerage company to lift up the efficiency of all the STPs - which in most cases it was believe that the problem could have existed well before the privatisation programme came into effect but to a lesser extent - to meet the standards set for sewage effluent discharges. Such incidence, further prove the importance of having the water quality criteria and standards set in place and under no circumstances the beneficial uses of river water be allowed to be deprived.

4.4.4 Existing Financing Arrangements

4.4.4.1 Financing water supply

Water resource development projects in Malaysia are financed in 3 ways i.e. either as direct federal projects, federally reimbursable projects and state projects (the classification in accordance with the respective and joint responsibilities of the Federal and State Governments). The financing, operation and maintenance of public water supply projects are the responsibility of State Governments. At present a large portion of the allocation for water supply development is financed by the Federal Government through loans to the State Governments. The amount of financing involved is substantial and the Federal Government obtains a part of the allocation through loans from external agencies.

The funds for public water supply, however, come from the State Consolidated Fund, Federal loan and water charges collected from consumers. For example, the main source of revenue for the SWSA is water sales. This revenue is used to finance the operation and maintenance costs and a part of it is used to repay loans.

Although Article 82 of the constitution (which provided for the distribution of financial burden relating to matters on the Concurrent List) appears to imply that Federal Government pays for Federal matters and State Governments for State matters, there are in fact sufficient provisions under the existing constitutional framework for Federal Government to finance the development expenditure on State matters. The federal Government has undertaken to finance some State projects on a reimbursable basis, while the Development Fund Act and the Revenue Growth Grant Act allow Federal Government to finance State projects as specified in a scheduled list. For recurrent expenditure, Federal Government may cover deficits in State accounts through the State Deficit Grant under the State Reserve Fund.

4.4.4.2 Financing other water resource utilisation

As in the case of other development projects, water resource development projects are financed from the Federal Consolidated Fund, the receipt of which is derived from tax revenue, and non-tax revenue receipt sources. Similar to the Federal Government system, each State also has a consolidated fund which is used to finance development projects.

Drainage and irrigation appear in the Concurrent List of the Constitution. Drainage and irrigation projects are therefore either financed as direct federal projects, or federally reimbursable projects or state projects.

Irrigation, agriculture drainage and flood mitigation projects are largely financed by the Federal Government as direct federal projects or federally reimbursable projects. Once completed, the projects are handed over to the State Governments concerned for operation and maintenance. The exceptions are the Muda irrigation project and the

Kemubu irrigation project which are operated by Muda Agricultural Development Authority [MADA] and Kemubu Agricultural Development Authority [KADA] respectively, and both the authorities was established by the Federal Government.

In the great majority of cases, irrigation water rates and drainage rates are nominal; the rates collected do not cover even operating and maintenance expenditure. Consequently, the operation and maintenance cost of many completed projects are heavily subsidised by the State Governments. No rate has been levied for flood mitigation projects.

As the subject on water power is a Federal matter in Peninsular Malaysia but a concurrent matter for the States of Sabah and Sarawak, the Federal Government undertakes hydropower development in Peninsular Malaysia through Tenaga Nasional Berhad - the power generation company, while the State Governments of Sabah and Sarawak undertake hydropower development projects through the state statutory bodies. As for sewerage projects, the responsibility rests with Local Authorities.

4.5 NATIONAL WATER POLICY OF MALAYSIA

Considering the enormous uses that water can provide whilst clean water is now becoming scarce, there needs to be a clear policy on development and management of this essential resource. It has been the prime objective that the utilisation of water resources will provide sound and fullest support for the development of the socio-economic sectors which are related to the water resources.

At the same time it is important that policies with regard to certain developments related to water need to give particular consideration in light of the limitation in water resources or the need to conserve these resources for a better alternative use. For example, in locating new industrial estates within the framework of regional development, consideration should be given to the availability of water resources at

the location and to the cost of developing public water supply to support the industrial development which should be balanced against the socio-economic benefits that can be derived, and also to weigh the impact of having such industries at the location on the local water quality as well as the downstream uses. If necessary, the proposed industrial estates should be resited. Thus a judicious balance between water resources development and the development of water-related socio-economic sectors would be necessary to achieve national socio-economic goals in the most efficient way. Currently there is still no National Water Resource Policy in place to lead the way for a better sustainable water resource for the country except for the pieces of existing legislation mentioned above, to control the use of water and providing protection against their deterioration.

As recommended under the National Water Resources Study, 1982, the priority need is in formulating a National Water Policy in Malaysia. It was viewed as crucial in providing a framework for target setting and at the same time, necessary measures may be prescribed to influence public actions and behaviour in developing and managing the water resources such that they are consistent with the national development goal (GOM, 1996). Fifteen years after the recommendation was made, urgent steps still need to be taken to make the proposal a reality. Moreover the National Water Resources Study (GOM, 1982b) which was conducted in 1982 itself needs a revision so as to take into account the current situation and make new future projection based on the current development pace.

Once the National Water Resource Policy is in placed, it will enable the setting-up of the National Water Resource Council. The function of the proposed National Water Resource Council would therefore, help to resolve legal, institutional and financial issues in order to improve and co-ordinate river basin development, management and planning on a national basis to ensure long-term sustainability of water supply. The mechanism will also be able to address issues relating to water resources development and river management as well as maximising potential river development with a view of protecting water catchment and watershed areas.

The proposed policy is anticipated to free the nation from water resources constraints and consequently helps to promote national economic development, to enhance regional development, while upgrading the environmental quality and improving social well-being by meeting water resources needs and by alleviating water resources problems.

The “*Love Our Rivers*” campaign introduced in 1993 by the Department of Drainage and Irrigation seems to be rather unsuccessful in attaining the primary goal of cleaning up the rivers in the country (Berita Harian, 10/11/97). Perhaps it should be allowed to take some time before a fair judgement could be made. Nevertheless, it is pertinent that such initiatives need to be further examined particularly in terms of its direction and approaches in order to make the overall programme a success. It is likely that the National Water Resource Council to be set up under the proposed National Water Resource Policy, will have its role to play especially in co-ordinating the task and to develop a comprehensive plan involving the commitment from all responsible agencies with a full support from the members of the public.

4.6 PLANNING AND ALLOCATION OF WATER RESOURCES

It has been recognised by the Government of Malaysia in the Seventh Malaysia Plan (1996-2000) that the institutional framework needs to be strengthened in order to establish and integrate the approach to environmental and resource management. It is for this reason that the mandate of the National Development Planning Council [NDPC] has been expended in 1993 to incorporate environmental dimensions into development planning. It is in the author’s opinion that only with a better appreciation of an integrated and holistic approach at the highest level (i.e. at the NDC), will the objectives and strategies including those under the National Environmental Policy, be achievable and this should involve all the environmental segments including air, land and water. The main reason for this is because planning of programmes and projects is essentially co-ordinated by Federal departments and agencies responsible for the

various water use sectors and often merely reflects the technical viewpoint. But their proposals will then be adjusted by the Federal Economic Planning Unit [Federal EPU] of the Prime Minister's Department to reflect an overall socio-economic and financial standpoint. Therefore EPU has *fundamentally* a strong influence over how developments might affect water sustainability and their uses.

The various sectoral plans for water resources development are seldom co-ordinated from the standpoint of maximising efficiency in water resource development and management, as these plans are prepared independently. At present, there is still no Water Resource Master Plan, either at the national or regional level.

In order to arrive to an integrated planning for optimum use of resources and conservation of water resources for long-term planning for water resources development at the national level, the preparation of a national water resources master plan is needed, which will translate the national water resources and targets into long-term programmes to facilitate allocation of resources. Such programmes should be co-ordinated with other socio-economic development programs related to water resources. Many water resource development projects have long gestation periods. The national water resources master plan should be prepared with future problems and needs in view, in order to provide the necessary direction to sectoral water resource planning in a meaningful way.

All activities in water resource development and use in a river basin affect one another through the river systems of that basin. For example, the rivers and water resource facilities, such as dams and water control structures etc., together constitute an integrated water system. Where necessity arises, water should be transferred from one or several basins in order to balance supply and demand, but this should be done after careful studies of their potential impacts. In practice, in areas of heavy demand such in the Klang Valley Region, therefore, there may be many cases that more than one river basin should be regarded as one region in water resources development and management.

At the regional level, regional water resource master plans should be considered and have to be designed within the framework of the national water resources master plan. Such regional master plan should be able to demonstrate specific water resources projects to be implemented, their priority ranking for implementation and implementation schedule.

The streamlining of the legislative mechanism forms part of the integration process, and its main intention is to improve the effectiveness in the development of water resource development schemes. At the same time it aims to reduce the adverse environmental impact of the proposed projects so that besides the enjoyment obtained from benefits provided by the schemes, other beneficial river uses could continually be sustained.

Meanwhile DOE has been proposing to amend the necessary provisions under the Environmental Quality Act, 1974, that will provide stricter regulation and stiffer penalties covering areas such as increased maximum fines, power to close factories, and mandatory compensation for victims. In so far monitoring and enforcement activities are concern, a great deal of efforts have been made by the authority to curb the problems of river pollution due to non-complying sources. It is therefore envisaged by the authority that stiffer penalties related to environment offences could at least deter repeated offenders. Coupled with these, aerial surveillance which uses remote sensing techniques in the detection of water quality changes is among the tools that have been considered so as to strengthen the existing programme of water pollution control through an effective water quality monitoring network that involves *in-situ* measurement, monitoring and tracking of pollution sources (GOM, 1996).

Nevertheless, strengthening of the preventive approach that involves the present and future strategies (as specified in Table 2.5) should prevail or at the very least be accorded an equal priority as the command-and-control approach to protect the vital resource. The approach should be operated base on the concept of partnership which is characterised by mutual co-operation and responsibility to achieve the goal of preservation of the water environment and sustaining the rivers uses.

Water resource master planning and water catchment zoning plans are among the initiatives that could be drawn up and periodically reviewed, and these plans together with the land use plans, which contained the essence of the preventive approach to water environment protection, could serve the role in guiding planners in delivering and undertaking development programmes in a sustainable manner.

4.7 LAND USE - WATER QUALITY RELATIONSHIPS

The relationship between land use and water quality is complex especially in the modern landscape. As a result, the establishment of scientifically reliable correlation between land use activities and features, on the one hand, and the contribution from the pollution sources on the other, has not come easily. Marsh (1991) suggested that for urban land uses, a fairly reliable correlation has been defined between the annual loading rates for various pollutants and land use based mainly on density of development. Impervious cover was taken as the most widely used measure of density, where studies uncover that pollutant loading of stormwater increases with percentage of impervious cover.

“Although impervious cover is closely related to pollutant loading, it, of course, is not the direct cause of stormwater pollution. Rather, the amount and types of land use activity associated with impervious cover are the source of pollution. ... However, impervious cover cannot be ignored as a contributor to water pollution in as much as it promotes pollutant removal from the land by facilitating surface flushing.” (Marsh, 1991)

Several authors (Felton & Lull, 1963; Ho, 1973, after Nather Khan, 1992) have reported on increased in the amount of suspended solids due to urban-based pollution. Nather Khan (1992) also quoted Leigh and Low (1972) study on the effects of urban development in two catchments in Malaysia and found that the sediment load generated from urbanised catchment (496 mg/l) about eight times greater than the

undisturbed catchment (64 mg/l). A study by Nather Khan (1992) supported earlier findings where he found that the undisturbed areas of Linggi River Basin showed very low suspended solids at all times (average of 8.5 mg/l) but for disturbed areas of the basin the level ranged widely (average ranging from 33.6 to 102.3 mg/l).

In the Phase IV study of Water Quality Criteria and Standards in Malaysia, the River Basin Management Information System (RB-MIS) was developed. RB-MIS is an improved version of the earlier Phase II study, that is the Integrated River Basin Information System (IRBIS) which had more limitation in its use. RB-MIS offers six modules and meant entirely for use by the DOE technical staff alone as a river basin information tool. The six modules include:

- a) Water Quality Databases Module;
- b) Pollution Sources Module;
- c) Aquatic Ecology Module;
- d) Flow and Catchment Data Module;
- e) Land use Data Module; and,
- f) Socio-economic Modules.

Since RB-MIS has not been put to test, it is difficult to judge its effectiveness in terms of its capability to be used as a basin wide decision making tool. Nevertheless, the author is of the opinion that the system could become a promising complementary databases system that can be integrated with the Geographical Information System (GIS) module to make up an integrated catchment management planning system, as this thesis advocates.

It is clear that a comprehensive land use plan with integrated environmental dimension has the potential to provide indirect influence over the extent of pollution control in the attempts to minimise environmental destruction. Several possible ways that could turn this into a reality such as: to designate areas suitable for development without increasing the rate of erosion; preserving the forest particularly in watershed areas; regulating water for irrigation purposes; and, planning on an urban environment

so as to enhance sustainability rather than jeopardising river water quality or depriving its beneficial uses, even the urban location is on the upstream area.

The idea of having water resource master plan, water catchment zoning plans and land use plan, is the steps taken in the right direction although their linkages in raising the effectiveness in protecting the water environment have to be further explored and frequently reviewed. Nevertheless, complementary to these plans which is in the form of an integrated catchment management plan, is envisaged as being able to serve the purpose better with its potential that integrate all the factors involved in water resource utilisation, preservation and control that are essential for the sustainability of the water environment.

4.8 CONCLUSION

It is important to realise that although water is in abundance, it could become scarce if less attention is paid to managing it efficiently and to plan for the future in a sustainable way. The water resources development programmes and projects need to be treated as an integral part of the overall national socio-economic development plan and to be incorporated with the necessary environmental considerations. The plan should also clearly define the various offstream and instream uses in order to avoid conflicting development strategies with the desired use for the river water. This is also important to avoid destructive and unsustainable types of development. Such a trend may be very costly not only in terms of having to initiate river clean-up programmes but also to move away certain development from the polluted areas.

Considering this, although Malaysia has been endowed with an abundance of water availability, the abstraction of clean water is becoming more expensive because either new water abstraction points are necessary in search of good quality raw water to

complement the existing ones, or an improvement in the treatment processes is required to produce quality water supplies.

Preservation of river water quality and maintenance of requisite quantity of flow in rivers play a major role in attaining the water quality objectives. In flood-prone areas, flood mitigation contributes towards the social well-being of the people and provides a better physical environment to permit socio-economic activities to continue to take place. Catchment management planning is envisaged to play an important role in this area.

Better control of the pollution sources is likely to be crucial in light of the fast growing economy for the past two decades and the simultaneous impact on water quality. While recognising that water quantity is important, water quality is also of considerable importance because bad water quality will render the available water unusable, thereby incurring higher cost in water treatment or in managing the problematic sources so as to improve the river conditions and help achieve the desired water quality objectives. Therefore, the formulation of area management plan that emphasises on practicability and holistic approach for a sustainable water use is essential.

It is unduly agreed that supply of water to any development is critical. Indeed development in locations where water resources are scarce can result in less reliable supplies to the existing population and industries, besides risking the existing water abstractions because of the needs for more abstractions. It may also be detrimental to water quality and threatening river water uses such as: river amenities, fisheries, inland navigations and nature conservation. On balance, development should be resisted where possible when the existing water supplies are inadequate, or where they cannot be augmented in time to coincide with the development without adversely affecting the water environment. This is a matter of consideration for the responsible agencies in their efforts to plan and implement development programmes for the sustainability of water environment and the river uses.

Key issues in water resources management and planning in Malaysia are therefore as follows:

- Although water exists in abundance in Malaysia, water use will not be sustainable without proper planning and management of the resource.
- The demand for water has risen over the years, whilst the search for new water sources becomes more difficult and costly. This requires a holistic approach in solving the problem of the scarcity of clean water.
- The protection of watershed (catchment) areas from deterioration is essential and at the same time the natural capital should not be allowed to diminish.
- Among the water related issues, water quality problems have been a pressing issue over the years, in addition to the problems associated with low flow and flooding. These water related issues are affected by land use practices and activities. Proactive planning of land uses is a requisite to avoid the unsustainable nature of development and degradation of the natural resource.
- The setting of threshold limits needs to be adopted and enforced so as to help protect the ability of water resource to meet the requirement it serves. The present non-complying discharges from sources of water pollution pose a potential risk to the river carrying capacity, thereby causing the river water quality to decline.
- Malaysia has established an environmental management programme that emphasises the main principles of sustainability. Nevertheless the mandate entrusted to the agency responsible for managing and protecting the environment through the national policies has been weakened due to problems associated with fragmentation of legislation.
- Whilst streamlining and strengthening the legislative procedures, and reinforcing environmental considerations through the process of integration, Malaysia also needs to approach the issue with the involvement of all sectors of the community, based on the concept of partnership in caring for the environment.

- Even in Malaysia, many attempts have been made to study the association between land use and water quality; but the findings fail to recommend an approach that could relate the problems to the courses of action in resolving the problems and the principles of sustainability. This chapter has identified that while the frameworks for managing water exist, their approach should be more integrated, holistic and based on a definite unit of management in the form of river catchment or basin.
- Water quantity and water quality are inseparable and both should be planned, coordinated and integrated through sustainable river management and land use planning.

CHAPTER 5

CATCHMENT MANAGEMENT PLANNING

5.1 INTRODUCTION

The role played by the river system is crucial to sustainable development of an area in terms of water resources, drainage and wetland ecology, and having impact on the general population. Water in terms of its quantity and quality needs to be preserved in order to sustain the various uses provided by the river system. The improvement in water quality and the protection of natural and cultural heritage will not only affect the overall environmental quality of the river but will also promote fisheries conservation and enhance river use as an amenity. The approach used in the protection and management of water resources should be holistic in order to be sustainable and Catchment Management Planning is a useful tool that could serve the purpose.

This chapter explores the background history of Catchment Management Planning [CMP], the CMP definition and descriptions, the Integrated Catchment Management Plan, the link between the Development Plan and the Catchment Management Plan. The chapter makes specific reference to the CMP as practiced in England and Wales, examines the adopted format for Catchment Management Plans and studies the recent Local Environment Agency Plan and its relation to the Catchment Management Plan. Based on these examinations, the scope of CMP for Malaysia is produced.

5.2 BACKGROUND HISTORY

People have sought from the earliest times to control and harness the rivers. Successful water engineering was fundamental of early civilisations. Of late, both developed and developing nations had engage in endless efforts to control over river water and not till very recently the task were mainly dominated by the construction of ever larger dams intended to regulate the distribution of water within the basin, which however posed many question with regard to the sustainability of the project and the environment.

Efforts to plan and manage catchment areas nevertheless have been an on-going process for centuries, though the trend towards having a more co-ordinated and integrated approach were emphasised lately. Perhaps it may be attributed to some form of recognition as highlighted by Gardiner (1994) that the effects of poor influence on planning and control can lead to system impacts, resulting in severe environmental damage.

It can also be seen with the development of river management legislation in England and Wales which dated back to 1388 (Appendix C) through the enactment of an Act for Punishing Nuisances which cause corruption of the Air near Cities and Great Towns with the target of deterring dung, filth, garbage, entrails, not to enter ditches, rivers and other waters (Newson, 1992), and subsequently pursued by many other aspect of legislature to accommodate the needs of controlling water resources so as to avoid nuisances.

Nevertheless, the modern history of river basin management can be traced back to the creation of the Tennessee Valley Authority (TVA) in the United States in 1933. TVA is the authority charged with jurisdiction over both land and water in the basin. TVA produced the first act that provided legislation on the construction of the hydro-electric power dam on the River Tennessee at Muscle Shoals and as mentioned by

Newson (1992) the Act carries the concept of 'conservation'. Newson also pointed out that TVA had become an exploratory concept in soil and water management because of its approach to erosion control (through watershed management), besides on vector diseases and flood control.

In terms of organisation on catchment basis had been applied in England and Wales as early as 1930, and the evolution of river management can be observed in Table 5.1.

According to Newson, profound changes in the organisation of river management in England and Wales been witnessed in the late 1980s (Gardiner, 1992) where river basin management became a leading example in environmental management, irrespective of the terminology associated to it: whether it is known as integrated river basin management, river catchment planning, etc. It was only in 1991 that NRA (the former agency responsible for river management in England and Wales) first announced in its corporate plan on the proposal to carry out CMP on a national basis (Slater et. al., 1994). The Thames region which played a major role in formalising many of the individual techniques in the preparation of CMP, has become one of the successful region in the implementation of CMP.

5.3 INTEGRATED CATCHMENT PLANNING AND MANAGEMENT

The term catchment in this thesis refers to river catchment which may be described as the area which contributes to surface water flow, derived from precipitation, to a specified point on a river system, usually to a confluence or to a sea and in other words it can be taken as a discrete geographical area with boundaries derived primarily from the topographical catchment. Exceptions may apply for urban areas where catchment boundaries may have undergone modification (e.g. where water supply or piped drainage networks may be the controlling factors), or where extensive aquifers contribute to more than one river system but are managed as a single water resource unit (Chandler, 1994).

Table 5.1. England and Wales¹: Development in River Catchment Planning Management.

Year	Law / Proposal	Number of Catchment Board/Authority	Responsibility Added / Subject
1930	Land Drainage Act (1930)	46 Catchment Boards	
1948	River Board Act (1948)	32 Catchment Boards	1. Fisheries 2. Pollution Control
1963	Water Resources Act (1963)	27 Water Authorities	1. Conservation 2. Control, augmentation and management
1974	Water Act (1974)	10 Regional Water Authorities	1. Water supply 2. Sewerage 3. Sewage treatment
1986	Proposal by Department of Environment (1986)		Proposal for privatisation of water industries (but not well received)
1989	Water Act (1989)	10 Regional Water Authorities	Privatisation of water utilities and formation of NRA in England and Wales. Conservation of water environment been integrated with land use planning and control through the structured approach of catchment planning
1996 ²		8 Regional Areas.	NRA been replaced by Environmental Agency

¹ Adapted from Gardiner et. al. (1994c).² NRA (1996).

Newson (1992) pointed out that river catchment or basin would be an ideal unit for many forms of environment management with the active participation from the population. The idea of river catchment planning had evolved over the years through the experience of major project appraisals, and the recent approach emphasises the holistic view towards catchment planning. The watershed approach is preferred particularly with its integrated management style (Eston et. al., 1986, after Margerum and Born, 1995). Gardiner (1992) in a manual for holistic appraisal of river projects and conservation specifically acknowledged the need for a catchment plan to provide the context for any significant investment strategy.

Arguments over the definition of development have been taking place as discussed in the previous chapter, among many including politicians and even geographers and are likely to continue. Development, in river basin terms, encompasses different priorities depending on the nature of service rendered, whether being as described by Newson (1992) as life-permitting water schemes or life-enhancing ones. These water schemes would carry different priorities especially when comparing between the developed and developing countries. Further Newson suggests that the development schemes have to be refined to the point where they can be interactively managed through time to reflect the changing needs of society and the environment at the catchment level.

Like the notion of development, the definitions of integrated catchment planning are numerous. The meaning to this ranges from simply river management for professional teams working on interdisciplinary basis to a firm policy of an ecosystem framework for the entire resource suite present within the surface (and underground) catchment boundary (Down et. al., 1991).

A distinctive description of Catchment Management Planning (CMP) was given by Pickles (1993) as: procedure to create a consistent framework by which its diverse responsibilities can be applied in a co-ordinated manner, with the main intention to bring about integration of its own sectoral operation - water resources, flood defence, pollution control, navigation, recreation, conservation, fisheries - and later, provide avenues for an extension into local government planning process. It is the process by

which problems and opportunities for enhancement within a catchment can be address in an official and cost-effective manner (Pickles, 1993). The description, therefore stresses on the concept of integration of sectors and the co-ordination of responsibilities involved in CMP.

The Catchment Management Plans would summarise relevant data and include an agreed action program to optimise catchment uses. The plans are produced after wide consultation and serve to complement local authority statutory plans. Similar to other plans, it needs to be reviewed regularly during their current period of implementation (normally for five to ten years).

CMP can be a useful tool in determining the development pattern of a catchment. It can be used to direct development away from areas which could cause problems downstream in terms of an increased runoff or deteriorating water quality and even resulting in impact that reduces their capacities for environmental protection. As an example: the development in the flood plain would reduce its capacity to retain flood water (Pickles, 1993). In many circumstances, CMPs can influence rural catchment as much as in urban areas (Gardiner, 1994). This is particularly so where agricultural practices may not sustain the water environment and sources of water need protection.

The result of such planning process served the intended purpose of being a basis for consultation with outside bodies when changes or new development are proposed (Pickles, 1993). The final stage of CMP will draw on the results of consultation process which includes a phased program of specific management actions backup by summarised information for the consultation report (Chandler, 1994)

As Newson (1992) pointed out that it is essentially useful to adopt a river basin approach to water resources planning and management, with consideration on land resources in conjunction with water resources and emphasising either on a distributive approach which deal with, for example: major irrigation or power scheme; or a collective one in terms of runoff management and pollution control.

The interaction between the different processes involved in land use activities on a river basin scale have to be assessed by means of a quantitative way. Many forms of methodology were developed to conduct such assessment with the predictive bases intended to assist in decision making process. This will allow the proper management of problems arising from certain activity. From the system, the assessment should be able to track how change at one place affects the other parts of the system.

It was suggested by Newson (1992) that to consider extending river management to basin scale and to take a broader role in global schemes, sustainable environmental intervention considerations on the following would be necessary:

- 1) Social aspect should be as important as technical aspect.
- 2) Technological aspect (such as distribution of water) should be using relatively simple scientific foundations but should be highly efficient.
- 3) Understanding on the contribution of science, as its contribution is becoming more coherent in handling collective systems such as flows in reservoirs and flows of pollutants to the stream.
- 4) Employment of legal instrument to control human use of the river which may determine and constrain environmental outcome.
- 5) Recognising scale issues that will influence distribution of information in the system.
- 6) Establishing response to environmental change which has been a key aspect in river basin management, having concluded that the need to consider every aspect such as social, legal, political and institutional just like the contribution of science when dealing with issues related to rivers.

It was the Water Act (1989), - beginning of new era with the privatisation of water utility and formation of the National River Authority (NRA), - which provided a further dimension in which conservation of the water environment is being integrated with land use planning and control through the structured approach of catchment planning in England and Wales (Gardiner, 1994). An announcement on the proposal to carry out catchment planning on a national basis (covering England and Wales) was made in 1991 by NRA through its Corporate Plan after having explored work on the

form and function of CMP in Wales (Slater et. al., 1994). Table 5.2 briefly described the implementation of the much accepted approach to river basin management that are structured, irrespective of their geographical locations, in upholding the concept of integrated catchment planning and management. The Thames River clean up programme is an example of the management efforts shown to produce significant outcomes in terms of catchment management although the work carried out in the basin started very much earlier than the formal CMP was launched. Progress was made in the entire basin to improve the water quality so as to put life to the river (Appendix C). Significant land use associated improvements resulted from decisions to clean the river with better sewerage treatment systems and non-complying industrial activities were removed from the upstream areas of Thames basin.

It is very clear that CMP has a very interesting history. Further, it has been practised in a number of countries (Table 5.2). There has been a growing tendency in advocating catchment management planning in those countries which advocate a democratic approach towards achieving sustainable development.

A contemporary example of such a movement is the “National Landcare Programme” in Australia, intended to achieve a more sustainable use of farming lands. It is important to note that members of the Landcare groups are voluntary and the groups frequently operate at catchment or sub-catchment scales. The variety of activities is related to management of issues affecting agricultural production and biodiversity such as water quality decline, soil erosion, ground water salinity, soil acidity, vegetation decline and introduced pest animals and weeds.

“The landcare programme emerged as a distinctive entity in the State of Victoria, Australia during 1986 ... and has been embraced by governments, farmers organisations and conservation groups throughout Australia as offering a model for effective community action to manage land degradation and assist the move to more sustainable development resource use”. (Curtis & De Lacy, 1996, p. 120)

Table 5.2 Scale Contrasts in River Basin Management in Selected Countries.

Aspect	England and Wales ¹ (Thames examples)	Canada ¹ (Ontario example)	Australia ² (Queensland example)	France ³
Terminology	Catchment Management Planning (CMP)	Watershed Planning	Catchment Management Strategies (CMS)	<i>Schémas directeurs d'aménagement et de gestion des eaux (SAGE)</i>
Watershed institution	National Rivers Authority: region / catchment / area	Conservation authorities - fit watershed boundaries	Catchment Co-ordinating Committee (CCC) under the Department of Primary Industries (DoPI)	<i>Agencee financieres de Bassin</i> - fit basin boundaries
Relationship to planning institution	Statutory consultees	Partnership between municipalities and province	Planning agency as member of CCC	Key actors in broad water planning with no power but managing through "give and take"
Funding available for catchment planning	Central (national) direction of CMP policy and resources. Regional priorities often determine detail	Locally financed and participatory consultation	Through DoPI (as lead agency)	Allocation from fiscal revenue generated from abstraction & discharge permits accorded by State regulators.
Role of drainage / flooding	Dominant in Thames Region but not in others, e.g. rural pollution in South West etc.	Focus is master drainage plans / stormwater drainage plans. Full watershed plans not yet funded. Master watershed plans emerging	CCC provides a forum for community input and discussion, identify and prioritise natural resource issues in the catchment & to develop, promote and facilitate implementation of CMS	Focus on ecological standards of water quality & the protection of aquatic environment as a whole and the integrated management of land and water
Size for plan	1,000-2,000 km ² - management unit focus.	10-100 km ² - source area focus	-	200-11000 km ²

Source: ¹ Gardiner et. al. (1994).

² Johnson et. al. (1996).

³ Buller (1996)

A whole range of activities under the Landcare programme were established. Curtis & De Lacy (1996) revealed that the activities involving the Landcare groups include the following:

- holding meeting to discuss issues, identify priorities, develop action strategies and debate a range of resource management issues with guest speakers;
- conduct field days and farm walks and establish demonstration sites;
- undertake a variety of education and promotional activities such as hosting tours and involving other community groups in landcare activities, organise conferences, write newsletters and file guides and prepare media releases;
- undertake a range of ground work including seed collection and tree planting, constructing salinity and erosion control structures, co-ordinating pest and weed control activities, erecting fencing to control stock access activities and streams and establish wildlife corridors;
- groups co-ordinate planning activities related to whole farm or property planning and catchment planning; and,
- some members are involved in the preparation of submissions for government funding.

5.4 DEVELOPMENT PLAN VERSUS CMP

Development plan stands at the very heart of the UK planning system in which planning decisions are made accordingly. The plan-led system has been strengthened with the requirement that local planning authorities need to take the environmental concerns in their widest sense while preparing their development plans. This is intended to ensure that the quantity of development envisaged in the plan and taking place in the intended locations can be scrutinised, and critical aspects of the

environment can be protected from adverse development. It is the key role of the UK development plans to achieve the goal of working towards ensuring that development and growth are sustainable, as mentioned in the PPG12 (Development Plans and Regional Planning Guidance No. 12), and this is to be achieved by ensuring future generations are not denied the best of today's environment.

As it may be seen, town and country planning had been mainly focusing on urban development particularly the built environment while neglecting the agriculture land use which undoubtedly may determine the sustainability of the water resources.

Nevertheless as mentioned by Gardiner et. al. (1994) that the approach to strategic planning is changing to focus broadly on the need and enhancement of both natural and built environment. Whilst the planning system manages to cope fairly in conserving important landscapes from urbanisation, the rural areas continue to develop to a level that threatens their characteristics with major land use change, fragmenting the rural area particularly in places where it is most susceptible and fragile.

Gardiner, 1994 mentioned that

“...Model statements supporting the water environment have now been adopted by the NRA nationally for inclusion in local authority development plans. The NRA is increasingly recognised as having a legitimate influence on strategic land-use planning and an important role to play in development control, which focuses on the issue of sustainable development. This influence is building a strong planning policy base for accommodation (negotiating agreement) with developers, to complement the power to allocate from the legislative base, particularly in pollution control and water resources. The current take-up of these policies in local authority development plans is encouragingly high ... The accommodation approach has also been assisted by the NRA's duty not only to conserve and enhance the environment when carrying out NRA function, but to promote conservation and recreation when commenting on external proposals, as stated in s. 16 and s. 22 respectively, of the Water Resources Act of 1991. A proactive and multifunctional NRA stance can ensure that any environmental opportunities afforded by land use change are fully exploited. Awareness, knowledge and negotiating skills are therefore required.”

There has been a shift in approach taking place in the last decade, with a structured, multifunctional approach, linking land use planning with the needs of water environment, evolved in regions where stress on water environment became most apparent, to an extent where it can be regarded as appropriate to overcome the effects of urbanisation merely using local and single-objective approach (Gardiner, 1996b). Rather a system approach based on strategic issues has to be considered in development planning on regional as well as local scale.

In bridging the gap between impact minimisation in project-specific control (i.e. development-led approach to land use and its consequent water use), and ecosystem planning and management (i.e. ecological sustainability) is expected to progress in future research into areas such as carrying capacities, sources, sinks, natural productivity and biodiversity and the way these may be related to any particular catchment (Gardiner et. al., 1994). However, certain issues such as the carrying capacities, sources and sinks, buffer zone priorities, catchment areas vulnerable to erosion and appropriate areas for source control, are complex and could be difficult to assess. This thesis will examine some of these issues in the context of catchment management planning.

Among the environmental requirements of the catchment which need to be identified include its relation to water quality, water quantity and physical features associated with the water environment, and how they would have implications for development programmes.

The majority of developments are controlled through Development Plans (DPs). The Plans identify areas for future residential, commercial and industrial development, and set out policies against which planning authorities consider development proposal and land uses. In the task of accommodating the catchment management plans into a real implementable document, the necessary linkages viable for its success need to be established. Slater et. al. (1994) in discussing catchment management plans (CMPs) as planning documents concluded that there are relatively few linkages between CMPs and the relevant Development Plans. Although four of his sample CMPs acknowledge

the existence of the DPs, not a single DP mentioned a CMP. It will be most useful if the DPs are still working their way through the adoption process, as there will still be time to develop a better fit between both sets of plans.

5.5 CMP REPORT FORMAT

Despite the general agreement that integrated catchment planning is desirable, it is still difficult to define the scope of such planning as it relates to ecological preservation and the reconstruction, and land use planning and control. Advocates of ecological planning assume such plans to comprise inventory of ecosystem for wildlife, use and restoration of wetlands and maintaining of biological diversity. In contrast, to water resource planners, such plans need to incorporate development of resource alternatives that on balance, would not harm natural species but would rather bring benefits in some ways. On the other hand, land use planners may forecast ways of controlling future growth and may influence land use policy favourably, the output is not specifically considered as a catchment plan.

Among the stated vision in the CMP Action Plan include :

“Their waters must be maintained and improved to be of a quality suitable for the uses to which it will be put. The flow in the rivers and the physical structure of the stream network and associated habitats must be protected so that their diversity is sustained. Controlled access for recreation may be developed but, as with all other uses of the water environment, must be balanced with the needs of the river’s natural ecology.” (NRA, 1996)

This is consistent with the intended mission statement which has been expressed by the following principles:

“... protect and improve the water environment by the effective management of water resources and by substantial reductions in pollution. ... aim to provide effective defence for the people and property against flooding from rivers and sea. ... operate openly and balance the interests of all who benefit from and use rivers, groundwater, estuaries and coastal waters. ... be business-like, efficient and caring towards our employees.” (NRA, 1996)

The key objectives of most CMP in England and Wales, are directed towards:

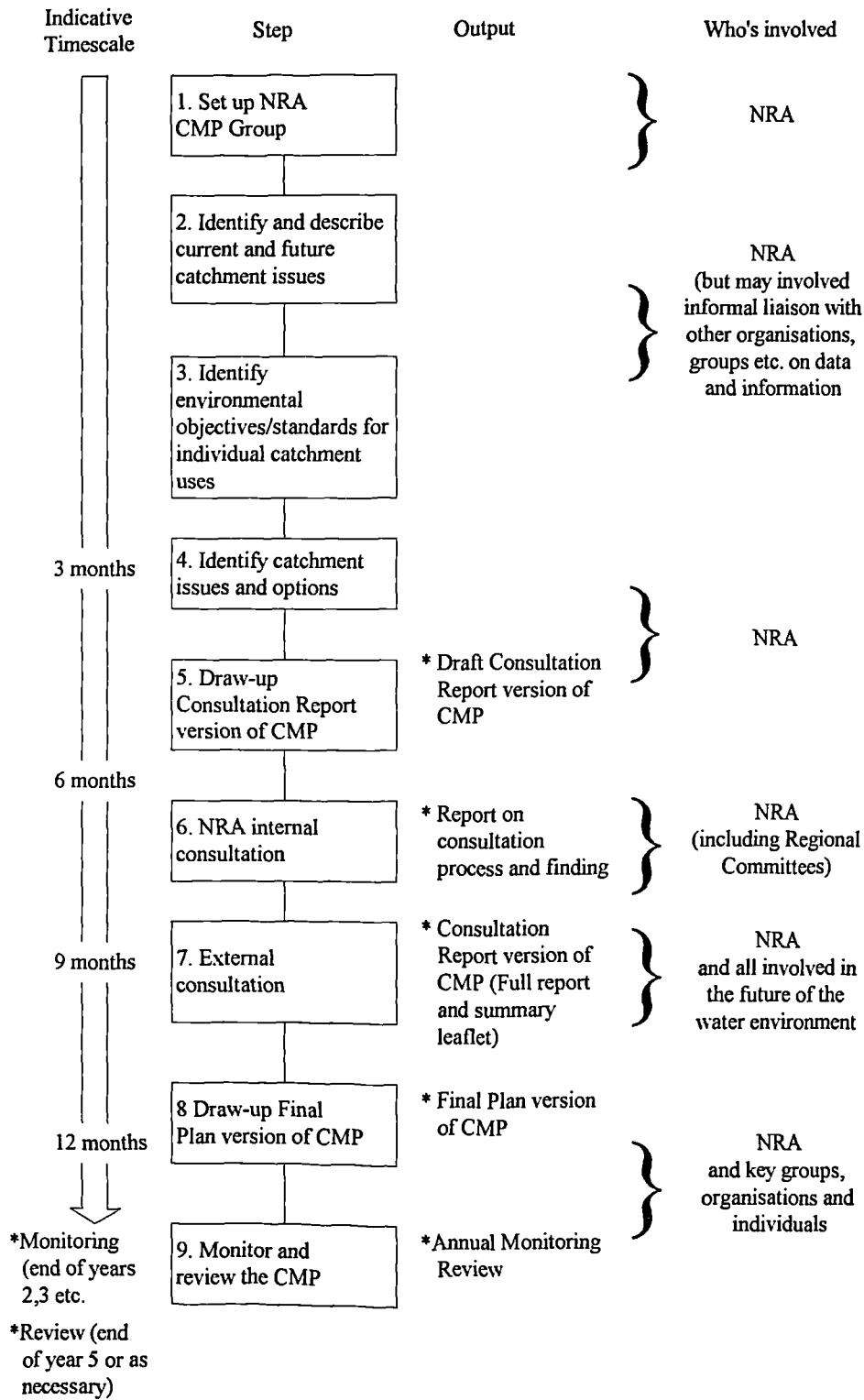
“... to ensure that all new developments within the (river) catchment meet the needs of the present without compromising current and future uses of the water environment (which itself comes from the definition of sustainable development).
... to protect the high water quality standards which exists throughout the majority of the catchment and improve the water quality in other stretches ...
... to provide effective defences for people and property against floodings ...
... to maintain and enhance the diversity of natural instream river features, river corridor habitats and their associated flora and fauna, and to identify, prepare, agree and implement enhancements for key sites.
... to work with other organisations in the preparations of a management plan ...
... to ensure, where appropriate, artificial barriers do not impede the natural fish migration, whilst maintaining their flood defence, landscape and recreational importance.
... to encourage appropriate access to the rivers for recreational by facilitating constructive dialogue between interested parties.” (NRA, 1996)

Catchment Management Plan, as it is known in the UK, comprises the “Consultation Report”, the “Action Plan” and the Annual Review as shown in Figure 5.1, which together:-

“... assess catchment resources, uses and activities
... are used to consult widely on issues to be tackled
... establish a long-term vision for individual catchment
... use effective and proactive planning to prevent further environmental problems.” (NRA, 1996)

The views arising from public consultation represents a working document for the achievement of improvements to the river environment. The views were gathered from planning authorities, Government departments, landowners, farmers, conservation organisations, developers, industry and recreational groups.

The Consultation Report is a more comprehensive document which describes the catchment, the uses of the catchment and activities within the catchment, reviews the state of the catchment against targets and identifies issues which need to be addressed.



Source: Woolhouse (1994) p. 466.

Figure 5.1 England and Wales: The Catchment Planning Process.

It is also at this stage that proposals for actions to address issues were made. Public consultation and open discussion was considered to be an essential feature of CMP.

The Action Plan comprises: overview of the river catchment which in brief describes the catchment; review of resources, uses and activities; restating the water quality objectives, as introductory component and followed by the vital component of the Activity Plan. The activity plan summarises: what will be done (objectives and actions); who will be doing it (responsibility with specifically stating the lead and participating agencies); when it will be done (implementation period); and, how much it will cost. The action plan is expected to be progressed and the CMP will continue to evolve as environmental circumstances, pressures on the river catchment changes or other organisations and individuals become involved, opportunities for joint project and funding opportunities arises.

In England and Wales, the responsibility to undertake monitoring and reporting back on the progress for the Action Plan in the Annual Monitoring Report falls on the Environment Agency.

Sustainable development has been the heart of policy on environment and the Agenda 21 which is the international blueprint for sustainable development identifies the need for an integrated approach to the management of land and water resources within the catchment boundaries. Included as a component of CMP (for England and Wales) is the Land use statement, served to highlight issues that Local Planning Authorities, and others involved in the management of urban and rural areas, need to consider and respond to if critical natural capital of the river catchment's water environment is to be managed in a sustainable way, though mentioned in brief. Government planning guidance (e.g. PPG12, PPG20, PPG23, RPG7, Circular 30/92) highlights the importance of communication between Local Authorities and the NRA and the relationship between land use and water matter.

In order to avoid duplication and to ensure that essential information and policy on the water environment is clear and concise, integration of efforts of public authorities and agencies seems to be inevitable.

The Action Plan has also been formulated in a manner that a distinction is made on matters pertaining to the following, with the water quality aims of (i) protecting and improving the water quality of all stretches of the River catchment to standards suitable to sustain current and future uses of the water environment; and (ii) managing water resources to achieve a balance between needs of water users and needs of the environment; and the flooding of land and property aims of (i) providing adequate arrangements for flood forecasting and warning; (ii) providing effective defences for people and property against flooding from rivers and sea, where justified; (iii) ensuring that any flood defence works include all reasonable opportunities to conserve and enhance the rivers' natural ecology. The objectives and targets based upon issues identified in the Consultation Report will form a checklist in the Action Plan, served to guide their implementation within certain time frame is as shown in Table 5.3.

5.6 LOCAL ENVIRONMENT AGENCY PLAN

The Environment Act, 1995 in England and Wales has led to the establishment of the Environment Agency [EA] for England and Wales in April 1996, and it has brought together the National Rivers Authority [NRA], Her Majesty's Inspectorate of Pollution, the Waste Regulation Authorities and several units of the Department of Environment. With the wide scope of responsibilities, the agency has become a powerful environmental regulator.

Table 5.3 Catchment Management Planning: Objectives / Targets Based Upon Identified Issues.

Issue	Objective / Target
Water quality	<ul style="list-style-type: none"> • To achieve the suitable class target with specific time table.
	<ul style="list-style-type: none"> • To remove and encapsulate specific contamination by specify time table.
	<ul style="list-style-type: none"> • To provide management information to assist in minimising the effects of the cessation of minewater pumping (depending upon existence of mining activities).
	<ul style="list-style-type: none"> • To achieve river ecosystem target by specific time table at specific stretch of the river.
	<ul style="list-style-type: none"> • To minimise the effects of blue green algae on specific lake.
	<ul style="list-style-type: none"> • To prevent pollution incidents forming a risk to water quality.
	<ul style="list-style-type: none"> • To assess the effects of the increased releases into the river at specific point.
	<ul style="list-style-type: none"> • To improve the ecological value at a specific place by a specific time • Improvement of conservation management at aspect place.
Flooding of Land and Property	<ul style="list-style-type: none"> • To identify land and property on 'Main River' which are not protected to the provision target standard of protection by specific time table.
	<ul style="list-style-type: none"> • To assist Local Authority in dealing with non-main river flooding.
	<ul style="list-style-type: none"> • To improve even further flood warning procedures for the specific river(s) by specific time table.
	<ul style="list-style-type: none"> • To improve co-ordination of emergency services during flood events.
	<ul style="list-style-type: none"> • To ensure that flood defence works contribute to the achievement of conservation duties of the drainage agency. • To raise the flood defence levels at specific point.
Physical features, species and habitat management, recreation <ul style="list-style-type: none"> • Physical Features 	To ensure, where appropriate, artificial barriers do not impede natural migration of fish, whilst maintaining their flood defence, landscape and recreational importance.
<ul style="list-style-type: none"> • Management of Habitat and Species 	<ul style="list-style-type: none"> • To enhance waterside habitats. • To encourage colonisation of the river catchment by specify animals. • To protect and support the native fish in the river catchment • To assist specific body/company in developing a nature reserve and education facility at specific places. • To work with other organisations on to preparation of a detailed management plan for the river estuary by specific time table.
<ul style="list-style-type: none"> • Fisheries. 	<ul style="list-style-type: none"> • To maintain and improve the specific type of fish population. • To reduce loss of fish as a result of porching.
<ul style="list-style-type: none"> • Recreational 	To encourage appropriate access to the river for recreational use by facilitating constructive dialogue between interested parties.

Issue	Objective / Target
<p>[cont.]</p> <ul style="list-style-type: none"> • Communication 	<ul style="list-style-type: none"> • To ensure clear communication between all the interested parties. (During consultation process many contacts would have been established and it is up to all parties to ensure that constructive two way communication is maintained and that the CMP is an evolving and effective document). • To ensure this happens the following actions are important. The agency will: <ul style="list-style-type: none"> • ensure that annual reviews of the plan are made available to all interested parties; • discuss the formation of a 'user forum' to assist in monitoring and developing the CMP; • encourage other parties to become actively involved in the development of the CMP; <p>Communication seek to ensure that the concept of integrated catchment management planning is taken forward by all relevant organisations. The Annual Monitoring Report will examine the need to update the CMP in the light of changes in the catchment compare work achieved with that shown in the Activity Plan and describe the reasons for changes to the content or timing of individual actions. Report on the environmental status of the water environment</p> <p>Annual Review In the Annual review the progress of the activity plan were monitored under the progress column .</p>

Source: NRA (1993)
 NRA (1995)
 NRA (1996)

Under EA control, the CMP procedure, produced by the former NRA is been replaced by the Local Environment Agency Plan [LEAP]. A LEAP is an integrated local management plan, for identifying and assessing, prioritising and solving local environmental issues related the Environment Agency functions, which means it now covers not only the water resource aspect but also the land and the air segments (EA, 1997). Nevertheless, the plan is still based on the surface water catchment area of one or more rivers, as it was designated in the CMP.

LEAP is now taken to supersede the CMP in England and Wales. The replacement of CMP with LEAP may be considered as a shift in the right direction for EA in which the overall issues pertaining to environmental problems are handled through a single plan, therefore providing convenience to the Agency in assuming its overall obligatory functions, apart from the main purpose of the plan to serve as a comprehensive coverage of all the environment segments. However, when it comes to the questions

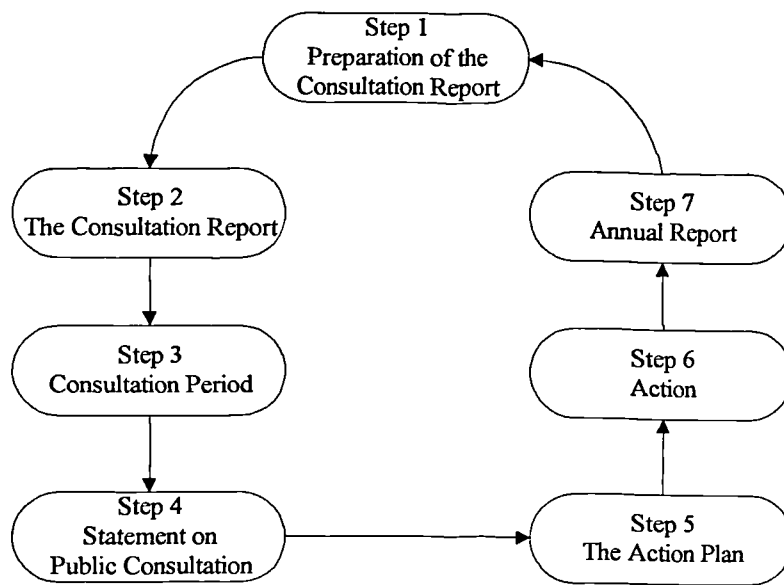
of sustaining the water environment, only issues related to water resource and protection of water quality become the central focus. This thesis considers both plans as viable but CMP would be much more appropriate when applied to matters relating to water resource planning management including water quality issues of the catchment area. Further, LEAPs still appear very much to carry the format of CMP except on the scope of its coverages where a whole range of other environmental issues are included.

As in CMP, LEAP is envisaged to improve the environment through an integrated process in order to optimise the benefits for the local environment. The integration process is felt to be the best approach as it is often realised that environmental issues are many and varied to the extent that it is not possible for one agency alone with limited power to fulfil all the obligation for a sustainable development. The LEAP process involves 7 steps as illustrated in Figure 5.2. In general the process is similar to that of the CMP (as shown in Figure 5.1), and it involves the production of three types of documentation for each LEAP area: (i) Consultation Report; (ii) Action Plan; (ii) Annual Review.

On the whole, LEAP Consultation Report covers two main parts:

Part I introduces the regulatory agency, describes the LEAP area, identifies a number of issues facing the local environment, and makes proposals for action to address those issues.

Part II provides the background information to support Part I. It describes the LEAP area, identifies uses and activities which are prevalent within the area and seeks to measure the environmental quality of the area against identified standards (where available).



Source: EA (1997a), p.2.

Figure 5.2 England and Wales: The Environment Agency LEAP Process.

Basically, the Action Plan for LEAP is similar to the one made for CMP, except in LEAP each action outlined is linked to the Environment Agency strategy. This is fair especially in the effort to justify for every action taken under the plan which must necessarily reflect the Environment Agency's role in protecting the environment.

5.7 SCOPE OF CMP FOR MALAYSIA

The experience gathered from the study as in the case of England and Wales illustrates a comprehensive Integrated Catchment Management Plan encompassing the various aspects of water resources and ecological planning and management while establishing (a non-formal) linkage to the land use plans (or statutory development

plans). CMP therefore, provides the avenue where environmental dimensions can be integrated into land use decision making processes, and they complement the local authority statutory plans. Incorporating the environment component into the statutory development plan such as the structure plan has already been practice in Malaysia. However the environment component itself only presents the state of the environment and policy relating to environment, whereas CMP contains within itself the action plan that will drive the relevant agencies towards achieving the specified environmental strategies as formulated in the National Environmental Policy.

The CMP will focus on water issues at local level based on the designated catchment area or water quality region as currently adopted by the Department of Environment, Malaysia [DOE]. As environmental matters are increasingly recognised as having legitimate influence on strategic land use planning, therefore, the presence of CMP helps to guide development programmes and set their focuses on issues of sustainable development.

Hence, development strategies and trends in the future can be influenced by establishing direct linkage between CMP and statutory development plan. This is because the development plan determines the nature of changes likely to occur and when the proposals are implemented, they can leave profound impact on the landscape, the water ecosystem and water resources availability. Under these circumstances, the CMP process is envisaged to provide the opportunity for the restoration of the river system functions where the water resources use and benefits can be optimised, wetland ecology can be preserved or maintained, fisheries conservation can be realised, river amenity sustained, river assimilative capacity not exceeded while the navigational uses could continue.

It is anticipated that such issues as in Table 5.4 can be conceived and integrated within a single plan and the approach to issues related to water and the search for their solutions could be undertaken in a holistic manner. Otherwise, these issues will be dealt with individually under the respective fields i.e., land use planning, ecological planning and water resource planning and they will be looked at from their own

perspectives, thereby failing to assist in imposing the current planning and management process of the vital resource. For example, it has expressed by Naess (1993) that “environmental concerns have only to a limited extent been determining the design of today’s urban areas, and prioritising one environmental target has often taken place at the expense of another”.

Table 5.4 The Way in Which Planning Related to Differing Sectors.

Land Use Planners	Ecological Planners	Water Resource Planners
Planners influence the land use policy.	Advocates plan that will depict ecosystem and wildlife use and restoration, including that of forest, river and wetland ecosystem.	Explores the option on development of water resource alternatives that will benefit the community.
Forecasting of ways of controlling further development with central focus on socio-economic aspect.	Aim at maintaining biological diversity within the area of interest.	Suggest ways where demand for adequate water could be met with sufficient supply.
Determination of how development pattern should proceed and how land use change will take effect.	Conservation as the approach to avoid depletion of resources and helps to improve quality of wildlife.	Incorporate mitigating measures of protecting the natural environment in water resource development.
Apply control over land with direct or indirect benefits on the local environment including water.	Include comprehensive management approaches with the focus primarily on preserving the integrity of the natural system.	Deal with regional approach to water management.
Recent development emphasises on the incorporation of environmental dimension to minimise impact of predicted change likely to take place which is pertinent to local planning.	Output often in the form of conservation management strategy.	Promote development of resource that bring benefits to the natural environment.
		Watershed approach with integrated management in which more ecological minded models that equate watersheds with ecosystems.
National Land Use Master Plan	National Conservation Strategy	National Water Resource Plan

At the same time reporting which is a core activity of the programme needs to reflect a universal coverage for the study area and be able to uphold the credibility brought with it. This is because environmental report, such as in CMP, is targeted at “the creation of a credible process of information ...” to resolve the problem of “scepticism as to whether a government department could orchestrate an authoritative and widely

accepted document as many of the potential partners held vested interests in the subject matter” (Selman, 1994).

Sectoral plans often result in the collection of bits and pieces which will need to be further scrutinised and consulted upon. When it comes to co-ordination, some difficulties arise especially on matters directly under the States jurisdiction. A procedure which attempts to resolve problems at local level will be most appropriate at a catchment level and this will be consistent with the activities of physical development planning and implementation that take place at this level. Such planning procedures will be related to the policy at the National level that aims to maintain its uniformity throughout the country.

The basic parameters which are of importance and should be specified in a catchment management plan area include: the definition, scope, external participation, CMP area, report / document publications, delivery of report, quality assurance, timescale, and links to other agency processes.

The adoption of CMP would not pose any difficulty in Malaysia because of the strong existing institutional set-up apart from the on-going activities which enable to support its processes. DOE has been managing the river water quality through its monitoring and enforcement programmes covering the 49 water quality regions in Peninsular Malaysia (Figure 5.3) and 46 regions in Sabah and Sarawak, in addition to its role in influencing the implementation of development activities without jeopardising the environment. CMP can also be tied up with the “*Love Our River*” campaign launched in 1993 by the Drainage and Irrigation Department [DID] and would act as a formal reporting for the actions taken but need to cover areas throughout the country and not merely on few selected rivers. It will need to incorporate the outputs from the main agencies i.e. DOE and DID.

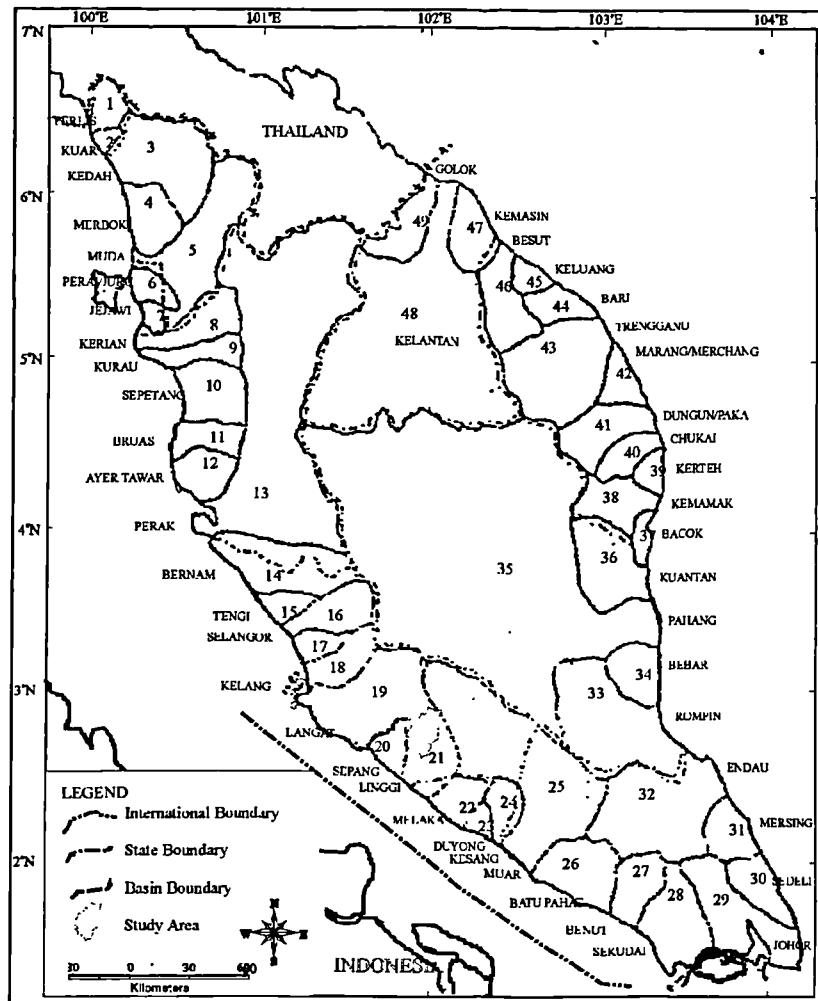


Figure 5.3 Water Quality Regions in Peninsular Malaysia.

Although there are some forms of informal CMP in Malaysia, there has not been any formal reporting on such basis, except those undertaken separately by DOE and DID on their monitoring data publications, and these reports never addressed specific actions that need to be taken through integrated approach and involving the participation of various responsible agencies. There are exceptions, however, on isolated reports such as: the Action Plan on Environmental issues in the Federal Territory (DOE, 1983); the Klang Valley Environmental Improvement Programmes (DOE, 1987b); the Klang River Clean-up programme; and the Environmental Management Studies of Sg. Sintok and Sg. Badak (SMHB, 1993).

Other types of reports such as the Baseline and Source Inventory Study by DOE for all the river basins; National Report for Malaysia on assessment of land-based sources of pollution (DOE, 1988b); River Classification for 16 Rivers (DOE, 1990a and DOE, 1993a) were used mainly for DOE internal matters or as research references. At present the state of the environment is reported in the Environmental Quality Report, which is published annually by DOE as a requirement under the Environmental Quality Act, 1974. All these reports have different formats and are targeted for different purposes and therefore this calls for a standardisation in reporting with specific target action plans to resolve the arising issues for each environmental segment.

It is proposed that the CMP for Malaysia should, therefore, contain the Report of Survey (which will be equivalent to the Consultation Report), an Action Plan report and Annual Review report. Generally, the proposed Report of Survey will cover the scope similar to the CMP Consultation Report as in England and Wales. Some of the probable issues of relevant in relation to water resource and water quality management may include the following subjects:

- Management of river-basins in an integrated way, via the CMPs;
- Ensure that all waters of sustainable quality for their different uses;
- Deliver a continual improvement in overall water quality;
- Provide effective flood defence;
- Provide an effective flood warning system;
- Increase the number of rivers and still waters capable of supporting viable fisheries;
- Enhance and conserve inland navigations, as national assets of environmental, economic, social and recreational value;
- Secure the most appropriate legislation, management systems and financial arrangements to ensure the sustainability of our navigational waters;
- Work with others to improve and develop inland waterways as an integrated network;
- Improve river habitat quality, as measured by river habitat surveys;

- Improve wetland management;
- Improve riverside landscapes;
- Improve bathing water quality;
- Improve estuarine waters for shellfisheries;
- Increase the number of Agency-owned sites available for public recreation; and
- Work with local authorities to maximise the conservation and recreational use and value of our river-basins.

An Action Plan will be one of the outputs from the process, which incorporates actions aimed at optimising catchment water use and direct development away from areas which bring about problems to the downstream river stretches. Such problems may be in the form of increased runoff or reduced capacity to retain floods in flood plain and deterioration in the water quality. It is anticipated that the process could help in providing the basis of consultation when changes / development have been proposed.

The procedure will integrate the fulfilment of the following aspect of water resource management, which include: water resource utilisation and the inherent benefits provided by the river system, flood defence, pollution control, ecosystem management, recreational use and other river amenities it can provide, implementation of conservation programmes that will sustain the biological diversity of the preserved areas and restore the beneficial use of the river in terms of fisheries, recreational and other river amenities. The aspect of ecosystem which is of prime concern and needs to be addressed, as it has a direct bearing on the water quantity and water quality of the river and aims to ensure the assimilative capacity of the river is left intact. The recognition of the extent of the source of water available, but to be met with the pollution sources, could result in the imbalance of water availability and the ability to function as a sink. It is essentially important to include consideration of placing sufficient buffer zones as step in overcoming the problem of environmental destruction. All these factors have to be seen in light of how they relate to catchment and have impact on the overall sustainable water use within the catchment area.

5.8 CONCLUSION

The role played by river system through time has gained importance and indeed the approach towards planning and management has also shifted to be based on a much more clearly defined unit (preferably the catchment) to ensure that the interaction taking place within it could be much more clearly understood. With clarity in the notion of catchment development and management, it would pave the way to integrated planning and management, based on experience of the past. Undoubtedly, CMP presents ways to enable control on water resources in terms of its quality and quantity that will further enhance initiatives in ensuring a sustainable development.

River catchment planning is progressively developing and much experience of the past has had some influence on the present holistic approach. Attempts to assess several interactions between processes involving land use activities and impacts on the water resources have been made. Such assessment would preferably be quantitative so as to provide means that may be utilised by decision makers in determining the pattern of development and avoiding adverse impacts on the environment and in particular the watercourses. Consideration on factors such as social, technological, knowledge and legal aspects along with issues on information dissemination and establishing responses to environmental change are essential in dealing with river catchment management. Though terminology may vary, CMP had in some way been carried out in a number of countries such as England and Wales, Canada, Australia and France on the bases of interdisciplinary principles and been implemented with positive outcomes. The proceeding stage should then enable these plans to influence the overall planning process and determine that development will go in hand with the targets under CMP. Although some environmental considerations have been included in the development plans, initiatives made to establish the links between DPs and CMPs will provide the necessary assurances on the improvement to be gained once the proposed actions in CMP are put into practice. The CMP reports should however, be

presented as a credible planning guide in conserving the water resources and enhancing environmental management processes.

Malaysia has been conducting a form of river catchment management since the enactment of her first Water Enactment in the 1920s. With the establishment of the Department of Environment in Malaysia, the initiative has grown in terms of its scope that covers many aspects of river water quality preservation. Nevertheless the form of management planning for a river system in an integrated manner has been lacking and it is timely that the approach to integrated river catchment management planning is instituted in the country to face the challenges ahead brought about by rapid development. The integrated concept to catchment management planning as practiced in England and Wales will be a useful reference to Malaysia where it can be put to complement the Malaysian local planning system which has very much been modelled using a similar planning approach as in England and Wales.

Several key issues have been drawn from this review and these are as follows:

- Catchment management planning has existed for several years in a number of countries and has a history that allows useful lessons to be drawn from the way it has evolved. Malaysia could adopt the approach of catchment management planning but needs to base this on its geographical, cultural, economic and climatic conditions.
- Catchment management planning which is based on the concept of partnership has proven to be more effective, especially when each and every sector of the community is committed to contribute to its success. The examples, as in England and Wales and in Australia, have shown beneficial results.
- The Australian “National Landcare Programme” , a voluntary community programme supported by the government, reflects the bottom-up approach to solving the problems of degradation in land and water quality and was found to be very effective. This example is much closer to Malaysia and several lessons could be gained through careful observation of the approach.

- In England and Wales, the change from Catchment Management Plans to Local Environmental Agency Plans has taken place, with the incorporation of Environment Agency Strategies included in LEAPS.
- It is recommended that catchment management plans for Malaysia contains 3 major components, i.e. the Report of Survey, the Action Plan and the Annual Review.
- The mechanism by which feedback from the public could be gathered and monitored should be made available so as to get the commitment from all sectors to contribute towards the success of the programme.
- The assessment of issues to be raised in the report of survey is suggested should be based on modelling, which will be discussed in Chapter 6.

CHAPTER 6

GEOGRAPHIC INFORMATION SYSTEM AND WATER QUALITY MODELLING

6.1 INTRODUCTION

The potential for Geographic Information systems [GIS] to address planning and policy issues (LCC, 1992) have been explored in a number of studies (Higgs et. al., 1994). Many studies have shown the methods by which GIS can be used for practical day-to-day management tasks whereby information integrated into GIS from a variety of different sources, at a range of scales, can be combined to produce new information and to extend the scope of analyses in planning.

This chapter explores the potential of GIS in spatial modelling and its applications in the fields of environmental management. The processes involved in GIS are also discussed. The catchment planning and management aspect emphasised under the methodology of this study, focuses on the management and preservation aspects of water quality and the ways of controlling land use activities to bring about improvement in water quality of the catchment. Various options are designed and later tested against the water quality model developed and applied using GIS. The chapter describes the model development for the research, the modelling modules, and their

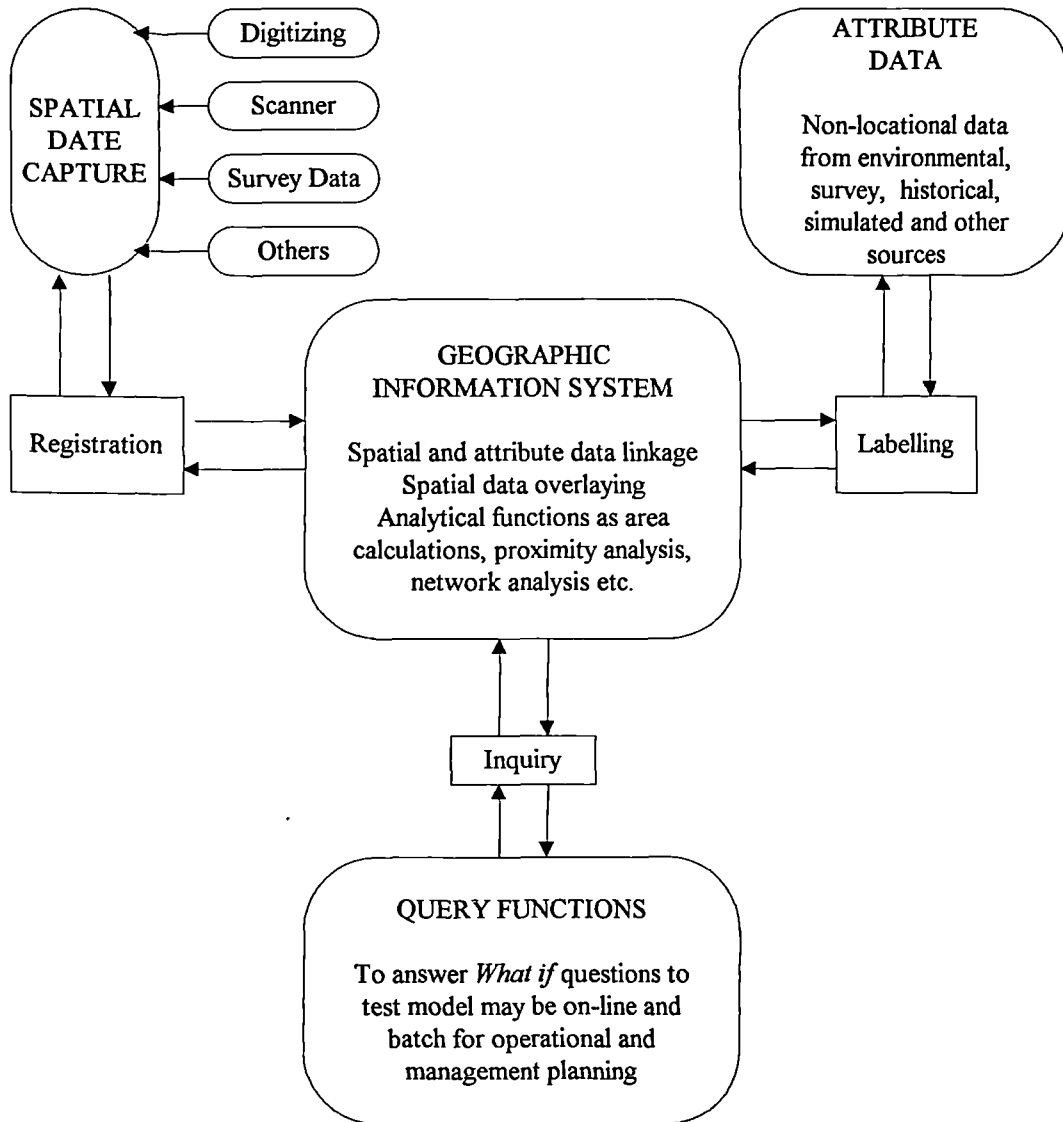
integration in the GIS environment to produce the projection of pollution loading and prediction of the water quality.

6.2 GEOGRAPHIC INFORMATION SYSTEM [GIS]

GIS relates to the digital capture of spatial data and spatial attributes and their linkage relative to one another. Essentially, the processing in GIS enables the user to deal with the query, analyses, reporting and output of these data (Archibald, 1987).

Until recently GIS has been perceived as a system that requires strong expertise and high cost to operate, resulting in the technology continuing to be underused. GIS however, may provide effective integration of data from various sources. Without the use of GIS, the problem often encountered is normally lack of data management which ultimately leads to uncontrolled data duplication, contradictory data and difficulties in accessing data and these being the main reasons for its being underused. With the aid of the GIS, data scattered and sometimes duplicated among several departments can be dramatically overcome when they are centrally managed and accessed in a distributed fashion.

Apart from the integration capability, GIS has numerous application with the ability to display maps, images or reports, and generate printed documents. Perhaps the most essential part of GIS capability is its use as a true decision-making tool with diverse *What If* scenarios that can be modelled (Figure 6.1). At the same time the tool enables the impact of the hypothetical decisions made to be visualised by the users. Therefore, with the ability of GIS as a powerful set of tools for collecting, storing, retrieving, transforming, and displaying spatial data from the real world (Burrough, 1986), GIS can be used as decision support tool that facilitates the integration of spatially-referenced data in a problem-solving environment (Cowen, 1988; Densham, 1991).



Source: Archibald (1987).

Figure 6.1 The Processes Involved in the Geographical Information System.

Many early systems were developed to solve relatively narrow, specific kinds of problems (Star and Ester, 1990). Vast progress had been achieved since the past where traditionally, GIS has been merely devoted to manipulating geographic databases and producing maps. However its application has recently been used extensively for planning, including the water quality protection programmes, and in studying the environmental processes (Goodchild, Parks & Steyaert, 1993).

Currently the application of GIS has expanded to include areas of urban, rural and environmental planning; coastal zone planning; natural resource conservation; health care and emergency planning; transportation and utilities management; agriculture; forestry; marketing and real estate management, and even in water quality management and catchment planning. GIS is relevant in many fields for which the handling, manipulation, and analysis of spatially referenced data is part of the analysis in decision-making process. Table 6.1 illustrates some of the fields of recent application of GIS in the UK.

With GIS becoming even more user-oriented, applications on which they are used have changed dramatically and promise a greater usability of GIS technology and brings new benefits to the users. This is well suited with the new release of GIS on Windows NT (i.e. ARCVIEW Version 3.1) which is much more user-friendly, hence the technology of GIS is becoming more promising. Even so, the purpose of using GIS needs to be fully understood in order to have the most out of the system that serves as a tool and provides support according to the functions and tasks of the institution.

In considering for a useful and efficient GIS support, the system should therefore, as described by Smith et. al. (1987) be able to provide the capability of (i) handling large, heterogeneous spatial databases; (ii) querying the databases about the existence, location, and characteristics of a wide variety of objects; (iii) allowing the user to work interactively with the underlying data and the required data analysis models; (iv) being easy to tailor to a variety of applications, as well as to many kinds of users; (v) being able to assess the data and the user's objectives; (vi) providing a readily interpretable output product for the ultimate users of the system.

Table 6.1 Some Recent Application of GIS in the United Kingdom.

Policy Area of Study	Researcher and year
Analysing land cover change	Miller et. al. 1991 ¹
Assessing the effectiveness of statutory designations on land use change	Higgs & Bracken, 1990a ¹
Assessment of discharge consents and abstraction licences	Bonvoisin and Moore, 1993
Assessment of recreational resources through visual impact assessment	Miller et. al. 1992 ¹
Catchment planning tool	
• AGNPS(Agriculture Non-Point Source) - linking the model to GIS.	Morse et. al. 1994
• CALSITE - simulation of erosion and sediment yield.	Bradbury, 1994
• NELUP (National Environmental Research Council - Economic and Social Research Council Land Use Programme) - Land use modelling.	O'Callaghan, 1994
comprising:	
1. the Quantitative models;	
2. the Hydrological models;	
3. the Ecological models; and,	
4. the Regional Agricultural Economic Model of Land Use.	
EIA	Selman, 1991 and Cocklin et. al., 1992 ¹
Environmental and landscape management	Cooper & Murray, 1992 ¹
Environmental auditing	Lancashire County Council, 1992 ¹
	Taylor, 1992 ¹
Environmental modelling	Goodchild et. al. ¹
Environmental targeting	Norman et. al., 1992 ¹
Farm woodland planting in a landscape ecological framework	Selman & Doar, 1992 ¹
Forest design	Priestnall et. al. 1993 ¹
Indicative forestry strategies	Aspinall & Miller, 1992 ¹
Monitoring landscape change in the national parks	Bird, 1991 ¹

Note:

¹ Source: After Higgs et. al. (1994).

6.3 GIS PROCESSES

The data capture exercise in the thesis has involved digitising the various thematic maps that are pertinent in the modelling process, using the Arc Digitising System module of ARC/INFO GIS. The resulting thematic maps will become the source inputs with useful information on resource management for further analysis.

For the purpose of the study, the sources which generate the pollution load of interest include the 'point' or localised sources and 'non-point' or diffuse sources. The point pollutant loads encompass: (i) the urban and rural residential which contribute to domestic sewage and surface water drainage effluents; (ii) the industrial sources, and (iii) the animal farming. The discharge from these sources are considered to originate from fixed stationary points. Hence, it would be sufficient for their location be represented as points. The centroid of the land tract for the point source was digitised to create point coverages. Each point will carry the attribute value representing their source identification. A look up table was formed to contain the discharge characteristics of each source.

The non-point pollutant load emanates due to runoff from built-up areas, agricultural and forest lands, etc. The runoff from these sources normally enters the waterbody over a large area at a relatively low concentrations. The area for which the non-point sources were derived was based on the present land use map. Polygon feature is used to represent the boundary of specified land parcel denoting its land use and it is from this polygon (later converted to grid cells) within the coverage the pollution load will be determined using the modelling technique which will be described in later part of this chapter. This will represent the non-point source contribution to the overall pollution loading.

To start with, before digitising commenced the map boundaries were drawn out and the tic, or registration points, (the four corners of each map) were marked and numbered. The points indicating tics were digitised and numbered and a master tic (registration) file was created. Once the digitising process had been completed, the coverages were 'cleaned' and 'built' in the ARC/INFO. After cleaning the coverages - these processes creates the topology - where any node or labelling errors were able to be displayed and corrected. Care, however, was taken in data capturing and registering to minimise errors, particularly where digital geographical data may be prone to imprecision and subject to variability that could affect its quality. When the ARC/INFO 'build' option is activated an attribute table is created. This table consists

of a listing of all the digitised points together with their corresponding user identification number.

The ARC/INFO GIS software (ESRI, 1992) was used extensively in developing the modelling system described in this thesis. The spatial objects dealt with in this thesis may comprise as points, lines, and polygons, with spatial elements associated attributes. It is the speciality of ARC/INFO GIS software where it can provide functionality for data capture, error refinement and verification, co-ordinate transformation, database construction and manipulation, spatial analysis and modelling, and data query and display (Morehouse, 1992). Two types of primary information are integrated within the ARC/INFO environment: (i) locational information that describes geographic information about the spatial elements and (ii) attribute information that describes what the spatial elements represent.

The basic unit of storage in ARC/INFO is coverage. Coverage represents a single layer of a map that contains information about locational feature. There is a topology in each coverage that defines the interrelationship between the spatial objects. With this topology, separation such as contiguity analysis can be performed without accessing the spatial features' tables or the co-ordinates of the features. Several programme modules (such as: ARCEDIT, ARCPLOT, GRID and TIN [Triangulated Irregular Network], which are capable of digitising, displaying and doing a wide range of spatial modelling and analysis, and surface modelling and analysis, as well as a menu driven visualising and display capability (using ARCVIEW)) make it very versatile and provide easy access to information particularly when in need to come with quick decision.

The ARC/INFO vector, grid, network and TIN data structures are each devised to produce a highly specialised type of representation that each of the others cannot accurately achieve. A grid is similar to an ARC/INFO coverage, but the attributes of grid are stored in VAT and managed by the INFO database management. Being a cell-based geoprocessing toolbox, integrated with ARC/INFO, grid provides a powerful environment in which spatial problem can be explored. In fact, spatial modelling is the

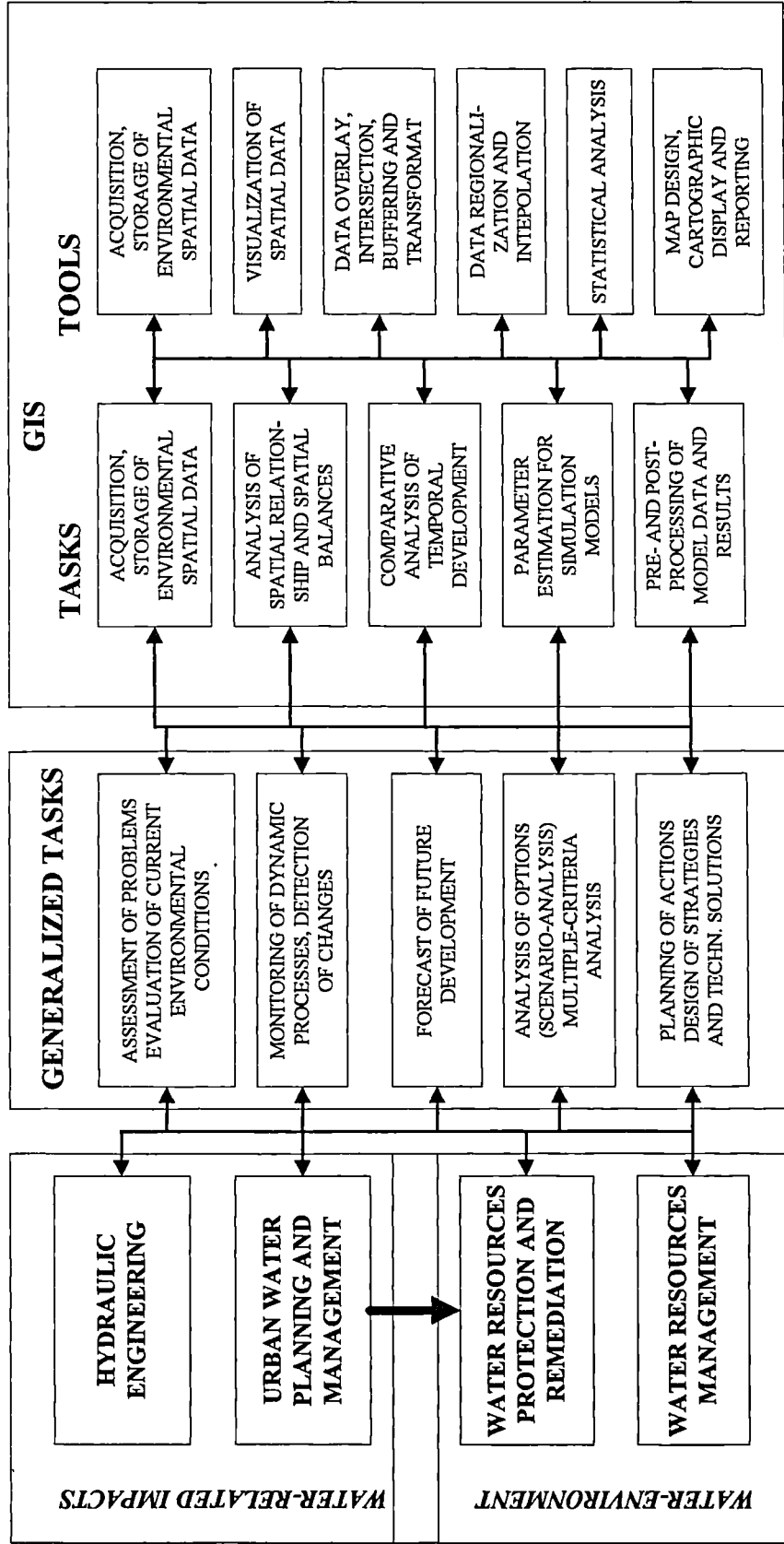
process of looking at characteristic of layers for each location to solve a problem. This thesis makes use of the ARC/INFO GRID (ESRI, 1993a) as the tool in the water quality modelling, in determining areas which are critically in need for consideration when selecting suitable development programmes. In fact, the hydrological modelling tool in GRID has the capability of using DEM to delineate a drainage system and then assess the characteristics of the system. It enables the determination of upslope area of any location and the downstream path water would follow. The models could also be used in determining the height, timing and inundation of a flood, as well as locating areas contributing pollutants to a stream and predicting the effects of altering the landscape (ESRI, 1993a).

6.4 WATER QUALITY MODELLING

6.4.1 Introduction

A number of water quality models have been developed to characterise the local, regional and national extent of environmental pollution problems and to assess the potential of socio-economic impacts (Liao and Tim, 1994). Water quality models developed on a catchment level will therefore provide an understanding of the processes involved in pollution generation from non-point sources as well as point sources and can be used to evaluate the effectiveness of alternative land management practices. Monitoring which is central to environmental planning and management application (Star and Ester, 1990), will be useful in determining the accuracy of the model and how development process results in deviation from the forecast scenario.

Bonvoisin and Moore (1993) presented the use of GIS technique to accelerate the estimate of river flows available to dilute discharges or to meet abstraction needs. In general, the water related impact, as shown by Kaden (1993) as in Figure 6.2, associated with GIS capability in solving specified task especially when dealing with spatial scales and spatial variability. Here, it shows that GIS are extremely useful with the ability of:



Source: Kaden (1993)

Figure 6.2 GIS in water-related environmental planning and management

- (i) making assessment of problems and evaluating the current environmental conditions;
- (ii) performing monitoring of the dynamic processes and detecting the environmental changes taking place;
- (iii) predicting the nature of future development;
- (iv) analysing the various options under the various scenarios; and,
- (v) pursuing with planning for necessary actions, and designing strategies and technical solution in ensuring the development activities do not caused destruction to the water environment.

Such capabilities of GIS will be applied in analysing the case study of this research.

6.4.2 Model Development For The Study

Many problems were encountered by modellers until recent development in GIS where it can now provide the opportunity and tools to spatially organised and effectively managed data for modelling. Large numbers of models have been developed to predict the non-point pollution problems especially in the rural (agricultural) landscapes. Such models have varying degree of empiricism, functional representation, and deterministic or stochastic description of the processes.

Modelling techniques thus far introduced, vary in complexity and approach from techniques using simple regression with few inputs to complex models needing large quantities of inputs. Attempts have been made to replicate real situations as closely as possible. Categorically, there are two types of models, namely the Screening Planning Model (SPM), and the Hydrological Assessment Model (HAM). The SPM, which is a simpler type, assigned unit pollution loads to the various land uses within the catchment. This tool is capable of estimating non-point pollution load for different land uses (McElroy et. al., 1976).

On the other hand, the HAM can produce long-time series outputs that reflect hydrologic and meteorological conditions. These models range from small field to deterministic process-oriented, large catchment model. Some of these models facilitate the analysis of water quality problems at landscape level. The HAM may be based on lumped parameter or distributed parameter type (Novotny & Chesters, 1981).

Unlike the lumped model, the distributed parameter approach divides the catchment in smaller homogeneous units with uniform characteristics whereby initially each unit been modelled separately and later these homogeneous units were summed up to produce the final output. The distributed model was known to represent spatial variability of rural catchments more accurately though they would require large amount of input data that are often unavailable.

However, for planning purposes such as in the thesis and especially where a larger area is involved, a simplified model such as the screening model is found to be much more useful. Such a model could be used to delineate critical areas of pollution for resource allocation and to characterise the water quality situations of complex rural landscapes. This will provides the first task in the modelling to assess the existing problem of specified area and evaluate the current environmental conditions (Figure 6.2), the output of which will be essential in the Report of Survey of the proposed Catchment Management Plan.

The land use map along with other maps, including soil types, topographical and rainfall maps will provide important pieces of information that determine the amount of pollution load generated by the system. The amount of soil particles washed to the watercourses that represent the non-point pollution load from the rural landscape was determined by the application of the Universal Soil Loss Equation. As for pollution loading from the point sources, the data required was gathered from the Department of Environment records and publications and other available literature.

The simulation model is carried out by incorporating the various equations using the GRID overlaying technique. The model is calibrated using the information on present (based on 1990 figures) land use, river hydraulics, water quality, and pollution load.

The output from the pollution load modelling in combination with the present water quality status and in comparison with the water quality objectives will enable the delineation of areas with high impact on water quality (Figure 6.3). The delineated areas are matched against the river sensitive stretches to determine the compatibility of the present land use in meeting the desired water quality objectives and these together will be utilised to form an action plan under the proposed catchment management plan for the area of interest.

In producing an integrated catchment management plan, the modelled GIS output above will be analysed together with the development plans to detect the compatibility of such plan and a final version map indicating areas which need reconsideration will be produced. This output is expected to form the basis in formulating the integrated catchment plan.

The case study area selected for the modelling purpose and CMP development is the Linggi River Basin. The background on the catchment area used for the modelling studies is described in the proceeding chapter. Linggi River basin has been known for being one of the most polluted river in Malaysia (Nather Khan, 1992 and Johari, 1995). Each source of inflow into the rivers is designated by a cell on the GRID map, and the individual cell representing the point source is assigned with attribute values according to the amount of pollution loads discharged. The monitoring stations are considered as nodes on the river channel at which point, the various loading rates between two nodes are totalled to give the amount of load received at the monitoring stations.

Evaluation on flow rates, amount of pollutants through the entire system, assuming 'plug flow' and complete mixing. The pollution loads considered in the model include the point sources and the non-point sources. The point sources as discussed earlier,

include effluents from domestic sources as well as pollutant load from industrial sources found in each area. The detailed background on Linggi River will be discussed in Chapter 7.

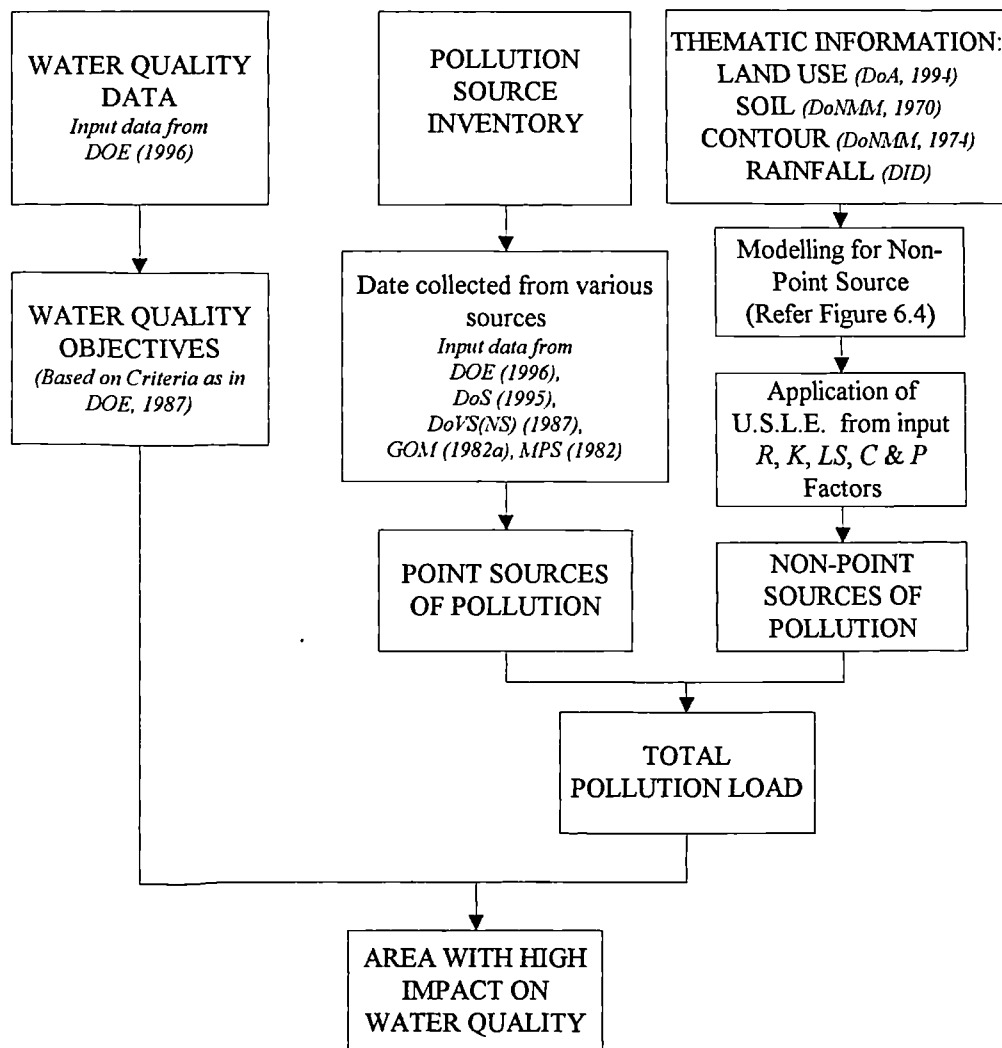


Figure 6.3 Analysis for areas having impact on water quality.

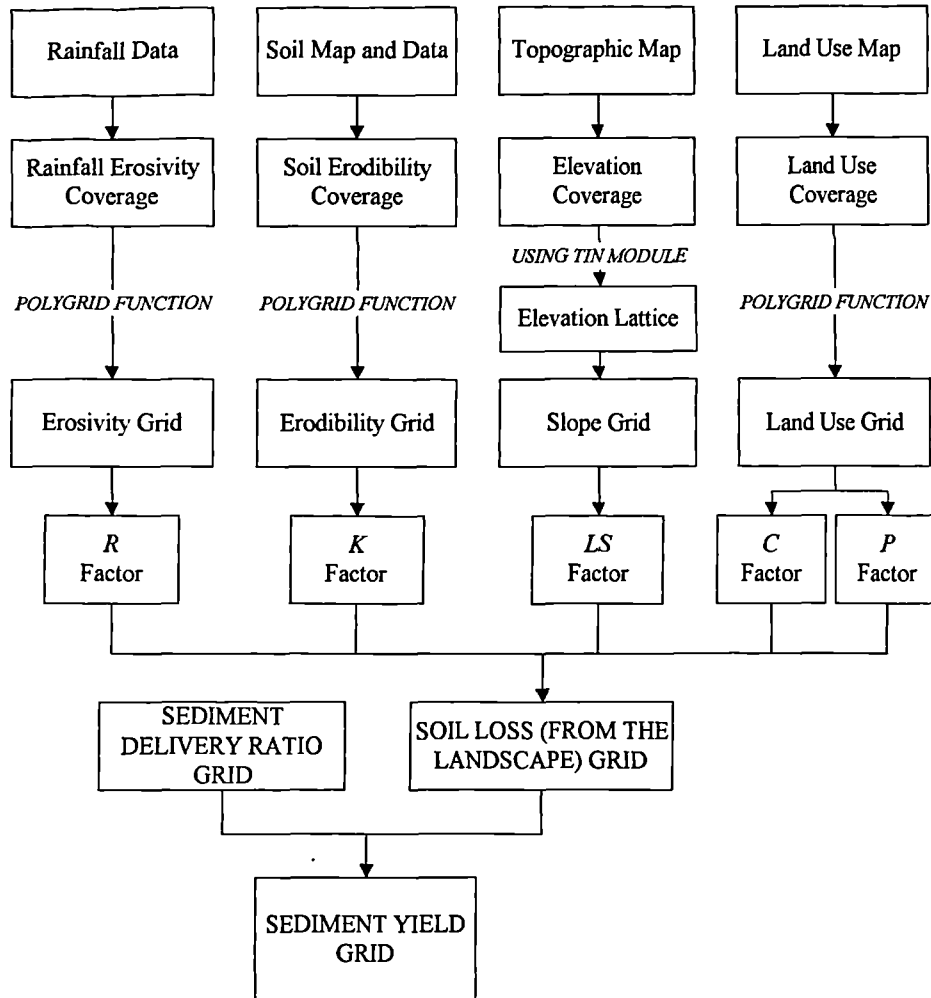


Figure 6.4 Water Quality Modelling for Non-Point Sources of Pollution

Analysis of water quality monitoring data for the study area enables the detection of changes in the river water quality as a result of land use changes taking place within the catchment area. Nevertheless, caution should be exercised in the interpretation of the water quality data as a positive change (improvement) in water quality can either be as a result of tougher control on the sources of pollution or it may also reflect that little developmental activities took place in the catchment area. However, as Seremban town is rapidly developing, it is not likely that any occurrence of an

improvement or a no change condition could be due to a “no-development situation” within the area. SHMB (1993) mentioned that the factors contributing to change in the existing river water quality include:

- changes in the effluent flow and pollutant loads of point source discharges;
- changes in land use which could affect the pollutant loading of non-point source discharges; and,
- changes in river hydrology caused by flow regulation, increases abstraction or discharges or improvements with controlled compensation releases.

Development programmes taken into consideration in the modelling process were based on the Report of Survey for Seremban Municipal Council area (i.e. the Seremban Structure Plan). It is necessary to realise that within a catchment, it may involve more than one land use planning authority but for the purpose of this study area, the Linggi Catchment comprises only one land use planning framework, and for this case it involved solely the Seremban Structure Plan. The lower part of the river falls under the District of Port Dickson planning area, and therefore the Structure Plan for Port Dickson will apply in that particular case. Identification of new development areas were based on the proposed land area for residential, industries as specified in the Seremban Draft Final Structure Plan (i.e. the Report of Survey for the Municipality of Seremban), 1982. Reference was made to this document as this is the only official document outlining the physical and socio-economic development of the study area.

Once calibrated, the model is ready to be used for predicting the water quality at the various river stretches under different pollution control scenarios. The selected policy areas used in the model testing include: development for (i) housing areas (which is related to the population distribution in the catchment area); and (ii) industries (or industrial estates where common discharge points were identified). An assessment was made on new development sites and these areas are defined as “new” after the 1990 base year. These land use units represent the main source of water pollution in

Malaysia in general and Linggi River in particular. The different scenarios developed for this study is as discussed in Section 6.4.6.

The main reason this study was felt important is that it will contribute a way of assessing certain impacts of decision making on the entire catchment in terms of both the quantity and the quality of the river water, as discussed in the previous chapters.

With the identified issues in hand, the appropriate actions will be designed and to be incorporated into the Action Plan of the CMP. Other sources where such issues can be gathered through feedback received from the participating agencies and parties in the CMP committee which is to be formalised or the existing River Clean-up Committee in each State. This should, however, include the representation from the public.

6.4.3 Modelling Modules

The study also aims at searching for methods to intelligently simplify complicated spatial environments - though the situation would be much more complex - and render them into interpretable and practical settings. The modelling system will assist planners and other users in assessing soil erosion, sedimentation from rural and urban landscape: representing pollution from the non-point sources; and pollutants from the point sources, within a single software environment. The modelling support system has the capability of delineating critical areas of the catchment in a very short time. Figure 6.4 illustrates the flow chart of the water quality modelling. Under this section, the simplified model used in the water quality modelling system is described in the various modelling modules.

6.4.3.1 Soil loss prediction

Soil erosion rate has been simulated from the model using the universal soil loss equation [U.S.L.E.] formulated by Wischmeier and Smith (1965, 1978). The U.S.L.E. was developed to (a) predict average annual soil loss from a given field slope under

specified land use and management conditions; (b) estimate the reduction of soil loss attainable from various changes in farm management, cropping system, and cultural practices; (c) provide localised data on soil erosion rates to conservation agencies and resource managers when discussing erosion control (conservation) plans with farmers; and, (d) guide the selection of conservation practices (Liao and Tim, 1994).

$$A = R * K * (LS) * C * P$$

where, A is the soil loss from the catchment area; R is the energy-intensity or rainfall-intensity factor that is equal to the sum of the rainfall-erosion indices for all storms during the period of simulation; K is the soil erodibility factor that represents a measure of potential erodibility of a given soil composition; LS is the slope-length factor that is a function of overland flow length and land slope, and adjusts the soil erosion rates for the effects of length and steepness of each land segment (grid cell); C is the cropping management factor that relates to vegetation cover, soil conditions, and general management practices on erosion rates; and P is the conservation practices factor that accounts for the erosion control effectiveness of land treatment as contouring, sedimentation basins and detention ponds, or other similar control structures.

6.4.3.2 Sediment yield prediction

Not all of the eroded soil particles find their way into streams and rivers. The amount of sediment delivered to the stream or catchment outlet (termed as sediment yield), from each land segment, is obtained by multiplying the soil loss rates (A), as determined in section 6.4.3.1, by a delivery ratio. This is given as:

$$SDR = A * DR$$

where SDR is the total amount of sediment delivered to the stream and catchment outlet; and DR is the sediment delivery ratio that depends upon land cover, slope, and distance to the stream channel or catchment outlet. The DR “provides a cover for real physical storage processes as well as for errors in estimates of the amount eroded and for temporal discontinuities of the [sediment delivery] process” (Wolman, 1977). Hence, DR generally decreases as the overland flow length increases.

6.4.4 Water Quality Modelling Using ARC/INFO

The basic components of the modelling process include catchment boundary, soils, land use and land cover information, topography, and climatic features.

The captured digital data are stored as vector coverages in ARC. The modelling data (R , K , LS , C , P) are extracted from the databases and converted to grid-cell data in ARC/INFO GRID for spatial modelling.

The basic coverages required in this module include watershed boundary; elevation (in the form of digitised contour lines) to be modelled using the Triangulated Irregular Network [TIN] (for generating LS factor); land use and land cover (for obtaining C , P) and soil data (for determining K). Attribute data for these factors are stored as INFO files, which are linked to a corresponding spatial data coverage.

6.4.4.1 Generating LS factor

The Triangulated Irregular Network [TIN] in ARC/INFO (ESRI, 1993b) was used to generate the grid cell-level values of the topographic factor LS . The recent version of ARCVIEW (i.e. Version 3.1) contains spatial analysis functions which enable a slope map to be derived from Digital Elevation Model [DEM] (note: this was not available at the time when modelling for the slope map was carried out). Consequently, the land slope (S), length of slope (L), and the corresponding LS factor were generated from the elevation grid. A look-up table was used to assign the values of S and L for each grid

cell. The corresponding L and S values were combined to produce the LS factor by using equation below:

$$LS = L^{0.5} [0.0138 + 0.00974S + 0.00138S^2]$$

(After Steward et. al., 1975)

6.4.4.2 Generating K , C , and P factors

The coverages included in generating these factors are the land use / land cover (with C and P factors) coverage, and the soil coverage (with K factor). The fishnet coverage was overlaid with the target coverage (e.g. K factor coverage), and the weighted average grid-cell values of each factor were calculated. Grid-cell level values of the C factor were derived in a similar manner from the land use / land cover coverage.

6.4.4.3 Generating Sediment Delivery Ratio

The Sediment Delivery Ratio (DR) represents the ratio of sediment yield to soil erosion for a given grid cell and the ratio will determined the amount of sediment that reaches the catchment outlet. There are two options where this ratio can be derived.

One way, in obtaining DR as described by Liao and Tim (1994), is to generate the distance as well as direction of stream flow in each grid cell from hydrography coverage. Then, an aspect coverage was obtained by combining the overland flow direction coverage with the channel flow direction coverage. The input grid required for this task include: boundary grid, elevation grid (from LS factor generation), stream grid (from LINEGRID command), and stream direction grid. Stream grid and stream direction may be obtained from the hydrological modelling module of ARC/INFO GRID (ESRI, 1993a).

Alternatively, the DR may be calculated using the formula given by,

$$DR = 77.683 * A^{-0.065} * (R/L)^{0.213}$$

(after ERINCO, 1994)

where,

DR = Sediment Delivery Ratio

A = Catchment Area, sq. km

R/L = Relief Length Ratio

R = Change in elevation of the stream, m

L = Length of the stream, m

For the purpose of this study the later option was chosen and this was converted into the grid-cells for further analysis.

6.4.5 Assessment Of Pollution Load

When dealing with a situation of a mixed urban-rural landscapes, the generation of pollution loading from point sources could be as important as for the non-point pollution contribution. Hence, to realise the actual amount of pollutant load entering the water system, data on point source discharges were collected from published and unpublished sources of information from the relevant agencies such as DOE, the Department of Town and Country Planning and the local authority.

As mentioned in section 3.3.5, the discharges of sewage, animal wastes and industrial effluents are the most prominent point sources and have become the main focus in this study, in addition to the non-point source contributing to the pollution load received by the river system.

To calculate the sediment yield, the ZONALSUM function in GRID is used in adding the values of all the cells within the same group (i.e. the sub-catchment). Hence, the amount of sediment load at a monitoring station will be equal to the total sediment load from its upstream locations, and this could be obtained by summing the amount of load from the sub-catchment involved. For other non-point source pollutants, the same procedure applies, but each land use type should first of all be assigned with an appropriate value that represents the pollutant generated. Similarly for point sources, the ZONALSUM function is used to give the total pollution load generated by domestic sewage, animal husbandry and industrial processing.

Based on these pollutant loading, the calculated value for river water quality in terms of concentration can be obtained. However it has to be adjusted by comparing with the actual river water quality based on monitoring results.

6.5 DEVELOPMENT PROGRAMMES UNDER DIFFERENT ENVIRONMENTAL CONTROL SCENARIOS

The assessment of development programmes needs to consider the essential principles that uphold strong sustainability which was discussed in Chapter 2. The criteria developed in determining the impacts under different environmental control scenarios include: (i) resolving the problems related to sewage disposal and the extent of its impacts. This is anticipated to be achieved through the implementation of the centralised sewerage treatment facility for Municipality area as opposed to the conventional septic tank facilities; (ii) improving the level of compliance for industrial discharges so as to achieve the limits as specified in the related legislation; (iii) controlling the discharge of animal wastes by the year 2000. Based on these defined criteria, three main categories of environmental control are identified, with each of the category having different options that could possibly take place when predicting the amount of wasteload and river water quality by the year 2000, and their ability to achieve the water quality objectives. These categories are:

- No Environmental Control
- Weak Environmental Control
- Strong Environmental Control

6.5.1 No Environmental Control

Basically, this reflects a “do nothing” option in which development would proceed without further control to prevent deterioration in the river water quality. The consequent effects on the river water quality will be devastating because the river may be deprived of its beneficial uses.

Case (c1) The scenario under this category can be described as: the population is expected to increase at the current growth rate, while it has been assumed that there will be no improvement in the present methods of sewage treatments or in their treatment efficiencies. Most development activities are anticipated to take place within or at the periphery of the Municipal Council boundary. No new industrial development is assumed nor would there be any change in the present industrial discharge pattern or to their wastewater discharge quality. It is also assumed under this scenario that no improvement will take place in the discharge quality from animal farming activities.

Case (c2) As compared with Case (c1), all assumptions made are the same except it explores the impact of development of industrial activity within all locations identified as *potential* areas in the Structure Plan. However, the discharge quality from the industries remain at the 1990 level.

6.5.2 Weak Environmental Control

Improvement in the river water quality is anticipated by regulating pollution discharges through legal means, such as licensing and the imposition of stringent discharge limits. Several generation of standards may be formulated to achieve the desired level of discharge and avoid contravening the river water quality objectives. The reduction of wasteload can be achieved through various ways such as:

- (i) imposition of the use of better treatment system with an improved efficiency;
- (ii) encourage only clean development i.e. through the selection of appropriate type of industrial operations within various sub-catchment areas or to allow only newer industries with zero discharge to operate;
- (iii) industrial discharges that may not be economically viable to undergo extensive treatment may consider to discharge their wastewater in a central sewerage system when such system is ready to accept the industrial wastewater; or they may be moved to locations that do not require high standard of compliance;

For the purpose of this study, the reduction in industrial pollution loading were based on the standards of compliance as stipulated in the Environmental Quality (Sewage and Industrial Effluents) Regulation, 1979 (Table 4.5), Environmental Quality (Prescribed Premises) (Palm Oil Mill Effluents) Regulations (1977) (Table 4.2) and Environmental Quality (Prescribed Premises) (Raw Natural Rubber Effluents) Regulations, 1978 (Tables 4.3 and 4.4).

It is possible that these standards could be complied with, as in the progress made for the wasteload reductions in palm oil processing and rubber processing industries. For both palm oil processing and rubber industries, their wasteload reduction has achieved more than 95 percent reduction in the organic loads and much cleaner discharges are anticipated. Nevertheless, it is important that environmental control proceed within the purview of the regulatory power under the jurisdiction of the Department of

Environment. In which case, the control over other sources such as domestic sewage and animal wastes or non-point sources would be unlikely to take place without the support and co-operation of other relevant agencies. The scenarios under this category follow the situation according to the assumption made below:

- Case (a) The trend of population growth is expected to continue at the same rate with an increase in population as in Case (c) but it was expected that the enforcement agency would take tougher actions to control industrial discharges which would therefore enable the achievement of a total compliance with the existing regulations. However, no new industrial source will be allowed to be established under this scenario. This scenario reflects the ability of DOE's role within its jurisdiction to abate pollution, given the present situation still prevail, whereby DOE has lesser power to act on matters such as animal wastes disposal and land. The status of sewage treatment facility is assumed to be pretty much the same as the 1990 situation although the privatisation process on of sewerage works has taken place.
- Case (b1) Similar to Case (a), but industries are expected to operate in all the *potential* areas identified in the development plan as suitable for industrial development.
- Case (b2) As in Case (a), but new industries will only be allowed to take up the locations within the proposed industrial land identified as *proposed* in the Seremban Structure Plan.
- Case (b3) As in Case (a), but new industrial development will be concentrated in areas identified as the *potential and proposed* industrial areas.
- Case (b4) With population increase at the current growth rate, the urgency to reduce the wasteload generated by the sector is assumed to exert pressure on the sewerage company to speed up the implementation of the centralised

sewerage treatment facility in order to handle problem of domestic sewage disposal particularly from the municipal areas. The treated sewage from the centralised sewerage facility is assumed to be discharged downstream of the water abstraction point for public water supply treatment plant at Kg. K. Sawah in the District of Rantau. The description of the study area and the location and capacity of this water works is given in Chapter 7. The waterworks supply water for the District of Seremban (the study area) and the District of Port Dickson. No new industrial development is assumed under this case scenario.

Case (b5) The scenario under this case is similar as in Case (b4), but it is assumed that new industrial development is allowed to proceed within the areas identified as *potential* within the study area.

6.5.3 Strong Environmental Control

The increase in public awareness for water conservation complements the efforts to minimise wastewater discharges into the rivers. All sectors need to effectively play their role in the conservation of water. On balance, the reduction of wasteload from domestic sector is essential as they contributed a large proportion of pollution hazard that affects river water quality of the catchment. Consideration on the option to implement the centralised sewerage treatment facilities is inevitable, due to increasing pressure to maintain the cleanliness of the Linggi River. There is a bright prospect of restoring a good and clean river water quality when the option is being implemented and the improvement anticipated will enhance other beneficial uses of the river. The local authority is anticipated to play an active role in promoting water conservation. However, this is not likely to happen without an effective public education programme on water conservation coupled with a defined mechanism for their proper implementation. At the same time, with the assistance from relevant agencies (mainly the Department of Veterinary Services and the Local Authority), the discharge of animal wastes can be put under control. This initiative is anticipated able to reduce the

impact of animal wastes on the river system enormously and it is expected to produce a significant improvement in the river water quality as a whole.

Case (b6) As in Case (b4), but with new industrial development assumed to take place as in Case (b2). Under this scenario, waste reduction is expected to be reduced by half. This can be achieved with the normal biological treatment system of sufficient capacity.

Case (b7) As in Case (b4), but with new industrial development assumed to take place as in Case (b3). No discharges from animal farming activity is expected, which means the treatment systems on farms should be able to treat the animal wastes and a wastewater recycling system has to be installed to allow for zero discharge. Alternatively, political decisions can be made, insisting all polluting animal farms be resited to an alternative location.

All the assumptions under the different case scenarios described above are summarised in Table 6.2. Through the modelling process in the ARC/INFO GIS environment using GRID, it will help to generate the best options that could be the basis of actions to be set under the Catchment Management Plan.

To allow for the selection of the best option(s), the various case scenarios will be tested against the model (Figure 6.5). The results from such tests will form the basis in deriving the action plan. Places - including those with critical slope limits (those greater than 20°) as identified in the Land Conservation Act, 1960; subjected to high erosion risks; within polluted water quality region; and, generating high discharge of pollution load - essentially fall within the critical areas where detailed mitigating measures should be specified to overcome the impact they have on the catchment's water resource. Concomitantly, a review of the development proposal from the development plan for these critical areas, along with the test case described above, would help to produce a concrete action plan for the catchment in ensuring a sustainable water use for the region.

Table 6.2. Deriving Strategic Choices in Controlling Development Programmes.

Planning Decision	Case	Central Sewerage Facility	New Industrial Development					Animal Wastes		
			No Improvement in Discharged Quality		Improved Industrial Discharged Quality			No Improvement	Improved by 50 %	None
			Only Existing	Potential Areas	Potential Areas	Proposed Areas	Potential & Proposed			
No Environmental Control	c1	No	Yes	No	No	No	No	Yes	No	No
	c2	No	No	Yes	No	No	No	Yes	No	No
Weak Environmental Control	a	No	No	No	No	No	No	Yes	No	No
	b1	No	No	No	Yes	No	No	Yes	No	No
	b2	No	No	No	No	Yes	No	Yes	No	No
	b3	No	No	No	No	No	Yes	Yes	No	No
	b4	Yes	No	No	No	No	No	Yes	No	No
Strong Environmental Control	b5	Yes	No	No	Yes	No	No	Yes	No	No
	b6	Yes	No	No	No	Yes	No	No	Yes	No
Strong Environmental Control	b7	Yes	No	No	No	No	Yes	No	No	Yes

6.6 SELECTION OF THE BEST OPTIONS

The selection of the best option will be guided by the results of the test case scenarios which are then compared with water quality criteria and standards for the particular river stretch under consideration. An assessment to determine whether the option tested manage to attain the desired water quality objective will follow.

The adoption of the water quality objectives is a prerequisite for the implementation of stream standards. The water quality objectives will provide specific direction in guiding planning activities, without which the attainment of the desired river uses cannot be achieved. The scenarios above help decision makers in choosing the option based on the appropriate environmental control strategy and ensure the implementation of development programmes do not jeopardise the desired water quality.

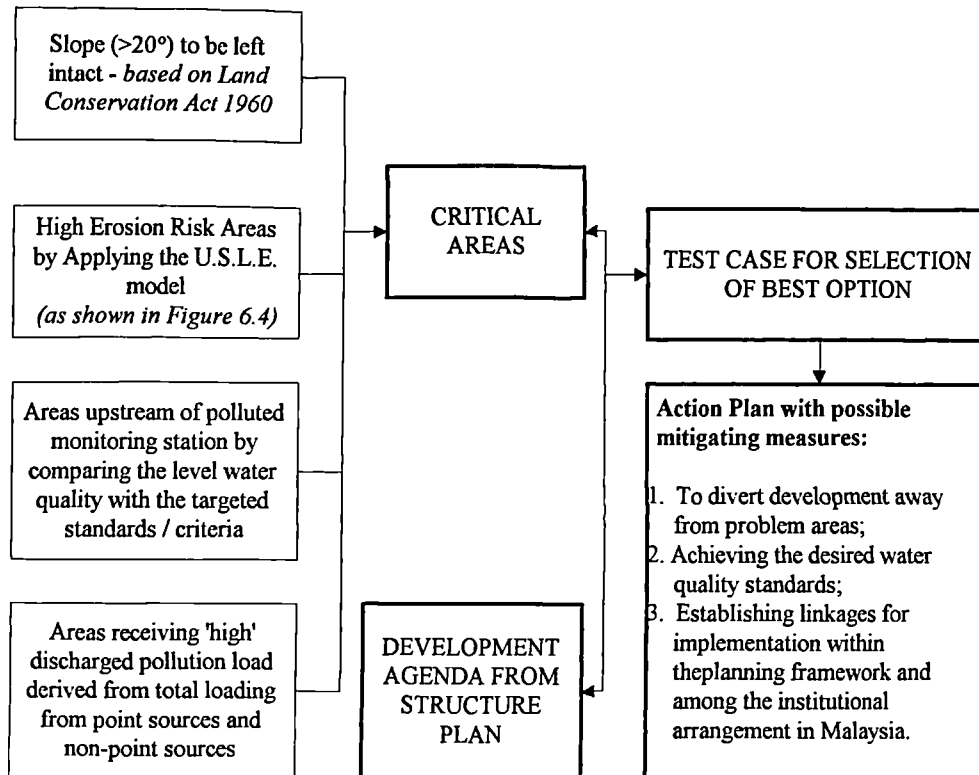


Figure 6.5 Deriving an Action Plan

The water quality classification as specified based on the water quality criteria and standards for Malaysia (DOE, 1988a) and summarised below, was used in the determination of the existing water uses at the various river stretches. Preference was made on the uses that concern the large majority of population. In the study, the main beneficial river use within the catchment is the abstraction for public water supply. The locations of the beneficial river uses within the catchment are as identified and illustrated in Chapter 7. Below is a summary of the water quality criteria classifications:

Class I	Conservation of natural environment
Water supply I:	Practically no treatment necessary (except by disinfection or boiling only),
Fishery I:	Very sensitive aquatic species.

Class IIA	Water supply II: Fishery II:	Conventional treatment required, Sensitive aquatic species.
Class IIB	Recreational use with body contact.	
Class III	Water supply III: Fishery III:	Extensive treatment required, Common of economic value and tolerant species, Livestock drinking.
Class IV	Irrigation.	
Class V	Water unsuitable for specified beneficial uses.	

This procedure provides a means of identifying problem areas that needed attention and helps the setting up of action plan that should be conducted in an integrated manner with the intention of restoring the river capacity so as to serve its purpose. This procedure, however, is not intended to replace the formal committee as required under CMP, since such committee has an important role to play in terms of identifying actions to efficiently rectify the issues relating to water resource, with the involvement and representation from the public.

Linkage to the development plan is made in order to identify future development activities and they can be tested against the designed model. Input data relevant to the modelling process as contained in the development plan such as population distribution and housing density, urban land use, drainage planning, sewerage facilities provided and planned, existing and proposed industrial development, and the preservation of essential landscape that could influence the river flow regime and water quality, are pertinent in the study so as to establish the context of the probable

scenarios. The forms in which the various pieces of information were utilised to make future prediction are further discussed in Chapter 7.

The modelling technique as described earlier, is also intended to demonstrate the extent in which various factors can be manipulated to achieve the water quality target. Generally, the forms of control as proposed will rely on proper management of land use, besides requiring the institution of stricter water pollution control strategies. Once the river's water quality is able to match the desired water quality objectives, application of effluent limits within the river segment will suffice to sustain the desired water quality target. However, if the predicted water quality could not match the water quality objectives, then the water quality limit has to prevail and this may require a wasteload redistribution scheme to be employed with a feasible source control (covering both point and non-point). Consequently, it would probably necessitate a revision or to reaffirm the water quality standards at any particular river stretch, where certain beneficial river uses are either maintained or otherwise be replaced with a suitable use in the future.

6.7 CONCLUSION

GIS has great potential to address planning and policy issues and it can even be used for practical day-to-day management tasks. Because of its capacity to effectively support quick decision making processes, and its potential to meet the present day requirements in portraying relevant information and complex analyses, this tool was chosen to be used in the modelling process in this thesis.

The evaluation on the impacts of land use decision on the water quality which normally involve long and tedious task can be simplified using the GRID ARC/INFO GIS cell-based modelling technique to generate: (i) an assessment of the diffuse (non-point) sources of pollution which is particularly important in rural landscape of the catchment area; and (ii) an assessment on the changes to water quality as a result of

any decided change in the land use units which will indicate either a positive or negative impact. In fact, GIS has been shown to be a useful tool for defining critical areas of environmental pollution and assessing the effectiveness of alternative management strategies for implementation at catchment level.

Although similar studies have been carried out before, no emphasis which relates the findings to land use planning decision was found. As such, development programmes were often undertaken with little understanding of the entire catchment areas or it will requires exhaustive tasks of conducting surveys and baseline studies which significantly have a direct effect on time consumed before proper decision could be made. This approach will help to expedite decision making process, by incorporating relevant information on catchment management planning with particular emphasis on their impact on water quality, when quick decision-making process becomes essential.

The methodology described in this chapter has listed ten test case scenarios which will indicate problem areas of the catchment and helps to established an action plan that will ensure the sustainability of the catchment water use to meet not only the present consumption or uses, but also for the future generation to meet theirs. These cases can be categorically divided into three, and the cases of environmental control to be adopted should imply the strong sustainability stance which is consistent with the underlying environmental policies of the country. This chapter discusses on method for the selection of option to be proposed for further examination in the next chapter.

The key factors as described in the methodology therefore include:

- Catchment modelling used in the thesis is based on a Simple Planning Model.
- Simple models are appropriate when spatial solutions are required; however more sophistication might be necessary as data accumulates and the political tempo hots up, making uncertainty less acceptable.
- The model used in the thesis, besides making assessments of the problem and evaluating the water quality status, also predicts the nature of future development,

analyses the various options under various scenarios, and recommends necessary action for sustainable water uses.

- Nevertheless, several model limitations were identified and these are discussed in the succeeding chapter.

CHAPTER 7

CASE STUDY ANALYSES, RESULTS AND DISCUSSIONS

7.1 INTRODUCTION

This chapter presents the background of the study area and provides the data and information used in the research. It elaborates on the results of analyses and modelling of water quality using the Geographical Information System [GIS], and proceeds with the discussion on the causes and impacts on the water quality due to the changes in land use pattern or arising from decision related to the land use activities. It also discusses the problems encountered while making use of GIS in delineating critical areas, the validity of water quality model described in Chapter 6 and introduced several recommended actions to improve the catchment water quality.

The main reason for the selection of the catchment under study is particularly because of the following:

1. Water in the catchment is an important source of water supply for the Municipality and its adjacent towns particularly the famous beach resort (i.e. Port Dickson).
2. The water quality at the water abstraction point for treatment has been seriously affected by activities taking place upstream and it is therefore considered as

critically important that the situation be corrected in order to ensure a sustainable water resource within the catchment area.

3. Poor water quality at most stretches of the river which unable to attain the desired water quality objectives.

7.2 PHYSIOGRAPHY OF THE STUDY AREA

7.2.1 Location Of Study Area

The study area is in the State of Negeri Sembilan (one of thirteen States in Malaysia) and covering mainly the District of Seremban. It includes the entire upstream catchment area of the Linggi River and its tributaries from just downstream of the confluence of the Linggi River with the Simin River. Located within the catchment is the Municipality of Seremban (MPS). Seremban is situated about 70 km. South of the Malaysian capital city of Kuala Lumpur and is about 32 km. inland from a beach resort, Port Dickson. Specifically Seremban is at latitude 2.75° North and longitude 101.9° East. It is the commercial and administrative capital of Negeri Sembilan. Seremban is also situated on both the main Kuala Lumpur - Singapore highway and railway line.

The MPS covers an area of 106 sq. km. which includes the old Seremban Town Council area as well as portions of six other zones within Seremban District comprising Ampangan, Labu, Pantai, Seremban, Rantau and Rasah. The location of MPS is also at the centre of the 950 sq. km. Seremban District. The MPS area is entirely within the Linggi River catchment area.

Historically, Seremban was known as Sungei Ujong. It was founded in 1800s near the confluence of several small rivers (i.e., Temiang River, Paroi River and Batang Penar River) and later it grew into a small tin mining centre around the year 1900. Now all tin mining activities in the area have ceased operation. Seremban has developed from the old Town Council area of 21 sq. km. to become the Municipality of Seremban on

1 March 1979, with an additional 85 sq. km. of partially developed and rural lands. The surrounding rural lands within the catchment are currently under the jurisdiction of the District Council. Figure 7.1 illustrates the location of the study area and the Municipality of Seremban within the Linggi catchment area.

7.2.2 Population

Population is one of the most fundamental considerations; not only will it determine the scale of programmes within the development plans, such as in the Structure Plan and Local Plan, but it also indicates the extent of impact on the environment from activities generated at the catchment level. In the development plans, the size of existing and future population provides the basic determinant of the type and level of education and other social and community services to be provided; the demand and supply of labour; types and levels of demand for public utilities and transportation; and all other social and economical services that have to be planned.

At the catchment level, apart from all these considerations, the generation of pollution both from domestic as well as industrial sectors will be of main concern. Population growth will also mean more development projects will be anticipated which will exert constraints on the existing water resources to meet the present as well as the future demand.

The 1991 census indicates that the population of Seremban Town is about 76,284, the Seremban Municipality having a population of 196,866, whilst the Seremban District has a population of 263,383. The spill over from the new development of Putra Jaya and the Kuala Lumpur International Airport (KLIA) will give rise to more development opportunities around Seremban Town and its environs. It was estimated that the population in the year 2000 for the areas concern will be as shown in Table 7.1, assuming the population growth rates of 3.4 percent for Seremban Municipality, 2.0 percent for the Seremban District and 2.0 percent for the State of Negeri Sembilan.

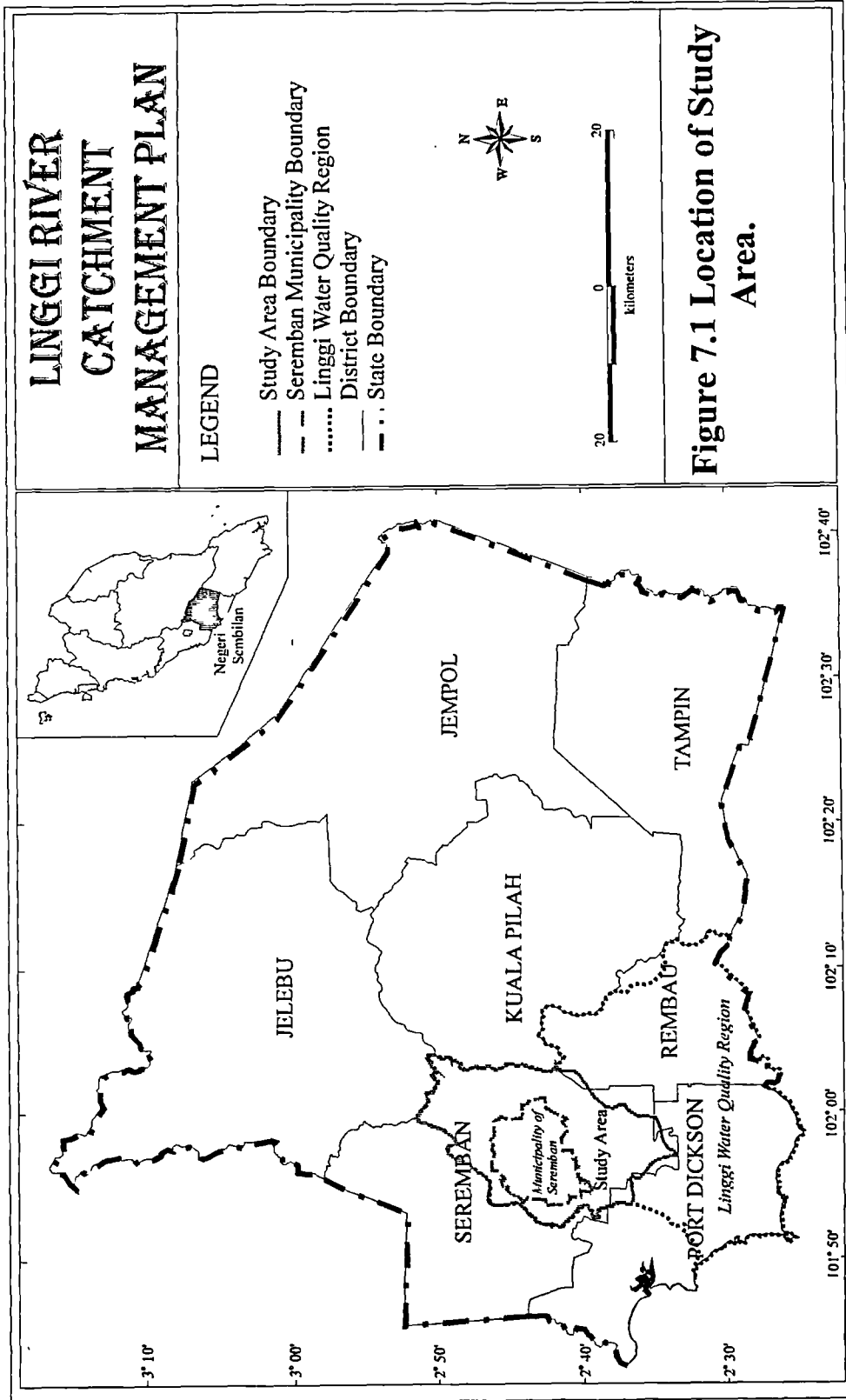


Table 7.1 Negeri Sembilan: Population 1970 - 2000.

Area	1970 ¹	1980 ¹	1991 ²	2000 ³
Negeri Sembilan	408,058	593,169	722,017	862,877
Seremban District	168,175	208,642	263,383	314,767
Seremban Municipality	98,655	138,006	196,866	265,983
Study area	NA	NA	200,832	271,340

Source: ¹ MPS, 1982;

² Department of Statistics, 1995; and

³ Estimated figures based on growth rates.

7.2.3 Climate

Seremban region experiences a tropical climate with high humidity accompanied by uniform high temperatures and rainfall brought by the seasonal monsoon wind systems. The climate is typical of inland west coast region of Peninsular Malaysia. The effects of Northeast monsoons (November to March) are reduced by the central mountain ranges of the Peninsular and the Southwest monsoons (May to September) are tempered by the nearby highlands of Sumatra, Indonesia. There are however limited meteorological observation stations in Seremban and a few rainfall stations within the Linggi River basin.

Total annual rainfall within the Seremban area has averaged approximately 2,100 mm during the last decade; it varies from 2,250 mm per year near the coast to less than 2000 mm per year in the upland areas. There is considerable variation in mean rainfall. Average number of rain-days per month varies from a low of 8 in January to a high of 23 in November, with a mean annual number of 178 days. On average, nearly 40 percent of annual rainfall occurs during the months of September through December during the Northeast monsoon. An additional 30 percent falls during March, April and May.

With the collated data on rainfall, a value for rainfall erosivity can be obtained. Rainfall erosivity is defined as the potential of the land to be eroded by rain. It is often used as an index to predict the rates of erosion. The rainfall erosivity, R indicates the impact of the rain and the erosive power of moving water.

The expression for this factor is:

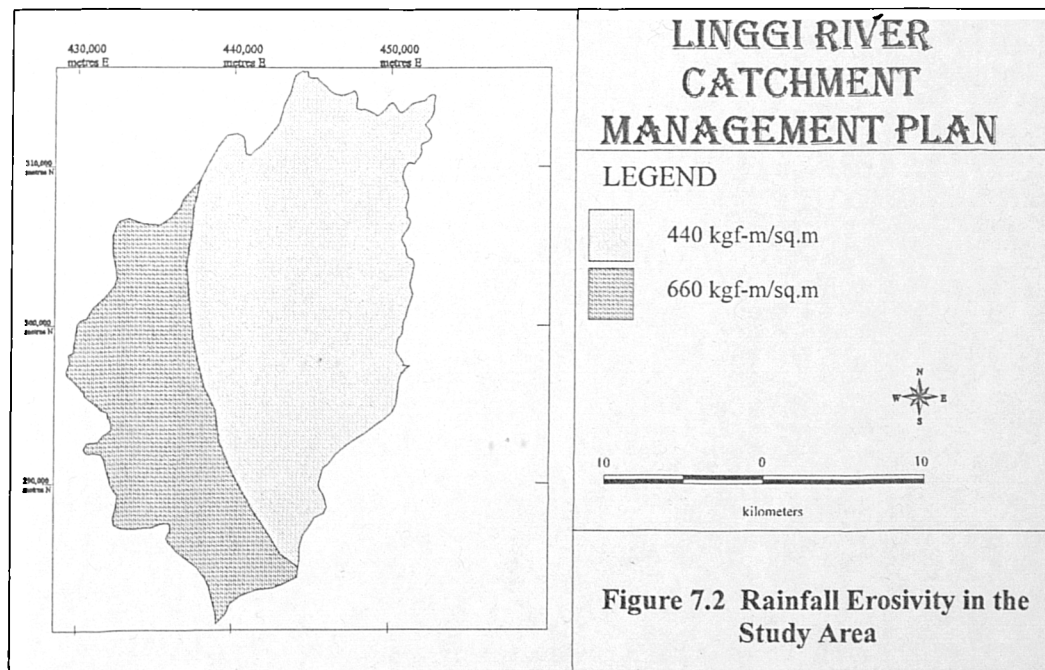
$$R = EI(30)/100$$

in which,

E is the kinetic energy of the storm rainfall in metric tons per I(30)

$I(30)$ is the maximum 30-minute intensity during the storm per hour.

For the purpose of this study, the output erosivity map has been categorically divided into 2 halves within the study area as shown in Figure 7.2.



7.2.4 Hydrology

The Linggi River drains a total area of 1,320 sq. km. The Batang Penar River and Paroi River converge to form Linggi River at Seremban Town approximately 62 km. upstream from the river mouth. Rembau River is a major tributary of the Linggi River

with its confluence about 8 km. from the river mouth. From this point downstream, the river flows through extensive mangrove and swampy areas.

Linggi River is relatively fast flowing and shallow, with a depth of less than one metre in most parts of the river. Downstream of the 28th km, the river is influenced by tidal conditions and the velocity of flow is very much reduced while the depth increases, particularly in the lower 20 km. estuarial reach.

The study area covers an area from upstream to just downstream of the confluence of the Linggi River and the Simin River with a total area of 442 sq. km. and this is about 40 percent of the total Linggi Water Quality Region. For the purpose of this research work, the study area has been divided into several sub-catchments. Figure 7.3 illustrates the sub-catchments within the study area. It is also useful to note that the MPS area is divided roughly into two halves by the Linggi River.

River flows are recorded by the Department of Irrigation and Drainage [DID] at a number of stations within the Linggi River Basin. The average and minimum daily flow at a number of important river locations within the catchment is presented in Table 7.2. The average flow rate of Linggi River is 430 thousand cu. m./d just upstream of the built-up areas of Seremban and the flow rate increases by more than double to 890 thousand cu. m./d at Rantau which is 12 km. downstream. The increase has been attributed to tributary contributions from both natural runoff and municipal wastewater discharges. Figure 7.4 illustrates the relationship between sub-catchment areas and river flow rates (discharges). The river discharge figures have been taken as one of the factors used in the analysis and prediction of the river water quality concentration level at the various locations along the river stretches.

The catchment area included in this study is the entire non-tidal portion of the Linggi River upstream of Kg. Linggi in the District of Port Dickson. At the same time, the low flows in the Linggi River at the Linggi Water Treatment Works are of particular importance as the natural river flows afford dilution to the waste discharged in the study area.

Table 7.2 Linggi Catchment: Catchment Size and Average Flow Rate at Ten Discharge Points of the Catchment.

Sub-Catchment	Area (km ²)	Distance from Mouth of Linggi River (km)	Average Discharge (‘000 m ³ / d)
Batang Penar	15	71	52
Terip	27	70	69
Sikamat	24	69	43
Temiang D	28	61	43
Kayu Ara	18	54	26
Simin	72	42	114
Rahang	159	60	530
Rasah	230	58	680
Rantau	343	43	890
Sua Betong	550	28	1800

Source: GOM (1982a) pp. 3-11 & 3-12.

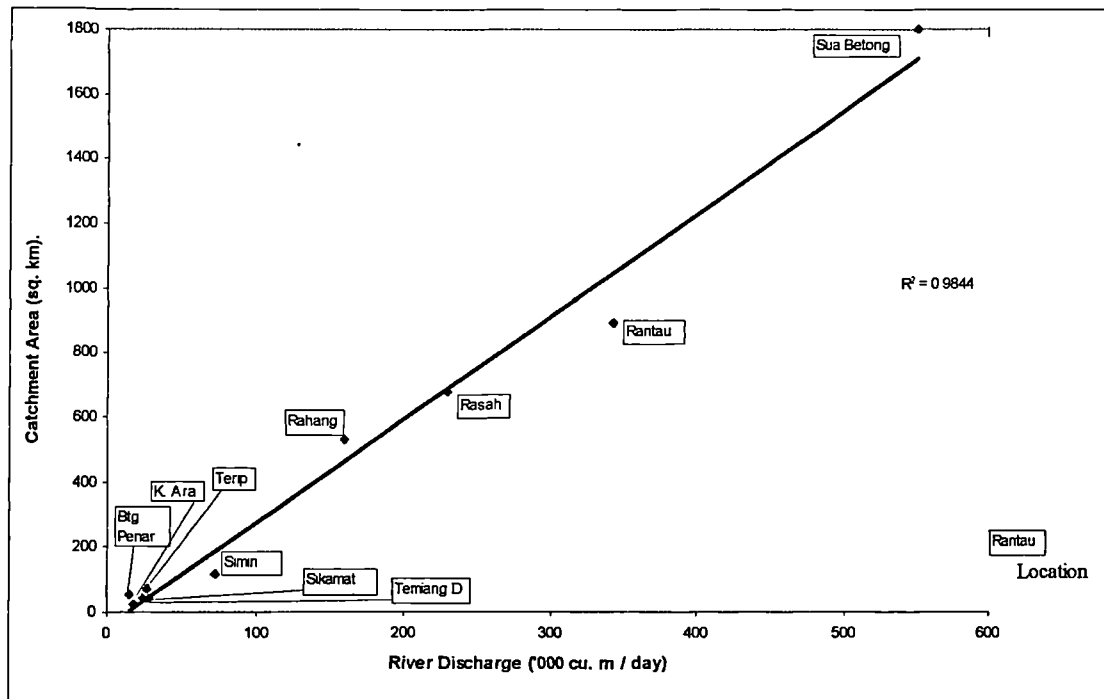


Figure 7.4 River Discharges Versus Sub-Catchments Area.

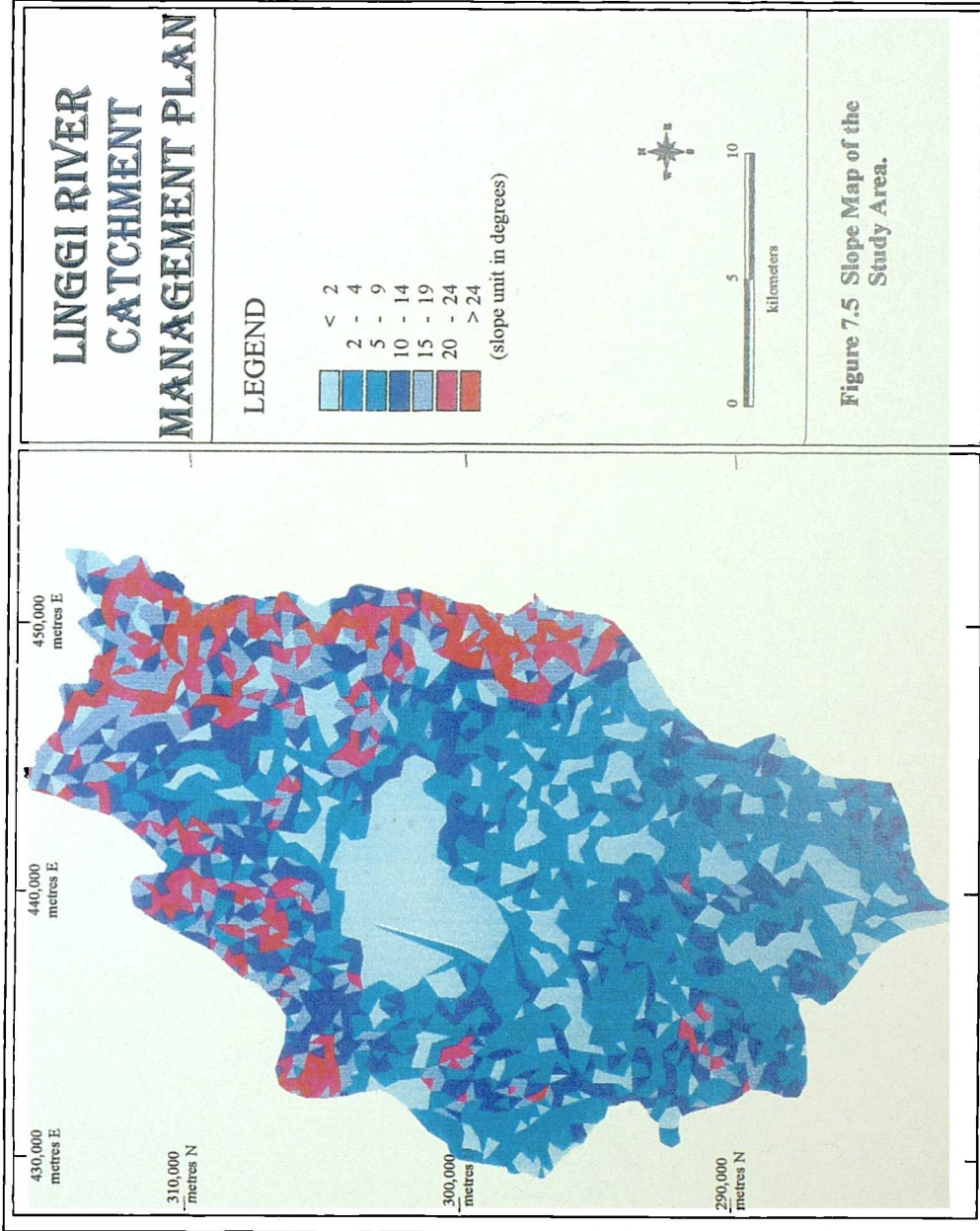
7.2.5 Topography And Slope

Linggi River basin is bounded to the east by the Muar River basin, to the north by the Pahang River basin and to the west by the Langat River basin. Generally the basin contains three principal relief forms: rugged uplands, undulating hills, and low-lying freshwater swampland near the coast. The upper reaches of Linggi River system comprise hilly and mountainous areas with elevation from 570 m. to 1,050 m. Swamps occur along the river valley throughout its lowland section but are most extensive within the estuarial reach. The MPS area is situated immediately west of the uplands region in the central hills region with elevation from approximately 35 to 150 m.

The topographical data used in this study were obtained from the Survey Department maps at the scales of 1: 25,000 and 1:63,360 (1 in. to 1 mile) (DoNMM, 1974); the contour intervals on these maps is approximately 20 m. Types of slope affect the rate of soil loss since erosion normally increases with slope steepness and slope length, as has been described in Chapter 6. The output from surface modelling with Triangulated Irregular Network [TIN] (in the ARC/INFO GIS environment) enables the generation of the slope map for the study area as shown in Figure 7.5.

7.2.6 Catchment Land Use

The whole catchment is made up of a mix of forested land, agricultural areas and some built up areas. The upper reaches of Linggi River system is heavily forested. Overall, the present land use is dominated by agriculture which accounts for 67 percent of the catchment land use (Figure 7.6a). These upland areas border gently rolling estates' lands and some paddy fields located along the river. Rubber plantations comprise the major portion of agricultural land. Table 7.3 gives the breakdown on the types of land use within the study area.



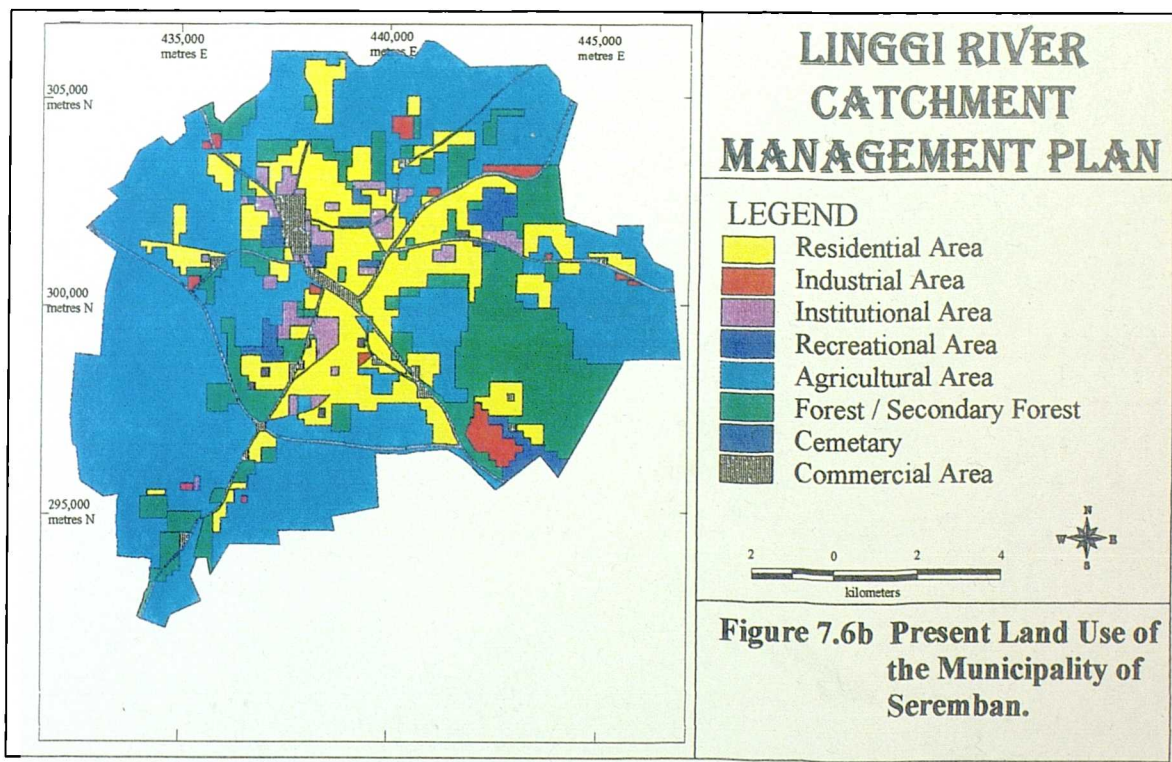
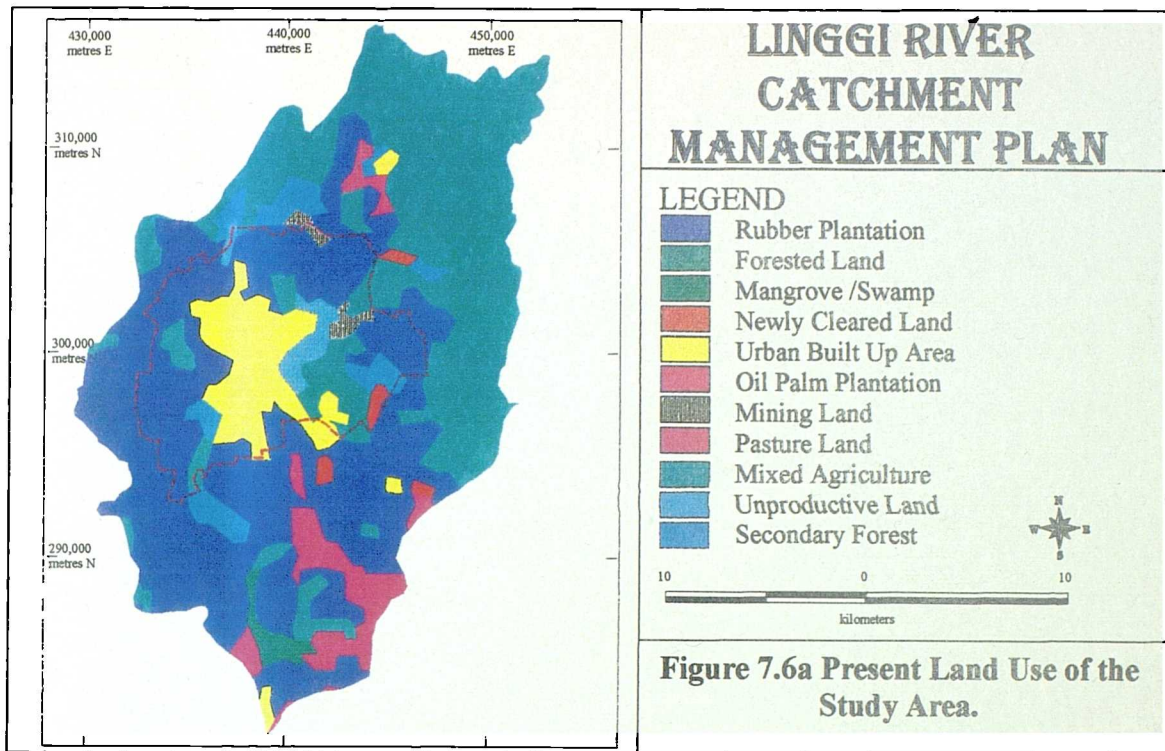


Table 7.3 Linggi Catchment: Present Land Use, 1990.

Land Use Category	Type of Land Use	Code	Area (Ha.)	Percent of Total land area
Agriculture	Coconut/Cocoa	100	145	0.13
	Oil Palm Plantation	104	11,039	9.67
	Mixed Agriculture	112	4,163	3.65
	Pasture Land	76	165	0.14
	Rubber Plantation	78	58,265	51.03
	Paddy	83	2,636	2.31
	Sub Total		76,412	66.93
Undeveloped Areas	Newly Cleared Land	32	847	0.74
	Forest	74	27,268	23.88
	Idle Land	43	10	0.01
	Mangrove Forest	65	3,144	2.75
	Scrubland	63	1,908	1.67
	Sub Total		33,177	29.03
Developed Areas	Built-up Areas	110	4,361	3.82
	Mining Land	45	323	0.28
	Sub Total		4,684	4.10
Total Catchment Area			114,273	100.00

The built-up areas include Seremban which is the only major urban area within the Linggi catchment, whereas other much smaller towns located downstream of Seremban on the non-tidal portion of the river include Mambau, S. Gadut, Kg. K. Sawah, Siliu and Rantau. The source of the present land use map is from the Department of Agriculture which has been updated to include all land uses up to 1990. Figure 7.6b shows the present land use of the Municipality of Seremban with a significant portion of the municipality area still under agriculture and green cover. Downstream of Seremban, the river flows through estate lands until it reaches the tidal stretch.

Land use is one of the important elements influencing the rate of erosion. Forest cover is generally effective in reducing erosion because the canopies obstruct the direct impact of raindrops. But barren or expose land results in substantial volumes of sediments washed to streams through the erosion processes. Urban land use, which has been regarded as a very dynamic land unit, often involved the conversion of agriculture lands for the construction of new town centres, development of housing

estates, high rise and commercial complexes, setting of industrial estates and constructions of highways. These activities often have significant impact on the catchment water quality.

In the modelling process using the Universal Soil Loss Equation [U.S.L.E], land cover determined the variation in the *C* (crop management) and *P* (control practices) factors throughout the catchment area. The *C* factor is the ratio of soil loss from land covered with specific vegetation and provides a convenient expression of the crop cover management factor (Morgan and Davidson, 1986). This factor describes the effect of vegetation in protecting the soil from erosion. The canopy protection of land cover depends on the type of vegetation and varies greatly in different months and seasons. As long as the native vegetation cover is left intact, whether forest or pasture land, erosion and surface runoff are small despite the rainfall erosivity, slope steepness, and erodibility.

The *P* factor represents the ratio of soil loss from a piece (plot) of land area with specified conservation practices to soil loss occurring from up and downhill tillage operation when other conditions remain constant. Terraces are effective practices used to reduce soil loss. The *C* and *P* factors for the land cover applied in the study area are as listed in Table 7.4.

Table 7.4 The *C* and *P* Factors Applied in the Modelling of U.S.L.E. for the Study Area.

No.	Land Cover	<i>C</i> Factor	<i>P</i> Factor
1	Newly cleared land	1 ^{1,2}	1 ²
2	Built-up areas	0.1 ¹	0.2 ¹
3	Forest	0.001 ^{1,2}	0.35 ¹
4	Swampland	0.001 ¹	0.35 ¹
5	Secondary forest	0.002 ¹	0.25 ¹
6	Pasture land	0.01 ²	1.0 ²
7	Mining land	0.05 ¹	1.0 ¹
8	Grassland	0.004 ²	1 ²
9	Oil palm plantation	0.1 ²	0.3 ²
10	Rubber plantation	0.1 ²	0.25 ²
11	Mixed agriculture	0.15 ¹	0.2 ¹
12	Paddy	0.15 ²	0.2 ²

Source: ¹DOE (1987b) pp. A6.1-25.

²Morgan and Davidson (1986) p. 327.

7.2.7 Soil

Three major land systems were identified in the study area (GOM, 1982a) and they are the Beremban Land System, the Rasah Land System, and the Sepang Land System. However, the most predominant is the Rasah Land System. A lowland unit of the Rasah Land System is composed mainly of granitic rocks. The landscape is characterised by broad valleys with tin-bearing alluvial floodplains and by low granitic hills. Soils within the land system are composed primarily of sandy alluvium in the valleys and stiff and sandy clays on the hills.

The Beremban Land System is found in the northern and eastern portions of the study area. This region is also underlain by granitic materials; however, unlike the Rasah Land System, the landscape is mountainous with deeply incised river valleys. The terrain is quite steep on the hills and soils are typically characterised by thin sandy clays with some lateritic clays along the ridges.

In the south, the major geologic unit is the Sepang Land System. This is a hilly region and its geology is characterised by partly metamorphosed shales and other sedimentary rocks. Most of hillsides in this region have gentle slopes. The major soil types in this land system include sandy silty clays on the sandstones, and stiff clays, frequently with laterite, on the phyllites and shales.

In defining the erodibility (K) factors, a schematic reconnaissance soil map of Negeri Sembilan with the scale of 1: 253,440 (1 in to 4 miles) (DoNMM, 1970) was used, where each soil type within the system area was analysed (based on several literature) for their soil characteristics and texture. The identified soil types present in the study area include the Rengam series, Malacca series, Tavy series, Munchong series, Seremban series (which may exist by itself or in association with several other series), the Local Alluvium, Steepland and the Disturbed land. References used in the gathering of information of soil characteristics and properties of these soil series

required for the determination of the K factor include: Wong (1970); Kwi et. al. (1980) and Yaacob and Jusop (1982).

The soil erodibility factor, K is a measure of the rate at which a soil erodes under standard conditions of slope and land cover. For simplicity, since no K values were found in the literature, the derivation of the K factors was made through the application of the USDA Nomograph for soil erodibility. Basically, the method relies on several parameters including the composition of silt, sand and organic matter, the soil structure and the soil permeability (as shown in Appendix E). The distribution of the various soil series and associations and the range of erodibility values is given in Table 7.5 and Figure 7.7.

Table 7.5 Linggi Catchment: Soil Types and the Associated K Values.

Code	Soil Series ¹ Soil Classification	Percent of Catchment Area	Soil Erodibility K Value ²
STP	Steepland	34	0.05
RGM	Rengam	19	0.05
DLD	Disturbed Land	6	0.05
LAA	Local Alluvium	6	0.05
MCA-TVY-MUN	Malacca-Tavy-Munchong	7	0.02
MUN-MCA	Munchong-Malacca	10	0.015
SBN-MUN	Seremban-Munchong	10	0.02
MUN	Munchong	8	0.01

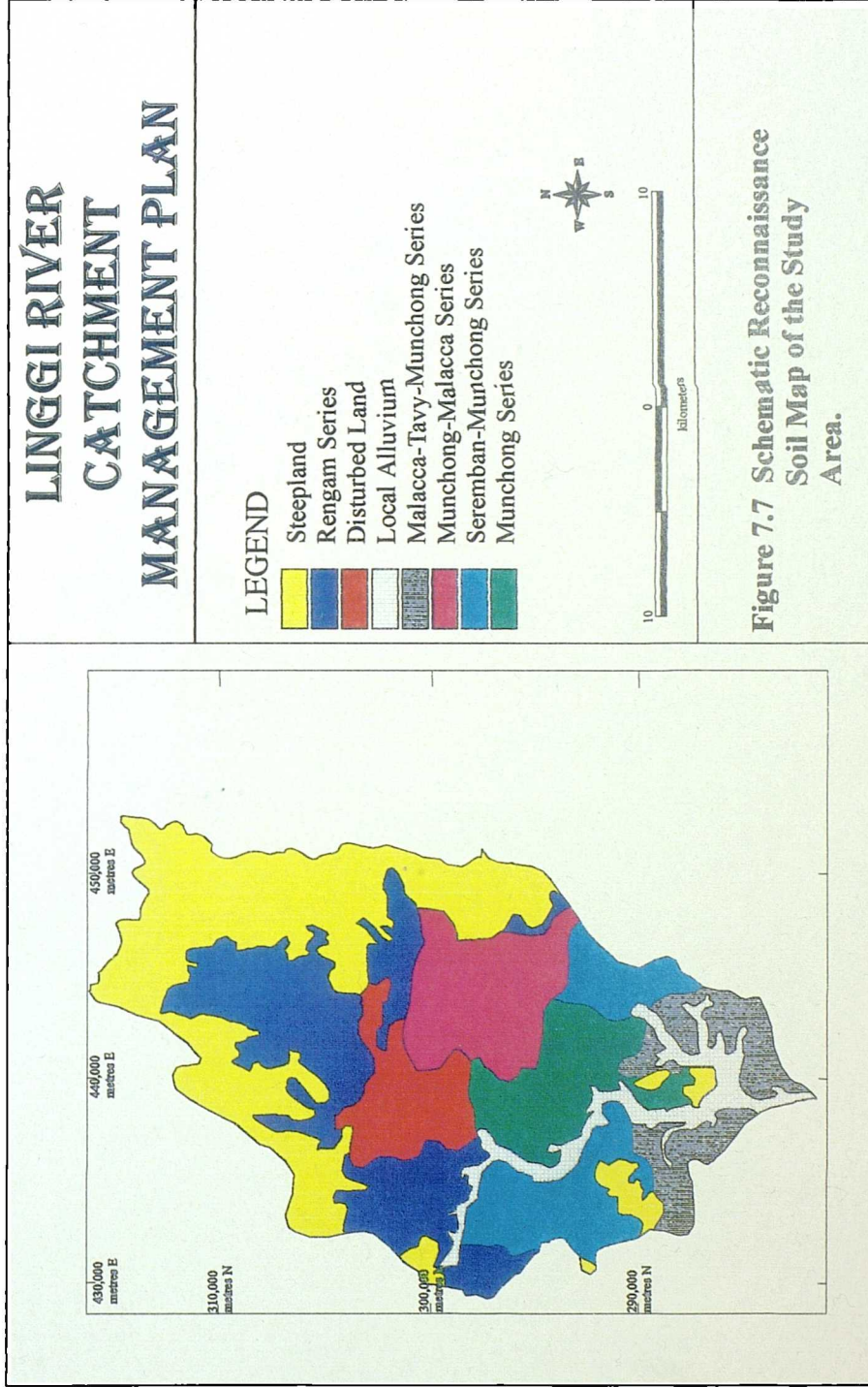
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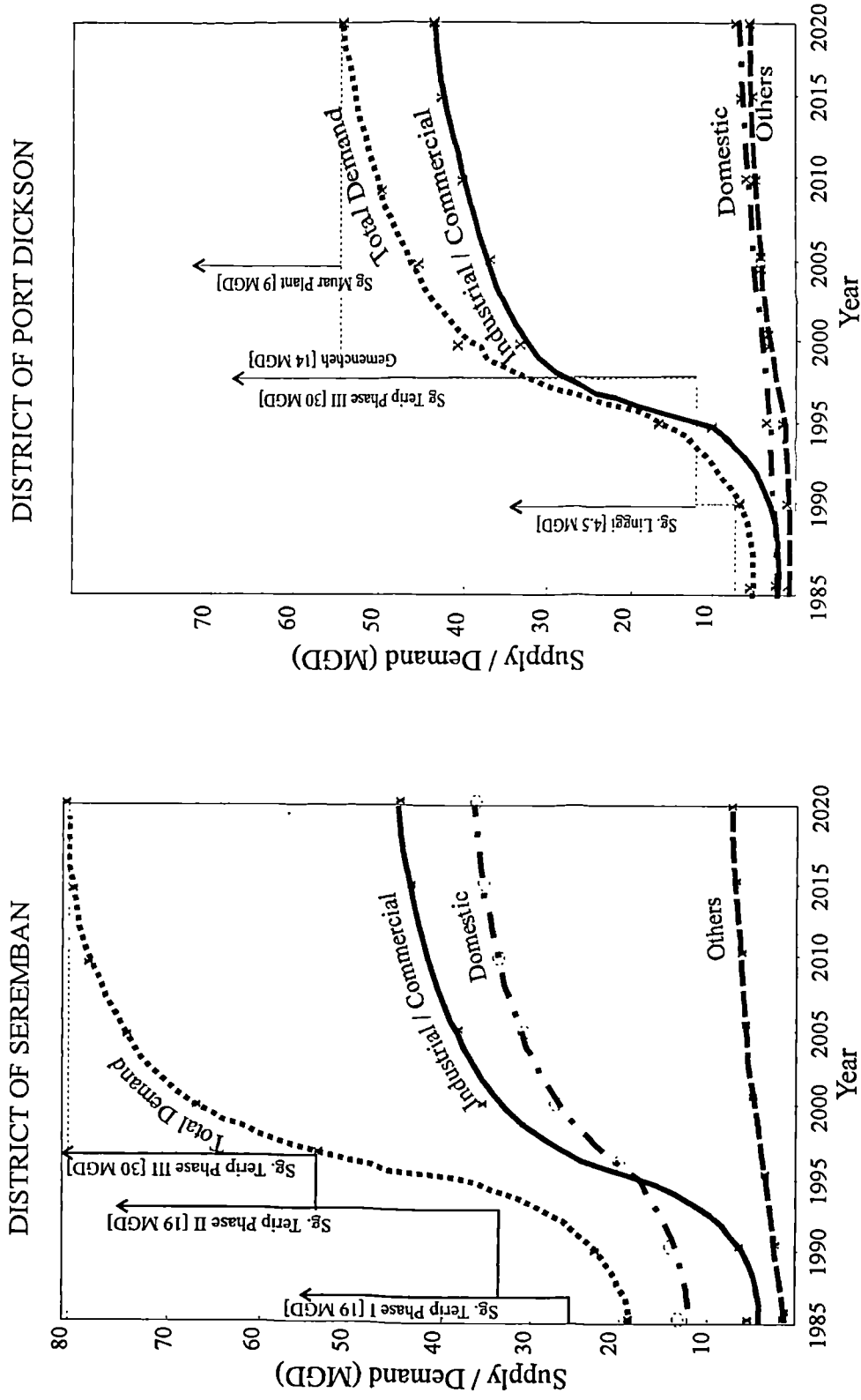
¹ Source: DoNMM (1970).

² Derived using the chart as in Appendix E.

7.3 BENEFICIAL USES OF THE RIVER

The major water use in the Linggi River catchment is as the main source of water supply to the area and its environs. Water demand has been anticipated to grow to a large extent at pace with rapid socio-economic development as described in Chapter 3. The water supply and demand curves for Seremban and Port Dickson are as shown in Figure 7.8. Although it may appear water resources in the area are abundant, the





Source: DoWS(NS) (1995)

Figure 7.8 Water Supply and Demand in the Districts of Seremban and Port Dickson, 1985 - 2020.

increasing demand coupled with the strain on the river water quality has put the region within the water stress area (Welch and Keat, no date).

At present, the public water supply is provided by two major and two minor schemes, i.e.,

1. The Linggi Water Treatment Works [SLWTP], located approximately 20 km downstream from Seremban on the Linggi River between Kg. K. Sawah and Rantau at 20 m above mean sea level and has a nominal capacity of 80,000 m³/d (or 17.5 million gallons per day [MGD]). The SLWTP is the only source of water supply for the District of Port Dickson and it supplies 60 percent of the demand of Seremban District.
2. The Terip River Treatment Works [TRTW], located upstream of Seremban on the Terip River operates at 42,000 m³/d (or 9 MGD) with the conventional treatment with water input regulated by the Terip Dam constructed upstream of Terip River. This water works is the second largest and subsequent development is underway to increase its present capacity.
3. The Pantai Water Treatment Works [PWTW], located upstream of Seremban on the Batang Penar River at 250 m above mean sea level and having a nominal capacity of 18,000 m³/d (3.9 MGD).
4. The water works at Ngoi-ngoï River [NRWW] operates at a capacity of 4,000 m³/d (0.9 MGD) with a sub-conventional type of treating water.

The river water quality is largely threatened due to the discharges from the densely populated town of Seremban and the Senawang industrial estates located within the catchment area. Recognising the potential hazards of contaminated water supply, the water authority i.e., the Department of Water Works has commissioned an ozonation system for the SLWTP (as in no. 1 above) in 1992, to treat the raw water in ensuring conformity of the supplied water to the drinking water standards. The systems were

able to achieve adequate removal of the solids, microbiological contents, ammonia, BOD, TTHM (Total trihalomethanes) and detergents and a good control of pH (Johari, 1995).

The other treatment works (i.e. nos. 2, 3 and 4 above) are based on the process of sedimentation, filtration and chlorination, and therefore it is extremely important that the river water be controlled so as not to exceed the BOD concentration level of 2 mg/l. In the treatment of industrial water supply, the process is mainly sedimentation, if the BOD concentration in raw water is not more than 5 mg/l. Pre-treatment is carried out by the rapid sand-filter bed and activated carbon absorption (secondary treatment). For exceptional cases where the BOD concentration may reach the level of between 20 and 200 mg/l, further treatment will inevitably need to be carried out through an aerated lagoon process such as aerated lagoon and maturing pond (primary treatment).

Other type of uses that can be found include private water intakes and irrigation water abstraction. Irrigation is still important especially upstream of Seremban in areas where paddy is cultivated. Fisheries are not at all important in this catchment at present. Moreover, the existing pollution loads have already eliminated the riverine fisheries at Seremban and downstream. Nevertheless, with improvements in river water quality, the revival of fishery activity is not impossible. Table 7.6 lists the offstream uses of water along the river in the catchment.

7.4 POLLUTION SOURCES

7.4.1 Domestic Sewage

The present types of wastewater disposal systems in the catchment include individual septic tanks; communal septic tanks; imhoff tanks followed by trickling filters; other

secondary treatment systems, and on-site systems including pit privies; and conservancy (night-soil) collection.

Individual and communal septic tanks are the major wastewater treatment systems used at about 90 percent of the premises in Seremban. After the privatisation of the sewerage facilities, the responsibility of maintenance and desludging the individual septic tanks (which was formerly under the jurisdiction of the Municipal Council), now falls under *Indah Water Konsortium* (the sewerage company). Only new developments with fewer than 30 premises are allowed to use individual septic tanks as prescribed in the Uniform Building By-Laws.

Table 7.6 Linggi Catchment: Beneficial Uses of Water.

Location	DoWS(NS) Water Supply Abstraction ¹	Private Water Abstraction ²	Fishing	Irrigation ¹	Recreation ²	Recommended Class for Beneficial Use
2719610 (at Batang Penar)	2 Nos. abstracting 22 Mld ³	1 No. abstracting		Multiple offtakes for 1.7 km ² paddy	Pantai waterfall	IIA
2719609 (at Temiang Div.)						III
2719622 (at Linggi 1)	1 No. abstracting 42 Mld			Terip Dam provide irrigation	Lake Garden in Seremban Town	III
2719608 (at Kepayang)						III
2619607 (at Linggi 2)		2 Nos. abstracting 0.28 Mld			Senawang Waterfall (10 km from Seremban)	III
2519605 (at Simin)		2 Nos. abstracting 0.39 Mld				III
2519604 (at Linggi 3)	1 No. abstracting 80 Mld					IV
2519621 (at Linggi 4)						IV

Notes: .

¹Source: DOE (1990b) p. S2-18.

²Source: DOE (1994b) pp. 105-108.

³Mld - unit in Million litre per day.

Septic tank effluents normally pass through rock filter beds before discharge to surface drains. The present practices in the study area are to discharge toilet wastes to septic tanks and to discharge kitchen wastes and other domestic wastewater to surface drains.

The quality of effluent from septic tank beds has been known to be highly variable in terms of pollutants such as BOD, suspended solids, and ammoniacal nitrogen, and depends on such factors as loading rates, influent quality, time of day, and levels of maintenance. Nevertheless direct discharge of septic tank effluent to surface drains is unacceptable and will pose a great danger to human life as the number of pathogens in septic tank effluent is not much less than in raw sewage. The main problems associated with the use of individual septic tanks include:

- blockage of the inlet to the tank due to the flushing of large objects into the septic tank;
- blockage of the filter bed resulting from the carry over of sludge and scum from the septic tank;
- back-up and overflow of the septic tank due to infrequent desludging.

Communal septic tanks and imhoff tank systems are used to serve buildings such as low-cost housing projects, schools, colleges, multi-storey flats, military camps, the General Hospital, and several housing estates. Most of the systems are followed by filter beds and the filtered effluent is then discharged into open drains or streams. Such systems are preferred in terms of management but studies indicate that concentrations of some pollutants from the communal systems are exceptionally high particularly for COD, nitrogen, and phosphorus (MPS, 1985).

The available data regarding the populations served by the various wastewater disposal systems are incomplete (as the data obtained from the Department of Statistics merely shows the type of toilet facilities (Table 7.7) and it is therefore

difficult to make an accurate estimate of the present wastewater loads and flows from each system). It is possible, however, to estimate the total domestic waste load and flow in the study area based on present domestic water usage and on typical waste generation rates. The average water consumption rate in the study area is approximately 215 l/person-day, it has been pointed out that 85 percent of the amount, or about 180 l/person-d, is discharged to drains. On average the unit BOD₅ generation rate is approximately 50 g/person-d. Nevertheless the net loading rates from urban areas differs from that of rural areas as described below in Table 7.8. The calculated amount of wasteload generated and discharged for the year 1990 is as shown in Table 7.9.

Table 7.7 Negeri Sembilan: Type of Toilet Facilities by Administrative District, 1991.

Administrative District	Type of toilet facilities						
	Total	Flush system	Pour Flush	Bucket	Pit	Enclosed over water	None
Jelevu	8,477	3,799	4,154	7	141	79	297
Kuala Pilah	15,426	5,325	9,194	13	264	200	430
Port Dickson	17,627	10,512	5,995	41	678	109	292
Rembau	7,907	2,785	4,723	3	114	110	172
Seremban	53,468	37,300	13,183	505	1,249	594	637
Tampin	14,975	7,364	7,116	22	281	47	145
Jempol	23,548	7,900	14,816	41	319	47	425
Total	141,428	74,985	59,181	632	3,046	1,186	2,398

Source: Department of Statistics (1995)

The BOD load flowing into a river was calculated based on the pollution load factor according to the pollution sources, which is basically similar to the method applied by Marsh (1991) who uses net loading factor by type of land use unit. In this study, estimation of the pollution load from sewage disposal however is based on the net loading rates as shown in Table 7.8. The estimated loading based on the projected year 2000 population will represent the extent of impact from the housing development. The amount of pollution load has been calculated depending on the type of sewerage facilities served in the housing area.

Table 7.8 Estimated Net Loading Rates from Sewage Discharges.

Area	Loading Rate (kg/day)				
	BOD	COD	SS	TN	NH ₃ N
Urban Population	0.024	0.100	0.036	0.008	0.006
Rural population	0.005	0.038	0.006	0.003	0.002

Source: DOE (1990b)

Table 7.9 Linggi Catchment: Pollution Load from Sewage Disposal, 1990.

Station Number ¹	Sub-Catchment Number ²	Pollution Load (kg/day)				
		BOD	COD	SS	TN	NH ₃ N
2719610	13	2	14	2	1	1
	15	5	39	6	3	2
2719609	12	165	820	235	76	47
2719622	6	32	241	38	19	13
	16	89	458	122	42	26
	20	325	1722	468	159	99
	22	136	586	197	58	35
2719608	17	103	696	131	57	37
2619607	19	962	4148	1451	411	247
	21	7	54	9	4	3
	24	163	1001	217	85	55
	26	13	97	15	8	5
2519605	23	53	405	64	32	21
2519604	25	21	156	25	12	8
	27	34	257	41	20	14
	29	2	13	2	1	1
2519621	30	30	231	36	18	12
	31	17	126	20	10	7
Grand Total		2158	11064	3079	1017	632

Note:

¹ Refer to Figure 7.9 for location of the monitoring stations in the study area.² Refer to Figure 7.1 for location of the sub-catchment in the basin and Appendix D for the names of sub-catchment.

7.4.2 Industrial Effluents

The industrial sector is the most rapidly growing sector and the main contributor to the State GDP, although occupying less than 1 percent of the state area. Most industries are concentrated within relatively few locations. The main industrial area in the catchment area is in Senawang (Table 7.10).

Seremban is likely to remain the major industrial growth centre by virtue of its links with the Klang Valley, which is the dominant industrial node of the country, and its location on the north-south development corridor. Seremban is seen to be a much preferred location for industrial development owing to the spillover from the Klang Valley as a result of lack of suitable land, rising land values and the associated environmental problems. It is also well and strategically located in relation to the new Kuala Lumpur International Airport and the proposed Putra Jaya Multimedia Super Corridor centre near Kuala Lumpur.

Table 7.10 Linggi Catchment: The Main Industrial Estates.

Industrial Estates	Distance from Seremban, (km)	Year	Total Land Area Plan (Ha.)	Total Land Area Developed (Ha.)	Type of industry
Senawang	7	1960	142	134	General industries - of skill intensive type and ancillary industries.
Senawang Industrial Park	7	1982	-	118	Small scale and service industries.
Tuanku Jaafar Industrial Park	7	-	-	279	Light industries, warehouses, cold storage and services industries.
S. Gadut	11	1981	49	49	Sawmill and woodbase industries.

Source: MPS (1982).

The proposed area for industrial development used in testing the impact on water quality was based on the one proposed by the Seremban Draft Final Structure Plan, in which the selection of the industrial development areas was made by using the simplified method of industrial sieve analysis where land was considered suitable for development and systematically eliminated if appeared physically and

environmentally (land use compatibility - in particular with respect to noise and air pollution) undesirable or economically not viable to be developed in relation to the following constraints: existing land use; land ownership; land value; susceptibility to flooding; degree of slope; soil bearing capacity; environmental (aesthetical) values; availability of infrastructure; accessibility; and labour supply. Nevertheless the selection appears to lack consideration of location within the catchment which could cause some impact on river water quality.

Based on the data gathered from the DOE, it appears that major industrial discharges used to be a significant source of pollution in the study area in the 1980s, where the load discharged was unusually high compared to the domestic waste load. Current assessment, however, indicates that the industries present produce only about 10 percent of the organic (in terms of BOD) load compared to 59 percent from sewage, while another 21 percent comes from animal wastes (as will be discussed in the next section). Nevertheless pollutants from industrial discharge could be much more deleterious to water quality of the Linggi catchment. Realising such circumstances, due consideration to the effects from industrial load were given before any plan was made to include them in the formulation of alternative sewerage schemes.

The agro-based industries also used to generate significant amount of effluent discharges. There are 9 rubber factories and 6 palm oil mills located within the study area. With the state-of-the-art treatment of organic waste from these two types of industrial discharges, the level of pollution load is effectively reduced by more than 90 percent of the load generated. Some industries have had recourse to land disposal, where the wastewater can be used to fertilise the plantation and were able to increase production using the method, as an alternative to watercourse disposal of mill effluents.

The amount of wasteload discharged into the river for the industrial sector in 1990 was determined using data obtained from DOE, and consequently the projections of wasteload in year 2000 were made by applying the assumption that full compliance with all the specified limits under the various regulation would be accomplished. The

amount of wasteload discharged from the industrial sources in 1990 and the projections for the year 2000 are as shown in Table 7.11.

Wastewater analysis of pollutants used in the study include BOD, COD, suspended solids (SS) and ammonia nitrogen (NH₃N). In estimating the total load for the area identified as *potential* and *proposed* land, it was assumed that by the year 2000 the treatment of industrial wastewater will be significantly improved to meet a more stringent discharge limit. Most rubber mills (references starting with code 35591) are at present discharging at comparatively higher wasteload compared to other types of industries and the trend is expected not to vary significantly by the year 2000.

Table 7.11 Linggi River: Industrial Sources of Pollution, 1990.

Sub-Catchment	Water-course	Source Reference	ID on Map ¹	Quantity of Effluent ² (m ³ /d)	Load in 1990 ² (Kg/d)				Load in 2000 with compliance to Std. (Kg/d)			
					BOD	COD	SS	NH ₃ N	BOD	COD	SS	NH ₃ N
6	Btg Penar	11000001		380	13	70	30	4	8	38	19	4
6	Linggi	31190012		35	1	4	2	0	1	4	2	0
6	Btg Penar	35591120	120	700	88	218	79	25	70	175	105	25
19	Linggi	35591251	251	3,336	19	496	222	30	20	497	224	30
23	Simin	11193004	SIE	151	6	18	9	0	8	15	15	0
23	Simin	31220086	SIE	60	6	10	5	2	3	6	5	2
23	Simin	32130001	SIE	600	84	244	189	0	30	60	60	0
23	Simin	35591313	313	72	2	9	6	2	2	9	6	2
23	Simin	35599136	SIE	60	20	47	7	0	6	15	7	0
23	Simin	38320069	SIE	60	0	2	1	0	0	2	1	0
23	Simin	38392014	SIE	454	0	1	0	0	0	1	0	0
24	Senawang	30000700	SIE	104	1	7	0	0	1	7	0	0
24	Senawang	31159018	SIE	230	9	14	7	0	5	23	12	0
24	Senawang	33111000	SIE	180	13	24	31	4	4	18	9	4
24	Senawang	35591278	278	600	36	117	46	22	36	117	46	22
24	Linggi	35599000		330	15	46	9	5	7	33	17	5
24	Senawang	36200010	SIE	60	0	1	7	0	0	1	7	0
24	Senawang	38320058	SIE	250	5	25	13	0	5	25	13	0
25	Kayu Ara	35591032	32	205	23	51	8	8	21	51	8	8
26	Land	31152099	99	0	0	0	0	0	0	0	0	0
27	Land	35591014	14	0	0	0	0	0	0	0	0	0
29	Land	35591004	4	0	0	0	0	0	0	0	0	0
29	Linggi	35591295	295	286	8	34	23	6	8	34	23	6
Grand Total				8,379	348	1,437	692	109	232	1,130	575	109

Note:

¹ Refer Map in Figure 7.9.

² Source: DOE (1990c).

An assessment on wasteload by type of industries shows that the proportion of wasteload from rubber mills alone comprised 45 percent of total BOD load, 64 percent of total COD load, 55 percent of total SS load and 85 percent of NH₃N load from all the industrial sources, whilst their discharges in the year 2000 are expected to be 68 percent for total BOD, 78 percent for total COD, 71 percent for total SS and 85 percent for total NH₃N. The situation indicates that in terms of organic wasteload from industrial sources, further imposition of a much stringent set of standards on rubber mills' effluent discharges is important, if the water quality of river water need to be improved.

In terms of the total load of each pollutant, their amounts are almost at the 1990 level, which imply there is hardly any improvement made by the rubber mills to attain further reduction in their wasteload discharges as most of the mills are currently already complying with the present standards of discharge. Another type of industry that contributes to high BOD, COD and SS load is the textile mill (reference number starting with code 32xxx) - but this is true only for one of the two mills existing in the catchment. Nevertheless, if the industry should be made to comply with the related standards for discharge, this means, the reduction in its existing BOD, COD and SS load has to achieve up to 64 percent, 75 percent and 68 percent respectively.

Table 7.12 Linggi Catchment: Summary of Pollution Loading, 1990 - 2000.

Sub-Catchment	Discharged Effluent (m ³ /d)	Load in 1990 (Kg/d)				Load in 2000 with compliance to Std (Kg/d)			
		BOD	COD	SS	NH ₃ N	BOD	COD	SS	NH ₃ N
6	1,115	240.0	708.3	1,439.1	29.4	78.3	216.5	99.9	29.4
19	3,336	19.4	496.0	222.4	30.0	20.0	497.1	222.4	30.0
23	1,667	664.6	2,093.3	371.3	28.2	59.2	130.0	114.5	13.2
24	1,754	1,265.2	4,448.9	1,170.0	71.9	56.8	223.2	101.9	38.9
25	205	44.4	110.4	7.7	50.4	20.5	51.3	7.8	8.2
29	286	7.6	33.5	22.6	6.0	7.6	33.5	22.6	6.0
Total	8,363	2,241.0	7,890.0	3,233.0	216	242	1,151.0	569	126

The projection on the amount of industrial wasteload discharges for the year 2000 above (Table 7.12) is made based upon the assumption as if it is unlikely to have further industrial development within the catchment and the wasteload from the

existing industries should be in compliance with the regulatory requirements especially pertaining to their effluent discharge limits. However, the scenarios set out earlier in chapter 6 suggested that the possibility of further industrial development and expansion are even greater due to the trend of industrial development within the central region of Peninsular Malaysia. Considering these scenarios, the likely locations for industrial development will focus within the sites as predetermined in the Seremban Draft Structure Plan where several classes of land suitability for industrial activities have been delineated, and these classes are identified as: potential land; proposed land; potential and proposed land; and proposed but suitable for housing (Figure 7.9).

The total potential land for industrial development is about 9 times the existing industrial land area (Table 7.13). Out of the land area identified in the Seremban Draft Structure Plan as *potential*, only six percent were categorised as *potential and proposed*. This study has assessed the amount of wasteload estimated to be discharged in the year 2000 under each of these options, except for land which is suitable for housing because of the possible conflict that could arise in the proposed land use which this study does not have sufficient information.

Senawang sub-catchment (no. 24) contributes the highest BOD load (Figure 7.10) within the whole catchment. These industries are located in the Senawang industrial area. The other portions of pollution load from the Senawang industrial area are being discharged into the Simin sub-catchment (no. 23). All the industries in the Senawang industrial area together formed the largest polluter in terms of industrial effluents discharged into the Linggi Catchment as a whole. Hence, particular attention is needed in dealing with the extent of pollution problem in the area so that the level of pollution can be reduced (Figure 7.10). The efforts taken to resolve the extent of pollution from the area will help, even with further development in the water related industrial processes, to reduce significantly the pollution level by the year 2000.

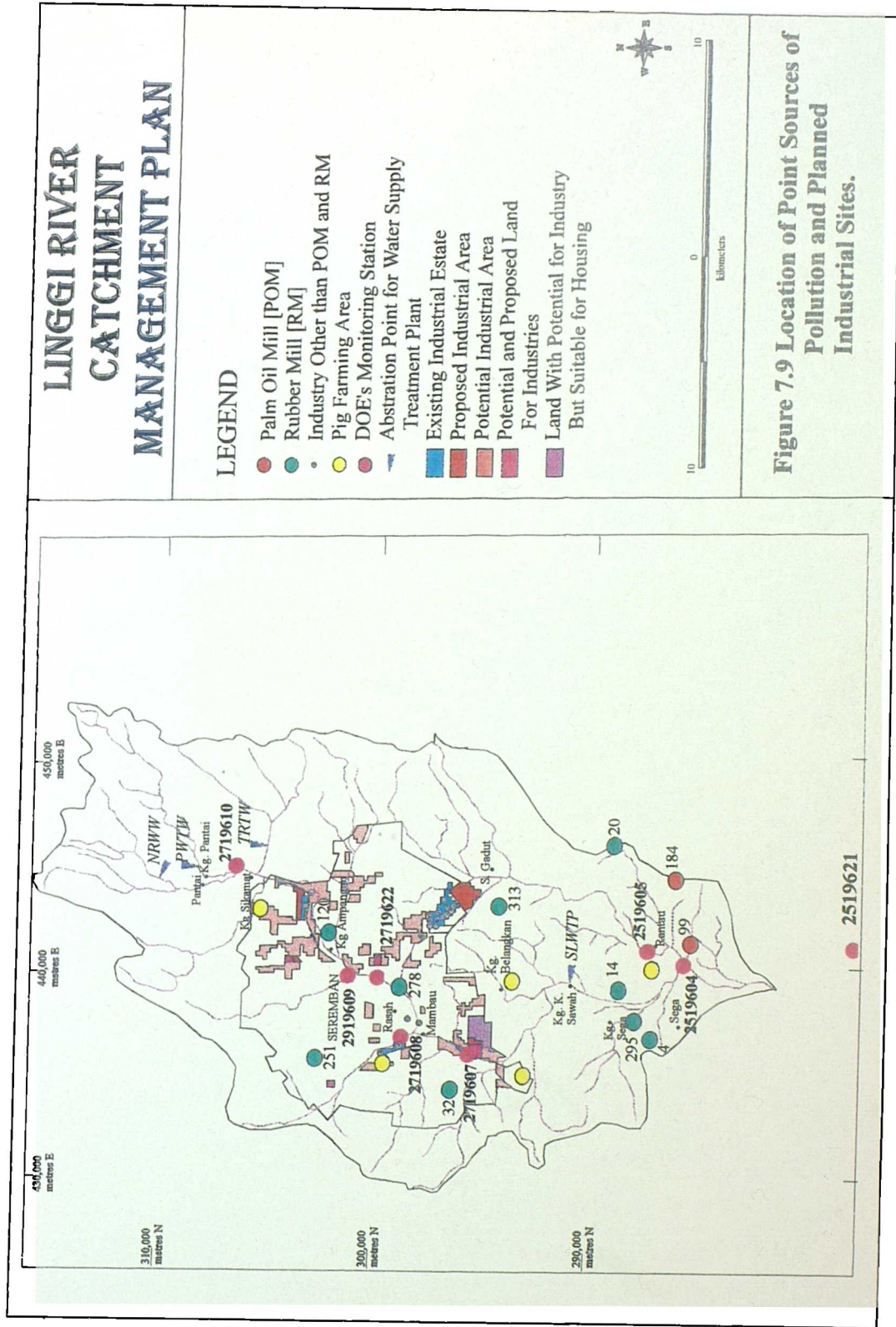


Table 7.13 Linggi Catchment: Land Area for Industrial Development, 2000.

Sub-Catchment Number	Option					
	Existing	Potential	Proposed	Potential & Proposed	Proposed but Suitable for housing	
	1 (Ha.)	2 (Ha.)	3 (Ha.)	4 (Ha.)	5 (Ha.)	Total (Ha.)
6	22	172	36	-	-	230
10	6	38	-	1	-	45
12	-	23	-	-	-	23
16	-	245	7	10	-	263
17	-	72	-	10	-	82
19	-	35	-	-	-	35
20	-	267	-	-	-	267
21	10	56	-	-	-	66
22	-	39	-	39	-	77
23	103	9	115	-	-	227
24	10	217	5	-	-	232
27	-	99	4	20	95	219
26	5	52	11	11	23	102
Total	157	1,324	179	91	118	1,869

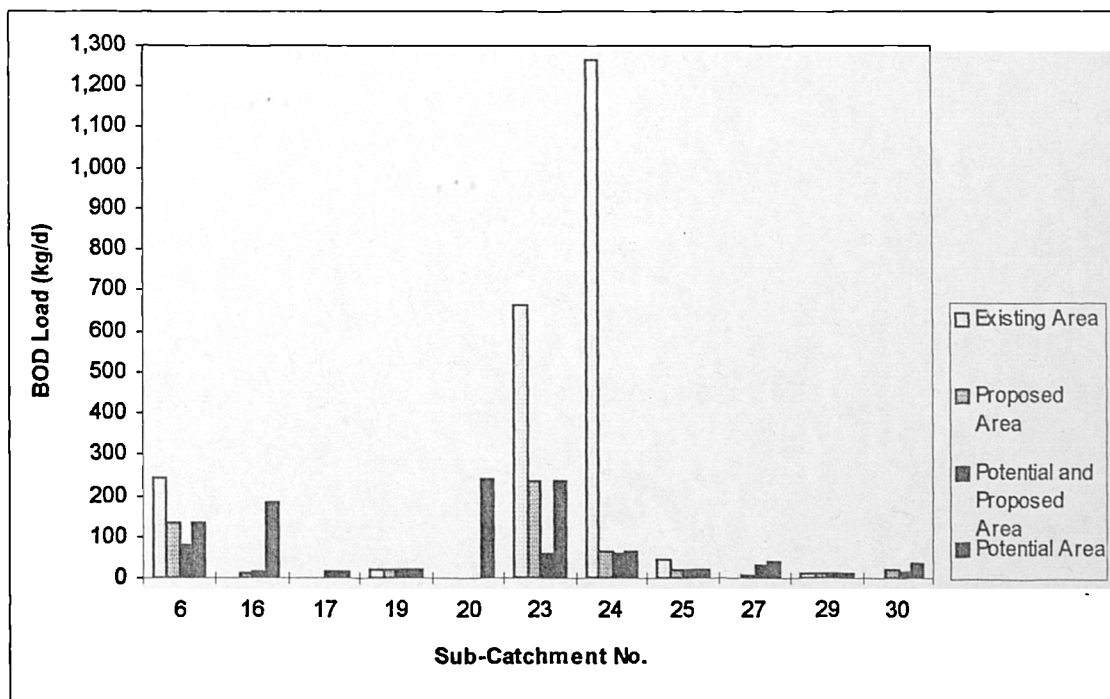


Figure 7.10 Linggi Catchment: Distribution of BOD Load by Sub-Catchment.

Table 7.14 Linggi Catchment: Estimated Pollution Load for Industrial Sector Based on Development Plan Options, 1990 - 2000.

Sub-Catchment Number	Station Number	Existing Wasteload (1990)										Wasteload Projection for the Year 2000														
		Without full compliance					With full compliance					Proposed Land					Proposed and Potential Land					Potential Land				
		Qe ¹ (m ³ /d)	BOD (kg/d)	COD (kg/d)	SS (kg/d)	AN (kg/d)	Qe (m ³ /d)	BOD (kg/d)	COD (kg/d)	SS (kg/d)	AN (kg/d)	Qe (m ³ /d)	BOD (kg/d)	COD (kg/d)	SS (kg/d)	AN (kg/d)	Qe (m ³ /d)	BOD (kg/d)	COD (kg/d)	SS (kg/d)	AN (kg/d)	Qe (m ³ /d)	BOD (kg/d)	COD (kg/d)	SS (kg/d)	AN (kg/d)
6	2719622	1115	240	708	1439	29	3023	134	479	236	58	1115	78	217	100	29	3023	134	479	236	58	1115	185	289	225	171
16	2719622	-	-	-	-	-	399	12	55	28	6	557	16	77	40	8	1113	16	75	39	8	547	16	75	39	8
17	2719608	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	2719607	3336	19	496	222	30	3336	20	497	222	30	3336	20	497	222	30	3336	20	497	222	30	3336	20	497	222	30
20	2719622	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	2519605	1667	665	2093	371	28	7807	237	975	552	105	1667	59	130	115	13	7807	237	975	552	105	1667	59	130	115	13
24	2719607	1754	1265	4449	1170	72	2010	64	258	120	43	1754	57	223	102	39	2010	64	258	120	43	1754	57	223	102	39
25	2719622	205	44	110	8	50	205	21	51	8	8	245	22	57	11	9	245	22	57	11	9	245	22	57	11	9
27	2519604	-	-	-	-	-	238	7	33	17	4	1076	31	148	77	16	1314	38	181	94	20	1314	38	181	94	20
29	2519604	286	8	34	23	6	286	8	34	23	6	286	8	34	23	6	286	8	34	23	6	286	8	34	23	6
30	2719607	-	-	-	-	-	604	18	83	43	9	573	17	79	41	9	1178	34	162	84	18	1178	34	162	84	18
Total		8363	2241	7890	3233	216	17908	519	2466	1249	269	11157	323	1536	768	168	29222	999	4159	2175	594	29222	999	4159	2175	594
Average (kg/Ha.)	Without full compliance		With full compliance		Without full compliance		With full compliance		Without full compliance		With full compliance		Without full compliance		With full compliance		Without full compliance		With full compliance		Without full compliance		With full compliance		Without full compliance	
	53.27	14.28	50.26	20.59	1.38	53.27	1.54	7.33	3.80	0.80	53.27	1.54	7.33	3.80	0.80	53.27	1.54	7.33	3.80	0.80	53.27	1.54	7.33	3.80	0.80	

Note: ¹ Qe = Quantity of Industrial Effluents.

7.4.3 Animal Wastes

The main type of animal husbandry in the catchment is pig farming. In 1990, there were 44,102 animals in 39 farms distributed within the study area. Piggery waste has been associated with most of the environmental concern, particularly with regard to water pollution, when it is not properly treated. Moreover, the GoNS (1989) has pointed out that severe degradation of several rivers in Negeri Sembilan which includes Sepang River and Lukut River and to a certain extent the Linggi River, are due to failures of the pig farming activities to comply and to install efficient pollution control measures. Recognising the potential damages these sources of pollution might caused, the State Government has enacted a legislation on the control these activities through the “Rearing of Pig Enactment, 1980” with effective date of enforcement from 1st January 1981. The State Government has also been looking into the possibility of relocating the farms located on State-owned land away from the sensitive area of the Linggi Catchment.

Pig farming has a high demand for water, resulting in large quantities of wastewater being discharged into the rivers, carrying with it a high organic load. In 1990 about 31 percent of the total organic load discharged in the study area was attributed to piggery waste. Table 7.15 shows the amount of pollution load received at the various monitoring stations contributed by pig farming activities in the catchment areas.

Table 7.15 Linggi River: Piggery Wasteload, 1990.

Station Number	Loading Rate per Pig		Pollution Loading (kg/d)			
			BOD ²	COD ³	SS ³	AN ³
	No. Farms ¹	Total Pig ¹	0.0260	0.6500	1.2700	0.0350
2719622	11	16,552	430	10,759	21,021	579
2719608	2	1,697	44	1,103	2,155	59
2619607	18	19,629	510	12,759	24,929	687
2519605	2	2,347	61	1,526	2,981	82
2519604	39	44,102	1,147	28,666	56,010	1,544
2519621	39	44,102	1,147	28,666	56,010	1,544

Note:

¹ Department of Veterinary Services, Negeri Sembilan (1987).

² Based on previous waste characteristic study from DOE (1990c).

³ Source DOE (1990b).

7.5 WATER QUALITY ASSESSMENT

Water quality standards may be established as an indicator that reflects whether or not the water pollution abatement targets have been achieved through the reduction of pollution load received by the river. Such an indicator is normally based upon certain parameters or in combination with several other parameters in the form of a water quality index.

The most common parameter in describing water pollution is the biochemical oxygen demand (BOD). The BOD represents the oxygen used to meet the metabolic needs of aerobic micro-organisms in water rich in organic matter. The self-purification mechanism of a river is greatly reduced and the aquatic ecosystem will also be affected if BOD concentration in the river is more than 5 mg/litre. Odours occur if the BOD concentration is over 10 mg/l.

Table 7.16 Water Quality Index According to the Various Classes.

Parameter	Unit	Water Quality Class ¹				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
BOD	mg/l	< 1	1 - 3	3 - 6	6 - 12	> 12
COD	mg/l	< 10	10 - 25	25 - 50	50 - 100	> 100
Dissolved Oxygen	mg/l	> 7	5 - 7	3 - 5	1 - 3	< 1
pH	mg/l	> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	< 5.0
Total suspended solids	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
Water Quality Index (based on 5 of the above parameters)		> 92.7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	< 31.0

Note: ¹The class is in accordance with the proposed water quality criteria and standards for Malaysia as mention in Chapter 6.

Source: DOE (1993a).

Where the raw river water is to be used for domestic water supply, at least a pre-treatment is necessary if BOD concentration is more than 3 mg/l (Table 7.16). Hence, a policy to preserve the river water quality is essential in ensuring that water uses in the catchment will be sustainable, since a few stretches of the Linggi River have water quality levels which exceed the standards. The Department of Environment has 8 water quality monitoring sites within the study area where routine samplings were

conducted to check the river water quality (Figure 7.9). At several places river water quality, in terms of the index, was found to be deteriorating between the year 1990 to 1996 (Figure 7.11), although they may seem to be in the same classification of water suitability. Such deterioration in water quality could be attributed to land use changes taking place in the area or the introduction of new pollution sources.

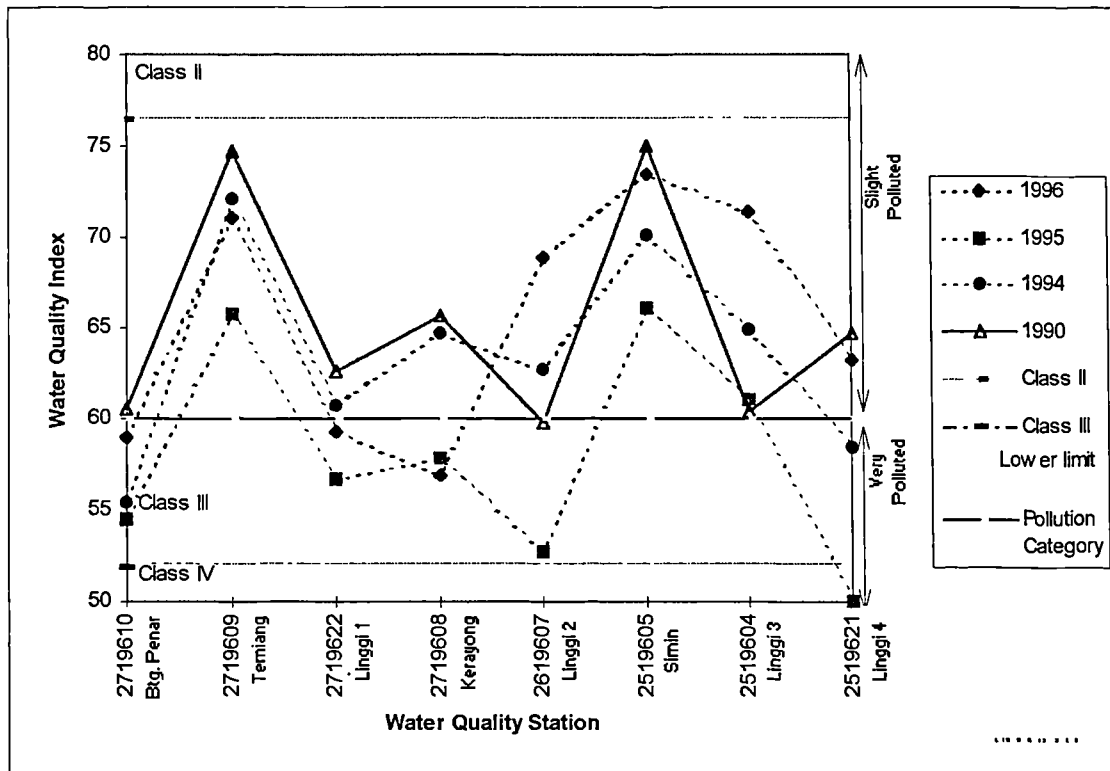


Figure 7.11 Linggi River: Status of River Water Quality, 1990 - 1996.

On the whole, Linggi River can be categorised as a polluted river. The 1990-1996 trend indicates a deteriorating status although the degree was less significant. However in 1995-1996, at least 3 monitoring stations recorded the status of river water quality as very polluted. The year 1995 showed the worst occurrence of pollution in the period with 5 monitoring stations recording very polluted status and these include the station at Mambau (downstream of Seremban Town) which is just a few kilometres upstream of the water abstraction point for the Linggi Water Treatment Works (SLWTP). The downstream stretch of the Linggi River seems to have been polluted, not only does it transport the wasteload from it environs but obviously it has been largely influenced

by the upstream water quality and this is especially so when the upstream location (e.g., at Batang Penar River) is already polluted. If the unfavourable situations persist, extra cost will have to be incurred in treating the domestic water supply on which the local people within and the neighbouring catchments depend.

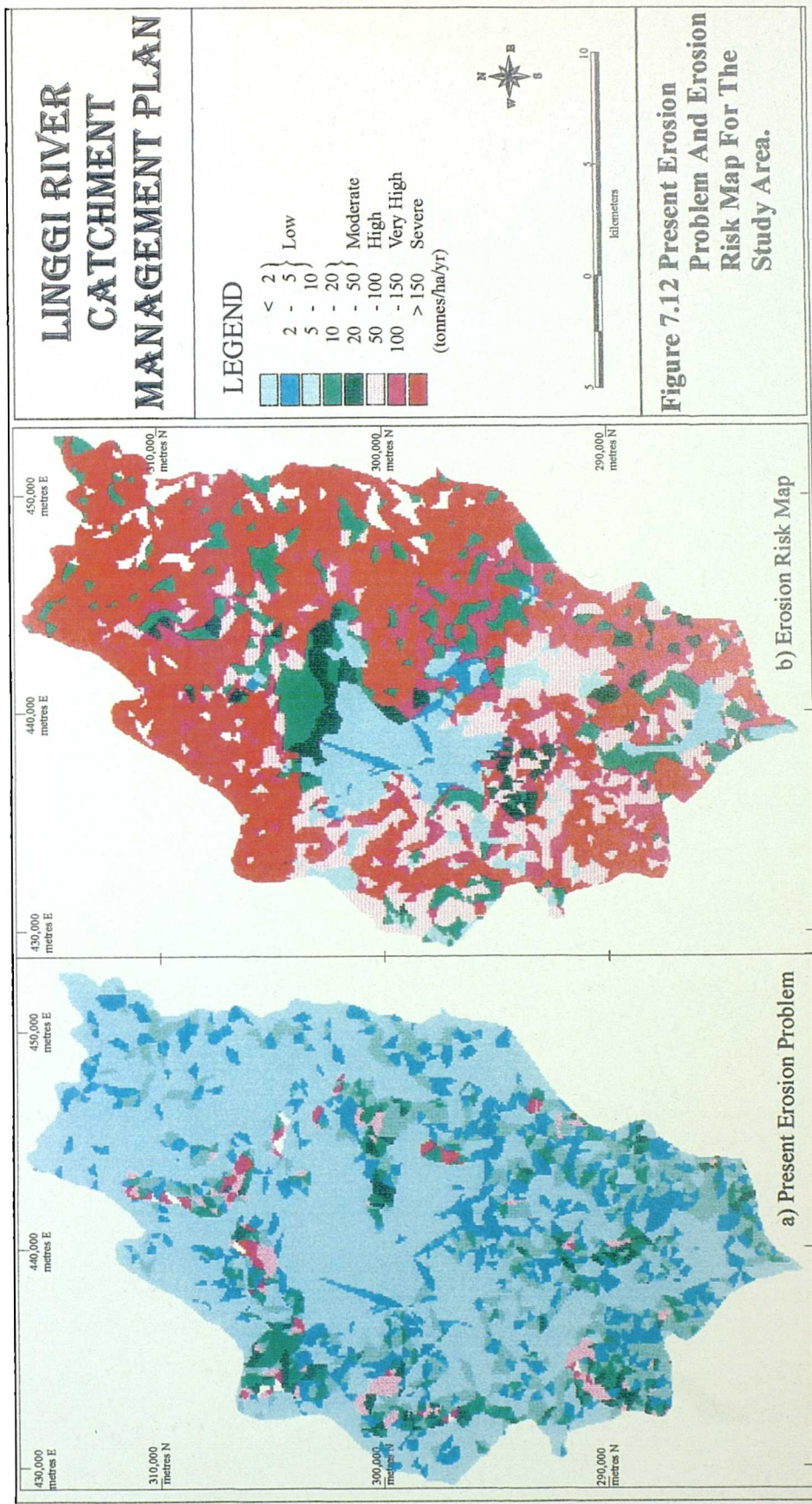
In most situations suspended solids (SS) were found to be the most problematic parameter compared with Biochemical Oxygen Demand (BOD) and Ammoniacal Nitrogen (NH_3N) for Linggi River as a whole.

The SS was mainly attributed (to be shown in the next section) to the non-point sources of pollution that include soil erosion or arising from earthworks' activities. The rate of soil erosion has enormously affected the streams and river system and has attributed to catchment problem in Malaysia, including the Linggi River. It is also believed, apart from soil loss problem, land clearing may induce frequent low flows on the one hand while on the other hand it could results in an increase of flood discharge. But due to lack of experimental records, it will be inadequate to draw any conclusion that associates land clearing activities with low flows which could be applicable to the study area in particular or to Malaysia in general.

7.6 MODELLING RESULTS

7.6.1 Results Of Erosion Risk Assessment

The wash-off of detached soil particles during heavy downfall from exposed soil often give rise to serious siltation problem in the river (Nather Khan, 1992). The modelling application using the Universal Soil Loss Equation [U.S.L.E.] in the GRID ARC/INFO environment, reveals the areas that are significantly affected by high erosion rate (Figure 7.12a). Most of the vulnerable areas are located upstream of DOE's

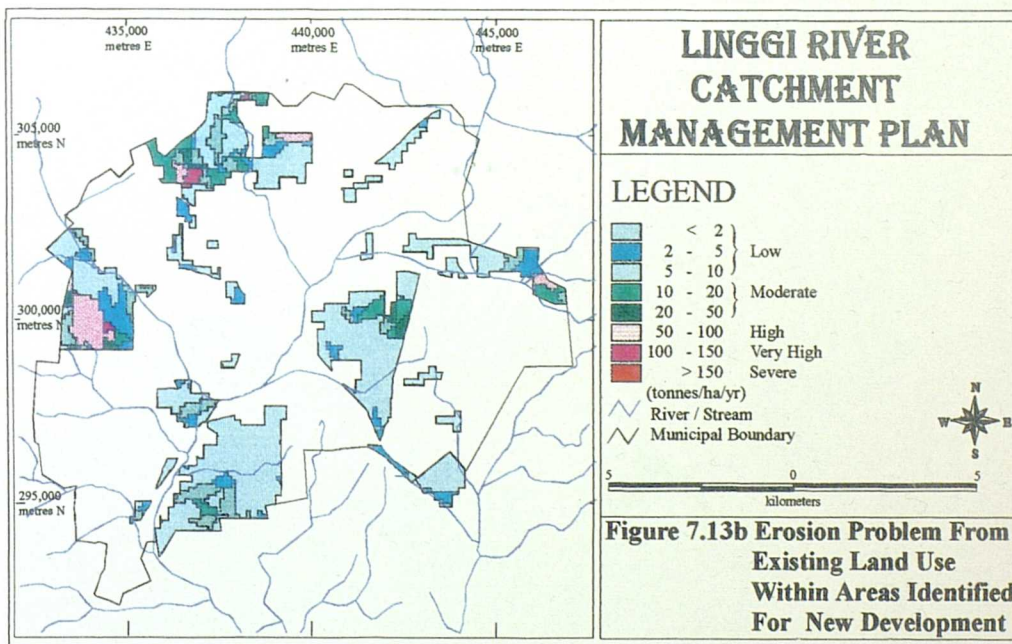
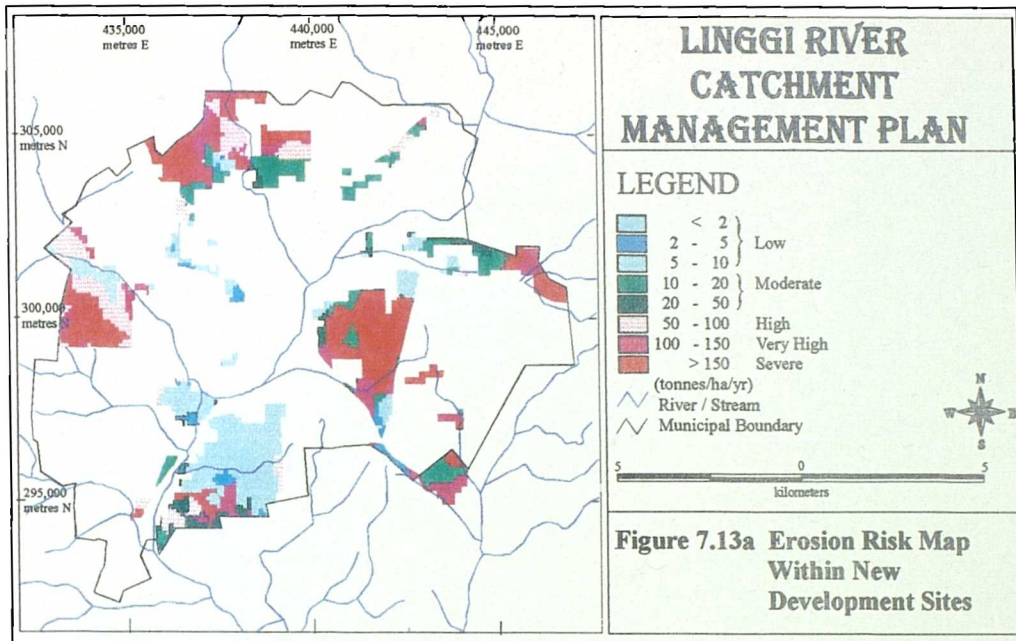


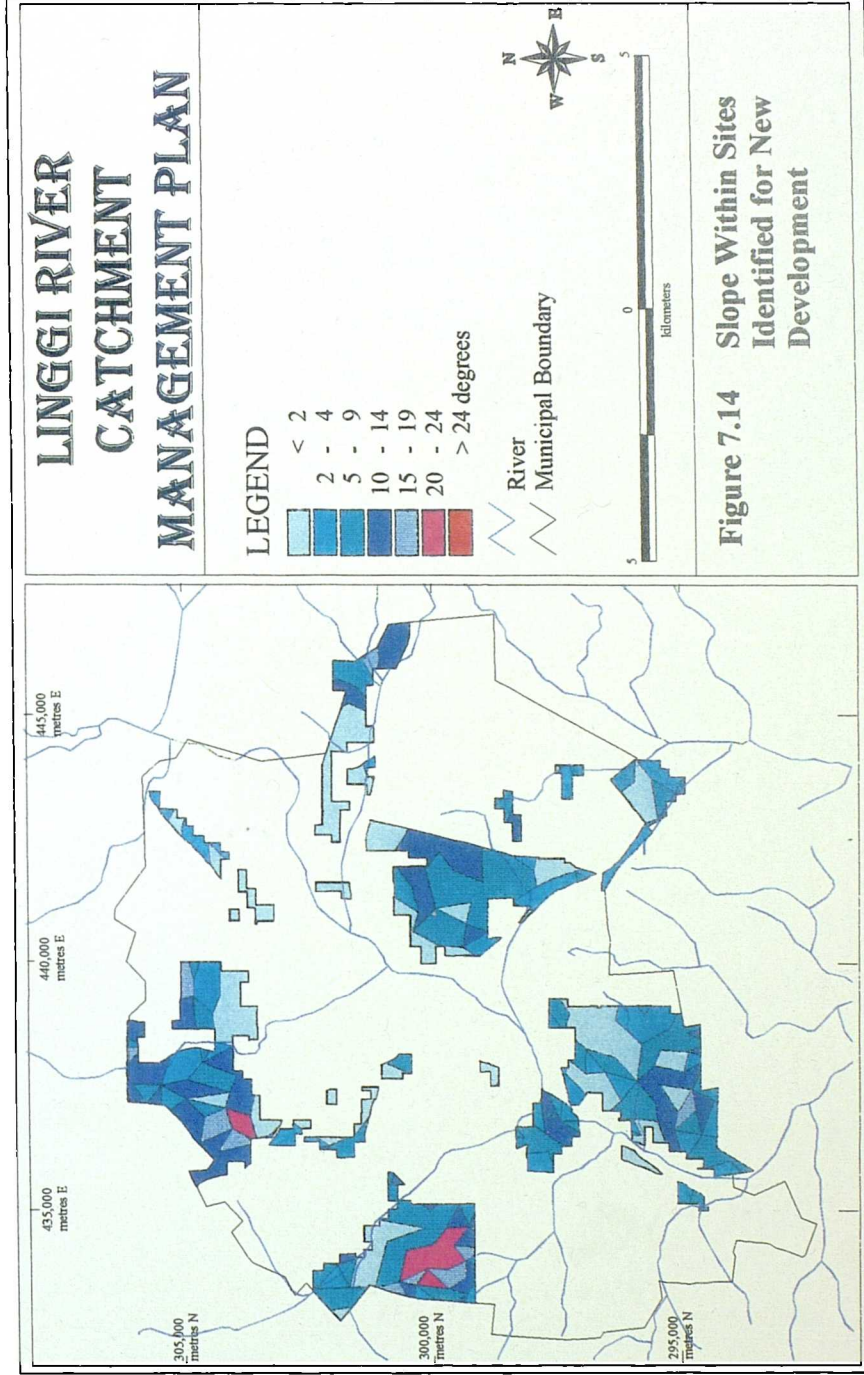
monitoring stations no. 2719622 at Linggi 1 and no. 2719609 at Temiang. As a matter of fact, Figure 7.12b illustrates that these areas when disturbed will consequently be impacted to severe erosion rate and will exert enormous stress on river water quality in terms of siltation problem. These are high risk areas and any development activity planned at these areas should be carefully scrutinised and subject to the approval of the EIA study report before decisions are made to allow such activities to proceed within the highly vulnerable areas in order to avoid them from causing significant impact on the environment.

As described in Chapter 6, the delivery ratio will actually determine the amount of sediment reaching the river system - thus affecting the river water quality and resulting in the siltation of rivers. As predicted, the hilly areas indicate high erosion risk and it has been quite fortunate that most the highland areas are still untouched. Despite this, a few areas with development activities taking place inevitably results in the generation of significant soil loss which has been washed to the rivers. Even some locations which have been identified for new development by the year 2000 are in fact, sited within the sensitive locations where disturbance to the land cover could trigger high or severe erosion risk (Figure 7.13b).

These are areas that should to be left intact and not be touched by any development activities. The Land Conservation Act, 1960 and EIA Order 1987 (Amendment, 1995) specify areas with slopes greater than 20° should strictly be protected from any sort of development unless their construction is unavoidable and their existence could be shown not to affect the erosion rate in addition to other safety and engineering requirements. This is one aspect where land use planning role come into play to help minimise the adverse impact and instead will ensure that both the present and future generation will benefit from the decision process. The modelling results suggest significant erosion can occur even on slopes greater than 14° (Figures 13a and 14).

Although slope is not the only criteria having impact on erosion as discussed earlier, it greatly influences the rate at which erosion will take place. Areas with moderate erosion rate could inevitably become areas of severe erosion risk when subjected to





land clearing. Assessment of areas identified for new development clearly shows the consequences during development project implementation and these include areas which are at present having very low rate of erosion, but they could pose severe erosion risk when the land covers are removed. Distinct differences in the rate of erosion are observed between the present (based on 1990 situation) rate of erosion and the erosion risk that will be induced by earthwork activities or related works especially during construction stages. Figure 13a shows the state of erosion that occur naturally as opposed to situation when the ground has been subjected to land cover removal with the results as illustrated in Figure 13b.

Potential soil loss can be reduced by implementing well planned mitigating measures to avoid erosion. Land cover helps to preserve the soil condition, and removing it will therefore not only results in great amount of soil loss but also, causes siltation of rivers. Hence, a requirement to prevent total land clearing should be in place in an effort to minimise the impact of the non-point source of pollution which is damaging particularly to the river water quality. Serious consideration on the measures to reduce erosion problem should be taken for works during the construction stages of project implementation, besides a whole range of other activities including deforestation, road constructions and replanting on agricultural land.

Areas with slopes greater than 14° should be defined as critical slopes in areas vulnerable to soil loss and easily eroded. Figure 7.14 shows the area with slope inclination of greater than 14° are likely to results in severe erosion as shown earlier in Figure 7.13b. The delineation of such areas could guide developers and planners on the exact areas they should avoid when deciding on approval for project development applications on hill land. The schematic reconnaissance soil map has established the classification of steepland, where the areas on the map coincides with the areas with slope greater than 14° as produced using the Triangulated Irregular Network [TIN] (in the ARC/INFO GIS environment). Such reference is sufficient to provide preliminary decision on the areas that are sensitive and require better regulations as to their land conversion. Nevertheless, as the requirements stated in the legislation related to hill

land areas of 20° or greater which need to be preserved, the delineation of areas with these slopes has to be distinctly specified to planners and other interested parties.

7.6.2 Validation With The Actual River Water Quality

In examining the validity of the above prediction, the contribution from the point sources are equally as important as the non-point sources. Therefore by incorporating point sources (i.e. sewage disposal, wasteload from the activity of animal husbandry, and industrial effluent discharges) into the model, better correlation could be shown between the predicted values to that of the actual values. The high levels of BOD and NH₃N that represent the organic pollutants are indicative of pollution due to human and animal wastes. The presence of a number of factories along the river could also contribute towards the level of pollutants in the river.

The level of SS largely indicates the contribution from erosion taking place and activities such as earthworks, river dredging and to some extent the disposal of effluents. Generally, most of the predicted values for SS level were close to the actual values for SS level, except for the monitoring station number 2719607 at Linggi 2. Due to the enormous number of variables involved such deviation may be reasonably acceptable considering the complexity of the interaction taking place in the real world. Nevertheless, the deviations could be due to the method used in the determination of *K* values (in the U.S.L.E. modelling) which rely on several variables included in the soil characteristics (i.e. soil composition, texture and permeability) and the interpolation of the values using the chart as shown in Appendix E. The lack of data on determined *K* values in the country indicates the urgent need for more research work in this direction.

Such deviations may be reduced if proper field tested data were available. Other factors that could account for the low predicted level as opposed to a reasonably high actual level, include the slope map generation especially for areas within the municipality which appear to be rather flat and thereby resulting in extremely low values being obtained in the simulation of the sediment yield in those areas. These are

particularly relevant to the sub-catchments upstream of DOE's monitoring stations no. 2719622 at Linggi 1, which is located in the middle of flat plain of the Seremban Town, and no. 2619607 at Linggi 2, which is located downstream of the flat plain.

Observation made from the results of sediment yield, indicates a number of locations which are currently experiencing a substantial erosion problem and contributing to the condition of river water quality. These areas are located in the sub-catchments no. 18 (Unnamed sub-catchment next to Terip River), no. 15 (Unnamed sub-catchment at Pantai), no. 13 (Unnamed sub-catchment at Pantai), no. 10 (Terip River), no. 21 (Mantau River), no. 17 (Kepayang River), no. 16 (Simpo River), and no. 8 (Batang Ganai at Kg Getok, Pantai) (Table 7.17).

Table 7.17 Modelling of Soil Loss and Sediment Yield using ARC/INFO GRID

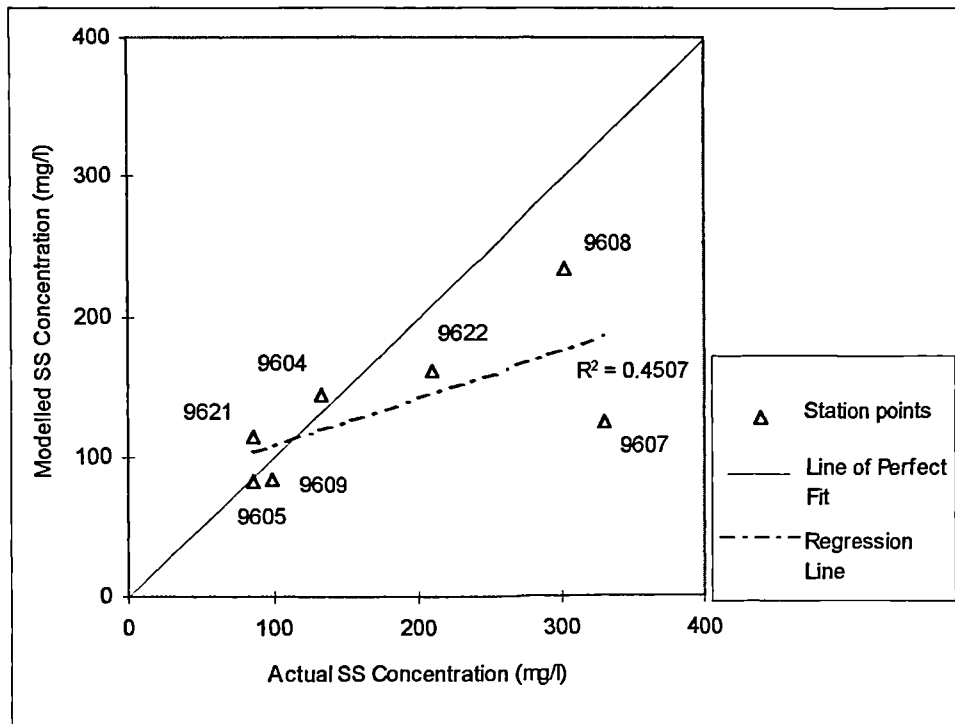
Station No.	Sub-Catchment Number	Hectares	Soil Loss (kg/day)	Sediment Delivery Ratio (%)	Sediment Yield (kg/day)
2719610	2	877	1585	39.38	624
2719610	3	209	36	39.00	14
2719610	4	1160	315	41.97	132
2719610	5	2177	2537	35.66	904
2719622	6	2429	14694	29.83	4383
2719610	7	75	14	57.34	8
2719610	8	295	1943	56.74	1102
2719610	9	285	828	66.65	552
2719622	10	2757	33031	36.74	12134
2719610	11	168	843	54.87	463
2719609	12	2428	10538	32.00	3372
2719610	13	173	2544	65.84	1675
2719610	14	637	923	45.00	415
2719610	15	215	8975	44.12	3959
2719622	16	913	6144	55.09	3385
2719608	17	2036	15077	32.94	4966
2719622	18	110	21362	36.00	7690
2619607	19	1432	1646	32.00	527
2719622	20	3379	15813	31.92	5047
2619607	21	1589	18315	27.50	5037
2719622	22	198	132	39.08	52
2519605	23	7276	21986	29.15	6409
2619607	24	885	1049	27.29	286
2519604	25	2146	4743	23.66	1122
2619607	26	668	784	26.86	211
2519604	27	3166	7069	21.09	1491
2519604	28	1217	4479	29.44	1318
2519604	29	2659	6001	26.30	1578
2519621	30	2162	3923	24.49	961
2519621	31	565	297	26.95	80

Apparently most of the erosion problems are associated with land use activities on slopes of more than 14°. The most serious of all is at sub-catchment no. 18 where the land area was cleared on the slope of more than 20° and the situation then can be regarded as very severe. Once land cover has been established in the area the erosion rate is expected to reduce significantly. Normally most of the top soil will be washed off before the erosion rate starts to decline. Other land uses on steep slopes in areas identified with substantial erosion rate are generally related to agriculture that include mixed agriculture (as in sub-catchments no. 15 and no. 16), pasture land (as in sub-catchment no. 13) and rubber plantation (as in sub-catchments no. 17 and 16).

Areas upstream of DOE's station no. 2719622 contribute half of the total SS load within the study area and a much significant impact is likely to effect when disturbances to the existing land cover on steep slopes are affected, either for conversion to agricultural use or residential purposes. A comparison made between the modelled and the actual SS level of river water, portrays a close relationships with the actual 1990 values except at station no. 2619607 at Linggi 2 (Figure 7.15).

On the whole, the result of the modelling exercise showed that the contribution of SS came largely from the non-point source of pollution and this is in agreement with many studies (e.g. by Novotny and Mahoney, 1978) carried out in many other places related to the subject of land-based pollution. Apparently little has been done to rectify the situation to the same extent as the efforts made in reducing emissions from point sources. It is also worth noting that apart from the non-point source contribution to the total SS load, the amount of piggery wasteload discharges was extremely high. It is therefore, obvious that these are the two main areas contributing to the problem where many different agencies were involved in the matters relating to planning, implementing and controlling of such land use activities.

A similar trend was obtained for the three other parameters namely the BOD, COD and NH₃N, though these parameters are largely associated with the point source of pollution.



Note: Station no. denoted with the last 4 digits.

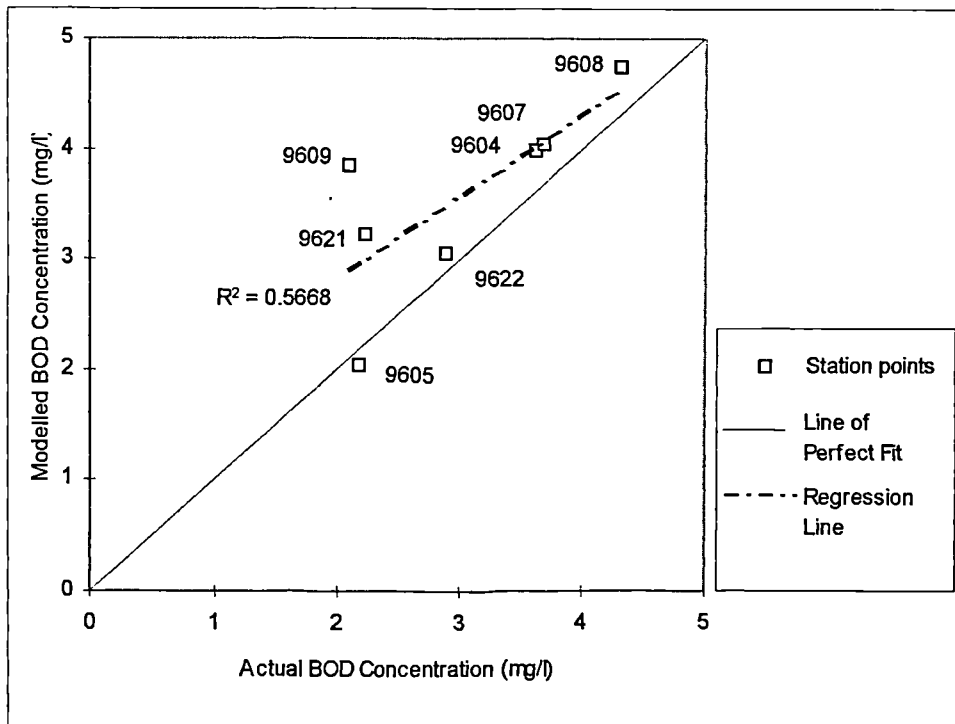
Figure 7.15 The Relationship Between the Modelled SS Values to its Actual 1990 Values.

The modelled values obtained for the BOD loading appear to show higher results at most places compared with the actual average values for the year (Figure 7.16). This is especially so for DOE's monitoring stations no. 2719609 and no. 2519621: which produces a considerably high values. Station no. 2719609 monitors the Temiang River which flows through major portion of Seremban Town and the high BOD is indicative of pollution from domestic and commercial sources. However, the actual quality was not as high as the predicted result possibly because of the channel modification in the drainage system which brought the wastes to the other river stretches particularly to the main river just upstream of station no. 2719622.

Factors such as BOD discharge variation and overestimation of discharge loading could contribute to the deviation of predicted values from the actual (1990) values. Another factor which could have some influence on the result is that the model did not include the assimilative capacity of the river where decomposition of the organics may

occur through self purification in the river system. However, the inclusion of such a factor will indirectly increase the complexity of the model.

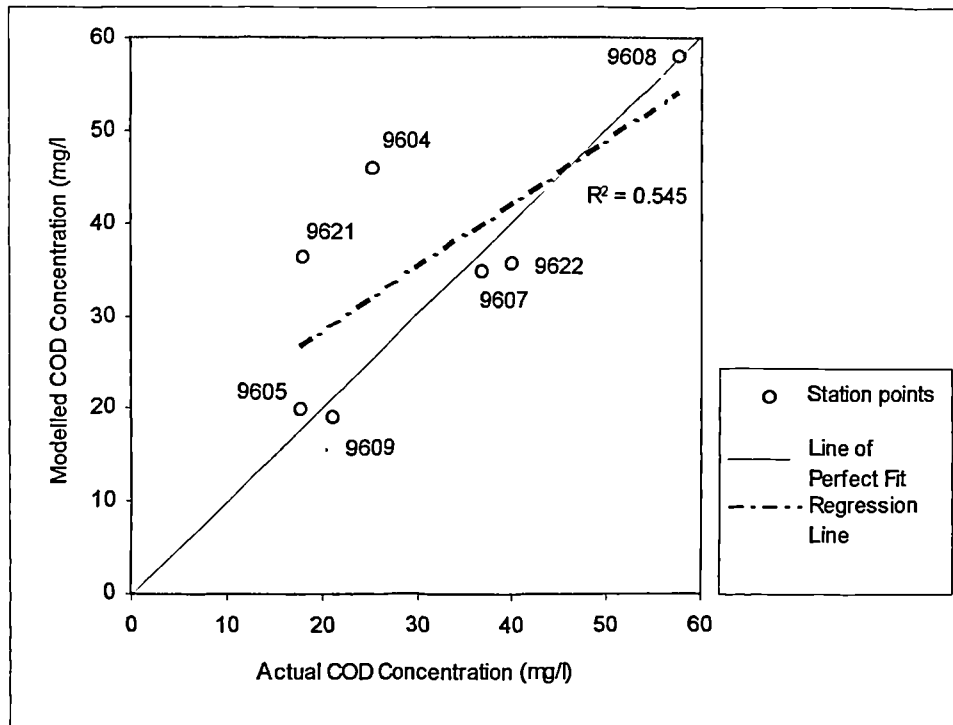
Overestimation can result when data on water quantity and waste quality are taken not at the same time. Factory inspection data often includes wastewater quality but very seldom the wastewater quantity. Wastewater quantity was often based on the reported data from the industries that sometimes were merely estimation of the pump capacity, or from the water bill. Factories are often reluctant to provide information on the wastewater load since those data could be used against them in the future. For all the parameters in the model, therefore, an adjustment figure should be obtained from the percentage difference between the actual and modelled (predicted) values; this is to minimise the incidence of over or under estimation.



Note: Station no. denoted with the last 4 digits.

Figure 7.16 The Relationship Between the Modelled BOD Values to its Actual 1990 Values.

The results obtained for COD at most stations are almost equal to the actual values except for monitoring stations no. 2519604 and no. 2519621 (Figure 7.17). The probable explanation for the high predicted results at both the stations is likely to be due to on-site improvement made in the treatment efficiency (where this piece of information has not been well documented), especially in the rubber mills and piggery farms that could significantly reduces the level of COD just upstream the two monitoring stations.

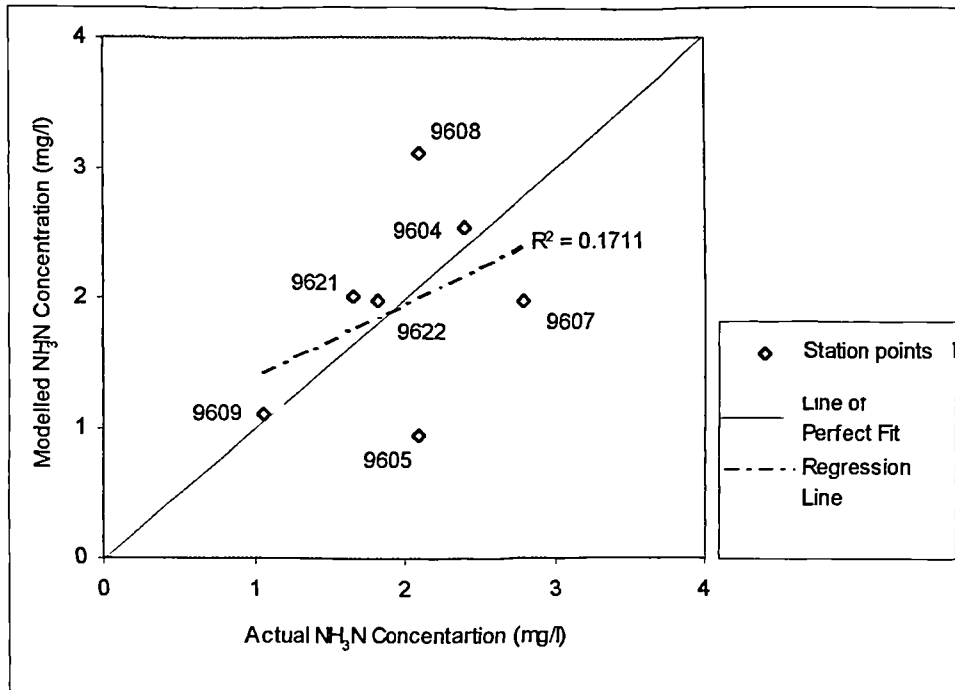


Note: Station no. denoted with the last 4 digits.

Figure 7.17 The Relationship Between the Modelled COD Values to its Actual 1990 Values.

There is no consistency however, in the high and low values among the parameters at each station except for the high values at station no. 2519621 especially for BOD and COD. This is obvious as in the case of parameter NH_3N (Figure 7.18), while four of the stations have the predicted values close to actual, the other three predicted values

are either slightly higher, as at station no. 2719608 (Kepayang), or much lower, as at stations no. 2619607 (Linggi 2) and no. 2519605 (Simin).



Note: Station no. denoted with the last 4 digits.

Figure 7.18 The Relationship Between the Modelled NH₃N Values to its Actual 1990 Values.

The results indicate that most of the time the modelling exercise yield values close to the actual, while for isolated cases the predicted and the actual values differ with gaps varying from slight to about double or half the actual values. Difficulties arise in confirming the exact cause of the deviations between the predicted and the actual, because apart from the contributing factors such as the collation of data and digital map preparation, the study requires field investigations to examine the reasons for the deviation. Field investigation would be able to identify and differentiate the various contributors and determine the extent of problems attributed to the sources of pollution.

The assessment made through the use of GIS is capable not only in identifying the problem on a spatial scale but at the same time it is also capable of quantifying the

amount of load generated in each spatial unit (represented by the cell unit of the grid). However, field verifications would help to minimise errors arising from the omission and inclusion factor in the land use map, unaccounted land use changes which occur when the land use map had been prepared; or even the operational status of point sources, which inevitably will lead to under or overestimation of the quantified pollution load. For example, the quantified load may be lower than the actual because there exist activities such as river dredging, sand mining or river bank beautification which might contribute to the increase in the SS level of the river water, but not accounted in the land use map. Necessary adjustments can be made once the actual contributors to the extent of problem they exert are known. This component was not included in the study because of limited resources and the constraint in time. The study however, recognises its importance.

Moreover, it is anticipated that further research should be able to include the component of *field verification, and thereby helps to increase the confidence in the generated modelling results*. This can be made possible with sufficient resources available. Nevertheless, the study has been able to produce a method that could greatly reduce the amount of time and efforts with the digital data made available through the study, in investigating the way planning decision could be assisted with the modelling information, while ensuring the water quality objectives of the river stretches are not jeopardised which would otherwise occur due to lack of information on the most critical sources of pollution.

7.6.3 Environmental Control For Future Development

The analysis above demonstrates that concentrated development within a catchment area has influenced the overall quality of the river water. The sustainability of water use appears to be threatened as more pollutants are continually being generated and discharged, in addition to the natural as well as induced rates of erosion. Deterioration in water quality is inevitable, at least in the short term, if development is not properly regulated and the environment is not control, while prolonged stress on the water system could cause long-term destruction of the aquatic life and rendered the river

water unfit for use or unable to meet the desired objectives. The choices remain with the planners and decision makers whether or not to proceed with further development in the upstream areas of the water supply abstraction point. The reliability of water supply is one of the essential elements for any development to be sustainable. The question remains to be answered is whether it will be appropriate to have too much development concentrated within a catchment area.

The criteria in making the right decision towards sustainability must firstly ensure that it is at least maintaining the existing clean status of the water quality without causing a reduction in the river flow rate. If the river status is polluted, appropriate actions must be taken to rectify the situation, so that its status can improve over time to an acceptable condition and consistent with the water quality objectives requirements. The test on the various case scenarios (as described in Chapter 6) helps identify the best combination in wasteload discharges in the Linggi Catchment and provides the course of action to be implemented in improving the river condition. The results of such analysis suggest a relatively easier control can be achieved for the point sources compared to the control of the non-point source of pollution. This explains the reason on the present approach taken in the protection of rivers by targeting the major point sources (and in fact, this is the best way in achieving significant load reduction within a short time frame). Nevertheless, it should not be regarded as the only target, since most of the cases of river pollution are attributed to the non-point sources (DOE, 1994a) (Figure 4.3).

Wasteload reduction for sewage disposal can be improved by a further 20 percent from the total organic (BOD) load of 3.4 ton/day in the year 2000 with the implementation of the centralised sewerage system for the Municipality of Seremban. To meet this target, discharges of the effluent must however, comply with the limits stipulated under the related regulations. Even after such reduction, the organic load (in terms of BOD) will still remained slightly above the 1990 total BOD load. This calls for a more drastic action to be taken to reduce the wasteload from other major sources of pollution. A reduction of wasteload from animal farming activities (in terms of its BOD load) by half will help to reduce the total BOD load by more than 60 percent of

the total BOD load at the location just upstream of the water abstraction point for SLWTP at Kg. K. Sawah. Hence, it will be inadequate to rely simply on sewage load reduction without a simultaneous step in reducing the amount of wastes from the animal farming industry in the catchment.

Consideration to move some of the pig farms out of the catchment (particularly those on State Government owned land) seems to be a practicable option, in an effort to reduce the wasteload from the sector. Alternatively, the pig farms will have to adopt a much more sophisticated treatment to reduce their wasteload by half, thereby incurring cost on the farm operators. This alternative might not prove useful, the authority often experience difficulties with the industry even having to adopt a simple biological system. When other solution could not be reached, at the very least, all pig farms within the sensitive locations need to be relocated to places outside the catchment area, where the river conditions and the water quality objectives (based on the beneficial river uses) are acceptable. The best site identified for their relocation would be at the Bukit Pelandok Pig Farming Area (in the Sepang Basin - but subjected to further suitability studies) which has been designated by the State Government specifically for the industry.

There seems not to be little significance between the options of either to take up industrial development on the *proposed* land or on the *potential and proposed* land for the purpose of industrial expansion within the study area, except for locations at Simin (2519605) and subsequently Linggi 3 (2519604). This thesis however, suggests that preference for industrial expansion should be taken up on the sites identified as *potential and proposed* land. It also appears that the level of organic wasteload will increase from the 1990 level and the prospect of seeking additional water source for abstraction on the Simin River will have to be re-examined.

An issue anticipated is at which point the wastewater from the propose centralised sewerage treatment system for the Municipality of Seremban is to be discharged. It is very likely that under the first option, the wastewater will be discharge to the upstream of the water abstraction point at Kg. K. Sawah as it will be closer to the location of the

treatment facility. Under the present requirement, such discharges will have to comply with Standard A of the Third Schedule of the Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979 (Table 4.5). The wastewater discharge option, on the one hand, helps to achieve the low flow maintenance of Linggi River which is critical to the water abstraction point at Kg. K Sawah. Alternatively, under the second option, the wastewater can be diverted and discharged to a location downstream of the water abstraction point at Kg. K. Sawah where the discharge will qualify for the effluent limit of Standard B of the regulations. However, this might have considerable effects on the river flow regime at Kg. K. Sawah.

The first option causes some concern, as any upsetting of the wastewater treatment system would render the water quality, at the water abstraction point, to become grossly polluted and the cost to rectify the problem could be tremendously high. Therefore, to avoid having to take such risk, the second option has promise as a safer choice. However, the authority will have to seek the nearest water source in order to meet the demand required for abstraction by the water works at Kg K. Sawah. The only possible source will then be the Simin River (tributary of the Linggi River) which is just a few kilometres adjacent to the Linggi River. Hence, it is very crucial that the water quality of Simin River be sustained at least at Class III. Any industrial expansion within the Simin sub-catchment, should be restricted only to areas identified as *potential and proposed* land (for industrial development), and animal farming at least should be kept well under control.

7.6.4 Acceptable Limits

The amount of projected wastes to be discharged into watercourses by the year 2000 should take into account the carrying capacity at the various river stretches. In terms of BOD (as illustrated in Figure 7.19), in all the sub-catchments, the present pollution load discharges are well within the acceptable limits, considering their compliance to Class III of the interim water quality criteria and standards for Malaysia. The Class III level is used to be consistent with the desired use of the river water, from Kg. K. Sawah and the upstream stretches, that is for use as water supply with extensive

treatment. In the year 2000, under most situations, especially in case scenarios b6 to b7, it is anticipated that the river condition can be sustained at the compliance level of Class III standards. In fact, the water quality in terms of BOD, could be better than the conditions in 1990 for locations at Temiang, Linggi 1, Kepayang and Linggi 2. Depending on which case scenarios have been decided, the amount of waste generated will determine whether or not the acceptable limits are exceeded. In some sub-catchments which include Temiang, Kepayang, Linggi 2, the case scenarios: c2, c1, a, b1 and b3, have either exceeded the limit for sustainable of water use or they are too close to the margin that would risk the beneficial river uses.

However, a different outcome has been shown in the case of the other parameters. On balance, COD (Figure 7.20) shows almost similar trend as BOD. Nevertheless, a considerably critical sub-catchment, that is Kepayang, has not only shown an exceedingly high level of COD load but also in terms of SS load (Figure 7.21) and NH_3N load (Figure 7.22). In fact, with all the proposed imposition of control measures, the best options b6 and b7 still could not achieve the Class III standards for Kepayang, although the level almost reaches the acceptable limits whereby the river could assimilate the wasteload received.

The Ammoniacal Nitrogen [NH_3N] analysis also indicates that only with the 2 case scenarios (i.e. b6 and b7) the future water quality could be sustained within the acceptable limits. Ammoniacal Nitrogen which has been used as an indication for sewage and animal waste pollution has been identified as the main cause of river water quality degradation not only in Linggi Catchment, but it has been detected to become a major threat in other catchments too. In certain areas, water supply had been at stake and at times the quality were unable to achieve the required standards due to ammonia contamination. For example, there were reports on situations where the water works had been temporarily shut down on a number of occasion because of high ammonia content detected in the water supply (Utusan Express, 4/11/97). This has prompted the Department of Environment to come out with a set of standards on the level of ammonia that can be safely discharged to the environment as a way to

reduce cases of ammonia contamination especially in water bodies (The Star, 12/3/98).

It is important that any improvement in water quality should be reflected particularly at Linggi 2 (station no. 2619607) which is located upstream of the water supply abstraction point at Kg. K. Sawah. The case scenarios, b6 and b7, have been found as the most acceptable choice, whilst case scenarios, b4 and b5, were close to the desirable levels or the acceptable limits. In fact, the proposal for strong environmental control is in agreement with the situation as illustrated in Figure 7.21D.

How different are b6 and b7, which make them more acceptable compared to the other case scenarios? The strong environmental control options impose a major restriction on the wastes discharges in an effort to increase the confidence level of attaining a cleaner water quality. It does this through the reduction in sewage disposals, limiting and restraining pollution from animal farming activities and imposing strict control on industrial development and discharges within the upstream area of the SLWTP water abstraction point at Kg. K. Sawah.

With such requirements, the case scenarios emphasise on a greater task in which the local authority has to commit while delivering and implementing developmental programmes so as to be consistent with the national environmental strategies of upholding the concept of sustainable development, and to be in line with the principles as outlined in Agenda 21. The key principle towards achieving this, is the precautionary approach which is embedded within the objectives of catchment management planning and environmental impact assessment. When dealing with applications for developmental projects approvals or when planning for any area development, the local authority and other planning and environment-related agencies have to adopt on source control and waste minimisation strategies, in order to attain the desired water quality objectives by adopting and enforcing appropriate threshold limits that have taken into account the carrying capacity of the river system. This calls for the setting of the water quality objectives at each river stretch.

7.6.5 Predicted Water Quality According To The Various Developmental Scenarios And Choosing The Best Option.

Simply considering the amount of pollution load entering the river system, would not be sufficient to provide the necessary guidance in the selection of the best case option. Hence, the proposal of adopting the water quality objectives would guide decision makers to come out with an effective way of indicating whether the selection of a certain choice would produce an improvement to the water quality, or result in no significant change, or becoming much worse than before. Specific water quality criteria and standards, for example: the drinking water were evaluated not only in terms of parameters which are or may be of significance to public health, but also in terms of parameters that affect the acceptability of water to consumers because of effects on appearance, taste, odour or other properties not directly related to health but important in relation to normal water use.

The classes appearing in Table 7.18 were based on the selection of the worse class among the 4 parameters under the above examination. The study indicates only certain cases (referred to as case b6 and b7), under the strong environmental control option, seem acceptable for development to proceed within the Linggi Catchment area by the year 2000. It will still ensure (based on the four parameters) that at the water abstraction point the raw water will be suitable for drinking water supply purposes but will require extensive treatment in order to meet this objective.

There are only two cases under the strong environmental control strategy found to be capable of sustaining the river water quality upstream of the water abstraction point at SLWTP (located downstream of station number 2619607), but with a challenging task ahead in implementing the decision. Besides needing to implement the central sewerage system and minimise animal farming activities by the year 2000, the two options only allow industrial development to be set up in locations identified as *proposed* land. Even under such level of control, the Kepayang River could only attain Class IV (Table 7.18).

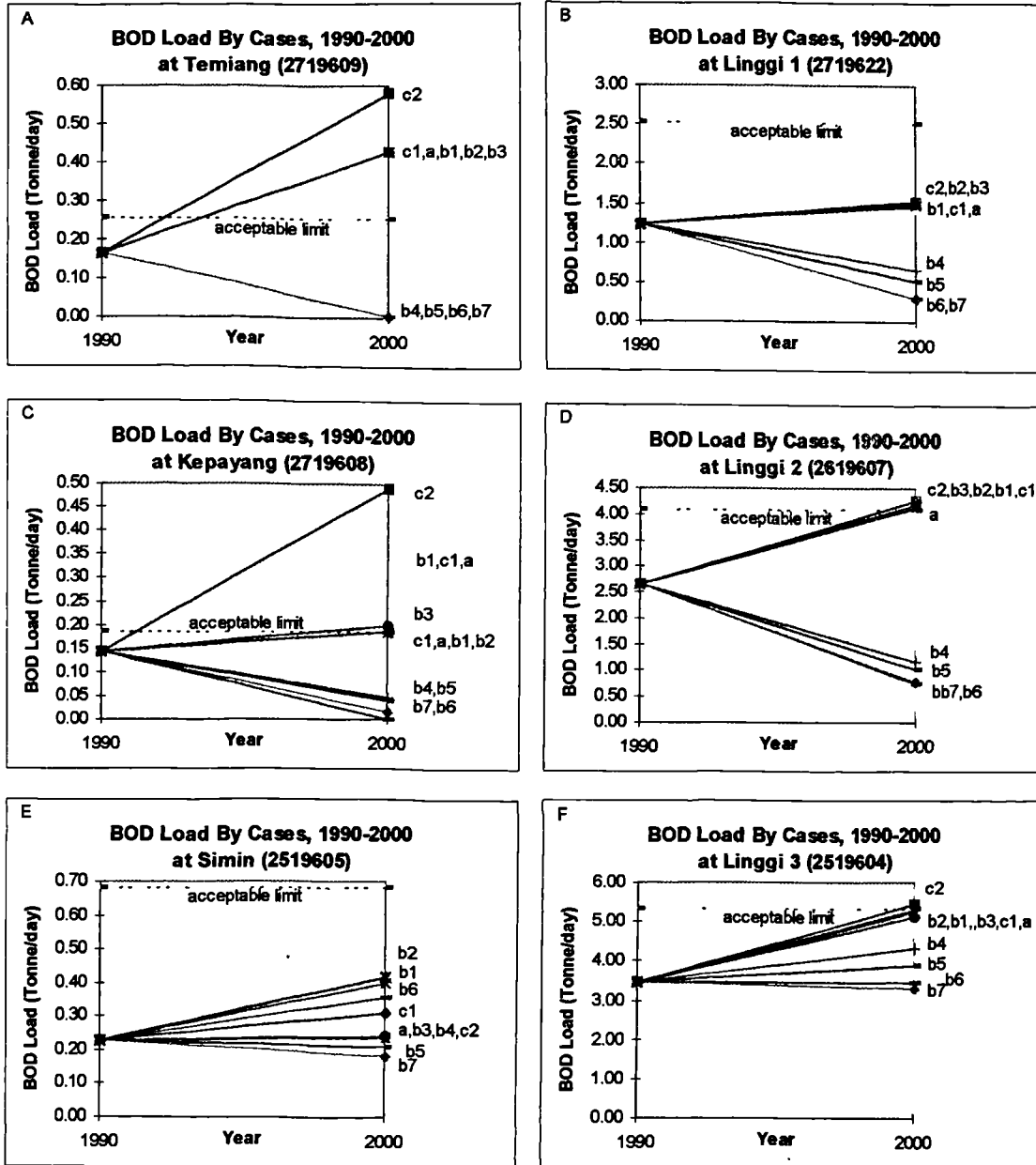


Figure 7.19 Linggi Catchment: BOD Variations Under Different Case Scenarios, 1990-2000.

Key to the Case Codes Above:

Planning Decision	Case Code	Central Sewerage Facility	New Industrial Development					Animal Wastes		
			No Improvement in Discharge Quality		Improved Industrial Discharge Quality			Improvement in Discharge	Reduced by 50 %	Zero Discharge
			Only Existing	Potential Areas	Potential Areas	Proposed Areas	Potential & Proposed			
No Environmental Control	c1	No	Yes	No	No	No	No	No	No	No
Weak Environmental Control	c2	No	No	Yes	No	No	No	No	No	No
	a	No	No	No	No	No	No	No	No	No
	b1	No	No	No	Yes	No	No	No	No	No
	b2	No	No	No	No	Yes	No	No	No	No
	b3	No	No	No	No	No	Yes	No	No	No
Strong Environmental Control	b4	Yes	No	No	No	No	No	No	No	No
	b5	Yes	No	No	Yes	No	No	No	No	No
	b6	Yes	No	No	No	Yes	No	Yes	Yes	No
	b7	Yes	No	No	No	No	Yes	Yes	No	Yes

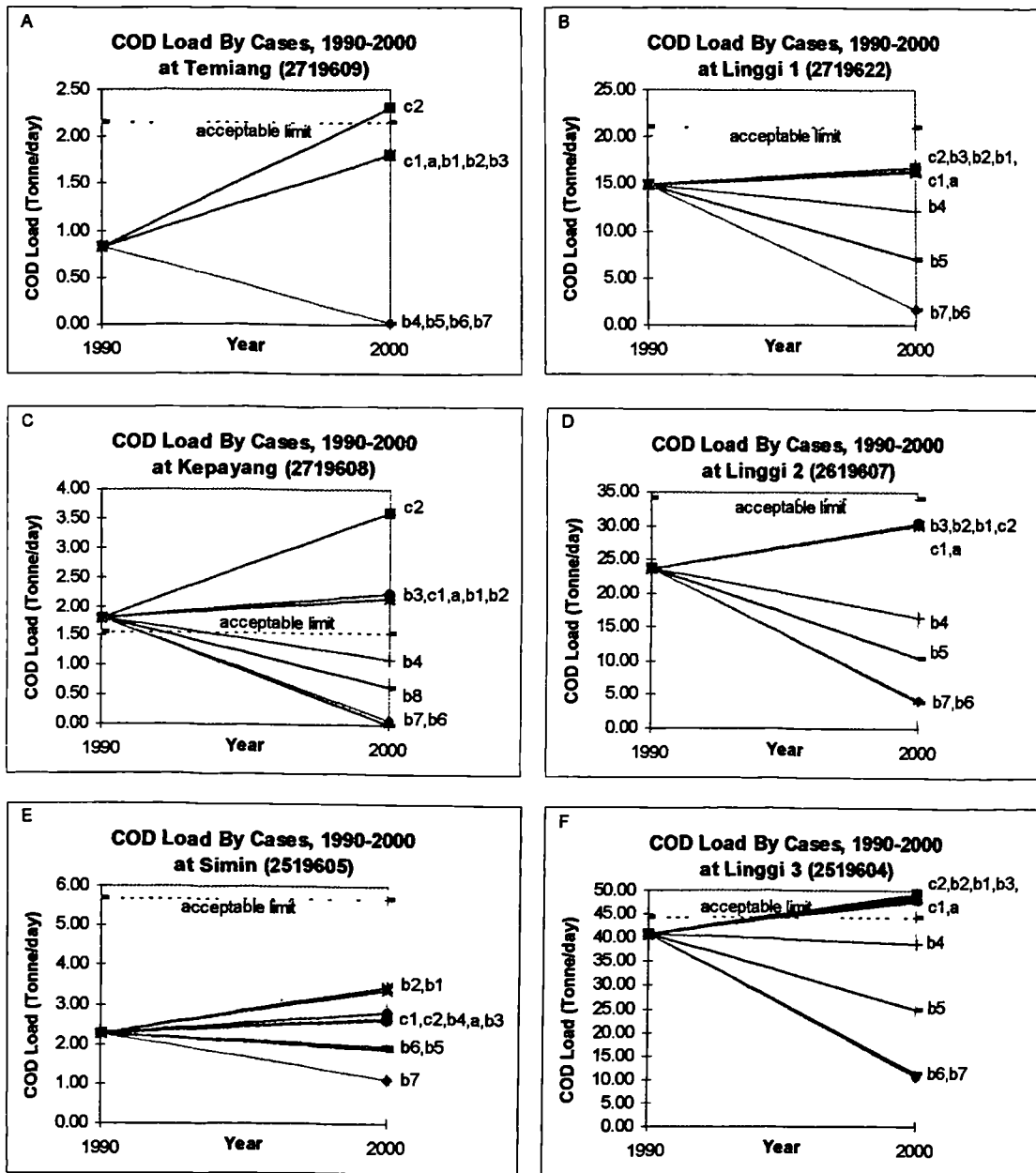


Figure 7.20 Linggi Catchment: COD Variations Under Different Case Scenarios, 1990-2000.

Key to the Case Codes Above:

Planning Decision	Case Code	Central Sewerage Facility	New Industrial Development					Animal Wastes		
			No Improvement in Discharge Quality		Improved Industrial Discharge Quality			Improvement in Discharge	Reduced by 50 %	Zero Discharge
			Only Existing	Potential Areas	Potential Areas	Proposed Areas	Potential & Proposed			
No Environmental Control	c1	No	Yes	No	No	No	No	No	No	No
	c2	No	No	Yes	No	No	No	No	No	No
Weak Environmental Control	a	No	No	No	No	No	No	No	No	No
	b1	No	No	No	Yes	No	No	No	No	No
	b2	No	No	No	No	Yes	No	No	No	No
	b3	No	No	No	No	No	Yes	No	No	No
	b4	Yes	No	No	No	No	No	No	No	No
Strong Environmental Control	b5	Yes	No	No	Yes	No	No	No	No	No
	b6	Yes	No	No	No	Yes	No	Yes	Yes	No
	b7	Yes	No	No	No	No	Yes	Yes	No	Yes

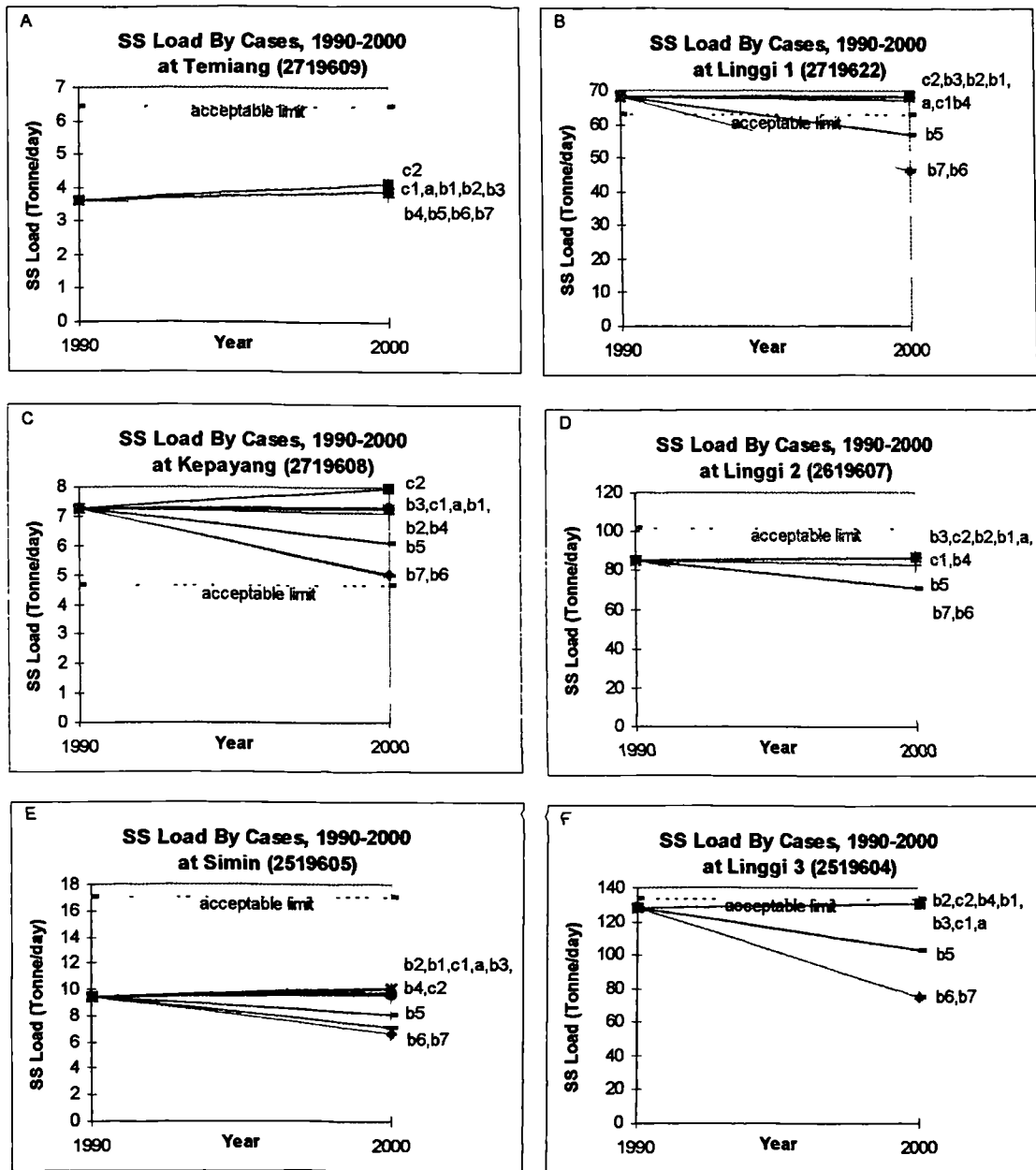


Figure 7.21 Linggi Catchment: SS Variations Under Different Case Scenarios, 1990-2000.

Key to the Case Codes Above:

Planning Decision	Case Code	Central Sewerage Facility	New Industrial Development					Animal Wastes		
			No Improvement in Discharge Quality		Improved Industrial Discharge Quality			Improvement in Discharge	Reduced by 50 %	Zero Discharge
			Only Existing	Potential Areas	Potential Areas	Proposed Areas	Potential & Proposed			
No Environmental Control	c1	No	Yes	No	No	No	No	No	No	No
	c2	No	No	Yes	No	No	No	No	No	No
Weak Environmental Control	a	No	No	No	No	No	No	No	No	No
	b1	No	No	No	Yes	No	No	No	No	No
	b2	No	No	No	No	Yes	No	No	No	No
	b3	No	No	No	No	No	Yes	No	No	No
	b4	Yes	No	No	No	No	No	No	No	No
Strong Environmental Control	b5	Yes	No	No	Yes	No	No	No	No	No
	b6	Yes	No	No	No	Yes	No	Yes	Yes	No
	b7	Yes	No	No	No	No	Yes	Yes	No	Yes

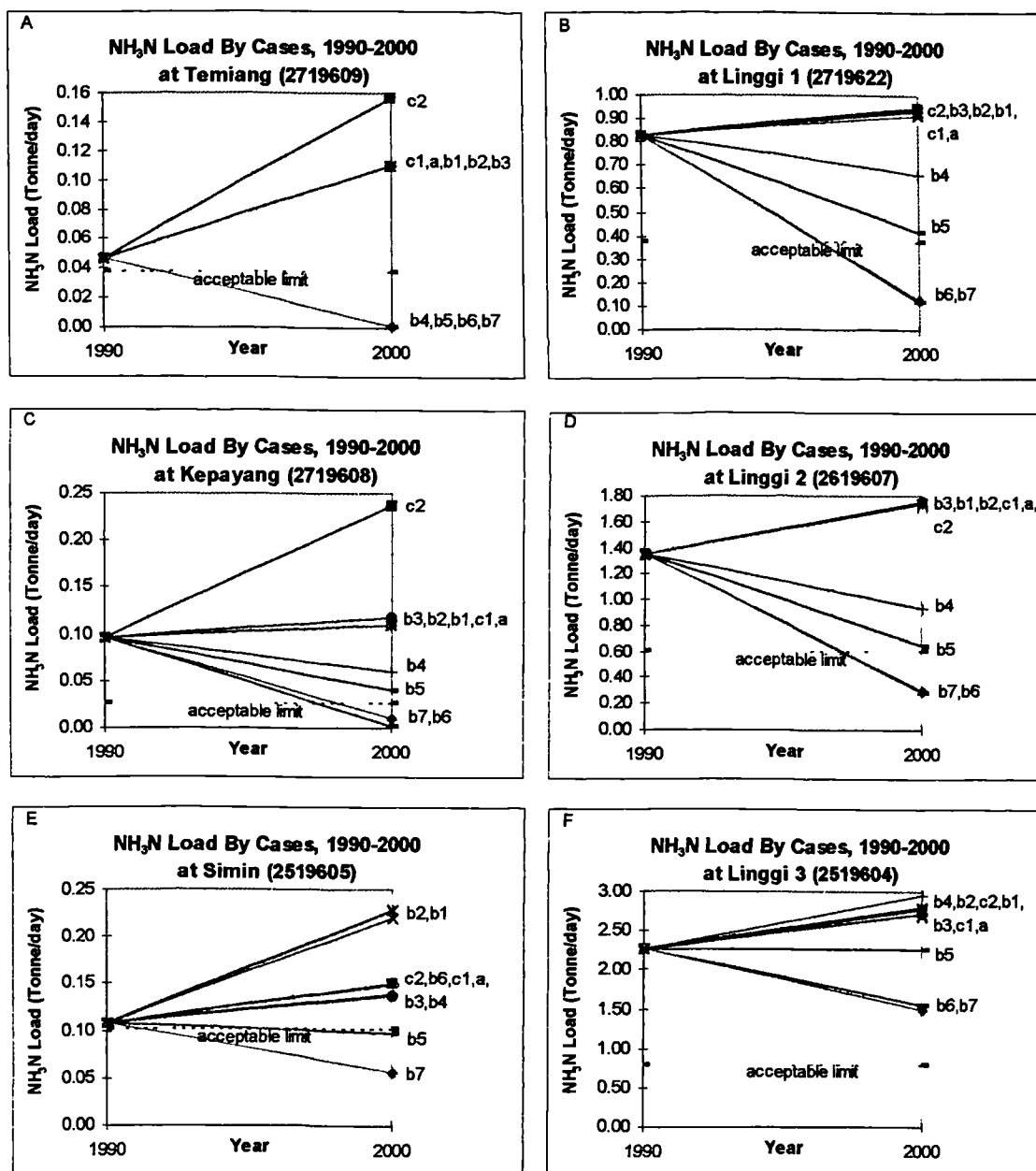


Figure 7.22 Linggi Catchment: NH₃-N Variations Under Different Case Scenarios, 1990-2000.

Key to the Case Codes Above:

Planning Decision	Case Code	Central Sewerage Facility	New Industrial Development					Animal Wastes		
			No Improvement in Discharge Quality		Improved Industrial Discharge Quality			Improvement in Discharge	Reduced by 50 %	Zero Discharge
			Only Existing	Potential Areas	Potential Areas	Proposed Areas	Potential & Proposed			
No Environmental Control	c1	No	Yes	No	No	No	No	No	No	No
	c2	No	No	Yes	No	No	No	No	No	No
Weak Environmental Control	a	No	No	No	No	No	No	No	No	No
	b1	No	No	No	Yes	No	No	No	No	No
	b2	No	No	No	No	Yes	No	No	No	No
	b3	No	No	No	No	No	Yes	No	No	No
	b4	Yes	No	No	No	No	No	No	No	No
Strong Environmental Control	b5	Yes	No	No	Yes	No	No	No	No	No
	b6	Yes	No	No	No	Yes	No	Yes	Yes	No
	b7	Yes	No	No	No	No	Yes	Yes	No	Yes

Table 7.18 Linggi Catchment: Selection of Best Case Option for the Year 2000.

Station No.	Name of River	Water Quality Index									
		No Environmental Control		Weak Environmental Control				Strong Environmental Control			
		c1	c2	a	b1	b2	b3	b4	b5	b6	b7
2719609	Temiang	IV	V	IV	IV	IV	IV	III	III	III	III
2719622	Linggi 1	IV	IV	IV	IV	IV	IV	IV	IV	III	III
2719608	Kepayang	IV	V	IV	IV	IV	IV	IV	IV	IV	IV
2619607	Linggi 2	IV	IV	IV	IV	IV	IV	IV	IV	III	III
2519605	Simin	IV	IV	IV	V	V	IV	III	IV	IV	III
2519604	Linggi 3	IV	V	IV	V	V	V	IV	IV	IV	IV
2519621	Linggi 4	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV

7.7 OVERALL DISCUSSION ON THE CASE STUDY ANALYSES

The modelling of the case scenarios assumed for the year 2000, provides a form of prediction on river water quality where comparison with the desired water quality objectives (WQOs) can be made. As been set out by Storey (1980) that a water quality model is essential to determine the impact of reduction in effluent load and the non-point source contributions on water quality within the catchment area. The study has shown the usefulness that match this objective, and the incorporation of the modelling process within the ARC/INFO GIS environment produces better spatial analytical results.

The comparison between the predicted condition and the actual river water quality confirms the validity of the designed model using the GIS environment, although, refinements and retesting will be necessary to improve the model for operational use. The use of the spatial modelling feature in the GIS environment has profoundly shown that the application could easily provide the necessary output and provide early warnings for planners and decision makers, that will help to protect the delicate and sensitive areas and at the same time preserving the beneficial uses of the river which supply the basic element of life i.e. water.

SS and NH_3N are the two main pollutants distinctly contributing towards the degradation of water quality at Kepayang sub-catchment. The control of SS in the river system has been and will remain a difficult problem to rectify, unlike the other pollutants. But there are ways where the extent of the problem could be minimised, such as by improving the *P* factor, avoiding steep slopes especially at inclination of 14° or more, maintaining areas under forest cover that could enhance the protection of water supply areas and many others which will be discussed further in the next chapter.

The generation and discharges from the point sources of pollution, however, can be manipulated to suit the desired WQOs in places unable to attain the desired quality level. The manipulation process may provide the means which enable development programmes to proceed and help to improve the river's capability to assimilate the received wastes, but with emphasis on waste minimisation which means the development activities should not be allowed to generate excessive pollution load that could choke the rivers.

For long term sustainable water use of the Linggi River Basin, development in an unpolluted area could be withheld to stay clear of a critical water stress situation in the overall catchment areas. Such areas can potentially be the sources for clean water in the future when the resource becomes less available to meet future demand. Therefore, decision makers will have to make strategic choices with the appropriate selection of a more suitable location in siting development projects while meeting the demand of the community.

The downstream areas of the Linggi Catchment have great potential to receive development opportunity as the impact would be less due to the dilution factor and would not severely affect the current uses of the river water. The development activities, however, will still need to comply with the legislative requirements and local environmental needs in order to maintain the ecological condition at the estuarine areas. New sites for development have to be carefully determined and planned to take account of the current water quality, wasteload generations and the

impact of the future development on the whole where the basin should be treated as an interrelated system.

Table 7.19 Linggi Catchment: Suitability Options and Problematic Sources.

Class	Station No.	Sub-catchment	Suitable Option ¹	Problems with other options ²	Source of Pollution	Specific Recommendation for Water Quality Improvement
III	2719609	Temiang	b4b5b6b7	BOD, SS	Sewage Siltation	Connection to centralised sewerage facility Erosion control measures and avoid development on slope greater than 14°
	2719622	Linggi 1	b6b7	SS, AN	Siltation Animal wastes	Erosion control measures and avoid development on slope greater than 14° Relocate or no discharge
	2719608	Kepayang		BOD, COD, SS, AN	Siltation Sewage Animal wastes Industrial effluents	Erosion control measures and avoid development on slope greater than 14° Connection to centralised sewerage facility Relocate or no discharge Improved treatment method and efficiency
	2619607	Linggi 2	b6b7	BOD, SS	Siltation Sewage Industrial effluents	Erosion control measures Connection to centralised sewerage facility Improved treatment method and efficiency
	2519605	Simin	b4b7	AN	Animal Waste	Improved treatment efficiency
IV	2519604	Linggi 3	c1ab4b5 b6b7	COD, AN	Sewage Animal Waste	Efficient communal treatment facilities. Improved treatment efficiency
	2519621	Linggi 4	c1c2ab1b2 b3b4b5b6b7 (all options)			

Note:

¹Based on the classes determined by the overall index.

²Based on the classes determined by the individual index, when the overall index fail to meet the desired class standards (see Appendix F).

This study has identified problematic areas and sources contributing to their water pollution problem. The problem arising in these areas need to be resolved and new development must consider the cumulative impact on the sub-catchment area in

meeting with the WQOs. The existing sources located within them will have to comply with better standards. Table 7.19 shows the areas with the identified problematic sources which need to be controlled right from the beginning.

By imposing the waste minimisation approach, the discharge load can be reduced to an appropriate level to protect the river water quality from exceeding the desirable level in safeguarding the beneficial uses. The model shows such manipulation of wasteload and the resulting improvement in water quality can be achieved. In practice, the manipulation can be made possible through the imposition of stiffer standards of compliance.

This analysis is important to assist the approving authority in testing the suitability of proposed activities or consider the effect of relocating or eliminating polluting sources. The model serves as a simple screening tool that can be used by planners. This technique of assessing the suitability of any land utilisation would benefit the users once it is been incorporated within the CMP report format.

There are however, several shortcomings which this research encounters. These can be summarised as the following:

1. Lack of research in producing the various factors involved in the study. These factors include the erodibility factor (K), crop management factor (C), field control practices factor (P) and rainfall erosivity (R). Their availability will expedite the overall assessment of the entire country.
2. The development plan has been produce since the last 15 years and this is the only official document on policies and proposals available for the study, which means many new developments which had not been included in the official document could not be accounted for. While some policies or development programmes have changed.

3. Water quality monitoring locations can be considered as scarce, and this has refrain from producing a good correlation between the predicted results and the actual values from monitoring activities.
4. No simultaneous river flow and water quality measurements (by DOE) are available and the study has resorted to the best available data obtained from another department (i.e., the DID) and government document for river flow data. This to some extent may have some implications on the predicted results, and due to nature of the situation, data used were based on annual average rather than seasonal. Seasonal fluctuation may reflect a better river-condition variation that could be a valuable piece of information in planning and development control.
5. Further improvements can be made to the water quality modelling by incorporating several other parameters such as the assimilative capacity of the river. This was not covered because of the lack of data relevant for the exercise. However, the author is of the opinion that the present model has produced appreciably reliable results for the purpose of this study, judging from the correlation obtained from the validation exercise.
6. Due to limited resources, field verification could not be carried out, which otherwise will help to improve the reliability of the output information.

7.8 CONCLUSION

This case study outlines the important sources of pollution that will have impact on water quality of the Linggi catchment. The estimation of the projected wasteload in the year 2000 was based on the available collated data from various sources including the government agencies and available literature on the area in particular or Peninsular Malaysia in general. For the present base year itself sewage is the dominant source of organic pollution, followed by discharges of piggery wastes. With the progress made

in the control of industrial wasteload, the discharged industrial effluents in 1990 only contribute about 10 percent of the total organic load. With further industrial development, but with sewage disposal and piggery waste put under control, it is anticipated that the industrial waste will increase to about 33 percent in the year 2000. This calls for a careful selection on the types of industrial processes to be set up so as not to jeopardise the available water resources within the Linggi catchment. The existing agricultural areas should be limited to the present land area while the forest area must be sustained at least to the 1990 figure.

Among the identified pollutants that are critically affecting the ability of river to be sustainable in terms of the organic load are the Biochemical Oxygen Demand [BOD] and Ammoniacal Nitrogen [NH_3N], but the extremely problematic parameter is the Suspended Solids [SS] which eventuate from the problem of soil erosion. This has significantly influence on the overall index of water quality. The study has confirmed an association between the predicted pollution load to that of the actual value for most of the time and their relationship are close, hence supportive of the model validity.

By and large, the best choices available for the case study area are case scenarios b6 and case b7. Under these option, the study suggested the implementation of the centralised sewerage system which will help in sewage treatment and disposals and improving the overall sewerage facilities; limiting and restraining pollution from animal farming activities and imposing strict control on industrial development and discharges within the upstream area. Case scenarios b6 and b7 differ in the limiting factor imposed on pig farming activities, whereby for the case scenario b6, the treatment improvement proposal will cut down the wasteload by half while case scenario b7 favour zero discharge in the activity.

This case study has proved useful in developing a quick method of processing development application and looking at the perspective of their impact on water quality of the area to ensure a sustainable water use. However, the initial preparatory work on building databases and to integrate with GIS application could be enormous. Nevertheless, analysis using GIS for such predictions could be invaluable over time,

when there is an increasing need for more predictions to meet the future challenges in distributing development programmes to suit the national development goal within the context of sustainable water uses.

CHAPTER 8

PLAN PROPOSAL FOR MALAYSIA

8.1 INTRODUCTION

This chapter incorporates the various elements of the previous chapters to outline a proposed Catchment Management Plan for Linggi River in particular and for Malaysia in general. Explicit through the thesis, the discourse has been focusing on the key elements of strong sustainability stance which will effectively be the primary objective in achieving the underlying essence of sustainable development. Among them includes the principles of preservation and conservation. Preservation and conservation are not easily achievable unless a carefully planned programme is formulated with clear goal(s) and objectives to lead to their implementation coupled with the will to make them successful.

Aldo Leopold (1949) pointed out that despite nearly a century of world-wide propaganda, conservation still proceeds very slowly (snail's pace) and called for an environmental ethic. In addition, clear guidance needs to be formulated which provides direction where harmonisation of land use practices with society's rights to water uses forms the basis of the environmental goal. This outcome forms a mirror image of the society where, according to Leopold, the quality of life and environmental quality are synonyms for a living society. In view of this it has been

strongly advocated that polluting water is to harm Man and other living creatures which are dependent on water, and should not be tolerated.

The conservation of the upstream area of a catchment helps to protect downstream activities from excess or too little water. Hence it is very important that planning consider preservation where necessary as a viable alternative to development. Preservation normally suggests no further development other than what already exists. Conservation, however, allows development to occur but with environmental protection measures taken into consideration.

The development of a model in this study serves as a screening process which is simple and rapid but effective enough to eliminate major potential environmental problems and produces the best choice to attain a sustainable water use in the catchment under consideration.

8.2 PROPOSED ACTIONS TO ACHIEVE SUSTAINABLE WATER USE IN LINGGI CATCHMENT

Water is a resource indispensable to all human activity and therefore must be appropriately valued. In view of this, to fully realise the target under CMP, it is important that the principles of strong sustainability are upheld. Actions critical for the success of a formulated plan to counter the problems that caused river water quality deterioration and to improve the river condition with the target of achieving the desired state of the river, by and large, would be derived from issues as identified in Chapter 7. In fact, these are the issues that posed major difficulties to bring about improvement to sustain the state of the water resource in most river catchments in the country. Hence, rivers should be protected through a combination of actions which have to be acted in an integrated manner by various responsible agencies. Although it has been recognised that some of these actions are already in place, this thesis emphasises that the approach towards catchment management should be holistic and

the actions to be implemented should be in an integrated form. Precisely, the activities of river protection that are already in place, but needing further strengthening include: river monitoring; source control; protection of water supply zones; and protection within the developable area zones of the catchment.

Control over the sources of pollution involve a great deal of efforts to reduce the wasteload from sewage discharges, animal wastes, and industrial wastewater discharges. These are treated as fundamental in source control as they are relatively easier to implement, despite they will sum up to the question of cost in bringing down a certain amount of the wasteload; or to the political masters, it will involve their willingness in making unpopular decisions such as in relocating certain problematic sources.

Technically, sewage disposal can be reduced by up to 80 percent in terms of the organic load through the connection of septic tanks to centralised treatment facilities. By having such connections, it is also expected to improve maintenance efficiency particularly in the major urban areas. The improved communal treatment facilities will be useful especially for smaller residential estates and smaller towns. Similarly, the reduction in the discharges of animal wastes, can be achieved by having the recyclable biological treatment systems in places and that could provide even up to 'zero emission'. If necessity arises, problematic farms should be moved out from sensitive areas within the catchment.

Analysis made in the previous chapter showed that these actions could lead to an enormous water quality improvement. Nevertheless, proper choices can be made to balance between the type of actions to be taken based on how sensitive the area can be. The alternative of control measures can either be in the form of introducing improved farm treatment technology; or, relocating problematic farms, which may need a political decision. The results of analyses in Chapter 7 have not rule out the threat due to industrial discharges as another major source of pollution causing deterioration in water quality at several river stretches within catchment. It is of advantage that in most major urban areas, locations earmarked as the proposed sites

for industrial development are being included in their respective structure plans. These greatly help the assessment of impacts using information that is available in the plan documents to guide decision makers in making strategic choices.

The issues prevalent in the Linggi Catchment are, by and large, socio-economic in nature and inter-linked with one another:

1. Lack of overall planning on a basin-wide basis;
2. Lack of protection of the water supply zones;
3. Insufficient management within the developable land units, in terms of:
 - i) development activities;
 - ii) siltation;
 - iii) sewage and sewerage;
 - iv) pollution source control.
4. Lack of efficient resource utilisation.

Table 8.1 listed these issues where the actions to be taken have been matched with the various principles of a strong sustainable stance that need to be incorporated within the CMP for the study area. The table was constructed based on the issues identified in Chapter 6 and are then associated with the principles (as discussed in Chapter 2) which contained the strengthening characteristics of environmental planning to ensure that a sustainable development process will take place through a holistic approach in management planning. Each principle may be realised when appropriate actions are implemented according to the arising problem(s) associated with source control or locations which are problematic. For example, the protection of forested area has to be assured in order to realise the principle of conservation. Control of non-point sources of pollution may be achieved by minimising changes to the rural landscape especially areas which are currently under forest cover. The forested land use provides the lowest erosion rate when left untouched. Preserving these areas as well as protecting the watershed may be realised through legislative means as provided in the provisions under the Forestry Enactments, 1935 and the National Forestry Act, 1985.

Table 8.1 Linggi Catchment: Identified Issues and the Relevant Principles of Sustainability.

Identified Issue	Relevant Principle	Remarks
A. Overall planning on catchment scale i.e. Basin-wide planning and management.	Holistic Approach	<ul style="list-style-type: none"> • CMP is based upon this approach. • An involvement of interdisciplinary group and public participation essential to ensure full access to information critical in sustaining the river water use and for future development. • Lack of information hinders efforts to sustain water uses.
B. Protection of water supply zones. 1. Land cover	Conservation Ecological Capital Stock	<p>The maintenance and preservation of existing forest cover is essential. The natural drainage of waters from the catchment can be maintained by careful management of soils and vegetation using practices consistent with watershed management requirements.</p> <p>Forest cover need to be inventoried and ensure efforts to preserve them should be taken.</p>
2. Beneficial Use of Water non sustainable	Threshold	The proposed interim water quality criteria and standards for Malaysia has been introduced in 1987, but only upon adoption by the State, will the water quality objectives applicable.
	Monitoring	This enables the detection of any changes taking place at any particular stretch of the river so that necessary mitigating measures could be efficiently applied. Frequent monitoring and sufficient monitoring stations required.
C. Management within the developable land units. 1. Development activities 2. Siltation	Precautionary Source Control	<p>As a precautionary step the EQA, 1974 has the provision requiring any prescribed activities to have their EIA approve prior to the start of any construction work. For other projects not subjected to the requirement, the presiting evaluation of the project for approval and written permission will complement this approach.</p> <ul style="list-style-type: none"> • Avoid critical slopes of greater than 14°. • A post-auditing and frequent monitoring on projects with EIA approval is also necessary.
3. Pollution source control. i. Increasing wasteload from sewage disposal. ii. Animal Wastes iii. Industrial Activities	Waste Minimisation	<ul style="list-style-type: none"> • This acts as curative measures to water pollution. • Effective enforcement on all sources of pollution are essential for a full compliance to the regulations.
	Source Control	The construction of the centralised sewerage facility (CSF) need to be speedup.
		At least consider the reduction of load by half, or otherwise the farms have to be moved out of the sensitive locations.
D. Efficient resource utilisation		<ul style="list-style-type: none"> • Wise use of water, to avoid wastage. It is important to educate the public and industries on their role to conserve water in their daily use or in the industrial processes. • Preserve all beneficial uses of river.

The strong sustainability stance as discussed in Chapter 2 (i.e. Table 2.1) requires the protection of critical capital (i.e. water) and the maintenance of the overall stock of capital, with special attention paid to the natural environment (Pearce et al., 1993). The strong sustainability stance advocates that river water quality should improve to meet the desired objectives as determined by the threshold values at the various river stretches. Therefore the threshold values need to be accepted and adopted by the responsible authority. As expressed by Bonn (1991), the threshold limit helps protect the ability of the water environment / resource to meet the functions that we rely upon, beyond which the carrying capacity begins to decline. Analysis in Chapter 7 reveals that the conditions on most stretches of the Linggi River are unsustainable and urgent steps need to be initiated to improve the overall situation within the catchment area. Further discussion on the recommended actions that are necessary to resolve the identified issues will be dealt with in section 8.5 (and as summarised in Table 8.9).

Once the necessary actions have been incorporated in the CMP's Action Plan and relevant agencies or authorities have engaged their respective roles and supported with the valid pieces of legislation, the catchment areas can be managed in an integrated manner to resolve the arising problems, in the effort to sustain the river uses. The author is of the opinion that the implementation of such a plan to manage the catchment area, will not pose much difficulties as the institutional arrangements and the relevant pieces of legislation are already in place, although the mechanism to set it to work may need some restructuring and strengthening. Integration is needed to steer the management of catchment areas and avoiding overlapping of functions and ineffective actions due to non specific target.

The actions that will be included in the CMP Action Plan will be discussed in the proceeding sections.

8.3 OPTIMISATION OF LAND USE - OPTIONS AND EFFECTS

Basically, the physical entities of land within the Linggi Catchment can be divided into 3 main zones namely the water management zone, buffer management zone and the developmental land units zone (as categorised by Marsh, 1991).

8.3.1 Protection Of Water Management Zones

The water management zone again comprises the water supply areas and the runoff management areas. The water supply areas of the Linggi Catchment are:

- the upper elevations of the catchment, very sensitive to disturbance due to erosion and instability;
- a contributor to water supply in the catchment that provide supplies to lower reaches;
- largely unaffected by development;
- the residual primary forest in the catchment; and,
- potentially support the existence of aquatic fauna and flora.

The maintenance of adequate vegetative cover, preferably forest land is essential for the conservation of water resources. The canopy cover of plants is critical to protect the soil. Therefore natural vegetation needs to be left intact unless other crop can be chosen to replicate soil protection but even with this, the impact will be at the cost of the bio-diversity existing in the forest. The preferred choice of preserving and conserving the tropical forest ecosystems at the water supply areas would help maintain the micro climate of the area, eliminate potential flooding of the lower reaches and secure a constant low flow in the catchment. This is truly important as demand for water supply has been on the increase, as its demand is a function of several variables that change over time and these include population, income, the household penetration of durable goods, and the level of industrial activity (Kindler and Russell, 1984; after Pearce et. al., 1993).

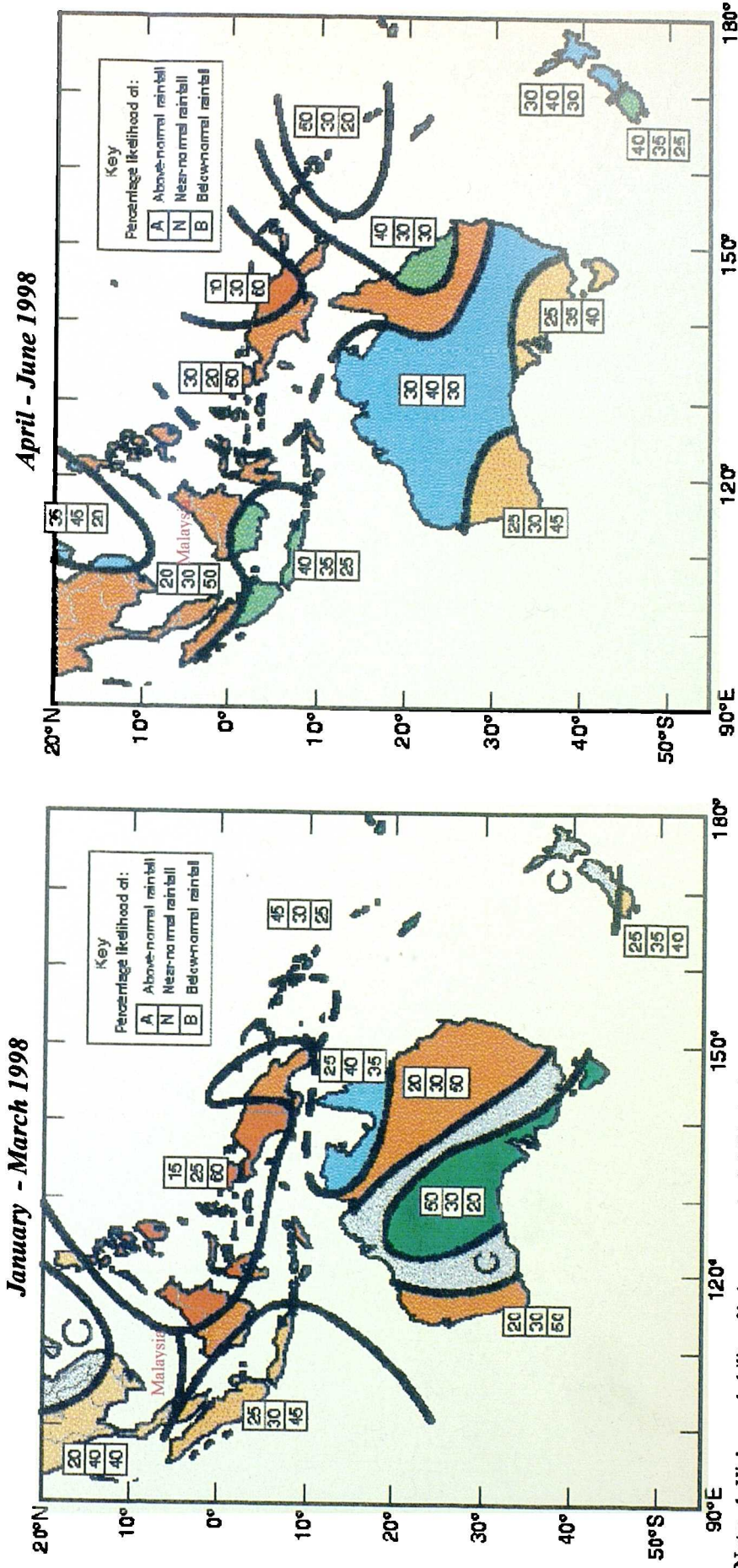
The latest environmental issue that has been largely discussed is the impact due to global climate change upon water demand and supply. On the demand side, a rise in mean temperatures could be accompanied by an increased demand for water, especially in the domestic and agricultural sectors. Demand for public water supply in the Linggi Catchment regions has already shown a huge increase in the years to come (Figure 7.8). On the supply side, the phenomena known as the El Nino is predicted to strike many parts of the world including the South East Asian region, resulting in very warm and dry weather leading to less precipitation (Figure 8.1) in the region. The scenarios as described in section 1.2.2 are believed to be attributable to the phenomenon. If higher temperatures are accompanied by greater precipitation coupled with higher rates of evaporation, this in turn will influence the runoff. This will not lead to an improvement in resource situation in those areas facing water stress problems such as in many parts of the country and potential water shortage in some others.

Available modelling techniques may help in assessing the problem and it would help to manage the water resource better, which otherwise would be very costly if a low-flow situation were to occur over a long-term period. Rivers may also suffer from the problems of over-abstraction.

“The costs associated with such over-abstraction are not just in terms of reductions in supply, but also the losses of amenity, wildlife habitat, recreational possibilities and so on. An environmental damage so caused can take decades to be repaired, bringing a distinctly intergenerational aspect to the low-flow issue. The reparation of certain types of damage might never be fully complete.” (Pearce et. al., 1993)

The main consequence of low-flow situation that is of concern in the study area will be the impact on the water quality of the river water and it may have a significant impact of the supply of water to the Districts of Seremban and Port Dickson.

“The prospects on the quality side are likely to be similar ... If we can expect the frequency of such events to increase with global warming, then quality will suffer as a result. Moreover the assimilative capacity of a receiving water is a function of its flow. Hence, increases in abstractions will also impact negatively upon river quality.” (Pearce et. al., 1993)



Note: 1. Higher probability of below-normal rainfall in Malaysia especially in April-June '98.
 2. C indicates no basis for favouring any particular category.

Source: International Research Institute For Climate Prediction (1998).

Figure 8.1 Predicted Weather Conditions As A Result of El Nino Phenomena (in South-East Asia & Australia).

The current uneven balance between supply and demand conditions in the catchment water sector is likely to be exacerbated over time, even though in Malaysia, the water supply appears to be sustainable at the aggregate level, sustainability at the regional or basin level is much less certain. This again can be one of the area for future research where application of GIS can be used.

In the U.S.L.E. modelling, the *C* factor and *P* factor are two factors likely to have strong influence on water resources availability in the catchment area. Any change in the present land use will results in sequential variation to the land cover factor. Forest cover, as an example, provides the best interception to rain water and hence significantly controls runoff and water availability. Any reduction of the area of existing forest cover will result in a corresponding increase in the erosion rate due to exposure of soil to the action of rain.

Most of the remaining forest cover is located on slopes of more than 20° and these areas are highly susceptible to land erosion as shown in the case study analyses. Studies indicate that if all natural forest even on the slope of less than 6° is disturbed, erosion rate will increase to 1,000 - 3,000 tonnes/km², except where natural forest has already been converted to other land use to a large extent (GOM, 1982b). One would be able to imagine the effect the phenomena will have on river sedimentation and the deterioration of the stream discharge capacity, if special attention were not given to avoid such occurrences. The preferred management option will essentially be to preserve and conserve the primary forest for the security of water supply and bio-diversity.

In undertaking the management strategy, firstly, in order for preservation and conservation to succeed, they must be given a legal status and regulated accordingly towards such use. Several options are available which are mutually supportive of the objective. For example the permanent forest in this supply zone is suitable as a Forest Reserve and may be classified in several classifications as stipulated in the National Forestry Act of 1985 including:-

- soil protection forest;
- soil reclamation forest;
- flood control forest;
- water catchment forest;
- forest sanctuary for wildlife;
- virgin jungle reserved forest;
- educational forest; and,
- research forest.

The likely choice available in sustaining water use will be to gazette the water supply (watershed) area as drinking water catchment forest. Advancing further with the option, apart from the National Forestry Act, other legislation such as the Protection of Wildlife Act, 1972 (Revised 1976) may also be considered for wildlife conservation and protection of the upstream forested area.

Due to the degradation of water quality within the catchment areas as a result of rapid development especially on the periphery of the Municipal boundary, uncontrolled clearing of land, deforestation, pollutant discharges from various sources, the State Government has identified all present and future drinking water catchment areas in the State of Negeri Sembilan with the intention to gazette them as reserves. The provision in the National Land Code under Section 62(1) may be used for the purpose of designating specific vulnerable areas to be gazetted for the use.

“The State Authority may by notification in the Gazette reserve any State Land for any public purpose.” (*National Land Code, Sect. 62(1)*) (MDC, 1990)

Drawing up a water allocation plan for the entire river basin to achieve a better match between demand and supply should give due consideration to the water requirements. All this is very much dependent on the development strategy within the catchment area, and with much of the potential owing to its location, the development pace is

expected to be very vigorous in the near future and especially so in an effort to achieve the goals of Vision 2020 set by the Government of Malaysia.

The State realised the importance of protecting the water management zone of Linggi basin and proposed the watershed areas to be differentiated into 3 classes (SEPU, 1993):

- Class A: where the watershed provides raw water sources to treatment plants that are of conventional type or more advance in design and treatment capacity required;
- Class B: where the watershed provides raw water source to treatment plant that are sub-conventional in design and treatment capability including direct supply system with only disinfection process; and,
- Class C: where watershed provides raw water source to treatment plants from impound storage.

However these classes are merely meant to provide guidance on the type of water treatment processes that should be installed according to the locations. Securing the water supply area is inevitably important to a sustainable water supply to the catchment area. Delineation of the designated watershed area may provide close protection for the vulnerable areas and it provides some relaxation on tolerable activities to take place especially in a catchment where the water abstraction point is at downstream of the municipal area. Nevertheless the priority should remain at maintaining the quality of water at levels suitable for their specified use and in particular to meet the appropriate public health standards.

Enforcement of the status of reserved land area can be implemented when a State Committee on Catchment Management Planning has been established. Access to the preserved area should be reviewed by the committee with membership at least from the State Economic Planning Unit, Department of Environment, Forestry Department,

Drainage and Irrigation Department, Wildlife Department and the Department of Water Supply.

Rehabilitation of landscape through reforestation / revegetation should be implemented by the authorities involved such as the Forestry Department or the Department of Land and Mines to restore drainage which was affected by forest clearing or past mining activities. Substantial improvement in reducing the erosion rates would enable the quality of river water to be significantly improved and the water quantity to be successfully regulated within the Linggi Catchment.

Any compromise on preservation and conservation status in favour of uncontrolled land use conversion (as practised in the past) would generate significant adverse environmental impacts to the environment particularly water supply and water quality which will affect downstream resident and users.

The general recommendation presented in the National Water Resources Study for Malaysia in 1982, on controlling forest clearing to reduce the impact of soil erosion could also form specific guidance in the prevention of degradation of the water resources. Despite that, the rationale of preserving the forest area especially in the Linggi Catchment should be of prime concern. The study suggested that (i) forest clearing should only be limited within the land of up to 20° in slope; (ii) after clearing forest, such land use as appropriately protecting soils against erosion should be undertaken; (iii) as a long-term programme for preservation of productive forest and soil conservation, reforestation should be undertaken in the disturbed forest.

There is no account of any specific aquatic habitats on any stretch of the Linggi river. However there should be a related study to identify such habitat in any part of the Linggi River system. If they exist the aquatic habitat should be preserved and any development activity planned and to take place must take into account of the existing aquatic habitat, especially at a more sensitive area such as the upper catchment area with possible presence of endangered aquatic flora and fauna species. It is recommended the upper area be preserved.

Hence, the approach of catchment management is to optimise the economic use and development of resources with environmental protection of resources, while other socio-economic development proceed without leaving negative impact on the environment. The recommended plan is directed towards the objective of achieving a sustainable development through the optimum land use option.

8.3.2 Protection Of The Catchment Buffer Zones

Establishment of buffer areas surrounding reserves in the most vulnerable ecosystems will help in the conservation of the natural values of the catchment areas. Whilst a clear definition on the specification of the buffer zones will help in providing decision makers in selecting the best choices according to the nature of development to be proposed and to be taken up.

The creation of a buffer or protective zone around the vicinity of the water abstraction point is particularly essential. Normally a setback of at least about 500 feet on both sides from the river banks and downstream of the abstraction point along the river, while on the upstream with a buffer of half a mile upstream should be provided. These areas should be designated as the catchment buffer zones specific for water supply reserve with their authority of management and surveillance under the Department of Water Supply. This buffer zone if necessary may be extended in their size depending on the conditions and type of land use activity adjoining it.

The situation arises especially at the stage when the application for license to operate in the area is being processed before a permission is given, which is often faced with failure on the part of project proponent to meet the minimum buffer requirement. As an example in allowing the construction of housing estate, there were instances where encroachment of residential areas into the industrial areas occur which resulted in complaints due to air pollution affecting the local residents. The set of Guidelines for Siting and Zoning of Industries produced by DOE provides guidance on the buffer

zone requirements between land uses (Table 8.2). Similarly there should be a riparian reserve which has to be maintained on both the river banks, which will restrict all kinds of development along the river corridor.

8.3.3 Management Of The Catchment Developable Land Unit Zones

Areas other than the two main zones mentioned above can be treated as developable land unit [DLU] zones. The zone includes the following areas:

- the mid and lower elevations of the catchment with low to moderately sensitive to disturbance due to erosion and instability;
- a high demand for water supply with user of water mainly in the mid-elevations and the lower reaches;
- currently at many places subject to moderate to rapid development in the zone comprising of new housing and industrial areas, commercial centres, infrastructure construction etc.,
- heavily impacted during clearing for new development and may pose serious threat to the water resources if uncontrolled;
- adversely affected by the discharges from sewerage facilities, farming activities and industrial discharges, which dramatically affected water supply (flow regime, flood peaks and duration) and water quality (increased concentration of suspended solids and sedimentation, increased Chemical and Biochemical Oxygen Demand, ammoniacal nitrogen, bacterial and heavy metal contamination within the zone);
- Further new development schemes are likely to be expected such as infrastructure development of roads and a variety of residential, commercial and industrial estates within and around the Municipality; but to commence only after proper

Table 8.2 Malaysia: Guidelines for Siting and Zoning of Industries.

Type of Industry	Siting	Compatibility	Space for treatment of effluent	Clean Industry	Produce Odour, Fumes	Fuel Burning Equipment	Scheduled premises	Offensive Trades	Noise Level	Involved with Toxic and Dangerous Material Incl. Heavy Metal	Effluent Discharged	Buffer distance to residential buildings	Treatment of Raw Material
Light	Industrial lots near housing or built-up areas			x	x	x	x	x	7am-10pm 60dbA 10pm-7am 50dbA	x	Non polluting	200 - 500 m.	x
General A	Industrial zones next to built-up areas		Essential		x				7am-10pm 60dbA 10pm-7am 50dbA	x		500 - 1000 m.	
General B	Designated industrial estates or pocket of Industrial zones but not upstream of water abstraction point if discharge heavy metals	Compatible among industries or buffer zone of 20 - 50 m. planted with trees if industrial zone not compatible.	Essential						7am-10pm 65dbA 10pm-7am 55dbA	x	no discharge upstream of water abstract. pt. if effluent with heavy metal	1000 - 1500 m.	
Special	Very critical that only in a particular area and downstream of water abstraction point.	Compatible among industries or buffer zone of 50 m. planted with trees if industrial zone not compatible. Industries requiring treatment may be grouped for central treatment.	Very Essential									1500 - 3000 m. & for dirtier type > 3000 m.	

Note: x - not allowed

Source: DOE (1992).

environmental impact assessments and with adequate mitigating measures in placed.

All potential development schemes indicate possible cumulative impact on the water resource unless considerable efforts based on an holistic approach and driven by the catchment management process in rectifying the arising water resource issues and in eliminating problematic sources. Policies made must address coherent issues relating to the proposed development and their possible consequences on the catchment water resource. Hence, the emergence of new activities within the developable land units [DLUs] of the catchment, require proper and controlled development approach with full environmental considerations for a better and improved situation on the water resources. Without proper control over land use upstream of water abstraction point, it should be anticipated that a great deal of remedial work would possibly be needed. The attitude of using the river capacity on which the community depends so heavily for effluent disposal as well as water supply results in the system becoming congested and more costly to use. This has been the case in many industrialised countries and is spreading to developing countries as well, and Malaysia is of no exception. When water is returned to a common space (i.e. the river) it must not impair further uses of the common space both public and private and the sources to be put will appreciably need to be adjusted to avoid harming the common space as in the case of the “tragedy of the commons”.

“We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.” (*Aldo Leopold (1886-1948), Quoted in: Stewart (1963)*).

The model discussed in Chapters 6 and 7, mainly emphasised on the main parameters directly having influence on the catchment water environment. The modelling system shows that GIS technology is able to programme and model water quality problem within the GIS environment. Nevertheless, a further research programme with the primary goals of developing linkages between environmental models and GIS should be taken up especially by the environmental modelling community which would

improve and address the accuracy and precision of GIS assisted modelling and the influence of spatial errors on model output.

There are some potentials which could be considered to minimise the threat posed on the catchment water resources.

8.3.3.1 Control of soil loss

The parameters R , K and LS of the model can be treated as almost constant and they resulted from the natural process. Nevertheless, we may influence (i.e. improve) the factor for land cover that will provides a better C value to the extent the water resource in the form of its quantity or quality will not be affected. Similarly P value may (or rather should) be altered to provide an optimal value for the preservation of soil from being eroded. Changing the factor C is the most likely event that could possibly help maintain the soil stability. This depends on the current land use policy of the area, and without preserving the upstream stretches of the river, rapid changes in the existing land cover (and to a certain extent even their landform) could take place. Such efforts are consistent with the suggestion made by Newson (1994) that “natural controls such as floodplains, wetlands and vegetation covers do a much better job for a longer period at cheaper cost than do revetments, groynes and traps”. Hence, conserving and preserving the areas especially in the water management zone is essential and should be of higher priority. At the same time, areas within the DLU zone also in need of close monitoring. Often the impacts from such areas are equally damaging.

Almost all forms of human use of the terrestrial environment induce soil erosion at least temporarily. In preventing any serious problem of siltation, developers were required to adhere to the minimum target by taking measures to adopt the DOE’s siltation and erosion guidelines as stipulated in the conditions of license of permission provided by the Municipal Council [MC]. A number of soil erosion prevention measures and silt transport control methods were recommended in many EIA reports and currently been employed in the field. Proper priority should be given right from the beginning particularly at the land clearing stage of project implementation where

adequate soil erosion prevention measures need to be employed especially from that point of time.

Abu Bakar (1994) proposed that control of erosion can be easily achieved through a revision to the existing schedule of works and payment (Figure 8.2). This revision is anticipated not only to reduce the risk of land slide and the extent of soil erosion but also helps minimise the need for expensive remedial works including desilting and river channelling and thus reduces public expenditure and the negative externalities including flash flood, traffic jams and air pollution. However, the proposal cannot be successful implemented unless with full co-operation from the developers and with the support from the Ministry of Finance to revise such policy.

In ensuring the effectiveness of any policy in housing or commercial development, the proposed activities must entail intensified enforcement leading to a minimum target of systematic phasing of earthwork by the Municipal Council. For some other activities, such as the infrastructure development, the establishment of a centralised planning and implementation committee to achieve a minimum target will necessitate an improved co-ordination among government agencies concerned.

8.3.3.2 Control of point sources of pollution

The main sources of pollution in the case study area in particular and in Malaysia in general, are sewage pollution, discharges from animal husbandry activities and industrial discharges. The 1995 situation on the contribution of organic waste reinforces the findings which pinpoint that sewage and animal waste are their largest contributors (DOE, 1995a). The existing pollution abatement approach is mainly based on the command-and-control (CAC) method which depends on legislation and regulations. It has been anticipated that by having an efficient pollution abatement programme, it will help sustain the existing river uses and improve the environmental quality.

Figure 8.2 Proposed Revisions to the Existing Schedule of Works and Payment:
 (i) Under the Housing Developers (Control & Licensing) Regulations, 1989;
 (ii) Under Government Contract.

EXISTING SCHEDULE	PAYMENT	PROJECT ACTIVITY	PAYMENT	PROPOSED PAYMENT
-Signing of Agreement	10%	CONTRACT AGREEMENT	10%	-Signing of Agreement
		PHASED SITE CLEARING	5%	-Identification and preservation of trees not to be cut. -Removal and gathering of vegetation and top soil by phase. -Composting of vegetative materials. -Putting in temporary drainage and construction and maintenance of stormwater retention ponds and silt traps.
		EARTHWORKS	10%	-Dust control and no open burning. -Slope stabilisation and turfing. -Crusher-run road surfacing. -Construction of the designed drainage system, including permanent silt traps and planting of trees.
		CONSTRUCTION	10% 15% 10% 10% 10% 15%	-Piling, noise & dust control and foundation. -Reinforce concrete. -Wall, door and window frames. -Roof, wiring, plumbing, gas, etc. -Internal & external plastering. -Road finishing & commissioning of waste, wastewater & sewage treatment systems.
		CF	10% 5%	-Handling over vacant possession. -Handling over to stakeholder.
	100%	Total Payment PROJECT COMPLETION	100%	

Source: Abu Bakar (1994b).

Sewage disposal

Sewerage works often lag behind other development projects in many cities/towns and most of the present sewerage plans do not take into account industrial wastewater. Apart from that, there is inadequate and uneven provision of services as only a small percentage of the city is linked to the centralised sewerage treatment. In many areas, the proliferation of many septic tanks in a small area results in localised problems. Further, the trends towards rapid urbanisation without sufficient sewerage treatment facilities has aggravated the hazards to the water resource with the growing population whereas waste-disposal capacities were intensified in relatively small areas.

The Seremban Municipality also faces the problem of delay in the implementation of the centralised sewerage system. Although the new sewerage system is near completion and awaiting commissioning, the overall efficiency of the treatment processes will take some time before the whole system stabilises and is ready to comply with the discharge requirements. The coverage of service (the amount of waste it can handle) might have to be extended to a much larger part of the Municipality. However there is little doubt that tackling sewage problems has to be given a priority. Proper centralised sewerage in place coupled with improved waste reduction efficiency will help to improve the river water quality. Whilst in the rural areas, encouragement of improved septic tanks should be made.

Animal husbandry wastes

As discussed in Chapter 7, animal waste has contributed enormously to the level of river water quality deterioration and it is expected the trend will persist if no concrete solution is found to reduce the wasteload. Moving such activity away from the catchment will definitely require strong political decisions. At the very least, a cut down in the wasteload by half will show some improvement rather than the do nothing approach which will continue to degrade river water quality in the long term if discharges from the activity were to be allowed at the 1990 level. The activity has

been the slowest among all others in showing significant progress in waste reduction, and this has been implicated by the vague jurisdiction over the control of discharges from the activity. The control by the Dept. of Veterinary Services and Municipal Council or the Local Authority cover only on farms that have been licensed. Unlicensed farms were often left to pollute, unless urgent steps to relocate them were made. Otherwise a concrete solution to an economical method for purifying effluent from animal husbandry have to be worked out.

Industrial waste disposal

The number of industrial water pollution sources in Negeri Sembilan in 1995 was 334 and that was 11 percent of the total in Malaysia, and in fact is the third highest after Selangor and Johor (DOE, 1995a). Most of these industries are located within the Linggi Catchment and are threatening the river water quality by their discharges not only in terms of the organic loads, but also from heavy metal contamination if their discharges were not frequently inspected. Improvements to the purification method for industrial effluents is one of the areas where advisory services could be provided to the industries by the research institutes such as SIRIM and the universities to help alleviate the problems caused by polluting discharges.

8.3.3.3 Integrated pollution control

Whilst the precautionary approach was taken for potential sources, curative approach to source control should continue to be employed on this existing and new sources of pollution through an integrated pollution control [IPC] approach. Malaysia has adopted a similar approach to IPC as practiced in Britain and other European countries. At the European level, a directive on IPC has been submitted in the effort to minimise emission to air, land and water (Zabel, 1994). In Britain, the adopted IPC involves several interlinking approaches and is based on the concept of 'best available technology not entailing excessive cost' (BATNEEC) where, the generation of wastes prescribed as dangerous for disposal, will be brought to nil or as close to that as

possible (Kinnerseely, 1994). Nevertheless, to arrive to an option defined as “best technology” could sometimes be difficult as there could be more than one option. ‘Best’ essentially means most effective in preventing, reducing or making harmless polluting releases to any medium - land, air or water. ‘Available’ means able to be obtained as long as it is accessible. However when it comes to cost, the technology often proves to be not economically viable or not affordable. With government intervention such as by providing tax incentives, the potential damages from pollution discharges due to treatment control inadequacy which could be costly to the public could be avoided. Malaysia has based its approach of pollution control on ‘Best Practicable Means’ [BPM] which is basically similar to BATNEEC, where the factors of ‘available technology’ and reasonable ‘cost’ are essentially vital when considering ways of improving discharge quality especially to industrial discharges. The potential of extending such approach to other sectors should be examined by the authorities and polluters in order to gain continuous progress in wastes reduction.

8.3.3.4 Economic framework for environmentally sustainable development

One of the two categories of instruments be employed to protect the environment and conserve natural resources is the command-and-control approach (CAC) as discussed earlier, that involves legislation and regulations, etc. While the other category is the market-based instrument (MBI) that comprises fiscal measures such as charges, taxes and subsidies and pricing. The MBI is increasingly being advocated over CAC as measures to attain environmentally sustainable development on account of their benefits. These are:

- a) minimisation of compliance costs;
- b) raising of revenues, even though this may not be the main objectives of MBIs;
- c) encourage the search for better and more environmentally technology; and
- d) economising on information gathering costs.

Despite its attractiveness, MBI is still relatively less popular when compared to CAC and this is especially true in Malaysia. This is because in reality locating the source of pollution and calculations of tax liability are both difficult. For example in sewerage, apart from the usual difficulty of identifying the incidence and measuring the magnitude of pollution emissions, two more factors favour the use of CAC in Malaysia, and these are: (a) the polluters often have great influence in determining pollution standards to be met and even the vigour with which these are to be enforced; and (b) the risk aversion. Businessmen are more certain about regulations than about taxes which they fear might be misused to become a measure to raise revenue rather than as an incentive tax to promote pollution abatement.

Nevertheless, there is a great potential in a wider use of MBI. However before this potential can be realised, the following considerations need to be given:

- a) reduce uncertainty about the future;
- b) send out the correct price and quantity signals in the market place;
- c) modifying the presentation of environmental economic statistics so that environmental impacts of economic change can be discerned, and the services of the environment highlighted; and,
- d) revising systems of appraisal; for investment and policies so that they adequately reflect an integrated environmental impacts (Pearce, 1991).

It is recommended that MBI be further studied to search for the practical ways where the approach could be accommodated as an option for environmental quality improvement.

8.3.3.5 Guidelines for development activities

In undertaking the tasks to improve the catchment water quality problem as a whole, the following steps have to be considered when dealing with projects application for permission to commence work or operation, or in dealing with the existing problematic sources.

A. To minimise problem of soil erosion and river siltation

1. Agriculture and animal farming

In the conservation of land for agricultural purposes, land use planning with due regard to watershed should consider provisions for soil conservation and erosion. For extensive land clearing for agricultural purposes, the following shall be enforce:

- a) sufficient setback from the boundary buffer zone (minimum distance a 500 feet);
- b) sufficient setback from the main drainage channel, its tributaries and sub-tributaries, outside the buffer zone (minimum distance a 500 feet and to meet other requirements set by DID);
- c) avoiding critical slopes (exceeding 14°);
- d) provision and maintenance of sufficient soil erosion control measures including sediment traps to be provided and maintained throughout to prevent the entrance of sediment loads into the water courses.
- e) land clearing and replanting of vegetation should be conducted in stages to avoid massive land exposure to the impact of rain. Forest clearing if necessary for conversion to agricultural use should be carried out during the dry season to control surface water runoff and minimise siltation.
- f) preserving and maintaining the riparian vegetation and forest belt along river banks to act as buffer areas.
- g) soil conservation measures for slope cultivation are to be strictly employed.

The measures may be in the form of:

- (i) bench terracing for farming to be complemented with mixed cropping;
- (ii) contour terracing for rubber plantations supported with a blanket of cover crop;
- (iii) contour ditches with platform for oil palm in combination with cover crops;

- (iv) mixed cropping and cover crops on middle and lower reaches (where areas are generally flat) where erosion is less;
- (v) contour planting for rubber plantations as well as other crops on slopes ranging from 2 % to 8 %;
- (vi) rearing of poultry and other husbandry in the non-water sensitive areas they shall be subjected to the condition A.1(a) and A.1(b) above.

2. Urban and housing development

New development will need to include the prevention soil erosion as follows:

- a) In regulating urban development, certain preventive measures should be taken like flood control. Other control measures are zoning of land use and imposing conditions on developers like:
 - Stream improvement works are needed so as to increase water discharge;
 - Construction of adequate and proper drainage system;
 - Provision of silt traps and turfing;
 - Terracing and turfing on sloping land and when necessary, constructing retaining walls or slope revetment with adequate subsoil drainage system.
- b) The development of new housing and commercial schemes will also need to take the necessary precaution as in items 4(i) to 4(v).
- c) For discharges from construction areas, the normal conditions include the installation of a series of silt trap to reduce the suspended solid levels to ensure full compliance with the standards set by the DOE. In terms of engineering measures, infrastructure constructions such as roads, drainages and bridges should be executed and well-planned.

Newson (1992) suggested that it is essential adopt the approach below in undertaking planning and development on a catchment or basin scale, while avoiding adverse impact on the water resources:

- i) work with and not against the environment;

- ii) start work from the existing situation, using the existing infrastructure, based on existing technical know-how, and cultural needs.

The details on method of control of erosion from various activities has been set out in the guidelines: i.e. the Guidelines for the Prevention and Control of Siltation and Erosion, produce by DOE.

B. Point source control

There is a need to assess the carrying capacity of excessive water use system. This calls for all discharges within the catchment to be reviewed in light of achieving the aims set under the water quality objectives at the various river stretches.

1. Animal farming

For existing farms, the wastewater shall be channelled into suitable treatment facilities and their discharges need to conform to the standards as set by DOE. In water sensitive areas, all farms have to achieve 'zero emission'. A relocation plan for existing farms in water sensitive areas shall be worked out in consultation with the local authority and DoVS. New activities involving the rearing of poultry and other husbandry shall be avoided in water sensitive zone.

2. Mining

Mining activities within the watershed areas of the catchment shall not be permitted under any circumstances.

3. Urban and housing development

Further urban development shall be permitted in consultation with DOE and connection to a centralised sewerage treatment facility have to be made available once the system is implemented. Housing development schemes shall be required

to be served and connected to a central sewage treatment facility and the system shall be properly operated and maintained at all times.

5. Industry

Only selected type of industries (preferably non water polluting) shall be allowed to operate within the catchment area. Rubber factories and palm oil mills (used to be the most polluting industries) need to be sited at a proper place and shall avoid discharging into water sensitive areas within the catchment. Light industrial activities including automobile workshops shall be sited together and shall be served and connected to a central sewage treatment system. There will be no restriction to industries that are not water based and do not generate any effluent discharges provided they meet other requirements set by DOE.

8.4 PLANNING DECISION AND IMPLEMENTATION

The adoption of environmental planning on a catchment basis, through Catchment Management Planning, is essential as freshwater resources are not inexhaustible and hence it need to be conserved and control. At the moment, there are already various pieces of legislation relating to water resources protection and management, with direct or indirect control. The question of whether conservation and preservation measures should be supported with legal instruments to safeguard watersheds is no longer an issue. Some of the important sectoral Acts that exist are as shown in Table 8.3.

It is therefore important that the implementation of CMP to be recognised at the National Development Committee level for the plan to be successful and adhered to, as this is where the planning machinery for national and state socio-economic process works. It would be an advantage to have the Economic Planning Unit [EPU], at the Federal level, acting as a co-ordinating secretariat in charge of planning, as the agency

Table 8.3 Malaysia: The Relevant Sections of the Main Legislation Related to Water Protection and Management.

Legislation	Year	Scale			Control			Section	Provision Related To Water Protection
		F	S	L	F	S	L		
Water Enactment	1920	*					*	5 7 7a	<ul style="list-style-type: none"> • Prohibition of acts affecting rivers except under license. • Prohibition of diversion of water from rivers except under license. • Provides for the control of disposal of any harmful or obnoxious matter or any matter which by virtue of its temperature, chemical, or biological content could be a potential danger to public health, safety or welfare to any beneficial uses.
Mining Enactment	1929	*					*	61-68 74 Rule 13 (1)	<ul style="list-style-type: none"> • Control and use of water for the purpose of carrying out mining operations. • Requires the occupier of mining land who uses water in connection with his mining operations to ensure that all water used, shall, before it leaves the mining area on which it has been used, be free from all material dilutors to animals or vegetable life. • Mining Rules 1934 • Requires that effluent water shall not contain solid matter in excess of 800 grains per gallon. The Minister or Chief Minister of the State has the powers to vary the acceptable limits of discharge.
Irrigation Areas Ordinance	1933	*					*	23 24	<ul style="list-style-type: none"> • Pollution of water. • Tempering with irrigation work
Drainage Works Ordinance	1954	*					*	11(1) 12	<ul style="list-style-type: none"> • Interference with drainage work. • Construction of unauthorised drains.
Land Conservation Act	1960	*					*	3 6(1) 7 11a 14	<ul style="list-style-type: none"> • Empowers the Ruler or Governor in Council to declare any area to be hill land. • Control of hill land - Restriction on clearing of land on hill. • Prohibits the clearing of any hill land or interfering with, destroying or removing any trees, plants, undergrowth, weeds, grass or vegetation unless authorised by permit, which shall be subject to such terms and conditions as may be imposed. • Control of silt and erosion. • Empowers the Collector to make orders to control land and erosion that may be likely to cause damage to other land, or to any watercourse, or to interfere with cultivation.

Table 8.3 Malaysia: The Relevant Sections of the Main Legislation Related to Water Protection and Management.

Legislation	Year	Scale			Control			Section	Provision Related To Water Protection
		F	S	L	F	S	L		
National Land Code	1965		*				*	62	<ul style="list-style-type: none"> The code empowers the State Authority to classify land use in three categories, namely, agriculture, industrial and building. The State Authority has the powers to change the designation of land for development and proper land use planning and management. Power of reservation of State land.
Environmental Quality Act	1974	*					*	11-12 18 20 21 25 30 31 34A 51	<ul style="list-style-type: none"> To grant any applicant for license or for a renewal or transfer thereof, either subject to conditions or unconditionally and specified in the license to which the application refers and may during the currency of the license revoke or vary any condition attached to it. Prescribed premises to be licensed. Requirement for approval of plan. Power to specify condition of discharge. Restriction on pollution in inland waters. Power to prohibit use of any material or equipment. Power to require occupier to install, operate, repair etc. Reports on impact on environment resulting from prescribed activities. Empowers the Minister to make regulations in respect to the prevention, abatement and control of pollution and to enhance the general quality of the environment.
Street, drainage and building Act	1974		*				*	50 55(2) & (3) 70A(1)	<ul style="list-style-type: none"> Local Authority to construct and maintain drains and watercourses. Water closets and trade effluent not to communicate with river etc. without approval. Prohibition to carry out any earthworks without approval.
Local Government Act	1976		*				*	69-71 72 73 84 102	<ul style="list-style-type: none"> Prohibit the deposition of trade refuse, solid or liquid sewage or any filth in or upon the bank of any stream, channel or public drain or watercourse within the local authority. Empowers the local authority to maintain public health in areas under its administration. Empowers the local authority to make, amend or revoke by-laws to establish, maintain and compel the use of any service for the removal of nightsoil, slop, rubbish and all kinds of refuse and effluent. Empowers the local authority to take action against any person where a nuisance within or effecting any part of a local authority appears to be caused by some act or default committed outside its areas. Provides for the control and supervision by registration, licensing or otherwise, including in proper cases by prohibition, a trade, business or industry which is of an obnoxious nature could be a source of nuisance.

Table 8.3 Malaysia: The Relevant Sections of the Main Legislation Related to Water Protection and Management.

Legislation	Year	Scale			Control			Section	Provision Related To Water Protection
		F	S	L	F	S	L		
Town and Country Planning Act	1976			*				3	<ul style="list-style-type: none"> • General planning policy. • Regulate, control and plan development and use of all lands and building within the local authority. • Provides for creation of a local planning authority for each local authority whose function is to institute a survey of the area to examine matters that may be expected to affect the development or the planning of the development or the planning of the development of the area. • Preparation of draft structure plan and draft local plan. • Prohibition of development without planning permission. • Prohibition of development contrary to planning permission.
								6a 7 8 & 12 19 20	
Fisheries Act	1985	*					*	6	<ul style="list-style-type: none"> • Prepare and keep under continual review fisheries plans based on the best scientific information available and designed to ensure optimum utilisation of fisheries resources, consistence with sound conservation and management principles and to avoid overfishing.

Note: F = Federal; S = State; L = Local.

could developed the planning framework in collaboration with DOE, the Department of Water Supply and DID so that the implementation of the action plan under the proposed CMP could be formalised within the national planning framework and acted upon with the involvement of all relevant agencies.

Similarly at the state level, the State Economic Planning Unit [SEPU] under the State Secretariat Office will need to co-ordinate the proposed actions in line with the action plan for CMP while directing all relevant agencies to integrate the proposed actions into relevant plans of action under the agencies programmes and within the local development programmes. For the smooth functioning of the EPU and SEPU, a separate division or unit with responsibilities for environmental issues, should be established to monitor the performance of CMP, besides ensuring that environmental planning process would be integrated into the larger planning process.

8.4.1 Policies

The formulation of relevant policies with the main aim to safeguard our essential common resource should be given a priority, although there are a number of existing pieces of legislation to protect water resources. Without such policies in place will impede the enforcement and implementation of the various existing legislation. Two main policies with regard to water resource protection need to be formulated apart from the National Policy on Environment.

8.4.1.1 National Water Policy

Watershed conservation and development could be successfully achieved through the formulation of a clear National Water Policy. It should comprise a system of targets and measures for the development and management of water resources. It should also be an integral part of the national policy framework in consonance with the overall national socio-economic development plan.

In its formulation, National Water Policy should be based on the criteria of water quality and quantity. The water quality component should aimed at promoting to achieve the water quality objectives for river water, thereby ensuring sufficient water availability to meet the demand for more water as well as protecting new sources of water supply. The water quantity component will emphasised on maintaining the low-flow level and their continuous supply for various utilisation. The issues of water scarcity in water stress areas could be avoided, when the National Water Council has been established to oversee distribution of water in the country as a whole. Nevertheless, the co-operation from all the State Governments will be essential, as under the constitution, water is strictly under state control. Through such body, attempts can be made to transfer available water especially in water-rich states of Pahang, Perak and Johor to areas of water stress in other states.

It is also through the National Water Council, the concept of Catchment Management Planning can be introduced in which not only will the council deals with water distribution, but more importantly all aspects of water management including efficient management of watershed and river system could be achieved. This body will represent the highest level at par with the National Land Council with its members comprising the Chief Ministers of the State and Chaired by the Prime Minister.

8.4.1.2 National Land Use Master Plan

The National Land Use Master Plan proposed for development, will enable a sound land use practices and in turn will ensure optimum and rational land use. The proposed master plan should be comprehensive and include a time-phased land use plan of the areas to be developed, conserved and redeveloped by the States, the Federal Ministries, Departments and their agencies. It should be prepared in consultation with the states as well as Federal agencies concerned. The criteria that must be considered in preparing the plan include suitability of the soil for various

land uses such as mining, agriculture and forestry. To a certain extent, it should also provide guidelines for urbanisation.

8.4.2 Legal Framework For CMP

The use and exploitation of water resources are regulated by the State legislation. The Water Enactment was the first piece of water legislation to be in place in the Federation (Figure 8.3) and all States including Negeri Sembilan has Water Enactment. Figure 8.3 also shows the some legislation related to water resources in Malaysia were enacted as early as those in the U.S.A. Some States have amended the Enactment to include Section 7A which provide the control of disposal of harmful or noxious substance in rivers.

As shown in Table 8.3, water resources protection and management are fragmented among many agencies and supported largely by piecemeal legislation. Further, they are not well co-ordinated to ensure a holistic approach to water resource use, development and management.

Soil erosion prevention and control of soil loss is governed by the Land Conservation Act [LCA], 1960 and the Street, Drainage and Building Act [SDBA], 1974 (through earthworks by-laws). The legislation on LCA has been specifically enacted to conserve hill lands and to prevent soil erosion and control siltation. Although this law has been adopted by all the states in Peninsular Malaysia, the enforcement of it has yet to be carried out. In fact, there was no gazette of “hill lands” except for the State of Penang and District of Cameron highlands in the State of Pahang. As such there is a pressing need that this law be implemented nation wide and that “hill lands” are gazetted and declared to the public so that the incidence of soil erosion or landslides can be successfully prevented.

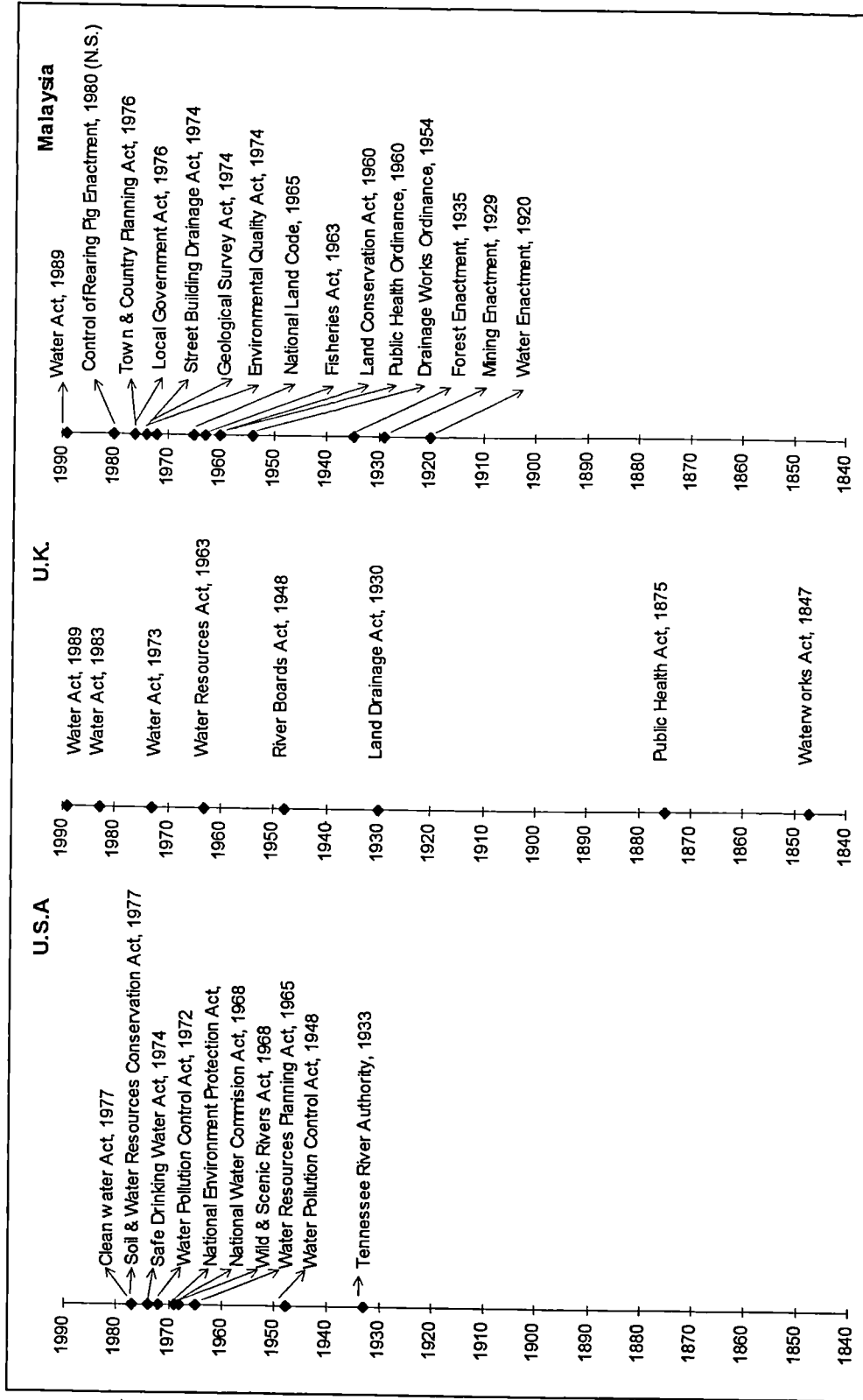


Figure 8.3 Water Related Legislation in USA, UK and Malaysia.

The laws governing land use had been well set out and enable to provide effective land use planning whilst the Town and Country Planning Act [TCPA], 1976 has been effectively implemented covering all areas. On the whole, land use need to be well-planned to ensure the ability of available land to meet future demands and treated as a resource for sustainable development. However, *ad-hoc* decisions for land conversion which often occur despite the fact that structure plans and sometimes the local plans are present, and this situation reflects the weakness of the current land management system. The situation has to be rectified in order to meet the needs of the future while avoiding adverse impact on the environment and the local community. On the contrary, the existing laws for soil conservation and management are weak and hence their provision need to be strengthened (GOM, 1996).

8.4.3 Effectiveness Of Environmental Impact Assessment In Development Project Screening

With the enforcement of the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, Amendment (1995), it has been made mandatory for 20 prescribed activities (as in Appendix A) to have an approved EIA report before any of such projects could be allowed to commence operation. It is the EIA study that predicts the environmental consequences of a proposed development project while ensuring that the potential problems are foreseen and addressed at an early stage in the project's planning and design. Like the economic analyses and engineering feasibility studies, the EIA is meant to serve as a management tool for project initiators (as well as the project approving authorities) to make decisions about the project. Information derived from an EIA study will be useful in designing an economically and environmentally sustainable project.

The EIA in Malaysia is based on projects and it is a vitally important process where a decision on the best site for developmental projects within the catchment would be

made after serious consideration on the main factors, namely land use compatibility, sufficient buffer and the downstream water uses.

One problem normally arising while handling cases on a project basis is that the impact on the overall environment, and in this case the water resource, would be difficult to account for the whole catchment or basin-wide basis until an overall assessment was made. On the whole, therefore, a readily form of overall assessment is required to transmit a correct signal when new sources are introduced or any activity will commence operation within the catchment concern.

At the early stage of EIA implementation as reported in the Fifth Malaysia Plan (1986 - 1990), it only managed to gain limited success as a complementary tool for environmental assessment in addition to that of pollution control (IAS, 1992). The EIA then continued to be only an informal procedure, resulting in the environmental considerations being incorporated only to a limited extent in the planning of development projects, until the EQA was later amended and strengthened to make the requirement mandatory to the 19 (20 after 1994) prescribed activities.

In order to keep the catchment free from pollution, policies related to catchment management need to go hand in hand with other procedural requirements. As for the EIA requirements, land use compatibility becomes a basic factor for consideration along with other guidelines including buffer zone distances and water uses (Table 8.4). In the case of impact on water resource, each project initiator is required to ensure that the development project will not jeopardised the water quality. This means the project initiator will have to bring down the wasteload to the level that the discharges will not cause a deterioration in the river water quality based on the recommendation of the National Interim Water Quality Standards and Criteria.

Table 8.4 Factors of Consideration in Project Approval.

Factor	Considerations	Standards / Guideline Applied
Land use	Compatibility with surrounding land use	Structure / Local Plan of the area
Buffer Distance	Acceptable buffer distances from nearest designated residential area	DOE's Guidelines For the Siting and Zoning of Industry and planning guidelines for land use by DoTCP
Water Use	Location relative to beneficial uses of water, such as water supply, fisheries, irrigation, and recreation	Proposed Interim National Water Quality Standards for Malaysia.

Source: Perunding Utama Sdn. Bhd. (1994), p.3-6.

For land use compatibility, reference has to be made to the Statutory Development Plan (i.e. the Structure Plan and Local Plan) and this has become necessary to avoid nuisance arising from incompatible land uses. Considerations of land use compatibility by project initiators were often disregarded in the past. The situation where housing development encroached to the industrial sites, and vice versa, has developed into much of the complaints received by DOE on air, land and water pollution. Other examples between compatible and incompatible land uses is as shown in Table 8.5.

Table 8.5 Compatibility of Different Land Uses For Industrial Development.

Sector	Compatible land uses	Non-compatible land uses
Agriculture	Non-food crops such as rubber, oil palm.	Food-crops, sensitive animal farming, such as deer.
Forest	Secondary, productive, or State land	Sensitive ecosystems of high conservation value such as with endemic, rare or endangered species.
Other Land Uses	Commercial / Industrial / Land used for industrial / commercial purposes.	Residential and Institutional areas (for General B and Special type of industries). Areas of high conservation value (mangrove, productive fisheries / aquaculture, national parks, wildlife reserves, reservoirs, lakes).

Source: Perunding Utama Sdn. Bhd. (1994).

Effectively source control would be the key driving force to combat against pollution and more often tackling a single major discharges will help reduce some pollution loading enormously. The control of the discharges from the sources of pollution and the contribution of the non-point sources will help in improving and preserving the self-purifying capacity of the river.

The precautionary principle is basically related to the planning efforts undertaken by the planning agency particularly by the Dept. of Town and Country Planning and implemented by the Local Authority. EIA itself is based on precautionary approach to environmental planning and has a promising capability to avoid massive impact on the local scale.

The CMP process, on the other hand, aims to ensure that the overall aspect of water resources protection and management at the macro level are taken into account and this will complement (but not replace) the requirements for an EIA study and land use planning process. It provides a clear view of what is happening on the entire river system within the catchment and basin-wide. Hence its approach will be proactive rather than retrospective. This plan proposal will not elaborate on water quantity aspects and the flood mitigation measures as the main focus of the thesis is with respect to river water quality preservation. Nevertheless, the water quantity and flood mitigation measures should become the very content within the CMP format.

8.4.4 Institutional Requirements For CMP

Problems arise as there are many other pieces of legislation apart from the EQA which deal on matters relating to the environment and many overlapping areas of jurisdiction exist. Despite this, communications between government agencies exist in the form of consultation process between one another for inputs, comments and recommendations with respect to any proposal for project implementation. Nevertheless, there are some weaknesses in the framework whereby the process sometimes ends up with little success. One clear example, is that: the agencies

entrusted with aspects of environmental management are often not integrally involved in the planning and approval of developments. As a result, enforcement becomes mixed up with limited powers and fragmented environmentally related laws and responsibilities of the various agencies (Table 8.6).

The implementation of CMP needs an active support especially from the States. It is unfortunate that there is no similar counterpart to the DOE (an agency assigned to protect the environment at the Federal level) at the State level. The existing State level committees (as in Table 8.7) normally are more concerned with the management and utilisation of resources and place little emphasis to deal with the ill-effects of development such as pollution control. Thus they are ineffective in environmental management and protection. Although the Local Authority has wide ranging power of pollution control, their priority is greater on accomplishing other responsibilities such as services provision, plan approval, health inspection rather than to be able to focus their efforts on environmental protection and management. Hence the main problem is, although each agency is aware of their roles and functions, the function of water management is so fragmented that all levels of government are involved depending on the nature of the issue or aspect of pollution. Such fragmentation may not be peculiar to environment management as areas such as urbanisation experience similar nature. The absence of co-ordination in intergovernmental setting according to Parker et. al. (1975) could be directly attributed to conflicts or inconsistencies in the policies and objectives of different programmes (Margerum and Born, 1995). Hence, he suggested that there should be a mechanism capable of mediating or authoritatively resolving the differences.

To overcome the problem of lack of co-ordination, new arrangements in interagency framework will have to be established. While reviewing the existing institutions and regulations relating to environmental management for the Klang Valley Environmental Improvement Programme [KVEIP], it was found that the current arrangements of interagency co-operation were ineffective (DOE, 1987b). As a solution to that the KVEIP study recommended “an appropriate regional or basin wide co-ordinating agency with responsibility for planning, implementation and

Table 8.6 Linggi Catchment: Recommended Agency Roles with Respect to the Sustainable Water Use.

Principle of Sustainability	Responsible Agency / Party	DID	DMS	DoA	DOE	DoF	DoLM	DoVS	DoWS	DoTCP	FD	GD	MC / LA	Project Proponent / Developer	Public	SDC	SEPU	SIC
1. Conservation		A	-	A	A	A	E	-	A	P/A	E	A	E	I	-	A	I	A
2. Precautionary		A	-	I	P/E	A	I	A	A	P/I	-	A	E	I	-	I	I	I
3. Ecological Capital Stock		I	-	-	E*	I	I	-	A	A	I	-	-	-	-	I	I	I
4. Efficient Utilisation		-	-	-	E	-	-	-	I	-	E	A	-	I	-	A	I	A
5. Threshold		A	-	-	A/E*	-	-	-	-	-	-	-	-	I	-	I	-	A
6. Holistic Approach		I	-	I	I	I	I	I	I	I	I	I	I	I	-	I	I	I
Industrial		A	-	A	E	A	I	-	A	P/A	E	A	E	I	-	A	I	A
	Agriculture	A	-	I	A	-	-	-	A	-	-	-	E	I	-	A	I	A
7. Source Control	Pig Farming	-	-	-	A/E*	-	-	E	A	P/A	-	-	E	I	-	A	-	A
	Sewage	-	-	-	E*	-	-	-	-	P/A	-	-	E	-	-	I	I	-
Commercial Development	Erosion Control	A	-	-	A	-	-	-	A	P/A	-	A	E	I	-	A	I	A
	Mining & Rehabilitation	A	-	-	A	-	-	-	-	-	-	-	E	-	-	-	-	-
8. Monitoring	Environmental Change	I	I	-	I	-	I*	-	I	-	-	-	-	I	-	-	-	-
	Feedback / Complaint	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	-	-
9. Waste Minimisation		-	-	-	E	-	E	-	I	-	-	-	E/I*	I	-	-	-	-

Note:
 * Future role
 A Advisory
 E Enforcement / Regulator
 I Implementor / To comply
 P Planning

DID Drainage and Irrigation Dept.
 DMS Dept. of Meteorological Services
 DoA Dept. of Agriculture
 DOE Dept. of Environment Malaysia
 DoF Dept. of Fishery
 DoLM DoLM
 DoWS DoWS
 DoTCP DoTCP
 FD FD
 GD GD
 MC Municipal Council
 LA Local Authority
 SDC State Development Committee
 SEPU State Economic Planning Unit
 SIC State Investment Committee

Table 8.7 Malaysia: Three Tiers of Government in Environmental Planning and Management.

Level of Government	Principal Environmental Agency	Environmental Planning	Environmental Management
Federal	DOE and other resource management agency	Virtually through the implementation of the Malaysia Plans, and other development policies Guided by the National Environmental Policy	Co-ordinating role through sectoral committees and also Federal Committees. Use of EIA's to require developers to incorporate environment in project planning.
State	State Environment Committees State DOE State Task Forces State Level Resource Agencies (including State Water Resource Committee)	Mainly concerned with land development and resource exploitation. State development policies and strategies do not contain a high environmental content, mainly economic / industrial growth-oriented. Absence if a state-wide environmental land use plan	State government have adopted forestry policies which require setting aside forests for long term exploitation. Other environmental management aspects suffer from lack of State committed resources (except where potential tourism sites could be developed)
Local	Municipal District Council	Local & Structure Plans, development Plans or ad-hoc planning	Refer project applications to various sections of local government and also state departments.

Source : Updates from IAS (1992)

monitoring” (DOE, 1987b) but insisted that existing agencies will be involved wherever feasible. Therefore the functions of such body will be in terms of planning, management and implementation but with the support and co-operation of the existing line and operational agencies.

Similar framework could be set out in the implementation of the CMP or alternatively the CMP could become a component of the local environmental plan, as has been current practice in England, which will be covering a regional scale. But the former will be much more easily implementable compared to the latter as overlapping of political and administrative control of resources will be immense and may prove not useful to be put to practice, as the control over resources rest on the various States.

All the suggestions made in this report require active participation of the authorities in undertaking the mitigation and rehabilitation measures for the preservation and conservation of the environment of the river basin concerned.

It is anticipated that the existing agencies are able to implement programmes such as in Table 8.8, but following the guidelines mentioned in the report. It is the commitment and conscientiousness on the part of these agencies to deal with the problems at hand that are required in order to carry out the recommendations proposed. For a river basin involving more than one local authority, a close co-operation needs to be established to protect the common resources as water knows no frontier. It is worth noting that the management of water resources should be based on their natural basins rather than administrative boundaries.

Therefore, in order to ensure a smooth implementation of the proposed plan, a state catchment management committee for Negeri Sembilan needs to be set up to oversee the full implementation of task. Nevertheless, as some river basins may involve more than one State, the co-ordinating role will be even more effective at the Federal level, with definite Federal agency holding the responsibility of ensuring the CMP will be produced in stages and realised at the catchment scale within a specific time table, as

wise husbandry of water resources require careful planning by the appropriate authority.

Table 8.8 Peninsular Malaysia: Present Responsibilities by Activity and Agency.

Activity	Agency
1. Mining	DoLM, DID, FD, DOE.
2. Logging	FD, DID, DOE
3. Farming	DoVS, DID, DoA, DOE.
4. Other Agricultural Activities	DoA, Felda/Felcra, Mardi, DOE.
5. New development	MC (MPS), DOE, DID, Project proponent.
6. New Township	MC (MPS) / LA, DoPW, DOE.
7. Road Development	MC (MPS) / LA, DoPW, DOE.
8. Water Supply Development	MC (MPS) /LA, DoWS, DOE.

As a precautionary principle, the catchment planning procedure should be designed to withstand and accept the unavoidable challenge of handling uncertainty (Clark and Gardiner, 1994). To this they suggest the notion of adaptability and flexibility the most effective responses to predicting uncertainty and are based on 3 major points, which could also be used in strengthening the Catchment Management Plan proposed for Malaysia:

1. Technical adjustment to cope with errors and involves a growing use of risk assessment;
2. Adjustment in management strategy which relates to optimising and scheduling of remedial investment; and,
3. Attitude adjustment which call for the re-evaluation of procedures consistent with the changing views on system behaviour.

8.5 CATCHMENT MANAGEMENT PLANNING IMPLEMENTATION

8.5.1 Catchment / Basin-wide Management

Catchment or basin wide management should be based in accordance with the national policy on sustainable development (as detailed in the Seventh Malaysian Plan) and the National Environmental Policy. Nevertheless, relevant policies such as the proposed National Water Policy need to explicitly state the provision for CMP and their frameworks. DOE will be given the task to play a leading role in CMP. However, matters relating integration shall be taken up by EPU which will bring the matter to the National Development Planning Committee. This shall take place in the framework as shown in Figure 3.2. It is also essential that a data bank be established to support the CMP process and it should be integrated to GIS facilities.

Protection of the watershed areas.

It was reckoned that without proper maintenance and preservation of the forested areas, water resources within the catchment areas will not be sustainable. There is an urgent need for the watershed areas to be gazetted and access to the area shall only be provided by the State CMP committee. The Forest Department should play a leading role in implementing the task.

Maintaining beneficial uses within the river system

It is necessary that river uses particularly for public water supply be given appropriate priority over all others. Hence, preservation and conservation of river water quality with the intention of accommodating the water quality objectives has to be implemented. Several agencies will be responsible to make proper assessment on these uses.

i) Public water supply

This type of river uses shall prevail at all times and shall to be maintained. River water quality related to this type of river function as reflected by the type of water treatment processes shall be based on the appropriate standards under the Interim Water Quality Criteria and Standards.

ii) Other river uses.

Initiatives shall be taken to preserve, develop and utilised river's spontaneous functions (as suggested by Newson, 1992). When conflict of interest arises between proceeding with development programme and maintaining river uses (other than for public water supply), the State shall decide after consulting the CMP committee on the priority, but with deepest consideration in the overall river uses. Once decided, appropriate standards shall be imposed based on the Interim Water Quality Criteria and Standards.

Management within the areas with potential for development

In any circumstances, the implementation of activities or projects shall be carried out with deepest consideration of precautionary measures. These matters have been discussed in the preceding sections. This involves the major portions of the tasks under CMP (and a number of agencies as in Table 8.8) and it is reckoned that the integrative functions shall be made to prevail in order to sustain the river uses within the catchment. Details of the recommended actions are as shown in Table 8.9.

Efficient utilisation of resources.

It is also reckoned that effective measures shall be taken, to inculcate the members of the public on the need to conserve water in their daily activities or in their industrial processes. A river has enormous other potential that can be explored and its benefits could be tapped, besides the benefit provided in terms of water supply. For example, the promotion of beautification programmes, introduction of aquatic life such as fish: to promote river fisheries, navigation, river amenities and recreation, etc. promise

some of the attraction river can provide. These initiatives can be developed by the relevant agencies with the main aim of promoting the sustainability of river uses not only for the present community but for the benefits of future generations as well.

Table 8.9 Linggi Catchment: CMP Action Plan

Identified Issue	Relevant Principle	Recommended Action	Legislation	Agency
A. Catchment / Basin-wide planning and management.	Holistic Approach	<ul style="list-style-type: none"> • Explicit policy on catchment / basin planning and management is required. • A special committee need to set up to drive and oversee the implementation of CMP recommendations. The committee to provide policy direction; designate problem areas; and, decide on development trend within the catchment. • Public representation shall be included. • Establishment of Environmental Data Bank and a common database at the National level to support CMP process. 	Appendix B (list of all water related regulations)	EPU DOE (Responsible agencies related to water management and Public Representation.
B. Protection of water supply zones.	Conservation			
1. Land cover		<p>Gazette as water catchment forest.</p> <p>Public awareness on the conservation need to be strengthened. Dissemination of environmental information to be more efficient.</p>	National Forestry Act, 1985 Forest Enactment, 1935	FD DOE
	Ecological Capital Stock	A National Natural Resource Accounting to be maintained as a long-term precautionary step towards sustainable resource use. * An Act on National Resources Accounting is required.	Fisheries Act Forestry Act	DoF FD SEPU DOE EPU
2. Beneficial Use of Water non sustainable	Threshold	The State need to adopt the National Water Quality Criteria and Standards and to prescribe river stretches according the beneficial uses of the water.	Drainage Works Ordinance, 1954 Local Government Act, 1976	SEPU DID MPS LA
	Monitoring	<ul style="list-style-type: none"> • Ideally sampling frequency will have to be increased and dedicate communication line be established to receive feedback from local residents. • There is a need to introduce more water quality monitoring stations within the sensitive sub-catchments. 	EQA, 1974 Water Enactment, 1920	DOE DoWS

Table 8.9 Linggi Catchment: CMP Action Plan

Identified Issue	Relevant Principle	Recommended Action	Legislation	Agency
[cont.]				
C. Management within the developable land.	Precautionary	The State Government is to ensure that before any permission or license given the project proponent must comply to the requirement set under the Act.	EQA, 1974 Street and Drainage Act, 1974	DOE MPS DoTCP SIC
1. Development activities		Consultation on the preparation of the Structure Plan and Local Plan on areas of environmental control and preservation must be made with the relevant agency / parties. Integration of environmental sector in structure plan	Town and Country Planning Act, 1976	SEPU SDC
2. Siltation	Source Control	<ul style="list-style-type: none"> • Strict enforcement of the provision provided by LCA, 1960. • A review to reduce the slope limit from 20° to 14° for hill development necessary. 	LCA, 1960.	DoLM
3. Pollution source control.	Waste Minimisation	A specific target for compliance need to formulated in ensuring that they will not jeopardised the threshold adopted at the particular stretch of the river. The State Committee on CMP will have to monitor the state of the current water quality and source compliance.	EQA, 1974. Local Government Act, 1976	DOE DoVS MPS
4. Reducing wasteload from: Sewage disposal.	Source Control	<ul style="list-style-type: none"> • Provide connection to centralised sewerage facility • Installation of communal. sewerage facility in residential areas of small towns. • Resettlement of squatters. 		MC/LA & Indah Water Consortium
Animal Wastes		<ul style="list-style-type: none"> • Improve treatment plant on farms. • Relocation of problematic farms in water sensitive locations. 	Control of Rearing of Pig Enactment (NS), 1980	MC/LA DoVS
Industrial Activities		<ul style="list-style-type: none"> • It must be targeted to reduce industrial wasteload to a minimal discharge., and the application of water quality limit in water sensitive areas. • In non-water sensitive areas, the application of effluents limit is sufficient. • New industrial development only to be proceed in areas earmarked for such purpose in non-water sensitive areas. 	EQA, 1974	DOE MC/LA
D. Efficient resource utilisation		<ul style="list-style-type: none"> • Wise usage of water. A campaign to instil the interest of efficiently utilisation or consumption of water and avoid wastage in the community and the efforts to be initiated by all relevant agencies. • Promote river attraction through river beautification programme, etc. 	Water Enactment. TCPA, 1976	DoWS DoTCP MC/LA

8.5.2 Public Involvement

Public awareness on the importance of conservation and preservation of the natural environment could be attained through proper education process. Concerted efforts to improve extension services as well as to develop the mass media must be undertaken to achieve higher awareness among the public. As Newson (1992) suggests that when undertaking action or introducing social change, preference should be made to those actions involving decision making at the lowest level. At the same time, it is necessary to consider the needs to protect the local cultures, institutions and know-how to ensure the successful participation and in arriving to the expected goal.

Public participation should be a unique feature and a component in the preparation of the catchment management plan. Provisions can be made to include the representation from members of the public and other sectors within the community to work in partnership with the relevant government agencies for the benefits of the community in the catchment and with the primary objective of striving towards the process of sustainable development.

8.5.3 CMP Reporting

The production of appropriate reports in the format as discussed in section 5.7 shall be made, firstly to bring about the understanding about CMP's programme among the agencies involved; the public; and other interested parties such investors etc., - this will be in the form of a report of survey; secondly to help in guiding various involved parties to take appropriate actions to bring about the desired improvement, - this will be in the form of an action plan report; and thirdly to help in the review process - this will be in the form of an annual review report.

8.5.4 Review Of Programmes

A monitoring exercise should be conducted from time to time to improve the plan and to adapt to certain changes that are deemed necessary. The monitoring exercise will keep track on identified task for implementation and identify any shortcoming so that they could be taken up to the appropriate channel for rectification. This function shall be reported in the annual review.

8.5.5 Delivery

An essential requirement that will ensure the success of the proposal is the delivery of the programme of action. The review has identified various possibilities that could help in achieving the aims of delivering the programme:

- The Meeting of the Ministers and Executive Councillors on Environment (MEXCOE) could be used as a platform where this programme could be tabled for decision and actions at State government level. The forum has successfully implemented a number of policy areas that require State co-operation to bring about the success of programmes that involve matters under State jurisdiction, particularly on land and water. The States have to be convinced that their involvement is essential for the sustainability of water uses throughout the country.
- Simultaneously, a proposal needs to be brought forward to the Federal Economic Planning Unit of the Prime Minister's Department to pursue the matter at the National Planning Development Committee [NPDC] and make follow up action to adopt the matter at the national level and to be endorsed at a higher level for State adoption and participation.

8.6 CONCLUSION

Water quality objectives may be used to represent an indicator which would enable us to monitor the extent of achievements, in adopting the preservation and conservation strategies and put to practice, within the catchment area. The targets of CMP, besides serving as a useful tool for planning and management of land use and water resources, influence the actions of relevant agencies in fulfilling their obligatory responsibilities in the efforts to maintain a sustainable water use within a specified time table. Environmental assessment conducted on the present and future land uses in the catchment to simulate the impact of development programmes or land use changes on the water quality, indicates that a sustainable development will not jeopardise the water quality of the catchment provided only appropriate types of development were allowed to proceed at the proper location while incorporating the necessary mitigating measures.

The present water supply which is largely affected by development activities and existing land uses, is dependent on the preservation of the system contributing. This requires the protection on the catchment reserves from any encroachment of development activities. The control of activities within the developable land unit zone can help to minimise the impact from point and non-point source of pollution and improve the river condition. The most serious are the problems of soil erosion, animal husbandry and sewage disposal resulting in high suspended solids and organic pollution levels.

Where adverse impacts are encountered due to the developments, present and appropriate mitigation measures based on the IPC would provide as a means of source control. However when an adverse impact from proposed projects was predicted, it should not be allowed to proceed within the environmentally sensitive locations. CMP would only be useful when formulated based on the strong sustainability stance and implement in an integrated manner.

The level of pollution was serious at certain river stretches which were supposed to attain the stream water quality of Class III, but instead were recording the concentration of Class IV or Class V. There is no doubt that rectification efforts have to be made in order to prevent further deterioration which could render the drinking water in the area unsafe for consumption. If development of the Development Land Unit [DLU] zone intensifies in all sectors as anticipated, it becomes more important to value the preservation of the water supply zone. This is because investment decisions, and valuation of development in the DLU zone will be based on the integrity of the basin to sustain development and the quality of life to the residents. Therefore, as valuation of land through use increases in the DLU zone so valuation of the water supply zone increases with no or limited use.

Legislation alone is helpless unless it is followed by enforcement and hence, it is essential to strengthen the programmes be made to improve its effectiveness. Formulation of specific and appropriate policies which have bearings to safeguard water resources will provide a clear direction for any action to be taken in protecting this essential resource. It was suggested that the National Water Policy and the National Land Use Master Plan be developed in lieu of the existing situation of water stress in a significant part of the country and water pollution problem. Without such policies in place, it will impede the enforcement and implementation of the various pieces of existing legislation.

The major problem of fragmentation of responsibilities between all levels of government, poor co-ordination between government agencies in the interest of environment management, overlapping or unclear lines of responsibilities and the inadequate capability and capacity in assessing changes in environmental management to cope with the increasing development pressure has undermined the ability in achieving acceptable environmental quality even at critical locations. Obviously the alternative way for better environmental control and preservation would take the form of an integrated approach as has been advocated by CMP.

The recognition of the importance of CMP right up at the National Development Committee level is important before the plan can be successfully implemented. Without such recognition it will be difficult to get the co-operation from all levels of government agencies in giving their full commitment to implement the plan. To overcome the problem of lack of co-ordination, an appropriate regional or basin wide co-ordinating agency with responsibilities for planning, implementation and monitoring has to be set up. This would enable the agency to give the fullest attention in implementing the content of CMP in all basins through out the country.

The key elements of the plan proposal for Malaysia therefore include:

- The adoption of threshold values by the States is essential in order to protect the ability of rivers to meet the function that we rely upon and to avoid the available carrying capacity of rivers from declining. This ensures that a strong sustainability stance prevails in the attempts to manage the river system.
- Catchment Management Planning is recommended for adoption and efforts need to be made to gain recognition of its role as an approach towards sustainable water use.
- Delivery of the actions nested in the principles of sustainability (as summarised in Tables 8.1 and 8.9) can be made using the existing fora or platforms for Federal / State co-operation in efforts to prevent the natural capital stock from diminishing. Further, such co-operation seeks to gain a quantum change in the protection of “critical capital” such as water.
- *Public participation is crucial and a mechanism which provides the opportunity for such involvement in terms of partnership in the CMP programme will be required. It is recommended that the experience of the “National Landcare Programme” in Australia be fully examined so that lessons from its success could be gathered and where suitable be adapted for adoption.*
- DOE will play a lead role in initiating the CMP programme. However, an appropriate co-ordinating agency with responsibility for planning, implementation

and monitoring is preferred and needs to be established to ensure the continuation of the programme.

- The catchment planning procedures need to be designed to handle uncertainty and be equipped with technical adjustment, management strategy adjustment and attitude adjustment, as a precautionary approach.
- While recommending the re-location of polluting sources to new locations, the option favours whole farm planning or integrated industrial complexes with common waste treatment facilities to avoid incidence of the “tragedy of the commons”.
- Interbasin water transfers often consider only the engineering aspects in resolving the problem of water shortages. Sustainable development would favour a redistribution of development programmes to those that have regard to the carrying capacity of environmental resources.

CHAPTER 9

FINAL DISCUSSION, RECOMMENDATIONS AND CONCLUSION

9.1 INTRODUCTION

This chapter concludes the thesis which emphasises the role which Catchment Management Planning [CMP] could play in assisting to achieve the sustainability of the water environment within a river catchment or river basin. It also concludes on the various aspects involved in the formulation of a proposal for catchment management planning in Malaysia and the benefits likely to be derived from implementation. This thesis opts for role of CMP and all parties involved should be explicitly defined within the national planning and development context, while the programme for actions should be clearly outlined in order to obtain the fullest support from all responsible parties.

This chapter also discusses the research problems identified in Chapter 1. This thesis has led to a procedure for auditing water management of a catchment, identifying its water-related problems that would cause river water quality degradation and jeopardise its beneficial uses, through the use of GIS. The various functions of CMP, its roles, responsibilities and programme of actions are also discussed in this chapter.

9.2 LINKAGE BETWEEN SUSTAINABLE DEVELOPMENT, LAND USE PLANNING AND ENVIRONMENTAL MANAGEMENT

In response to research question no. 1, this thesis recognises the great deal of effort made to incorporate the essential concept of sustainable development at the various planning and management levels in Malaysia, since the subject been introduced by the Brundtland Report in 1987. However, marked progress of integrating the concept of sustainable development into national planning and development process has taken place after the Earth Summit in 1992 with various parties giving their commitments to ensure that all decisions are to be considered along with the principles of strong sustainability in mind. This helps in the establishment of many programmes that strengthened environmental planning and management in the country and within many government agencies and private institutions. The role as the guardian of the nation's environment which has been entrusted upon DOE has been given more emphasis, and this is obvious with the policy statements in the most prominent national planning document, namely the Sixth Malaysian Plan (1991-1995) and the Second Outline Perspective Plan [OPP2] (1991-2000) and with added emphasis in the Seventh Malaysia Plan (1996-2000) which explicitly states the need to ensure the success of achieving national environment policy. Therefore, the willingness on the part of the government is evident. By and large, although it is also evident that the policy on the environment carries the essential principles of sustainable development, this study discovers the need for the supporting mechanism to realise the concept of sustainable development be strengthened and the plan for actions be clearly drawn out to provide the necessary guidance.

In response to research question no. 2, this thesis reaffirms that significant changes have been made in land use planning to support programmes on sustainable development, with closer linkage made between prominent participating agencies in the efforts to ensure the process of integration. At the policy level, the Economic Planning Unit of the Prime Minister's Department has been performing a coordinating role in the integration process, and this is seen as a steppingstone in *influencing other government departments and agencies to adopt strategies based*

upon the concept of sustainable development. The Federal Department of Town and Country Planning is actively contributing towards the process through the incorporation of environmental consideration within the statutory development plans, whilst many state planning committees have included DOE in screening of application for development approvals. These outcomes provide immense support for the sustainability of water use in Malaysia. Nevertheless, this thesis views that while the issue of integration is considered, enough emphasis must also be placed on the subject of carrying capacities of the environment segment to ensure a lasting sustainability of the water sector and this has to be explicitly defined throughout the whole process of environmental planning and management.

In response to research question no. 3, this thesis distinguishes that the present approach in water resource planning and management in the country could pose difficulties in achieving a sustainable water use and this is evident with the large number of rivers which are already polluted. With a change in the approach of planning and managing land uses, solutions to the existing predicaments could be reached, provided CMP is allowed to play its role; the water quality objectives are to be carefully set; appropriate water policy should be formulated to include CMP functions, roles, responsibilities and framework; and land use planning is to be carried out with adequate consideration of the environmental aspects. The thesis recognises the strong linkage between sustainable development, land use planning, water *resource planning and environmental planning* as a whole and of the opinion that they cannot be treated in isolation.

9.3 CATCHMENT MANAGEMENT PLAN AND ITS IMPLEMENTATION

In response to research question no. 4, this thesis holds the opinion that the implementation of CMP is inevitable. CMP should, however, be adapted to suit the Malaysian framework with proper consideration on what has already been in place, but requires a restructuring for better management of the resource. The selection of an

appropriate type of development to be allowed can determine the sustainability of water use within a catchment, and certain choices may be unique to certain catchments. For this purpose, a well informed decision making process, where CMP has a role to offer, needs crucial pieces of information to develop the nature of actions necessary in preventing water degradation, while enhancing the catchment water quality. It has been shown in the case study that only programmes developed based upon strong sustainability stance can be a suitable choice under CMP. Such programmes should be able to rectify problems arising from high sewage load contribution, extensive discharges from animal farming activities and growing industrial discharges, by reducing their pollution load to meet the acceptable limits.

Implementing CMP can overcome the shortcoming of project level EIA which would otherwise, by and large, overlook impacts from ancillary developments and cumulative impact on the river water quality and quantity. The CMP emphasises on establishing the links between policies, development planning and water environment assessment and management, which focuses to avoid cumulative effects, while targeting to achieve the desired water quality objectives, developing within the carrying capacity of the catchment, and sustaining water environment to meet the demand on water use within the catchment area. This has been explicit throughout the thesis.

9.4 INFORMATION SYSTEM SET-UP

In response to research question no. 5, the thesis identifies several advantages of using GIS in this work that can be summarised as:

1. It provides as a powerful tool for handling, updating and integrating databases which are important to ensure the required information for analysis on a basin-wide scale are readily available and can be utilised in decision making process.

2. The works involving the use of GIS can help planners to examine various scenarios and make better decision to support the sustainability of catchment water quality.
3. The ability of GIS to analyse several input data for the identification of problem areas and performing environmental auditing helps in the study of the impact on water quality in the study area in order to formulate relevant policy measures for catchment protection in future, through land use planning and development implementation and control. The generation of erosion risk areas and prediction of wasteload from contributing sources of pollution are potentially useful in the prediction of the impact of water quality due to future development.
4. The functions available in GIS enables the generation of outputs, through various available techniques and synthesising several different parameters in a much more systematic and manageable fashion, apart from the features which could provide better real-world presentation flexibility.

The potential of GIS in relation to environmental management and in particular the environmental audit and predicting future impacts is revealing. Although, there has been great interest in GIS among authorities, the use of GIS in catchment management and planning is still in its infancy. Only a small number of authorities within the country have used GIS or have plans to use GIS in related fields in the foreseeable future. The thesis opt for the use of GIS in providing inputs for CMP and to achieve this, a link to the facility that is providing an integrated database contributed by existing establishment shall be utilised.

9.5 CMP FORMAT AND PLAN OF ACTION

In response to research question no. 6, the thesis proposes that the CMP in Malaysia need to be defined by 4 major functions. These functions include:

- (i) to promote planning for sustainable development;
- (ii) to promote the management of catchment area;
- (iii) to promote a well-informed decision making in planning process; and
- (iv) to overcome the shortcoming arising from piecemeal management of water resource and identification of impacts through the EIA studies.

Roles and responsibilities for CMP

It has been identified that the Department of Environment shall play a key role in the co-ordinating the initiation of a catchment management planning process, in the absence of a catchment authority in Malaysia. Other implementing agencies should be included in the CMP framework and should contribute in a constructive manner to fulfil the functions of CMP. Existing tasks involving river clean up management should be merged under this framework to avoid duplication of activities and manpower. In short, several tasks has been identified that are crucial for CMP to be functional.

- (i) Policy formulation
- (ii) Information base for CMP
- (iii) Programmes for Action
- (iv) Reporting

The thesis opts for a catchment or basin wide management that should be implemented in accordance with the concept of sustainable development and consistence with the National Environmental Policy for Malaysia. Relevant policies should explicitly include the provision for CMP, their functions and the framework to implement its task. The thesis suggests that matters relating to the strengthening of policies relating to CMP and integration should be taken up to the highest level with assistance from EPU which act as the secretariat to the National Development Planning Committee.

The thesis opted for techniques of identifying issues, in assessing water quality problems within a catchment, be undertaken with the help of computer generated analysis through the use of GIS, and their results can be treated as valuable source of information in verifying issues identified by the CMP committee before appropriate actions are planned to rectify the arising problems. Hence, this calls for (i) the development of a data bank nation-wide to provide access for easy storage and retrieval; (ii) the development of an integrated GIS; and, (iii) the development of an expert system to aid the planning process on a catchment / basin scale.

Using the Linggi River catchment as the basis in identifying the problem areas and its associated causes, the anticipated programme of actions to improve the catchment water quality within CMP, as disclosed in the thesis, should at least consider the following aspects:

1. Protection of the watershed areas.
2. Maintaining beneficial uses within the river system that include preserving river stretches associated with public water supply and other river uses that could be benefited by the community.
3. Management of areas with potential for further development without jeopardising the sustainability of water use in the catchment.
4. Control over sources of pollution.
5. Efficient utilisation of resources.
6. Public involvement.

Several objectives of CMP reporting have been identified based on the level of task involved. The report of survey will bring about the understanding and information base on the entire catchment and to present CMP's programme among the agencies involved; the public; and other interested parties such investors etc. The action plan report will help in guiding various parties involved to take appropriate actions to bring about the targeted improvements. The annual review is intended to help in the review process in identifying the strengths and weaknesses of the entire programme. The thesis considers that monitoring plays an important role in assessing the entire

programme which will be the main input in the annual review report. The production of the reports become the responsibility of the leading agency.

9.6 RECOMMENDATIONS FOR FURTHER RESEARCH

The research undertaken on the development of catchment management planning with respect to the water quality preservation in Malaysia has been based on a comprehensive approach. Nevertheless, the detail is by no means exhaustive. There are still some aspects that can be further explored, and below are some of further work recommended to be undertaken on this subject.

1. Scope of CMP

- **Water quantity aspect**

It is recommended that future work shall incorporate the water quantity aspects into the modelling process so as to identify its associated problems and to complement this study which is essential for a comprehensive scope of CMP. Such a piece of work will simultaneously cover water quality and water quantity aspects and is anticipated to highlight their distinct relationship in sustaining the catchment water resource.

- **Development of functional data bank**

Further work is recommended to be carried out to evaluate the potential of GIS for environmental audits on the local authorities that involve in a particular CMP and how improvement can be achieved in minimising the arising problems through the integration of a functional data bank that complement the use of GIS.

- **Economic analysis**

A study on the cost benefit analysis is recommended to enhance the effectiveness of CMP implementation which takes into consideration values of

different river uses and people's preference towards various utilities river could provide, and where suitable river amenities could be developed with the aims of attracting community participation in sustaining the river system.

- **River carrying capacity**

Research on the carrying capacities of the river system in the catchment has been lacking. There is a need to study the carrying capacities, which itself is a component of CMP, of all the rivers in the country where it will help not only to cater for a possible plan of redistribution of development programmes but also to find the extent in which the limit of the various parameters could be varied within the sustainability limit.

2. Level of study

Research in related field with emphasis at different levels (that is at National and State levels) to develop approaches and processes for wider scale CMP implementation, and to determine the variation in the nature of problems and the reinforcement of existing available resources to handle CMP that involve more than one State jurisdiction.

3. Legislative aspect

Review the Environmental Quality Act 1974 is recommended for the possible inclusion of a requirement for CMP.

9.7 CONCLUSION

The examination on the principles and processes involved in sustainable development, land use planning and environmental planning and management in this research, reveals the justification to take up the option for management planning on a catchment level. The thesis has included a proposal for catchment management planning that will be applicable to Malaysia, which aimed at arriving at sustainable

water uses within the catchment, and thereby helping to alleviate problems of water pollution and water stress in the country.

The water quality model has presented a procedure of generating an assessment of the pollution problems within a catchment in terms of the contributing sources and their locational identifications. This not only helps in the understanding of the arising conflicts between land uses and river water uses with significant amount of knowledge obtained from the modelling output, but also present value input to the planning process in the catchment. The modelling techniques developed in this research offer the method of assessing developments so that the carrying capacities of river are not exceeded, as advocated by the capacity limit of sustainable development. The issues compiled through such assessment aid the construction of a set of action plans within the scope of catchment management plan, where the solution to them require management of resources and development activities in an integrated manner.

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APPENDICES

APPENDIX A

**Prescribed Activities Defined by: Quantum; Project Size; and, Category
(with no Unit of Measurement).****Malaysia: Summary of Prescribed Activities (Defined by Quantum)**

Quantum	Unit	Activity	Number
60000	Barrel	Construction of product depot for storage of petrol, gas or diesel	12 (e)
5000	Tonnes	Shipyards	8 (f)
4500	Cubic-metres	Groundwater development for industrial, agricultural or urban water supply	19 (b)
200	Tonnes/day	Iron and steel industries using scrap iron	8 (e)
100	Family	Agricultural programmes necessitating resettlement	1 (b)
100	Tonnes/day	Chemical production industries	8 (a)
100	Tonnes/day	Lime production industries using rotary kiln	8 (d)
100	Tonnes/day	Iron and steel using iron ore	8 (e)
50	Tonnes/day	Non ferrous industries other than aluminium and copper	8 (c)
50	Tonnes/day	Lime production industries using vertical kiln	8 (d)
50	Tonnes/day	Pulp and paper industry	8 (g)
30	Tonnes/hour	Cement industries	8 (d)
10	Mega-Watts	Construction of steam generator power stations using fossil fuels	13 (a)

Malaysia: Summary of Prescribed Activities (Defined by Project Size)

Project Size	Unit	Activity	Number
5000	Hectares	Irrigation schemes	3 (c)
500	Hectares	Land development schemes to bring forest land into agricultural production	1 (a)
500	Hectares	Development of agricultural estates involving changes in type of agriculture use	1 (c)
500	Hectares	Logging	6 (c)
400	Hectares	Construction of dams and hydroelectric power scheme reservoirs	13 (b) ii
250	Hectares	Mining of mineral in new areas	11 (a)
200	Hectares	Construction of dams and man-made lakes and artificial enlargement of lakes	3 (a)
200	Hectares	Construction of dams or impounding reservoirs	19 (a)
100	Families	Agricultural programmes necessitating resettlement	1 (b)
100	Hectares	Drainage of wetland, wildlife habitat or virgin forest	3 (b)
80	Rooms	Construction of coastal resort facilities or hotel	17 (a)
50	Hectares	Coastal reclamation	4
50	Hectares	Land-based aquaculture projects accompanied by clearing of mangrove swamp forests	5 (c)
50	Hectares	Conversion of hill forest land to other land use	6 (a)
50	Hectares	Conversion of mangrove swamps for industrial, housing, or agricultural use	6 (d)
50	Hectares	Housing development	7
50	Hectares	Industrial estate development for medium and heavy industries	9 (b)
50	Hectares	Sand dredging	11 (c)
50	Hectares	Hill station resort or hotel development	17 (b)
50	Kilometres	Construction of off-shore and on-shore pipeline	12 (b)
40	Hectare	Construction of dams and hydroelectric power schemes with dams over 15 meters high	13 (b) i
2.5	Kilometres	Construction of airports	2 (a)

Source: DOE (1993b) p.15-16.

APPENDIX A [cont.]

Malaysia: Summary of Prescribed Activities¹ (Not Defined by Unit of Measure)

Category	Prescribed Activity	Number
AIRPORT	Airstrip development in state and national parks	2 (b)
FISHERIES	Construction of fishing harbours	5 (a)
	Harbour expansion involving an increase of 50 per cent or more in fish land capacity per annum	5 (b)
FORESTRY	Logging or conversion of forest land to other land use within the catchment area of reservoirs used for municipal water supply, irrigation or hydropower generation or in areas adjacent to state and national parks and national marine parks	6 (b)
INDUSTRY	Petrochemicals industries - all sizes	
	Primary smelting of aluminium and copper - all sizes	8 (c)
INFRA-STRUCTURE	Construction of hospitals with outfall into beachfronts used for recreational purposes	9 (a)
	Construction of expressways	9 (c)
	Construction of national highways	9 (d)
	Construction of new townships	9 (e)
PORTS	Construction of ports	10 (a)
	Port expansion involving an increase of 50 per cent or more in handling capacity per annum	10 (b)
MINING	Ore processing including concentrating for aluminium, copper, gold or titanium	11 (b)
PETROLEUM	Oil and gas fields development	12 (a)
	Construction of oil and gas separation, processing, handling and storage facilities	12 (c)
	Construction of oil refineries	12 (d)
POWER GENERATION	Construction of combined cycle power stations	13 (c)
	Construction of nuclear-fuelled power stations	13 (d)
QUARRIES	Proposed quarrying of aggregate limestone, silica, quartzite, sandstone, marble and decorative building stone within 3 kilometres of existing residential, commercial or industrial areas, or any area for which a license, permit or approval has been granted for residential, commercial or industrial development	14
RAILWAYS	Construction of new routes	15 (a)
	Construction of branch lines	15 (b)
TRANSPORTATION	Construction of Mass Rapid Transport projects	16
RESORT AND RECREATIONAL DEVELOPMENT	Development of tourist or recreational facilities in national parks	17 (c)
	Development of tourist or recreational facilities on islands in surrounding waters which are gazetted as national marine parks	17 (d)
WASTE TREATMENT AND DISPOSAL		
(Toxic & Hazardous Waste)	Construction of incineration plant	18 (a) i
	Construction of recovery plant (off-site)	18 (a) ii
	Construction of wastewater treatment plant (off-site)	18 (s) iii
	Construction of secure landfill facility	18 (a) iv
	Construction of storage facility (off-site)	18 (a) v
(Municipal Solid waste)	Construction of incineration plant	18 (b) i
	Construction of composting plant	18 (b) ii
	Construction of recovery/recycling plant	18 (b) iii

Malaysia: Summary of Prescribed Activities¹ (Not Defined by Unit of Measure)

Category	Prescribed Activity	Number
	Construction of municipal solid waste landfill facility	18 (b) iv
[cont.]		
(Municipal Sewage)	Construction of wastewater treatment plant	18 (c) i
	Construction of marine outfall	18 (c) ii
DEVELOPMENT OF HILL LAND ²	Clear of hill land and logging with slope of $\geq 20^\circ$	20 (i) a
	Construction of roads and highways at slope of $\geq 20^\circ$	20 (i) b
	Construction of resorts and recreational facilities at slope of $\geq 20^\circ$	20 (i) c
	Construction of buildings and structures at slope of $\geq 20^\circ$	20 (i) d
	Development resulting in achieved slopes of $\geq 20^\circ$	20 (ii)

Source: ¹ DOE (1993b) p.17.

² Abu Bakar (1994a).

APPENDIX B

Environmental-Related Legislation In Malaysia

No.	Legislation	Year	WR *	F/S	Subject	F/S	Agency Responsible
1	Water Enactment, Chapter 146	1920	Y	S	Water Use	S	Land Office (S)
2	Mining Enactment, Chapter 147	1929	Y	S	Minerals	S	Mines Department (S)
3	Mining Rules, GN 2426	1934	Y	S	Minerals	S	Mines Department
4	Forest Enactment, Chapter 153	1935	Y	S	Forests	S	Forest Department
5	Natural Resources Ordinance	1949	Y	S	Natural Resources	S	Sabah / Sarawak
6	Poisons Ordinance	1952	-	F	Chemicals		Health Department
7	Merchant Shipping Ordinance	1952	Y	F	Shipping		Marine Department
8	Sales of Food and Drugs Ordinance, No. 28	1952	-	F	Food and Drugs		Health Department
9	Dangerous Ordinance, No. 30	1952	-	F	Drugs		Health Department
10	Federation Port Rules	1953	Y	F	Port		Port Authority
11	Irrigation Areas Ordinance, No. 31	1953	Y	F	Irrigation	S	Drainage and Irrigation Department
12	Drainage Works Ordinance, No. 1	1954	Y	F	Drainage	S	Drainage and Irrigation department
13	Explosives Ordinance, 1958	1958	-	F	Explosives		Police
14	The Road Traffic Ordinance	1958	-	F	Motor Vehicles		Road Transport Department
15	Land Conservation Act, Act 3	1960	Y	F	Land (hill land)	S	Land Office
16	Public Health Ordinance	1960/62	Y	S	Health	S	Health Department
17	National Land Code, Act 56 & P.P. 474	1965	Y	F	Land Use	S	Land Office
18	Housing Development Act (Licensing & Control)	1965	Y	F	Housing		Housing Department
19	Civil Aviation Act, Act 3	1969	-	F	Civil Aviation		Civil Aviation Department
20	Malaria Eradication Act, Act 52	1971	Y	F	Malaria	S	Health Department
21	Continental Shelf Act, Act 52 / (Revised) Act 83	1966/67	Y	F	Continental Shelf		Ministry of Land & Rural Development
22	Petroleum Mining Act, Act 95	1972	Y	F	Petroleum		Prime Minister's Department
23	City of Kuala Lumpur (Planning) Act, Act 107	1973	Y	F	Urban Planning		Kuala Lumpur Cityhall
24	Environmental Quality Act, Act 127	1974	Y	F	Environmental Protection		Department of Environment
25	Geological Survey Act, Act 129	1974	Y	F	Local Authority	S	Geological Survey Department
26	Street Drainage and Building Act, Act 133	1974	Y	F	Local Authority	S	Local Authority
27	Factories and Machinery Act, Act 139	1967/74	-	F	Worker's safety		Factories and Machinery Department

No.	Legislation [cont.]	Year	WR*	F/S	Subject	F/S	Agency Responsible
28	Pesticides Act, Act 149	1974	Y	F	Pesticides		Agriculture Department
29	Destruction of Disease-Bearing Insects Act, Act 154	1975	Y	F	Insect Pests		Agriculture Department
30	Municipal and Town Boards (Amendment) Act, Act A289	1975	Y	F	Urban Areas		Local Authorities
31	The Protection of Wildlife Act, Act 76	1972/76	Y	F	Wildlife	S	Wildlife & National Parks Department
32	Local Government Act, Act 171	1976	Y	F	Urban Services		Local Authorities
33	Town and Country Planning Act, Act 172	1976	Y	F	Urban Planning	S	Dept. of Town & Country Planning
34	National Parks Act, Act 226	1980	Y	F	National Parks		Wildlife & National Parks Department
35	Malaysian Highway Authority Act, Act 172	1976	-	F	Highways		Highway Authority
36	Rearing of Pig Enactment	1980	Y	S	Pig Rearing		Dept. of Veterinary Services & Local Authority
37	Atomic Energy Licensing Act, Act 304	1984	Y	F	Atomic Energy		Atomic Energy Licensing Board
38	Exclusive Economic Zone, Act 311	1984	Y	F	EEZ		Prime Minister's Department
39	National Forestry Act, Act 313	1984	Y	F	Forestry	S	Forest Department
40	Fisheries Act, Act 317	1963/85	Y	F	Fisheries	S	Department of Fisheries

Note:

WR *: Water Related Legislation.

F: Federal Legislation / Control

S: State Legislation / Control

Source: IAS (1992) p. 100.

APPENDIX C
London: Thames River Pollution History and Clean Up Programmes.

Year	Action or Incidence	Outcome
1383	An Act in Medieval times was introduced. It ordered those with latrines to pay Lord Chancellor two shillings a year to clean up the river	The law specify it as illegal to "corrupt or pollute ditches, rivers, water and the air of London and elsewhere"
1821	The upper part of the river was used to supply drinking water to London with little or no treatment.	No complaint recorded to the 1821 Select Committee on the Supply of Water to London.
1831 - 1866	Cholera epidemics	London's first cholera epidemic occurred resulting in over 6,000 death.
	1831	Some 14,000 died out of 30,000 cases.
	1848 -1849	Further 10,675 deaths.
	1854	Over 5,000 deaths in just 3 weeks.
	1866	
1847	Metropolitan Commission of Sewers was set up. It amalgamated the 8 separate local bodies responsible for sewers and decreed that all cesspits should be abolished.	
1848-55	Six successive Commissions of Sewers were appointed to seek a solution to the pollution problem.	
1855	Metropolitan Board of Works replaced the function of the Commissions.	The Board considered many proposals including the option of no sewerage discharge to the Thames but all waste being piped away from Central London to be converted to manure for agricultural use. The plan of the Board was finally adopted. However excess flow will discharge directly to the river at two main outlets considered far away downstream from Central London to ensure sufficient dilution and discharge been done at ebb-tide. The project was considered to be inadequate.
1858	The Board was absolved from the requirement for Government approval	
	Thames Conservancy was set up.	
	Also the year of the 'Great Stink' with disgusting smell emanating from the river.	Tons of chalk lime, chlorine of lime and carboic acid were tipped into the river but with little effect.
1864	Work on the scheme outfalls completed .	Commissioning of the outfalls improved the situation in Central London area but the problem was transferred downstream adjacent to the outfalls.

Year	Action or Incidence	Outcome
[cont.] 1875	Thames Embankments were completed.	
1869	Public inquiry looked into the complaints of the residents near the outfalls.	
1882	A Royal Commission was appointed to look into the being received with respect to the state of the Thames around the outfalls.	
1889	Precipitation works were completed. The London County Council replaced the Board of Works. The council carried out an examination of the whole system. Work was carried out on improvements to the capacity of the sewers and new intercepting sewers were built which considerably reduced the discharge.	
1890		Report of cleaner river and an increase in fish life.
1895		Plentiful supplies of whitebait reached the London market and both salt water and freshwater fish were found along the estuary.
1935	Mogden STW came into operation replacing 27 smaller inefficient works which were already overloaded.	Tributary of the Estuary were becoming severely polluted due to outward growth of London adding to water quality problem.
1934 - 1935		Complaints about foulness of the water were voiced.
1940	Extensive bomb damage to sewers during the Second World War	Resulting in adding problems of improving water quality.
1950s		The river was anoxic for large stretches and devoid of life.
1951	The Thames Survey Committee was set up. Under this committee, a wide ranging investigation was carried out by the Water Pollution Research Board (<i>Technical Paper No. 11 HSMO, 1961</i>) alongside that of a committee appointed by the Minister of Local Government and Planning.	Direct industrial discharges accounted for about 9% of the total pollution load to the Thames in 1952-1953 but only a small number of these discharges were likely to have an appreciable effect. Between 1950 and 1980, a number of closure reduced the industrial pollution load on the Thames.
1961	The 'Pippard' report, 'Pollution of the Tidal Thames' was published	The report recommended the following actions: i. maintain aerobic condition all year round in tidal Thames. ii. advisory standards of treatment for the STWs on the Thames Estuary. iii. aeration of some cooling water discharges.

Year	Action or Incidence	Outcome
[cont.] 1964	A completely rebuilt STW at Crossness was providing full treatment for daily flow and by 1974 an extended Beckton, one of the largest works in the UK, was fully treating daily flow.	
1966		the 'Pippard' Committee's improvement target for the Thames was achieved.
1972	A Third report of the Royal Commission on Environmental Pollution made further recommendation.	Development of a system of water quality management for the Estuary involving objectives and standards; a pollution budget which allowed for setting Consent standards for industrial and sewage treatment works discharges on an equitable basis for dissolved oxygen and more stringent trade effluent controls.
1974	Sewage works improvement carried out hand-in-hand with improvements in the quality of effluent from direct industrial discharges, or where treatment was too difficult or expensive.	Water quality improvements
1980	The prototype Thames Bubbler was launched, the oxygen injection equipment mounted on a converted Thames barge. It had a capacity which can provide 10 tonnes of oxygen per day.	The Bubbler proved to work effectively and manage to prevent several major fish mortalities during the 1980s.
1986	The bubbler out of action during the intense rainfall of summer 1986 after long, hot, dry period.	Parts of the river of Central London became anoxic and numerous fish kills were reported.
Summer of 1986-1988		The Estuary failed its water quality objectives due to an increase in the organic loads discharged from the major Thames Water Authority STWs. These deterioration prompted a review of the water quality strategy for the Estuary which later resulted in the current management strategy for the Thames Estuary.
1989	The current Thames Bubbler II was launched with the capacity of 30 tonnes, to meet the requirements of 30 tonnes oxygen per day for 5 days. The Bubbler is now subject to an operating agreement between the Environment Agency and the Water Utilities.	

Source: After EA (1997b) pp. 29 - 35.

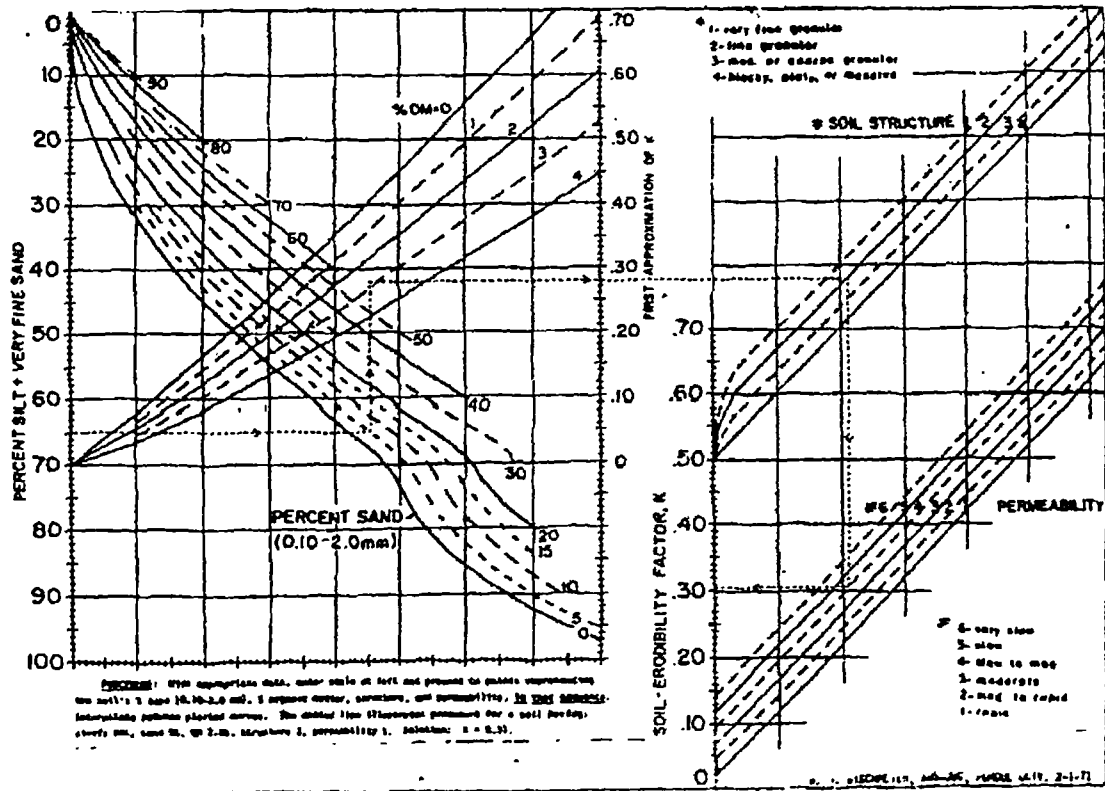
APPENDIX D

Linggi Catchment: The Sub-catchments Within the Study Area.

Sub-catchment Number	Name of Sub-catchment (based on name of stream / tributary)	Location Based On Nearest Town Or Village
2	Batang Jeralang	Water Supply Catchment Area / Forest
3, 7	Batang Merling	Water Supply Catchment Area / Forest
4, 9	Sg Nyoi-nyoi / Sg Segalek	Kg. Egang Water Supply Catchment Area / Forest
5	Sg Batang Penar	Pantai & Water Supply Catchment Area / Forest
6	Sg Sikamat	Sikamat Estate & Lee Hin Tin Mine
8	Sg Batang Ganai	Kg. Getok
9	Sg Goler	Pantai
10	Sg Terip	Terip Dam
11	Sg Jelatok	Kg. Mayor, Pantai
12	Sg Temiang	Temiang & Seremban Town
13	Unnamed (1) / Sg Jeralang	Pantai
14	Sg Elang / Sg Emi	Kg Jerlang
15	Unnamed (2) / Sg Jeralang	Pantai
16	Sg Simpo	Kg Jiboi, Seremban
17	Sg Kepayang	Rasah
19	Urban Drainage	Seremban Town
20	Sg Paroi	Kg Ampangan
21	Sg Mantau	Mantau
22	Unnamed (3)	Rahang Kecil
23	Sg Simin / Sg Gadut	Rantau, Gadut & Seremban Industrial Estate
24	Sg Senawang	Seremban Industrial Estate & Seremban Garden
25	Sg Kayu Ara	Kg Baru Mambau
26	Anak Ayer Garam	Temiang Seremban Est South Div.
27	Sg Belangkan & Sg Nyatoh	Kg Belangkan, Kg Nyatoh
28	Sg Bemban	Kg K. Sawah
29	Sg Sega	Kg Sega
30	Sg Kanchong	Kg Linsum
31	Sg Siliau	Kg Siliau

APPENDIX E

USDA Nomograph for Soil Erodibility.



Source: Wischmeier and Smith (1965).

APPENDIX F
Summary of Analytical Results.

Table F1 Summary of the SS Load at the Various Monitoring Stations.

Station No.	Count	SS Loading (kg/day)					Flow Rate ('000 m ³ /d)	Actual SS	SS level (obtained through the model)
		Sediment Yield	Piggery Waste	Sewage	Industrial Effluents	Total SS			
2719609	198	3372	0	235	0	3607	43	98	84
2719622	18492	45911	21021	1069	111	68001	420	210	162
2719608	2037	4966	2155	131	0	7252	31	301	234
2619607	25103	56937	24929	2891	445	84757	680	330	125
2519605	7276	6409	2981	64	216	9454	114	86	83
2519604	41568	68856	56010	3022	692	127888	890	133	144
2519621	44295	69897	56010	3079	692	128985	1135	86	114

Table F2 BOD Modelling using the GRID ARC/INFO.

Station Number	No. of water samples	River Flow Rate ('000 m ³ /d)	Actual BOD (mg/l)	Modelled BOD Conc. (mg/l)	Piggery Wastes (kg/d)	Sewage Effluents (kg/d)	Industrial Effluents (kg/d)	Total BOD Load (kg/d)
2719609	9	43	2.1	3.8	—	165	—	165
2719622	10	420	2.9	3.1	430	754	101	1,286
2719608	8	31	4.3	4.7	44	103	0	147
2619607	8	680	3.6	4.0	510	2,002	200	2,712
2519605	9	114	2.2	2.0	61	53	118	232
2519604	9	890	3.7	4.1	1,147	2,112	348	3,606
2519621	5	1,135	2.2	3.2	1,147	2,158	348	3,653

Table F3 COD modelling using the GRID ARC/INFO.

Station Number	No. of water samples	River Flow Rate ('000 m ³ /d)	Actual COD (mg/l)	Modelled COD Conc. (mg/l)	Piggery Wastes (kg/d)	Sewage Effluents (kg/d)	Industrial Effluents (kg/d)	Total COD Load (kg/d)
2719609	9	43	21.1	19.1	0	820	0	820
2719622	10	420	40.0	35.6	10759	3880	292	14931
2719608	8	31	57.7	58.0	1103	696	0	1799
2619607	8	680	36.8	34.8	12759	9876	1020	23655
2519605	9	114	17.8	19.8	1526	405	332	2262
2519604	9	890	25.1	45.9	28666	10708	1437	40811
2519621	5	1135	18.0	36.3	28666	11064	1437	41167

Table F4 NH₃N modelling using the GRID ARC/INFO.

Station Number	No. of water samples	River Flow Rate ('000 m ³ /d)	Actual NH ₃ N (mg/l)	Modelled NH ₃ N Conc. (mg/l)	Piggery Wastes (kg/d)	Sewage Effluents (kg/d)	Industrial Effluents (kg/d)	Total NH ₃ N Load (kg/day)
2719609	9	43	1.1	1.1	0	47	0	47
2719622	10	420	1.8	2.0	579	222	29	831
2719608	8	31	2.1	3.1	59	37	0	97
2619607	8	680	2.8	2.0	687	570	90	1347
2519605	9	114	2.1	0.9	82	21	5	108
2519604	9	890	2.4	2.5	1544	614	109	2266
2519621	5	1135	1.7	2.0	1544	632	109	2285

APPENDIX F [cont.]

Table F5 Linggi Catchment: Projected River Classes at the Various Locations, 2000.

Station No.	Name Of River	Indexed Parameter	Case (in terms of Water Quality Index)									
			c1	c2	a	b1	b2	b3	b4	b5	b6	b7
2719609	Temiang	BOD	IV	V	IV	IV	IV	IV	I	I	I	I
		COD	III	III	III	III	III	III	I	I	I	I
		SS	III	III	III	III	III	III	III	III	III	III
		AN	IV	V	IV	IV	IV	IV	I	I	I	I
		Overall Index	IV	V	IV	IV	IV	IV	III	III	III	III
2719622	Linggi 1	BOD	III	III	III	III	III	III	I	I	I	I
		COD	III	III	III	III	III	III	II	II	I	I
		SS	IV	IV	IV	IV	IV	IV	IV	IV	III	III
		AN	IV	IV	IV	IV	IV	IV	IV	III	II	II
		Overall Index	IV	IV	IV	IV	IV	IV	IV	IV	III	III
2719608	Kepayang	BOD	III	V	III	III	III	IV	I	I	I	I
		COD	IV	V	IV	IV	IV	IV	III	II	I	I
		SS	IV	V	IV	IV	IV	IV	IV	IV	IV	IV
		AN	IV	V	IV	IV	IV	IV	I	I	I	II
		Overall Index	IV	V	IV	IV	IV	IV	IV	IV	IV	IV
2619607	Linggi 2	BOD	IV	IV	III	IV	IV	IV	I	II	II	II
		COD	III	III	III	III	III	III	II	II	I	I
		SS	IV	IV	IV	IV	IV	IV	IV	IV	III	III
		AN	III	III	III	III	III	III	III	III	III	III
		Overall Index	IV	IV	IV	IV	IV	IV	IV	IV	III	III
2519605	Simin	BOD	II	II	II	III	III	II	II	II	III	II
		COD	III	III	III	III	III	III	III	II	II	II
		SS	III	III	III	III	III	III	III	III	III	III
		AN	IV	IV	IV	V	V	IV	III	IV	IV	III
		Overall Index	IV	IV	IV	V	V	IV	III	IV	IV	III
2519604	Linggi 3	BOD	III	IV	III	III	III	III	III	III	III	III
		COD	IV	V	IV	IV	V	IV	IV	IV	II	II
		SS	III	III	III	III	III	III	III	III	III	III
		AN	IV	V	IV	V	V	V	IV	IV	IV	IV
		Overall Index	IV	V	IV	V	V	V	IV	IV	IV	IV
2519621	Linggi 4	BOD	III	III	III	III	III	III	II	III	III	II
		COD	IV	IV	IV	IV	IV	IV	IV	III	II	II
		SS	III	III	III	III	III	III	III	III	II	II
		AN	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV
		Overall Index	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV