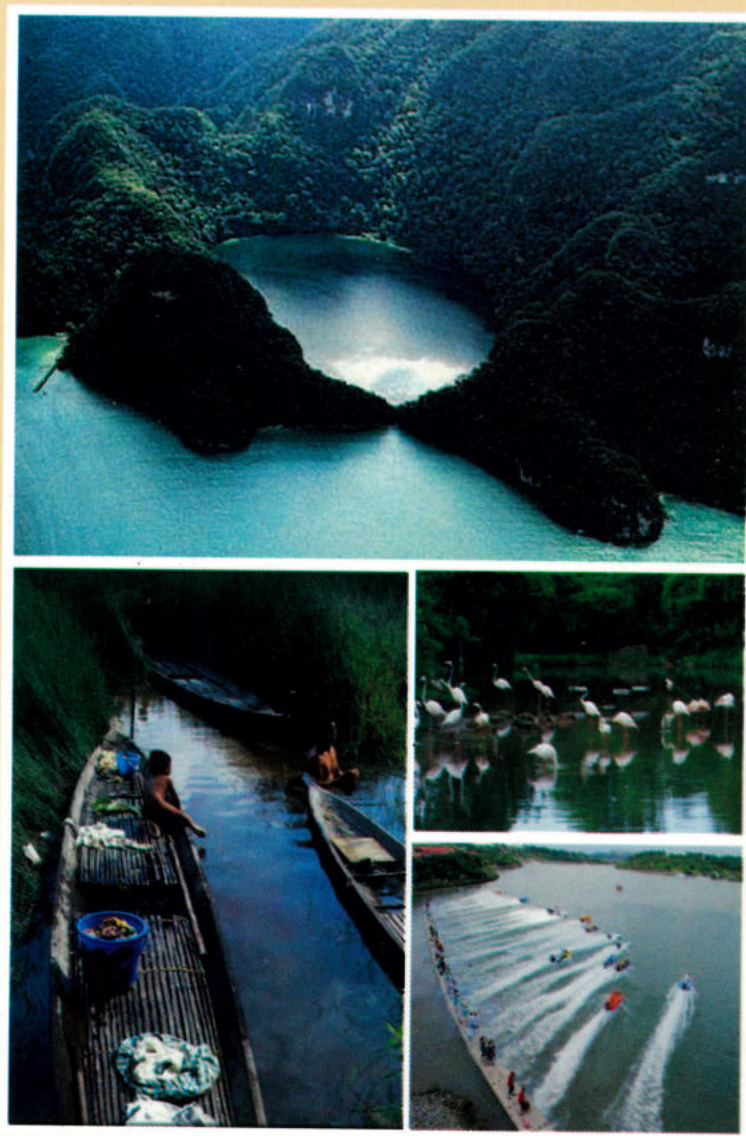


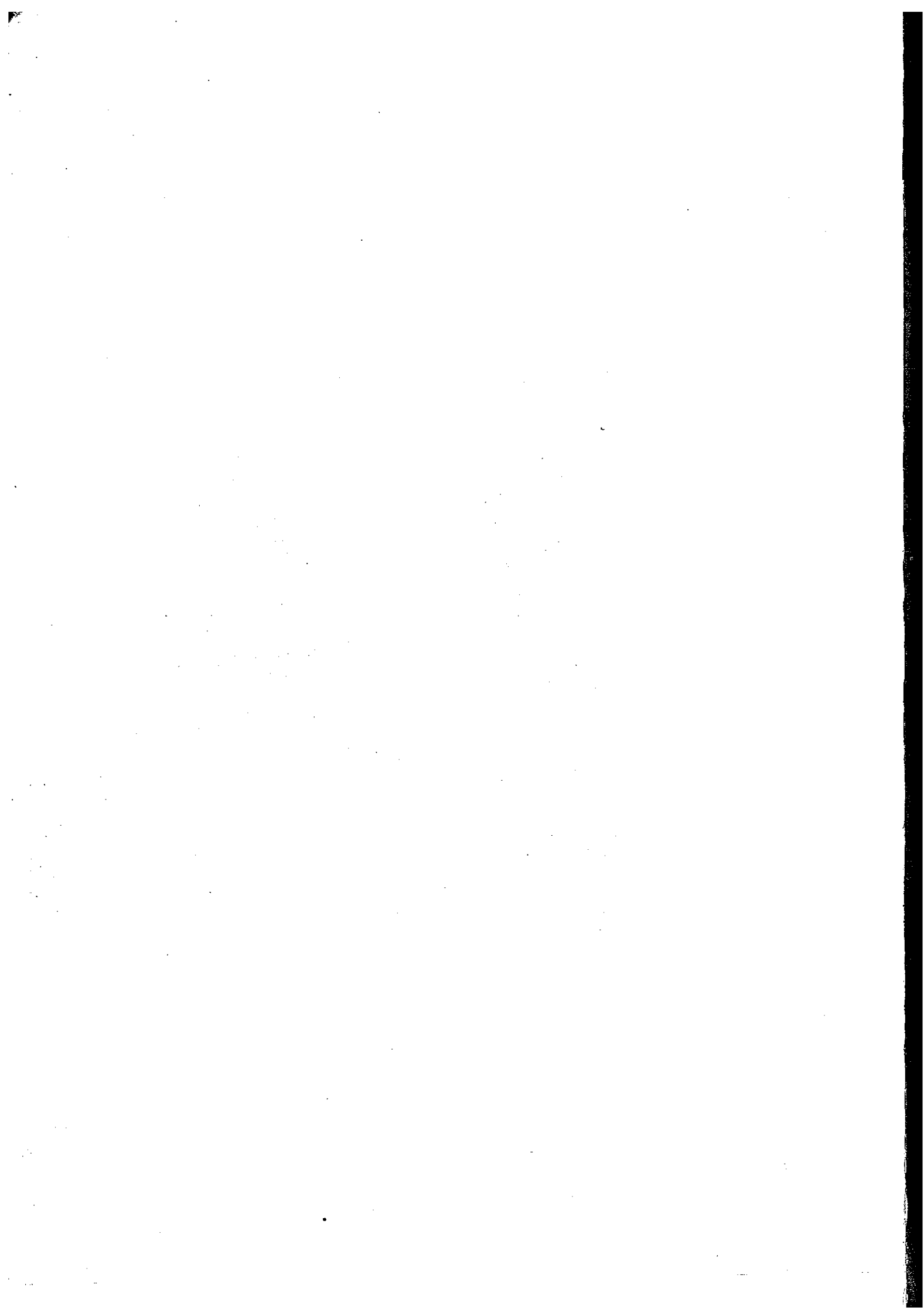
STRATEGY PLAN

STRATEGIES FOR THE SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF LAKES AND RESERVOIRS IN MALAYSIA



VOLUME 1: MAIN REPORT





**STRATEGIES FOR THE SUSTAINABLE
DEVELOPMENT AND MANAGEMENT
OF LAKES AND RESERVOIRS IN MALAYSIA**

**VOLUME 1: MAIN REPORT
2009**



**A Report on the Strategies for the Sustainable
Development and Management
of Lakes and Reservoirs in Malaysia**

MESSAGE

It gives me great pleasure to present this report, entitled "Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia", to the relevant authorities for their consideration and adoption.

Malaysia, with its annual rainfall of close to 2000 mm a year, has always been recognized with a rich and sustainable fresh water resource base. So much of our lifestyle choices, from the clothes we wear to the design of houses, revolve around the rainfall that is part of our daily lives.

However, what is less recognized is the fact that much of the country's utilizable freshwater resources – water that can be drunk, water that industries can use, water that washes things – are stored in the country's lakes and reservoirs. These water bodies, covering over 100 000 ha, hold over 30 billion cubic metres of water and support numerous economic, recreational and social functions.

The lack of awareness on the extent of our lake-based freshwater resources, and most importantly, their immensely crucial strategic value in sustaining the nation's people and economy has created a policy vacuum as far as the management of these resources is concerned. Current management strategies are fragmented, pursued by different management agencies, each having different, and often competing sectoral agendas. This mosaic of competing interests and management emphasis has been inimical to the long-term development of lake resources in the country, besides shrouding its true value to the nation and its development goals. Cognizant of this crucial strategic and financial value of the country's lake resources, the Academy of Sciences Malaysia (ASM) and the National Hydraulic Research Institute of Malaysia (NAHRIM) jointly undertook efforts towards developing a Strategic Plan for Sustainable Development and Management of Lakes and Reservoirs in Malaysia.

The preparation of the Strategic Plan was undertaken over the year 2008 through a multi-stakeholder consultation process commencing with an initial Conceptual Framework Plan followed by preparation of more detailed Thematic Component Plans. These reports were later synthesized to formulate a concise Strategic Plan for Lake and Reservoir Development and Management in Malaysia. The Academy believes that, with this consultative approach, there will be input from a wide array of scientific and non-scientific individuals and organisations, including the relevant government agencies and non-government organisations. This Report is the culmination of the collective effort and contribution of the members of the joint Academy of Sciences Malaysia – NAHRIM Lake Management Technical Committee and the input derived from the component plan teams, position paper authors, workshop facilitators, and the numerous institutional and community stakeholders from around the country that participated actively at the Lake Colloquium, and the many consultation workshop sessions.

The production of this report is in fulfilment of the Academy's many functions, among which are to provide independent advice to the government through the dissemination of ideas and suggestions amongst decision- and policy-makers, scientists, engineers and technologists through identifying where the innovative use of science, engineering and technology can provide solutions to particular national problems towards sustained national development.

Thank you.



Tan Sri Dr Yusof Basiron, F.A.Sc.
President
Academy of Sciences Malaysia

FOREWORD

The Academy of Sciences Malaysia (ASM) has since the year 2004 taken special interest in lake and reservoir management following its involvement in a global Water Programme initiated by the Inter Academy Panel where the topic of eutrophication of lakes was one of the priority areas identified for initial focus. ASM in collaboration with the National Hydraulic Research Institute of Malaysia (NAHRIM), had then commissioned a desk study, undertaken by Universiti Teknologi Malaysia, to assess the status of eutrophication of some 90 selected lakes and reservoirs located around Malaysia. The study completed in the year 2005 revealed that 62% of the lakes were nutrient-rich or eutrophic, while the rest were considered mesotrophic. This deterioration of water quality stems largely from poor or ineffective management of these vital water sources.

As an essential first step, ASM, in collaboration with NAHRIM, and under the auspices of the Ministry of Natural Resources and Environment, successfully organized the Colloquium on Lake and Reservoir Management in Malaysia in August 2007. There was general consensus at the end of the Colloquium that an urgent need to formulate a national integrated plan for sound and comprehensive lake management in the country was required.

A Technical Committee on Lake Management was soon established thereafter, jointly hosted by ASM and NAHRIM to develop a Strategic Plan for Lake and Reservoir Management in Malaysia. Preparation of the Strategic Plan was undertaken over the year 2008 through a multi-stakeholder consultation process commencing with an initial Conceptual Framework Plan followed by the preparation of more detailed thematic component plans. These reports were later synthesized to formulate a concise Strategic Plan for Lake and Reservoir Development and Management in Malaysia.

This Report is entitled "Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia". It represents the sum total of the collective efforts and contributions from the members of the Lake Management Technical Committee together with the joint secretariat staff from ASM and NAHRIM, the component plan teams, position paper authors, workshop facilitators, and the numerous institutional and community stakeholders from around the country that participated actively at the Colloquium, and the many consultation workshop sessions.

The report comprises three volumes:

- Volume 1: Main Report
- Volume 2: Conceptual Framework, Component Plans, and Position Papers
- Volume 3: Part 1—A Desk Study on the Status of Eutrophication of Lakes in Malaysia (2005)

Part 2—Proceedings of the Colloquium on Lakes and Reservoir Management in Malaysia
Status and Issues (2007)

On behalf of the Lake Management Technical Committee, I take this opportunity to thank all those who have contributed towards the successful completion of this undertaking culminating in the publication of this Report. A special appreciation is accorded to the chief facilitator, Mr Gopinath Nagaraj, for his commendable effort in undertaking the onerous task of synthesizing the findings into a concise and succinct strategies report compiled herein as Volume 1: Main Report.

Last but not least, a word of appreciation to Ir Dr Salmah Zakaria, and her successor, Ir Ahmad Jamaluddin, both in their capacities as Director General of NAHRIM, for co-hosting this undertaking with ASM until its completion.



Academician Tan Sri Ir Shahrizaila Abdullah, F.A.Sc.,
Chairman, Lake Management Technical Committee
Academy of Sciences Malaysia

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Acronyms

ASM	Academy of Sciences Malaysia
CBO	Community-based Organisations
DID	Department of Irrigation and Drainage
EQA	Environmental Quality Act
ERCE	European Regional Centre for Ecohydrology
ESA	Environmentally Sensitive Areas
ILBM	Integrated Lake Basin Management
ILEC	International Lake Environment Committee
IWRM	Integrated Water Resources Management
JPS	<i>Jabatan Pengairan dan Saliran (See DID Above)</i>
LFA	Logical Framework Analysis
LGA	Local Government Act
LUAS	<i>Lembaga Urus Air Selangor</i>
MADA	MUDA Agricultural Development Authority
NAHRIM	National Hydraulic Research Institute of Malaysia
NLC	National Land Code
NLRC	National Lake Resource Centre
NRE	Ministry of Natural Resources and Environment
NWRC	National Water Resources Council
SDBA	Street Drainage and Building Act
TCPA	Town and Country Planning Act
TNB	<i>Tenaga Nasional Berhad</i>
UNESCO	United Nations Educational Scientific and Cultural Organisation
WSCA	Water Services Commission Act
WSIA	Water Services Industry Act

Executive Summary

Lakes and reservoirs in Malaysia are natural or man-made. The common uses of these water bodies are for water supply to serve domestic, industrial and agricultural purposes; for hydroelectric power generation; for flood control; for navigation and for recreation. They are also home to diverse biological species and fisheries. Lakes and reservoirs are vital storage areas of the country's water resources.

The Academy of Sciences Malaysia (ASM) and the National Hydraulic Research Institute of Malaysia (NAHRIM) initiated a study to provide a baseline appraisal of the current state of the country's lakes and reservoirs in October 2004. The resulting report entitled "A Study on the Status of Eutrophication of Lakes in Malaysia", confirmed that about 62% of the ninety lakes studied were nutrient-rich or eutrophic while the balance was considered mesotrophic. This deterioration of water quality is a matter of serious concern. A subsequent National Colloquium on Lakes and Reservoir Management held in August 2007 recommended the need for a National Plan for Integrated Lake Management for sound and comprehensive lake management in the country. ASM and NAHRIM later established a Technical Committee on Lake Management to further develop a Strategic Plan on Lake and Reservoir Management in Malaysia. This document is an outcome of the Technical Committee's initiative in this regard.

While there are a few natural lakes in Malaysia such as Tasik Bera and Tasik Chini in Pahang and Paya Bungor (Pahang), man-made lakes include Kenyir (Terengganu), Pergau (Kelantan), Batang Ai (Sarawak), Temenggor (Perak) and Pedu/Muda (Kedah). The ninety major lakes in Malaysia occupy an area of approximately 1000 square kilometres with a total volume of 30 billion cubic metres, the equivalent of two-and-a-half times the annual consumption of water for agriculture, industrial and domestic purposes in Peninsular Malaysia (estimated at 12 billion cubic meters by 2010).

Together with smaller lakes and new impoundments currently being constructed, total volume is expected to reach 100 billion cubic meters over the next few years. Lakes support a wide range of national and locally important economic functions. Among the most pertinent are:

- **Hydroelectricity:** Hydroelectric reservoirs currently account for 6% of national power supply valued at RM12.61 billion. This is expected to increase to 30% (RM63 billion) in the next few years.
- **Water supply:** Lakes supply some 98% of the urban population and 95% of rural households with clean water. Malaysians consume an average of 208 litres/person/day.
- **Flood mitigation:** Dams protect the lives and property of hundreds of thousands of people throughout the country.
- **Fishing and aquaculture:** Many lakes support fishing populations, and serve as a vital food source for lakeside communities. On a larger scale, aquaculture in floating cages is also carried out in many reservoirs: both Pergau and Kenyir are currently being developed as major centres for industrial-level fish production.
- **Biodiversity:** A large number of species are found in Malaysia's lakes, and many species are of global significance.
- **Recreation and tourism:** Though these lakes are not considered large, from the standpoint of volume and area, their importance as an amenity to urban populations cannot be understated. Tourism is an important adjunct to recreation. Many lakes have tourism

appeal because of their recreation values. There may be as many as 2 million active anglers in the country, involving about 30 million man-days valued at RM1.5 billion. Though angling is carried out at a number of venues, lakes and reservoirs are a major focus of the activity.

- Heritage and patrimony. Many of the older lakes in Malaysia support community and cultural values that are an essential part of our heritage.

The root problem facing lake management in the country is a governance regime that does not have an overarching policy and strategy framework. There is a need for a better understanding of the issues surrounding governance of lakes. Among the major issues that must be grappled within lake management are pollution and habitat degradation, lack of sustained research and development, fragmented policy, legal and governance framework, man-power and human resource issues, information management and knowledge dissemination and public awareness and stakeholder participation.

Four major interventions required include:

- The development of a National Vision for Malaysian Lakes
- The development of a Policy Framework
- The development of a Mission Statement for Lake Management; and
- The development of a Strategy Framework for Development and Management of Malaysian Lakes.

The proposed vision statement for management of Malaysia lakes is as follows:

"Engender the sustainable use of lakes for their ecosystem services and economic values"

Pending the framing of a National Water Policy that can encompass lakes, it is recommended that a policy statement be included on lakes in the 10th Malaysia Plan to highlight the importance of lakes and the need to manage them sustainably. This statement can take the form of:

Lakes and reservoirs will be sustained, restored and protected through the adoption of an Integrated Lake Basin Management (ILBM) approach.

The proposed mission statement for lakes is as follows:

"To engender sound management of lakes through the adoption and application of IWRM principles and practices".

A strategy framework towards this end is proposed as follows.

Strategy I: Identify and Empower a Lead Ministry/Agency

Water is a natural resource and hence, the overall responsibility for reaching out and integrating across boundaries would rest largely with the Ministry of Natural Resources and Environment (NRE). In executing this role, the agency within NRE that best lends itself to be the implementing agency for the enhanced mandate is the Department of Irrigation and Drainage.

Strategy II: Establish a National Lake Resource Centre under NRE.

The National Lake Resource Centre (NLRC) would be a one-stop agency which would act as a centre of excellence for research into lakes and lake management, and as a reference and

database centre for all information and research on lakes in Malaysia. It is proposed that this role be vested in NAHRIM.

Strategy III: Establish a Standing Committee on Lakes within the Purview of the National Water Resources Council

Considering that lakes comprise one of the three vital yet vulnerable sources of water (the other two being rivers and groundwater) that are closely linked and impacted upon by land development within their basins, and involve many stakeholders, it would be appropriate that a standing committee be set up under the NWRC to oversee the integrated management of lakes so as also to enable policies that have an administrative transboundary dimension to be engendered and implemented for integrated lake basin management for use at all levels.

Strategy IV: Establish Lake Management Committees at State Level

These committees would be at the political level of Government, allowing co-ordination among the various agencies that are involved in the management of lakes. The model for this would be State Agriculture Committees or State Industrial Committees that are headed by State Executive Councillors or State Ministers.

Strategy V: Development of a Detailed Action Plan

The establishment of an implementing agency without a corresponding action plan for the immediate term would be counter productive. Under this ASM/NAHRIM initiative to address lake management, a set of preliminary activities and action plans have been identified and collated through wide consultations with relevant stakeholders. Using these findings to start with, the implementing agency would be able to build on them to develop a detailed Plan of Action with necessary priority settings.

Strategy VI: Support the Role of Local Communities in Lake Management

The public can play a major role in such situations and it can be very beneficial to seek the public's view, in the form of public hearings or other relevant fora. An example is the creation of a community stakeholder committee (alternatively called citizens' advisory committee, "*rakan tasik*" or "friends of the lake"), that includes inhabitants that live in the lake or reservoir drainage basin.

Strategy VII: Pass Appropriate Legislation to Strengthen Existing Legal Framework.

Both at National and State level, appropriate legislation must be passed to enable management of lakes as a resource.

Strategy VIII: Enhance Networking and Strengthen International Strategic Alliances

Networking and international alliances with other countries would enable the country to learn from experiences of other countries as well as share our own with them. It is important to point out that such linkages have already been established with organisations like the International Lake Environment Committee (ILEC), UNESCO-European Regional Centre for Ecohydrology (ERCE) in Poland, and the University of Sao Paulo in Brazil. Building on these linkages and facilitating capacity building initiatives and programmes, the country would be able to position itself into becoming a leading advocate and knowledge hub for lake management in the region.



*A lake is the landscape's most beautiful and expressive feature.
It is earth's eye; looking into which the beholder measures the depth of his own nature.*

Henry David Thoreau

1.0 INTRODUCTION AND BACKGROUND

1.1 Lakes – A Valuable Yet Vulnerable Resource

Water is an inescapable necessity for all life on Earth. Two thirds of the Earth's surface is covered by water, amounting to approximately 1.4 billion cubic kilometres. If we consider human water needs, however, this picture is deceiving. This is because more than 97.5% of the Earth's water is in its oceans. Of the remaining 2.5%, 70% is locked in polar icecaps or glaciers. Most of the rest lies deep underground and beyond easy human reach, and another sizable fraction is saline. This means, therefore, that all human and other life depends on less than 1% of the total quantity of water on this planet. However, despite its limited availability, fresh water is an absolute prerequisite for economic development of nations and regions. Adequate supplies of clean and safe fresh water are fundamental for the establishment of communities and to support economic well-being. That water represents a vital and strategic economic and social resource is underscored by the fact that most human civilizations of the world emerged in or near river valleys.

In particular, lakes and reservoirs are essential components of the freshwater supply scenario, as vital to freshwater supply as vaults are to banking. However, far more than just acting as repositories of a valuable resource, lakes support livelihood, food production and are often precious repositories of biodiversity. Even saline lakes are of great value, not the least for their role in supporting ecological and hydrological functions.

The 2001 Environmental Strategy of the World bank, divided the value of water and water-based ecosystems into the following four categories:

- Direct Values (consumptive and non-consumptive use of resources)
- Indirect Values (ecosystem functions and services)
- Option Values (premium placed on possible future uses and applications); and
- Non-use Values (intrinsic significance).

Based on these categories, we examine the major types of lake values below.

Direct Values

The most obvious direct use of lakes is as source of drinking, irrigation and industrial water. The Laurentian Great Lakes contain 20% of the worlds available freshwater and serve as a drinking water source for over 24 million people. Even the relatively small Lake Biwa in central Japan supports the activities of over 13 million people in the Kyoto-Osaka-Kobe conurbation. Lakes and rivers have also been used as a means of transportation while some natural and most artificial lakes are harnessed for power. Lake fishing, along with aquaculture, provides protein and employment for many people. Lakes are also well known as focal points for recreation, while many serve as a breeding ground for migratory waterfowl. For example, the Mono Lake in California is an essential feeding stop to wintering grounds in South America for tens of thousands of phalaropes and is an essential stop for thousands of photographers, both amateur and professional.

Indirect Values

Lakes as ecosystems provide a wide range of services that defy direct valuation. Large lakes absorb large inflows of water during floods, thereby moderating damage downstream. For example, the volume of the Tonle Sap in Cambodia increases dramatically during the flood season, effectively channelling the flood waters into an established basin.

Lakes often have a moderating influence on local climate due to the relatively high heat capacity of water. Decreases in lake size, such as has occurred in the Aral Sea, can have adverse impact on local climate. Also, the method of waste disposal pioneered in Europe, namely the

transport of wastes in water through sewers, has been adopted in many watersheds, with lakes acting as sinks for wastewater discharges. They provide dilution of waste, and in exoreic (open) basins, a way to send the waste elsewhere.

Option Values

Lakes are repositories of biodiversity. For instance, the ancient lakes in Africa are home to hundreds of endemic species. Besides the direct benefits of biodiversity known today, it is possible that future values may be equally as important. Hence, one value of preserving lakes is to keep options open for many different kinds of future needs.

Non-use Values

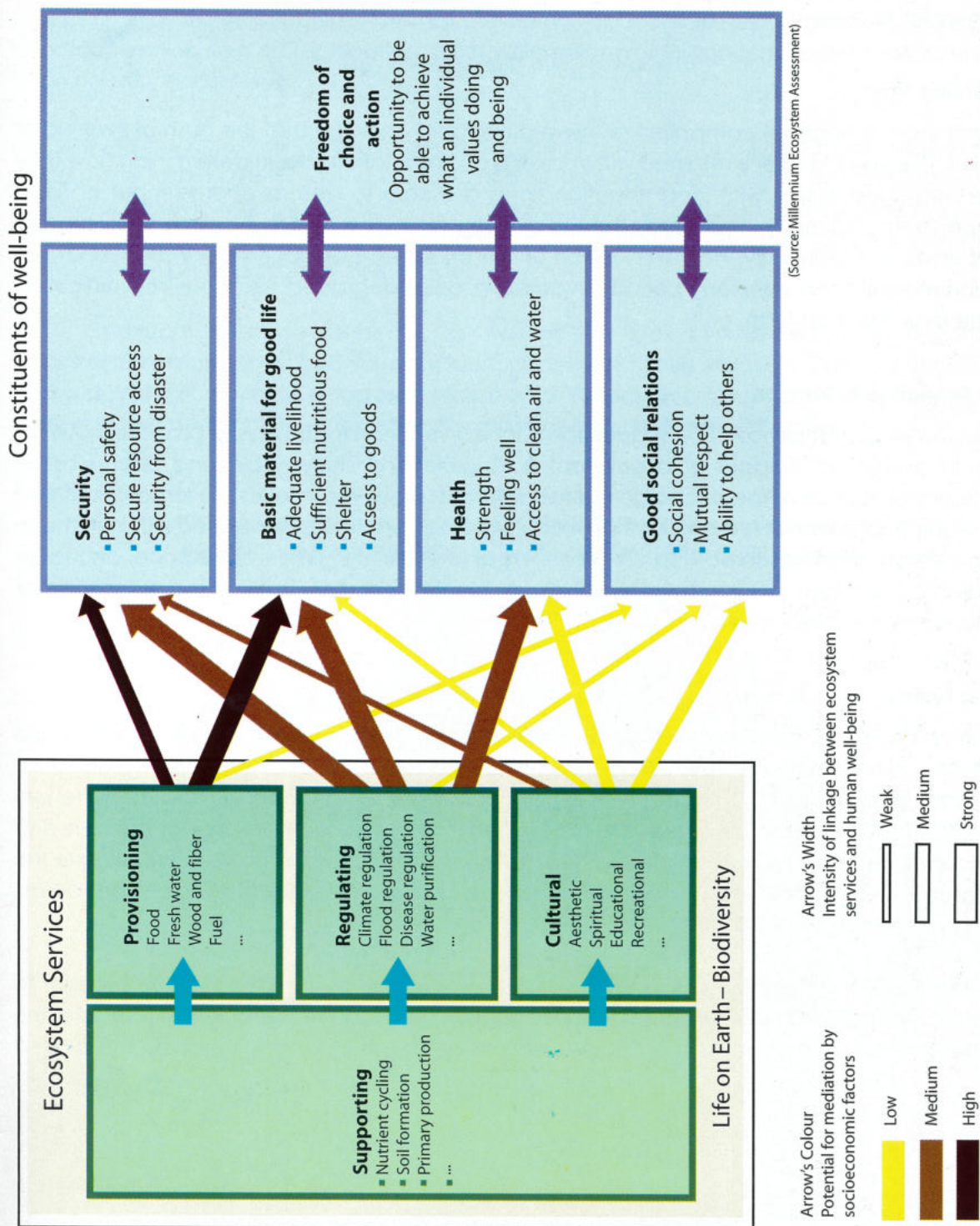
The cultures of many lake communities centre on legend, myths and social values drawn upon the water body in their midst. Many lakes are also sacred sites for religious and spiritual activities. In addition, simply knowing that a particular lake exists and has clean water, carries a particular value. For instance, some people may be interested in the preservation of a particular lake, even though they may never expect to see it first hand.

The multiplicity of facilities that lakes offer should have led to a situation where they are managed as key natural assets by the countries in which they occur. The reality, however, is that most lakes are undervalued and therefore face stresses resulting from inappropriate management.

These problems are global in nature, occurring in developed as well as developing countries. In most cases, the many values of lakes have not been fully considered by policymakers, resulting in serious lapses in their management and development.

The many values of lakes and the complex manner they relate to human activity are captured in *Figure 1* on the next page. Clearly, lakes are vital resources that impact our lives at a very fundamental level. Our ability to effectively manage them in a sustainable and coherent manner would affect the quality of our lives and those of the generations that would come after us.





(Source: Millennium Ecosystem Assessment)

(Source ILEC)

Figure 1. Linkage between Lake Ecosystem Services and Human Welfare.

1.2 The Challenge in Managing Lake Resources

In any discussion of lake management, it is important to understand the peculiarities of lakes as a resource and the manner in which it impinges in the way the resource should be managed. In this respect, it is important to point out that lakes have many exclusive challenges that managers must cope with. Though each lake has its own character, three major differences separate it from rivers and other water bodies.

Long Retention Time

The water in lakes is stagnant compared to the relative rapid changes that the gush of river water brings with it. The period water is retained within lakes is an important factor in determining how they should be managed. Lakes with long retention times are able to absorb a large input of flood waters, pollutants, sediments and heat. They also often have the carrying capacity to support significant levels of biodiversity. However, much of the changes that accompany such input are invisible and manifest only over long periods. In addition, once degraded, lakes are very difficult to rehabilitate over the short term.

Complex Response Dynamics

Unlike rivers, lakes do not behave in a sequential manner in relation to stressors, a process known as hysteresis. In a river, the impact of a pollutant is tangible and discernable and occurs as an immediate consequence of the discharge of that pollutant. However, in lakes the large volumes of standing water that are involved and complex ecohydrology processes generated within it, mean that responses are often obscured and only manifest at later point in time. For instance, discharge of nutrients into lakes may not immediately manifest as eutrophication, but it can suddenly occur when initial levels are already very high.

Integrating Nature

Lakes receive numerous input from surrounding catchments, from the atmosphere and from the rivers that flow into it. They are affected by rain, wind and wave action. The effects tend to be retained within the lake itself, in contrast with rivers, where changes are often limited to the tenure of the inputs affecting them. The effects are disseminated throughout the volume of the lake and can have a major impact on its ecohydrology and biodiversity. This means that issues relating to the management of lakes are often inseparable and management measures must be across geographic, administrative and political jurisdictions to be effective.

These three factors collectively mediate the kind of management that needs to be brought to bear where sustainability of lake resources is concerned. Any approach that does not consider the complexities of the lake environment and its specialised demands is not going to yield the desired results.



1.3 Global Trends in Managing Lake Resources

Despite the many values that lakes confer on the global community, lake resources have continued to suffer a number of stresses. A comprehensive survey of 217 lakes around the world carried out by the International Lake Environment Committee (ILEC), a network of leading world institutions and individuals involved in the field of lake management, concluded that lakes were facing five major problems, namely lowering of water-levels, siltation, acidification, toxic contamination and eutrophication, all of which alone or in concert, have led to adverse effects on aquatic ecosystems.

Though measures have been taken to obviate from any further degradation, stresses that impair the use of lakes have remained. In short, most of the world's lakes are still not sustainably managed. Several reasons why the counter-measures to date have not been entirely effective include lack of awareness, lack of integrated responses, lack of conflict resolution mechanisms and lack of meaningful participation by stakeholders.

Cognizant of these problems, as well as the lack of knowledge on resource-specific management regimes, ILEC formally launched "World Lake Vision: A Call to Action" at the 3rd World Water Forum held in Japan in March 2003. The Vision provides a set of guiding principles for developing and implementing effective management of the world's lakes.

World Lake Vision

The seven principles detailed in World Lake Vision provide a road map for achieving the transition to managing lakes for their sustainable use.

Principle 1

A harmonious relationship between humans and nature is essential for the sustainable use of lakes.

Principle 2

A lake drainage basin is the logical starting point for planning and management actions for sustainable lake use.

Principle 3

A long-term, preventive approach directed to preventing the causes of lake degradation is essential.

Principle 4

Policy development and decision making for lake management should be based on sound science and the best available information.

Principle 5

The management of lakes for their sustainable use requires the resolution of conflicts among competing users of lake resources, taking into account the needs of present and future generations and of nature.

Principle 6

Citizens and other stakeholders should be encouraged to participate meaningfully in identifying and resolving critical lake problems.

Principle 7

Good governance, based on fairness, transparency and empowerment of all stakeholders, is essential for sustainable lake use.

(Source: ILEC)

The shortcomings of the current approaches to lake management have been further taken up by ILEC which has advocated for Integrated Lake Basin Management (ILBM) as the primary instrument in its realization.

Integrated Lake Basin Management (ILBM)

ILBM is a way of thinking that assists lake basin managers and stakeholders in achieving sustainable management of lakes and their basins. It takes into account that lakes have a great variety of resource values whose sustainable development and use require special management considerations for their lentic (static) water properties. Good basin management of a lake can be realized only through ILBM, or continuous improvement of lake basin governance that integrates institution, policy, participation, science, technology and funding.

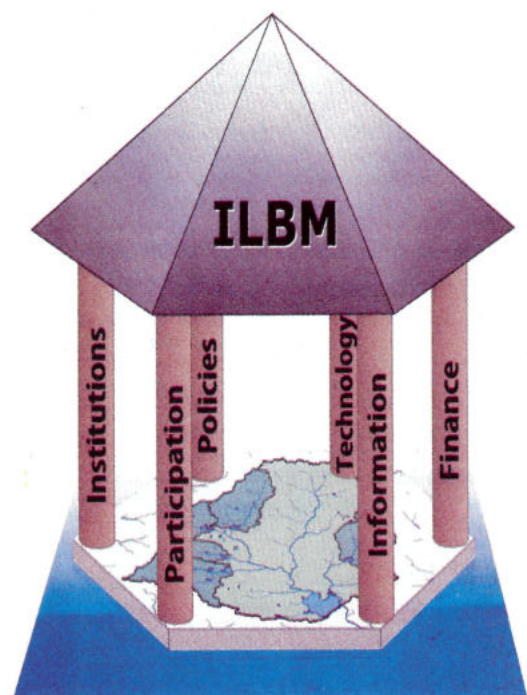
(Source ILEC)

In undertaking Integrated Lake Basin Management, it is crucial to note that planning strategies are not likely to work if they do not take into account the exigencies of the basins in which they are located or are fragmented according to geographic, administrative and political boundaries. The employment of appropriate technologies, involvement of stakeholder groups and implementation of structured monitoring regimes are vital tools in ILBM. Most importantly, it must be emphasized that ILBM is a long-term commitment and should not be seen as a one-off measure.

The manner in which governance converges to support ILBM is exemplified in Figure 2.

In short, good lake governance would demand:

- Institutions that manage the lake and its basin for the benefit of all its stakeholders
- Policies that govern people's use of lakes in relation to the impact of the use
- Involvement of people central to Lake Basin Management
- Evaluation of appropriate technological possibilities for ILBM
- Continuous efforts to increase knowledge on lakes; and
- Sustainable finances to fund all of the above.



(Source ILEC)

Figure 2. Integrated Lake Basin Management and Governance.

1.4 The Malaysian Lake Management Initiative

Malaysia, with its annual rainfall of close to 2000 mm a year, has always been recognized as having a rich and sustainable fresh water resource base. So much of our lifestyle choices, from the clothes we wear to the designs of houses, revolve around the rainfall that is part of our daily lives.

However, what is less recognized is the fact that much of the country's utilizable freshwater resources – water that can be drunk, water that industries can use, water that wash things – are stored in the country's lakes and reservoirs. These water bodies, currently covering over 100 000 ha, hold over 30 billion cubic metres of water and support numerous economic, recreational and social functions.

The lack of awareness on the extent of our lake-based freshwater resources, and importantly, its immensely crucial strategic value in sustaining the nation's people and economy has created a policy vacuum where the management of these resources are concerned. Current management strategies are fragmented, pursued by different management agencies, each having different, and often competing, sectoral agenda. This mosaic of competing interests and management emphasis has been inimical to the long-term development of lake resources in the country, besides shrouding its true value to the nation and its development goals.

Cognizant of the crucial strategic and financial value of country's lake resources, ASM and NAHRIM jointly initiated a study to provide a baseline appraisal of the current state of the country's lakes and reservoirs in October 2004. Undertaken by the Institute of Environment and Water Resource Management, University Teknologi Malaysia, the resulting report, entitled "A Study on the Status of Eutrophication of Lakes in Malaysia" (see **Volume 3**), confirmed that the condition of Malaysian lakes largely reflected the global situation.

Out of the 90 lakes that were studied, 56 (62%) were in a poor condition (eutrophic), while the balance were in a mediocre to reasonably good state (mesothrophic). The study went on to conclude that eutrophication of lakes has reached levels for serious concern and restoration efforts were urgently needed for many lakes. In addition, the report called for a lake management and restoration plan, intensification of research in identified priority areas and increased public awareness and capacity building for lake managers.

On the 2nd and 3rd August 2007, a two-day Colloquium on the Management of Lakes and Reservoirs in Malaysia was held among various stakeholders as well as invited speakers from other countries (see **Volume 3**–Proceedings). The Colloquium concluded that there was an immediate need for a national plan for integrated lake management for sound and comprehensive lake management in the country. Towards this end, the ASM and NAHRIM jointly established a Technical Committee on Lake Management.

The priority focus of this Committee was to further develop a strategic plan on lake and reservoir management in Malaysia as part and parcel of their overall respective organisational role and responsibility and offer strategic advice to Government on matters pertaining to sustainable development and management of lake resources. As a first step, the Committee organized a brainstorming workshop on 15 January 2008 to develop the conceptual framework for lake management in Malaysia.

The planning approach that was taken was a multi-stakeholder consultative process which commenced with an initial Conceptual Framework Plan. This was followed by the preparation of more detailed Component Plans on the following aspects of lake resource management:

- Governance
- Research and development needs
- Capacity building for management agencies and other stakeholder communities
- Lake management
- Information management; and
- Community stakeholder participation in the management process.

Individual workshops for each of the component sections were held with the participants selected from various stakeholder groups, whose linkage to lakes related closely to the various components being discussed. Specialists from academia and agencies were invited to present position papers on each of these component topics and the issues raised were discussed extensively by workshop participants. The position papers, output of the workshop groups and their collective opinions collated into workshop reports appear in **Volume 2**. These form the basis of this document which represents the finalised Strategic Plan.



2.0 Malaysian Lakes – A Valuable Resource

2.1 Resource Profile

In discussing lakes and their value as resource, it is important to clearly define what is at stake. Lakes may be defined as expanses of water entirely surrounded by land and unconnected to the sea except by rivers or streams. Lakes may be natural or man-made. Man-made lakes are more appropriately called reservoirs.

Natural lakes would include:

- Wetlands and swamp lakes
- Ox-bow lakes; and
- Other ponds/lakes formed naturally.



Man-made lakes (or reservoirs) would include water bodies such as:

- Lakes (or pools) formed by mining
- Lakes formed by drainage systems including retention ponds
- Lakes formed by dams – power, irrigation, water supply; and
- Lakes created for recreation.



There are very few natural lakes in Malaysia. These include large wetlands such as Tasik Bera and Tasik Chini in Pahang, and Tasik Dayang Bunting in Langkawi. However, there are numerous swamp lakes and ox-bow lakes throughout the country such as Paya Bungor (Pahang) and Loagan Benut (Sarawak). The Kinabatangan river system in Sabah is home to over twenty large ox-bow lakes, many of which are known to support exotic and endemic biodiversity.

In terms of the area of coverage, man-made lakes far exceed the extent of natural lakes. Such lakes or reservoirs have been constructed to meet demand for hydroelectricity, water supply for domestic, industrial and agricultural use; for flood control; through mining; and for recreational purposes largely in and around urban centres. Notable reservoirs include Kenyir (Terengganu), Pergau (Kelantan), Batang Ai (Sarawak), Temenggor (Perak) and Pedu/Muda (Kedah).

For most part, these lakes, particularly reservoirs, sustain the best quality freshwater resources that the country has at hand. Unlike rivers, which have been subject to immense environmental degradation through pollution and wastewater discharge, many of the country's lakes (with the possible exception of mining pools) have been largely protected from the same degree of degradation by the agencies managing them.

2.2 Spatial and Volumetric Extent

There has been no comprehensive inventory of lake resources in Malaysia. A preliminary assessment listing (Table 1) indicates that there are over 90 lakes in the country covering an area of at least 100 000 ha and hold about 30 billion cubic metres of water.

To put things into perspective, this volume of the freshwater is sufficient:

- To submerge the entire Federal Territory of Kuala Lumpur (241 square kilometres) to a depth of 124 metres
- To meet the annual consumption of water for agricultural, industrial and domestic purposes in Peninsular Malaysia (estimated at 12 billion cubic metres by 2010) for more than 2½ years; and
- Generate a total of RM45 billion if sold at a commercial water rate of RM1.50/cubic metre. Commercial water rates vary from RM1.20 – RM2.20 in different states.

TABLE 1. INVENTORY OF LAKES IN MALAYSIA

State	Number	Area (km ²)	Volume (M m ³)
Perlis	2	13.33	40.00
Kedah	7	95.03	1637.76
Perak	11	284.68	6766.50
Selangor	15	11.38	511.32
Pahang	10	94.69	355.71
Kelantan	4	11.34	76.80
Johor	13	84.22	940.02
Labuan	3	0.50	5.40
Melaka	4	8.75	81.30
N. Sembilan	5	2.25	182.33
P. Pinang	4	0.94	47.20
Sabah	5	1.81	29.61
Sarawak	4	97.08	6080.00
Terengganu	2	370.80	13 600.00
Putrajaya	1	7.50	45.00
Total	90	1094.89	30 398.95

It is pertinent to point out that the inventory does not take into account ox-bow lakes. For instance, there are over 20 ox-bow lakes in the Kinabatangan basin alone, some so large they are thought to support some degree of endemic biodiversity. Ox-bow lakes are also found associated with other river systems such as the Sg. Baram, Sg. Perak, Sg. Muar and Sg. Bernam.

Another lake type not included in the listing is ex-mining pools. Many of these were constructed for tin mining, though large impoundments for iron (Bukit Besi) and gold (Tasik Biru in Sarawak and Jaras in Pahang) can also be found. Estimates indicate that there are about 4000 tin mining pools in the country with a total area of 16 000 ha. Assuming an average depth of 10 m, these mining pools hold at least 1.6 billion cubic metres of water.

The listing also does not take into account newer hydro-electric projects such as the proposed Bakun, Murum or the Upper Limbang Dams in Sarawak and the Upper Terengganu dam

in Terengganu. These dams are expected to collectively expand the country's lake area by at least another 100 000 ha in area and at least 40 billion cubic metres in volume.

Collectively, in the inclusion of new impoundments, mining pools and ox-bow lakes would have the effect of bringing their total volume to 100 billion cubic metres or more, underscoring even more the stark strategic profile of Malaysian lakes.

2.3 Economic, Biodiversity and Patrimonial Values

There has been no effort to collate the totality of the economic and social value of lakes to the country. However, a brief review suggests that it is of immense importance. Lakes support a wide range of national and locally important economic functions. Among the most pertinent of these are as shown below.

Hydroelectricity

Hydroelectric impoundments supply about 3 600 mW of electricity every year to the national grid, or about 6% of national electricity demand. Based on a rate on RM0.40 sen/kWh, the commercial value of this power amounts to RM34.56 million a day or RM12.61 billion every year. This value is expected to escalate in the coming years. The Government plans to increase hydropower supply to 30% over the next decade to reduce dependence of fossil fuels. Assuming the same rate applies, this would escalate the commercial value of hydropower to over RM63 billion annually.

Water Supply for Domestic, Industrial and Agricultural Requirements

Malaysia's lakes, directly or indirectly, supply much of the national water use. Only 2% is contributed by groundwater and this is almost entirely in Kelantan. The role lakes play in water supply can be:

- Direct, as when reservoirs hold and supply water directly into the treatment plants and thence into the supply network, or
- Indirect, when reservoirs hold water and sustain base flows within rivers so that water can be abstracted without interruption during dry weather low flows.

Thus though direct abstraction from rivers is the common means by which most water supplies in the country are sustained, dams play a crucial role in the process.

The role that water plays in the average Malaysian's life cannot be understated. Some 98% of the urban population and 95% of rural households have access to clean water supply. Malaysians consume an average of 208 litres/person/day, a rate that exceeds that of many developed countries. The social and economic benefits of piped water are immense. In addition to the more direct benefits of drinking, cooking, washing and cleaning, piped water enables sanitation and hygiene, ending the scourge of water-borne diseases such as cholera and typhoid.

In addition, the country has over 2450 sq km of irrigated land that consume over 68% of the total volume of water used in the country and provides gainful employment to over 138 000 farming families. Reservoirs such as Muda/Pedu and Bukit Merah provide water to major granary areas such as the Muda and Krian rice schemes. Though most of the other granary areas rely on river fed supply, reservoirs and dams continue to play a supporting role in ensuring their sustainability.

The Temenggor Dam, for instance, was primarily built for hydroelectricity but its ability to regulate the waters of the Sg. Perak has been crucial in mitigating annual floods in the lower Perak River basin and in maintaining base flows to meet the needs of the Trans-Perak irrigation scheme.

In 2007, over 72% of the nation's 7.6 million tonnes of rice production came from granary areas. Current government efforts to promote self-sufficiency in rice, from about 70% to 86% over the next few years, is expected to see the opening up of 31 213 ha in Sabah and 41 000 ha in Sarawak. This is expected to increase water demand, and thus lakes and reservoirs for food production play a greater role.

Flood Mitigation

Floods in Malaysia are a consequence of natural and human induced factors. About 2.7 million people live in flood prone areas and, in addition to risk to life, are subject to serious loss of property, economic resources and public amenities when flooding does occur. Average annual flood damage in the country has recently been estimated at about RM1.2 billion. Floods are not necessarily confined to rural or undeveloped areas. Many urban conurbations are also subject to flooding and, from an economic standpoint, the devastation is often more severe. In 2006, a flood inundated over 4000 houses in the relatively affluent neighbourhood of Shah Alam. Though no lives were lost, property damage was estimated at over RM60 million.

Though floods continue to occur, the construction of flood mitigation reservoirs such as the Batu Dam, Sembrong Dam, Bekok Dam and Macap Dam have gone a long way to save countless lives and mitigate properties from flooding. The Batu Dam, constructed as part of the Kuala Lumpur Flood Mitigation Project, and located about 16 km from Kuala Lumpur, has significantly reduced the flooding risk of Sg. Batu, which flows through some of the densest neighbourhoods in the city such as Batu Caves and Sentul.

Similarly, the Sembrong Dam has reduced flood risk for the 140 000 inhabitants of Kluang town, while the Macap Dam has achieved the same for 110 000 residents who call Simpang Renggam their home. Dedicated flood mitigation dams are not alone in their function. Many dams have had flood mitigation capacities inbuilt into them. Both Kenyir and Temenggor, though being hydro-electric impoundments, have a significant storage capacity to accommodate monsoonal flooding surges. These dams have been instrumental in reducing flood risk for the hundreds of thousands of people that live in the basin area of both rivers.

Fishing and Aquaculture

Many lakes support fishing populations, mainly undertaken by surrounding communities. Though these are generally small, they serve as a vital food source for lakeside communities. On a larger scale, aquaculture in floating cages is also carried out in many reservoirs, with Batang Ai, Kenyir and Pergau leading the pack. At Batang Ai, there are close to 2000 cages producing in excess of 300 tonnes of fish annually. Cage culture is also extensively carried out in Kenyir and Pergau, the latter being designated an aquaculture industry zone. Both Pergau and Kenyir are currently being developed as major centres for industrial level fish production.

Biodiversity

Consistent with the country's status as one of 12 mega biodiversity nations in the world, Malaysia has a rich and diversified freshwater fish assemblage, extending to at least 1000 species. A large number of these species are found in Malaysia's lakes, and many species are of global significance. For instance, ox-box lakes such as those found on Kinabatangan support endemic freshwater sharks such as *Glyphis* sp. (Yu Sungai) and Bull shark (*Carcharhinus leuca*), that are found only in the Kinabatangan river basin and nowhere else in the world.

The Bukit Merah reservoir supports populations of the Golden Kelisa, the only location in the world where the variety is found. However, the biodiversity value of lakes is not confined to fish alone. Ox-bow lakes also support endangered fauna such as the estuarine crocodile and the False gharial. Many indigenous aquatic flora are also found in Malaysian lakes and impoundments and play an important role in creating habitats and sequestering nutrients.

Recreation and Tourism

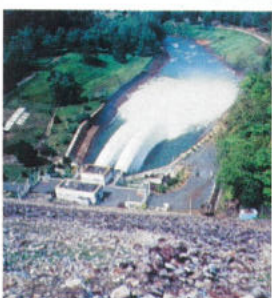
Most of the town parks in Malaysia feature lakes as a recreational facility. Though most of these lakes are small, lakes such as Titiwangsa (Kuala Lumpur), Putrajaya and Air Keroh (Melaka) are of significant size. Major resort developments such as Genting Highlands also feature lakes for their aesthetic and recreational value. Though these lakes are not considered large from the standpoint of volume and area, their importance as amenities to urban population cannot be understated. This is particularly exemplified by the large numbers of people that patronise lake-based parks in all major urban centres, particularly during weekends. The importance of the recreational value of lakes is also exemplified by the fact that water features such as lakes are a major selling point of many real-estate developments in the country.

Tourism is an important adjunct to recreation. Many lakes have tourism appeal because of their recreation values. For instance, the hydroelectric impoundments of Kenyir, Batang Ai, Muda and Chini support significant levels of tourism. Of major significance in this respect is recreational fishing or angling. The Malaysian Institute of Economic Research estimated in a 2001 study that there may be as many as 2 million active anglers in the country, involving about 30 million man-days valued at RM1.5 billion. Though angling is carried out at a number of venues, lakes and reservoirs are a major focus of the activity.

Lakes such as Kenyir, Batang Ai, Muda and Pedu support an angling service industry for the rental of boats, tackle and sales of bait. Angling is also carried out in mining pools and recreational ponds throughout the country. It is thus likely that Malaysian lakes support much of the RM1.5 billion that accrues to the national economy through the activity.

Heritage and Patrimony

Many of the older lakes in Malaysia support community and cultural values that are an essential part of our heritage. The folklore and legends that surround Dayang Bunting in Langkawi and Tasik Chini, for example, are part of country's myriad mythos and cultural tapestry. The loss of these lakes would mean that the basis of the existence of the legends and myths would also disappear.



3.0 Managing Lake Resources – The Challenges We Face

Lakes, because of their inherent nature, are unique and more difficult to manage than rivers. A lake, being a contiguous body of water, would result in its resources and problems being shared throughout the lake. Lake basins are easily impacted by complex land and water relationships; they receive water, sediments, contaminants, nutrients and biota from rivers, surface runoff, groundwater and the atmosphere.

It is extremely difficult to isolate and treat parts of the lake differently. Lakes must therefore be treated as a single integrated entity, avoiding different parts being subjected to different management regimes. Being contiguous would also mean that it would be difficult to exclude users from accessing the lake to exploit its resources and services. The management of lakes must therefore utilize wide ranging policy instruments. They must also be adaptive to the unique problems presented by each lake.

Many Malaysian lakes face serious problems that relate back to the absence of an adaptive and comprehensive management regime. Among the major issues that must be grappled with in lake management are:

- Pollution and habitat degradation
- Lack of sustained research and development
- Fragmented policy, legal and governance framework
- Manpower and human resources issues
- Information management and knowledge dissemination; and
- Public awareness and stakeholder participation.

These issues are discussed in further detail below.

3.1 Pollution and Habitat Degradation

Pollution and habitat degradation are probably the most important factors leading to the loss of functional value in many water bodies. The most affected water bodies are usually mining pools or natural lakes, including ox-bow lakes.

Such lakes are usually seen as convenient repositories of solid waste and waste water. Mining pools located near urban centres suffer particularly from such abuse. The lack of civic awareness among many urban communities is often blamed for litter and other solid waste in urban lakes, but this is largely due to malaise in the management of such water bodies by local authorities.

However, the same bad habit that is tolerated for the mining ponds is often carried over to recreational lakes ostensibly maintained for public use. Management authorities often face an uphill task in maintaining the facility.

In the case of Tasik Chini, pollution largely from tourism-based activities has led to a significant deterioration of water quality. Again the lack of proper sewerage treatment infrastructure for a National Service camp contributed to the problem.

In many cases, pollution of the water courses feeding the lakes are a major source of pollution. Logging and land clearing has affected the water quality of many rivers such as the Kinabatangan.

which in turn had led to deterioration of the habitat within the ox-bow lakes. Sedimentation from logging and uncontrolled catchment development is also a major concern in ox-box lakes in Sarawak, in recreational lakes in Putrajaya, in Tasik Chini and even in hydroelectric reservoirs like Kenyir. The sedimentation of the Sultan Abu Bakar dam (completed in 1963) under the Cameron Highlands Hydro-electric Project is yet another extreme case in point where heavy siltation due to catchment degradation caused by extensive and uncontrolled agricultural activities had recently threatened the operational functionality of the dam for hydropower generation. It required massive investment by TNB to undertake desilting works to restore storage capacity and reinstate operations.

The current state of lake pollution is disturbing. A survey of 90 lakes in Malaysia indicated that 62% were classified as eutrophicated i.e. excessively enriched in dissolved nutrients (nitrogen and phosphorus). Eutrophication, in turn, causes deleterious changes in the biogeochemical and biological processes of water bodies and can have serious socio-economic impact on the quality of life and human health.

Lakes need not be the victims of pollution alone. Lack of planning and poor reservoir design can create conditions where man-made lakes can themselves cause serious disruptions to surrounding social, biological and physical environment.

Such impacts can include:

- Displacement of local populations following inundation of the reservoir water basin
- Excessive human immigration into reservoir region, with associated social, economic and health problems
- Deterioration of conditions for original population
- Increased health problems from increasing spread of waterborne disease and vectors
- Loss of edible native river fish species
- Loss of agricultural and timber lands
- Loss of wetlands and land/water ecotones
- Loss of natural floodplains and wildlife habitats
- Decreased aesthetic values
- Loss of biodiversity, and displaced wildlife populations
- Decreased river flow rates below reservoir, and increased flow variability
- Decreased downstream temperatures, transport of silt and nutrients
- Decreased concentrations of dissolved oxygen and increased concentration of hydrogen sulphide and carbon dioxide in reservoir bottom water layer and dam discharges
- Barrier to upstream fish migration; and
- Loss of valuable historic or cultural resources (e.g. burial grounds, relic sites, temples).

Pollution and habitat degradation need not be an inevitable impact of development. Careful planning, comprehensive resource management and enforcement of regulations in relation to pollution and soil conservation, would mitigate much of the impact that befall lakes or lakes bring onto others.



3.2 Lack of Sustained Research and Development

There are no R&D institutions (along the lines of the Great Lakes Research Institute in Canada) that are specifically empowered to undertake research into lakes. Though sporadic studies have been carried out by various institutes at various occasions, these have neither been comprehensive nor undertaken over a long-term basis.

Though setting up a lake specific R&D institute may not be justified at this point of time, centres of excellence within existing institutions dedicated towards lake research could be an important first step.

A review of research input into Malaysian lakes indicates that there are few sustained initiatives that are in a position to provide the kind of long-term data that would support comprehensive resource management initiatives. Almost all studies undertaken on lakes in Malaysia have been sporadic, one-off events, undertaken with little reference to each other and over limited spatial and temporal ranges. From the standpoint of research areas, most of the studies that have been undertaken are on water quality, phyto and zooplankton, and fish speciation.

This lack of baseline data on lakes and their various values has not allowed for a comprehensive understanding of the hydrological and ecological dynamics of the lakes and the manner they have changed over time, preventing the development of sustainable management regimes based on long-term trends and requirements. More importantly, the lack of data prevented the values of these lakes to be adequately quantified, as a consequence of which planners and managers have little understanding of the full value of the country's lake assets.

Dams have a serious negative impact on riverine biodiversity, particularly in tropical areas. However, there has been little research into how this can be ameliorated. Again, the core of the problem here lies in the fact that the agencies that build dams for specific purposes are satisfied if those purposes are achieved. They have no compelling need to examine the impact of their activity on other values of the lake.

Many lakes support local communities whose economy, lifestyle, culture and ethos are closely intertwined with that of the water body on which they depend. However, outside of a few studies, there has been very little research on the manner in which such communities interact with lakes. There are limited, or no, studies on resource dynamics, resource economics and engineering, especially as they relate to the environment, nor have technologies to make dams more environmentally friendly been investigated.

This situation again relates back to the lack of an overall planning and management framework for lakes that would set the basis for such long-term studies to be carried out.

3.3 Fragmented Policy, Legal and Governance Framework

Lakes are classed as water resources. In general, under the Federal Constitution, States have greater powers over water, coastal foreshores and rivers. They also have greater jurisdiction over land and local government. The Federal Government has powers over shared rivers, federal projects, hydro-electric power and navigation. Both the State and Federal authorities have concurrent powers over drainage and irrigation, raw water, mining pools, ox-bow lakes and natural

lakes. There are no specific Federal laws or rules related to lakes. There are, however, numerous Federal and State laws related to the management of rivers in Malaysia. Federal laws include the Environmental Quality Act (EQA), Town and Country Planning Act (TCPA) and Water Services Commission Act (WSCA) and the Water Services Industry Act (WSIA). However, there is no specific law on lake management at the Federal level.

The DID has established itself as the expert organisation for matters related to water in general and rivers in particular. However, it does not have a specific mandate for lakes. There are no dedicated divisions within the organisation that looks at lake and reservoir management separately. Tenaga Nasional Berhad pursues lake management largely in relation to its own mandate to produce power, while the Water Industry Commission (previously the state Waterworks Department) focuses on lakes only in relation to water supply.

The State laws include the Local Government Act (LGA), Street Drainage and Building Act (SDBA), Waters Act, National Land Code (NLC) and State Water Resources Enactments. The Federal Constitution largely empowers State Governments to manage water resources (including lakes) but it appears that lake management has been a poor cousin to more visible issues such as land use which provides the State with its main source of revenue. Water resources at State level are handled by the state Drainage and Irrigation and Waterworks Departments, either in relation to flooding, drainage and irrigation, or water supply. Where it is needed to be treated as a resource in its own right, the District and Land Offices are mandated.

However, the District and Land Offices, being licensing and revenue collection agencies, do not have the technical capacity to do anything more than issue permits and collect fees. In recent years, some State governments have set up specific agencies in relation to water resource management. These include the Sarawak River Board and Selangor Water Resources Board (LUAS), while Kedah is in the process of establishing a similar organisation. This trend is expected to continue into the future.

Local governments also lack the expertise and funding to manage lakes within their jurisdiction. However, an exception here has been Putrajaya Corporation which has taken serious efforts to sustain the lake resources under its jurisdiction.

Nonetheless, it is important to emphasise that the key issue here is not legal or institutional fragmentation in itself. Such fragmentation is an inevitable consequence of the Federal system that the country follows. A mosaic of institutions and legal instruments are also seen where the management of other resources are concerned, for instance land and forestry.

However, what the management of these resources enjoy, and is sorely lacking where lakes are concerned, is an overall policy and strategy environment that would provide an overarching framework which all lake stakeholders would be able to subscribe to. This absence of a strategy framework has led to a situation where lakes are managed according to the primary mandate of the organisation under whose responsibility they fall.

Historically, there has been no requirement, and thus no attempt, to view the wider resource potential of the lakes and stakeholders upon whom they impinge. Some lakes, such as Tasik Chini, come under the administrative cover of agencies of the Land Office, that do not have even the basic capacities to understand lake dynamics, much less to be able to manage them.

This one-dimensional management approach has led to conflict with other users who see their use of the same resource as their right. Conflicts that ultimately lead to the estrangement of primary stakeholders who often have the least leverage in the dispute.

The overlap of Federal and State jurisdictions highlights the call under the Global Lake Vision to pursue lake management beyond administrative, jurisdictional and political boundaries. In Malaysia, this can only occur if there is an overarching policy and strategy framework to which all stakeholders can subscribe.

3.4 Manpower and Human Resource Issues

Having such a strategy framework would only be a preliminary step in enabling more comprehensive management of the country's lake resources. Actualizing strategy statements and giving it a tangible dimension would still fall in the hands of managers and administrators at local, provincial and national levels. There is thus a fundamental need to strengthen capacity at various governing levels before improvements in management regimes are going to yield the requisite results. Requirements for sustainable management would include adequate knowledge of inland water systems and functional linkages – physically, chemically and biologically through meteorological and hydrogeologic processes – essentially an integrated approach relating to the local environment. It is pertinent to note that tropical lakes differ from temperate lakes thus requiring different controls or management techniques.

Though there have been some efforts at capacity building in IWRM, especially through data networks such as CapNet/MyCapNet, Aguajaring, this is far from adequate. There are no courses in local universities on lake management or training modules for existing managers on lake management.

This has led to the situation where there is little awareness for the need for these resources and, as a consequence, no imperative for agencies to seek them out. Over and above that, there is no proper expertise to run these courses, even if these were to exist. The training of academic personnel at lake research institutes could potentially provide the necessary pool of expertise and experience to teach and undertake research. Such a focused pool of talent can be engendered by establishing the centres of excellence as pointed out above.

3.5 Information Management and Knowledge Dissemination

Effective management of Malaysian lakes would demand access to the kind of data that can support intelligent and informed decision making. The need for such data to be made available to managers and researchers cannot be underestimated. A networking database that links managers, administrators and researchers, would enable a free exchange of information that can empower stakeholders in the management process.

When communicating to an end-user, real-time information can provide accurate and timely answers to questions of how much, where, when, and by whom, about particular lake management activity. This capability can form the foundation of a more comprehensive, proactive management and planning capacity where, ultimately, information acquired from lake managers and researchers can be used to optimise the management process itself.

It is significant that the first steps towards this end have already been initiated. In 2007, NAHRIM has developed a computer-based "National Lake Information Database of Malaysia" to support the compilation, monitoring, archiving and dissemination of all relevant lake information in the country.

All lake researchers and managers in the country are expected to assist in populating and sharing their lake information through this central database, which when operational would serve as an important decision support system (DSS) for effective lake management.

3.6 Public Awareness and Stakeholder Participation

Ultimately, the management of lakes would rely intrinsically on the perceptions stakeholder communities have of them. Public awareness of lakes and their importance is crucial in this. By and large, communities living around lakes have a strong affinity and association with the water body, regardless of whether they are rural or in urban areas. They are used by communities for a range of purposes, recreational, social, cultural, historical, and economics. However, the ability of communities to manage or have an active stake to affect change or improvement of these water bodies is weak as there are jurisdictional, institutional, local capacity barriers.

The ability of these communities to play a meaningful role in ensuring the benefits of lakes are optimised lies in a sense of possession that they would need to have over the resource. Resource managers, in particular, need to be trained to engender this sense of possession, and the tools they need to reach the public. The challenge is to keep the participative instincts of lake communities alive over the long term, a process that recognizes the stakeholder communities as co-managers.

Co-management would involve the communities before, during and after the impoundment of dams. It would need to consider potential displacements of communities and their heritage, values and tradition.

These would include loss of graveyards and hunting grounds as well as access to forest products such as honey, rattan, bamboo, materials and medicinal plants. Stakeholder communities would also be able to explore new economic opportunities that may potentially open up to them as well as frame equitable compensation mechanisms where these resources are compromised by dam construction.



4.0 Lake Resources – The Way Forward

It is painful to note that the management of a resource that has the value and strategic importance that lakes have, is not covered by an overarching policy and strategy framework that would enable the nation to optimise its impact on its well-being. In the past, this has occurred because of the fragmented approach to its management and development. The consensus of all the parties that have come together in producing this document concur unequivocally that the root problem facing lake management in the country is a governance regime that does not have an overarching policy and strategy framework that would engender the various stakeholders to work together in the interest of the resource.

In taking stock of the current situation in the country, it is important that the following issues be addressed:

- The Federal-State dichotomy must be acknowledged and adequately addressed. The Federal Government has the finances and perhaps the expertise to undertake and implement lake management, albeit in relation to their respective administrative mandates. The State Government is vested with the legal jurisdiction on several key matters including land and water resources. Without a partnership in place, lake management will face almost insurmountable hurdles
- The current approach is to consider lakes as part of other larger issues such as river systems or wetlands. The unique nature of lakes may not be adequately addressed when it is subsumed within a larger framework of other issues
- Outside of Selangor and possibly Kedah, no specific Federal or State laws that cover lake management
- There is no institution vested with responsibility for the management of lakes. In the event lakes are geographically located within river systems or wetlands, then it appears that institutions assigned responsibility for the latter also manage lakes on *ad hoc* basis
- There is no national or state policy dedicated to management of lakes. Some lakes have been declared as RAMSAR sites and therefore come under the provisions of the Convention. However, in the absence of an enactment providing legal force, implementation of the RAMSAR Convention is largely administrative. Enforcement, regulation and control may not be possible as there are no supporting laws; and
- There is currently little or limited scientific information and data on lakes in the country. Efforts at establishing a central Lake Information Database have begun recently and would take some time to be fully operational.

There is a need to arrive at a better understanding of the issues surrounding governance of Lakes. The current *ad hoc* approach to management of lakes will only lead to further deterioration of resources within the lake environment. There must be sustained action to arrive at a better understanding of major lakes in the nation. In this respect, there are four major interventions whose necessities bare themselves, that is:

- Development of a national vision for Malaysian lakes
- The development of a policy framework that, while reflecting the vision statement, takes the management exigencies of lakes into account
- The development of a mission statement for lake management: and
- The development of a strategy framework for development and management of Malaysian lakes.

These interventions are articulated in greater detail below.

4.1 Development of a National Vision for Malaysian Lakes

The articulation of a national vision for Malaysia would be the first step in engendering a unified approach to lake management. In this, we can draw on the World Lake Vision to formulate the following outlook:

"Engender the sustainable use of lakes for their ecosystem services and economic values"

The accompanying principles to serve as guidelines in framing the vision should be addressed separately.

4.2 Development of a Policy Framework for Malaysian Lakes

The lack of an overarching policy framework guiding lake management is a major shortcoming. The Outline Perspective Plan 3 (Chapter 7, Item 70) called for the development of a National Water Policy. Given the complexities of such an undertaking, the formulation of the policy is still on-going.

However, pending its full development, it is recommended that a policy statement on lakes be included in the 10th Malaysia Plan to highlight the importance of lakes and the need to manage them sustainably.

This statement can take the form of:

Lakes and reservoirs will be sustained, restored and protected through the adoption of an Integrated Lake Basin Management (ILBM) approach.

Where the development of the National Water Policy itself is concerned, the following is recommended:

- If the current terms of reference for the proposed National Water Policy allows for it, the specific requirements of lakes be incorporated in it; and
- If there is variance in the objectives of the National Water Policy and lake management, then a lake-specific policy must be framed separately.

The overarching objectives of such a policy would enable lake resources in the country to be valued and managed optimally to ensure the health of the resource itself and communities that rely on it.

4.3 Development of a Mission Statement for Malaysian Lake Management

The development of a mission statement for lake management would be an important precursor to setting strategic goals. The mission statement would provide a sense of direction and orientate strategies to achieve the outcomes exemplified in the Vision statement.

Since Malaysia has formally adopted IWRM as the central thrust to water resources management, the obvious IWRM sub-set applicable to lakes would be ILBM. Hence, the mission statement would be:

"To engender sound management of lakes through the adoption and application of IWRM principles and practices".

4.4 Development of a Strategy Framework for Malaysian Lake Management

The absence of a policy means there is no strategy framework for the management of lakes. Strategic initiatives must address key issues relating to the management of resource in its entirety. A strategy framework towards this end is as follows:

Strategy I: Identify and Empower a Lead Ministry/Agency

Every policy needs a dedicated ministry and associated implementing agency to champion its cause and garner valuable resources and capacities within government agencies. State actions will also require sustained Federal funding and incentives. However, this paper does not advocate the establishment of a new agency but rather to vest the role of co-ordination within existing agencies.

Water is a natural resource, hence the overall responsibility for reaching out and integrating across boundaries would rest largely with the Ministry of Natural Resources and Environment (NRE).

In executing this role, the agency within NRE that best lends itself to be the implementing agency for the enhanced mandate is the Department of Irrigation and Drainage which in its present location within the Ministry of Natural Resources and Environment, is probably better described as the department in charge of water resources. DID is already responsible for river management and extension into lakes would be relatively seamless but it may require the setting up a dedicated lake division under its wing to perform the task.

In performing this function, it must be duly recognized that the ultimate management of lakes would be decentralized and hence shall for all intents and purposes remain with current owners/operators, many of which involve other agencies like TNB, Water Supply Department, MADA, Local Authorities and the like. Notwithstanding, the management should conform to a common set of ILBM principles and practices. DID would be responsible for, *inter-alia*:

- Facilitating, developing and implementing jointly with various agencies ILBM programmes and initiatives, including lake rehabilitation and restoration works as and when required;
- Develop and disseminate common lake management standards for adoption and compliance by lake managers;
- Develop the necessary human resources, both within itself as well as in other management agencies, with respect to ILBM through:

- Training; and
- Extension and technical support.

Appropriate manpower and financial resources would have to be provided to NRE and DID to take on this burden.

Strategy II: Establish a National Lake Resource Centre under NRE.

The National Lake Resource Centre (NLRC), would be a one-stop agency which would act as:

- A centre of excellence for research into lakes and lake management, bringing together experts from various research institutions and universities to focus on priority areas for research and study; and
- A reference centre and database for all information and research on lakes in Malaysia. Again, this paper does not advocate the establishment of a new agency but rather to vest this role in NAHRIM. This is because:
 - NAHRIM is a research institute and has as its mission to be "an expert centre on water and its environment management to ensure sustainable growth in order to improve the quality of life and well-being"
 - NAHRIM already has strong links with local research institutions and universities
 - NAHRIM is located within NRE and this would better enable intra-agency co-ordination.

When established, the immediate tasks to be undertaken by the NLRC are:

- To develop together with relevant lake management stakeholders an agenda for sustained multi-disciplinary research related to lake environment, its development and operational management; and
- To ensure the lake database already initiated by NAHRIM is populated and updated regularly to include lake briefs of all lakes in the country. Being web-based, all information should be easily accessible to all stakeholders to facilitate sound and efficient decision making.

Strategy III: Establish a Standing Committee on Lakes within the Purview of the National Water Resources Council

The National Water Resources Council (NWRC) is modelled after the National Land Council, the National Forestry Council and National Spatial Planning Council, all of which bring State and Federal stakeholders together to engender a consensus on land use, forestry and spatial planning respectively.

Considering that lakes comprise one of three vital yet vulnerable sources of water (the other two being rivers and groundwater) that is closely linked and impacted upon by land development within its basin, and involve many stakeholders, it would be appropriate that a standing committee be set up under the NWRC to oversee the integrated management of lakes so as also to enable policies that have an administrative transboundary dimension to be engendered and implemented. NRE would be best positioned to lead this standing committee having been mandated to deal with the integrated management of all natural resources in the country. Among the first tasks for this national level committee is to develop a common set of guidelines for integrated lake basin management for use at all levels.

Strategy IV: Establish Lake Management Committees at State Level

These committees would be at the political level of Government, allowing co-ordination among the various agencies that are involved in the management of lakes. The model for this would be State Agriculture Committees or State Industrial Committees that are headed by State Executive Councillors or State Ministers. Among the first tasks for this state level committee would be to

ensure that all lakes and reservoirs within the State (inclusive of adequate buffer zone around their periphery) are duly gazetted as environmentally sensitive areas (ESAs). Development in and around these gazetted lake areas would require prior clearance from this committee. Water catchment areas above reservoirs and water intakes would normally have already been gazetted with appropriate development restrictions and controls. An immediate review and extension of this requirement to cover all lake and reservoir basins should also be undertaken. Where considered relevant and desirable, the need for Special Area Plans or other such equivalent statutory plans may also be prescribed.

Strategy V: Development of a Detailed Action Plan

The establishment of an implementing agency without a corresponding action plan for the immediate term would be counter productive. Under this ASM/NAHRIM initiative to address lake management, a set of preliminary activities and action plans have been identified and collated through wide consultations with relevant stakeholders under five thematic areas, namely governance, management, R&D, capacity building, information management, and community stakeholder participation. The thematic output from LFA workshops held over the year 2008 can be found in the compiled reports accompanying this document (**Volume 2**). Using these findings to start with, the implementing agency would be able to build on it to develop a detailed plan of action with necessary priority settings.

Notwithstanding that, it is recommended that a more detailed assessment be undertaken nationwide to determine the current geographical position of lakes, classification of these lakes into various categories, the issues and problems related to each of them, and the technical and/or management solutions and remedies that should be put in place to resolve them in the short, medium and long-term.

Following the recommendations under Strategies I and II above, the responsibility of preparing the detailed action plan must fall on the collective efforts of NRE, JPS and NAHRIM working closely with relevant stakeholders and lake managers at Federal and State levels.

Strategy VI: Support the Role of Local Communities in Lake Management

As noted, lakes and reservoirs are complex aquatic ecosystems, as well as important sources of water for human use and ecosystem maintenance. Many people assume that the management and protection of lakes and reservoirs is primarily a function of the local, State or Federal Government.

However, the public can play a major role in such situations and it can be very beneficial to seek the public's view, in the form of public hearings or other relevant fora. An example is the creation of a community stakeholder committee (alternatively called citizens' advisory committee, "*rakan tasik*" or "friends of the lake"), that includes inhabitants that live in the lake or reservoir drainage basin.

These committees can provide valuable insight and information about past conditions of a lake or reservoir, particularly in the absence of written records. The participation of non-technical individuals is equally important in protecting lakes and reservoirs, e.g. farmers, urban planners, lawyers, economists and communication specialists. Knowledge gained in this manner can be disseminated among the general basin population, and so prepare people for more informed future judgments and actions.

In this regard, environmental NGOs and CBOs have demonstrated capabilities in facilitating the formation of community based movements (e.g. in Tasek Chini, and Kelana Jaya Lakes). Their services could be solicited to be extended to other lake basins around the country.

Strategy VII: Pass Appropriate Legislation to Strengthen Existing Legal Framework

Both at National and State level, appropriate legislation must be passed to enable management of lakes as a resource. Where they exist, management agencies such as LUAS (Lembaga Air Selangor), should work with DID on the management of lakes. It is not sufficient that RAMSAR sites are declared and then managed in an *ad hoc* manner. States should enact specific laws and rules for the implementation of lake management at these sites. In the long run, all States should have enactments with sufficient provisions to make rules for lake management.

Strategy VIII: Enhance Networking and Strengthen International Strategic Alliances

The problems that beset Malaysian lakes are not unique. Globally, the sustainable management of water resources, particularly those within lakes, has taken on a crucial profile as freshwater resources in rivers have dwindled to leave lakes as the only reliable sources. Networking and international alliances with other countries would enable the country to learn from experiences of other countries as well as share our own with them.

It is important to point out that such linkages have already been established. Malaysia is an important member of ILEC, currently participating actively in their ILBM-Governance Project, and has been represented in many conferences on lakes and lake management in recent years. Steering Committee members of ILEC have also visited local lakes, to share their experiences and to recommended suitable human resource development regimes to empower local managers to ensure their sustainability. Linkages have also been established with organisations like the UNESCO-supported European Regional Centre for Ecohydrology (ERCE) in Poland, and the University of Sao Paulo in Brazil. It is crucial that these global links be pursued to their fullest. Malaysia has so much to share, and learn, from other countries that are equally as diligent in ensuring the sustainability of their lake resources. Through these linkages, the country would be able to leapfrog into becoming a leading advocate of lake management in the region.





".....We made from water every living thing"

(Holy Quran 21:30)



ACKNOWLEDGEMENT

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Water Supply Department

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Universiti Sains Malaysia

Universiti Teknologi Malaysia

LESTARI, Universiti Kebangsaan Malaysia

Universiti Malaya

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MUDA Agricultural Development Authority (MADA)

Suruhanjaya Perkhidmatan Air Negara (SPAN)

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Tenaga Nasional Berhad (TNB)

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G&P Water Sdn Bhd

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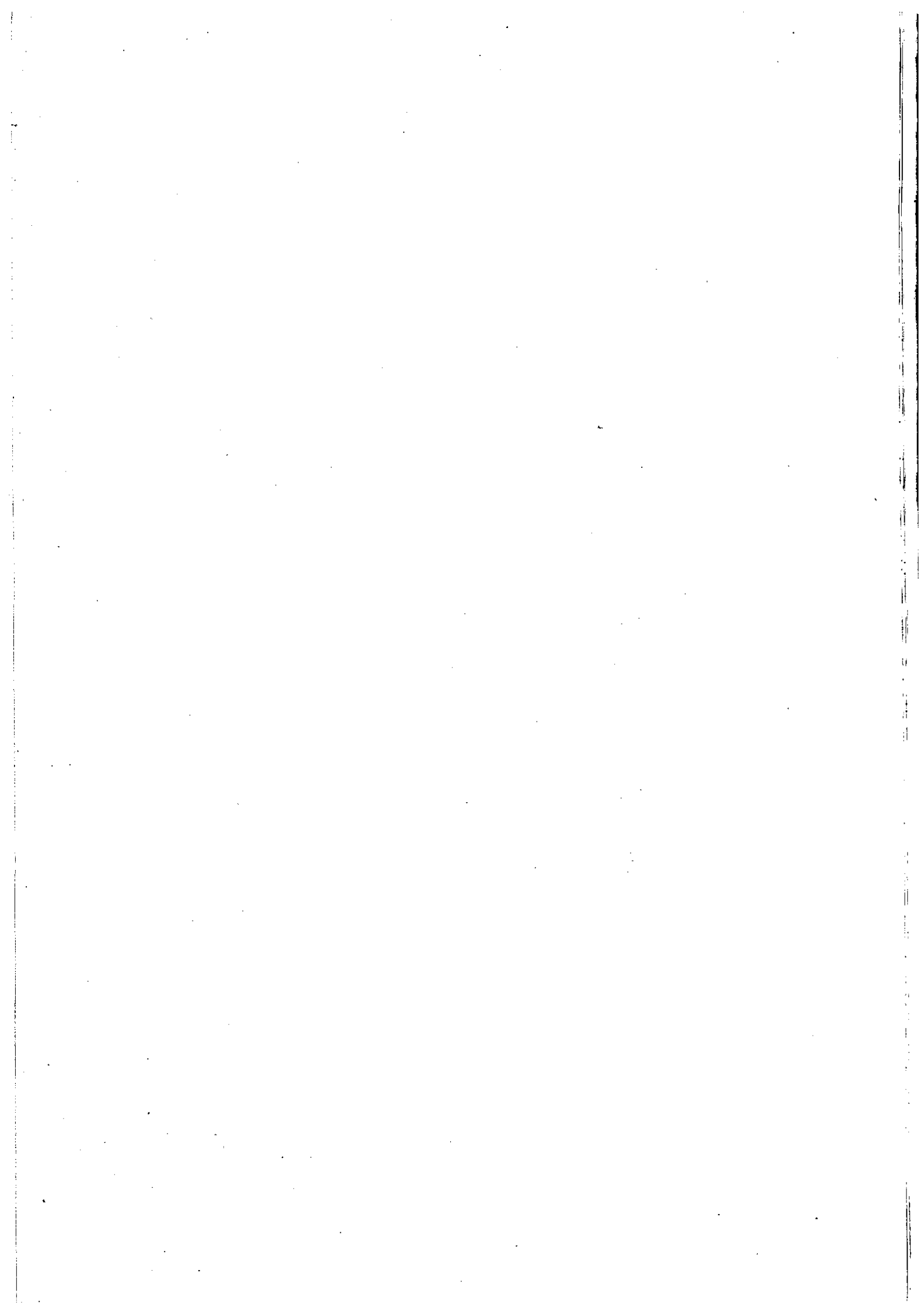
Loagan Bunut National Park, Sarawak

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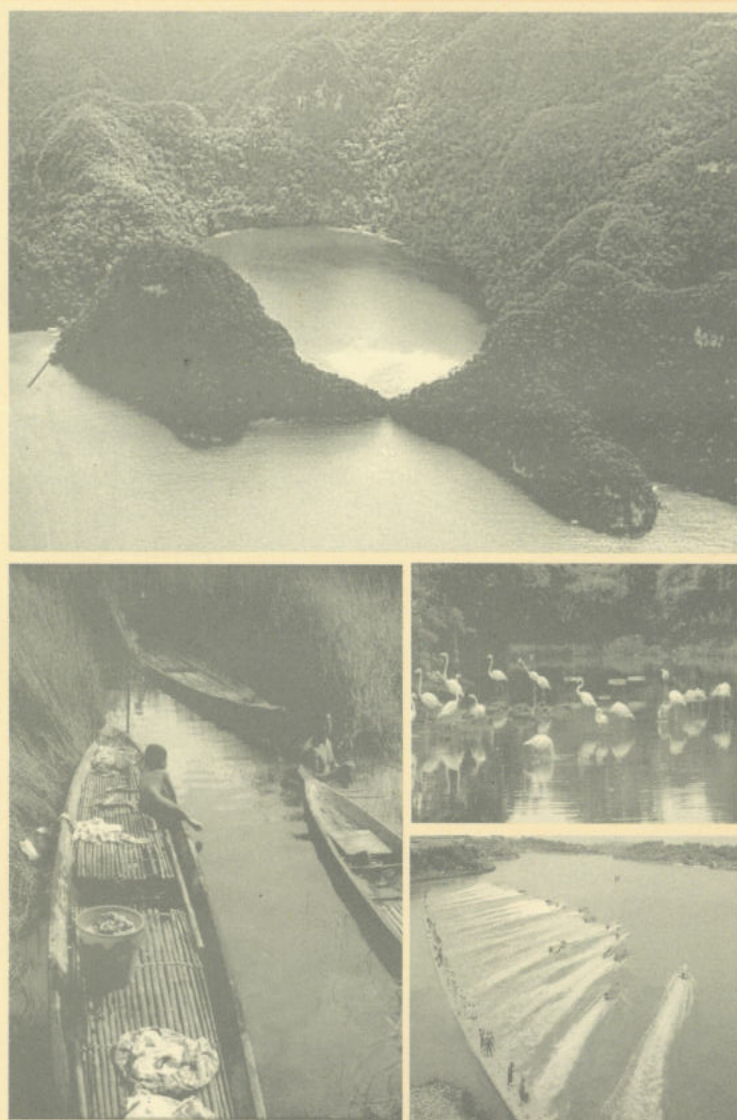
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