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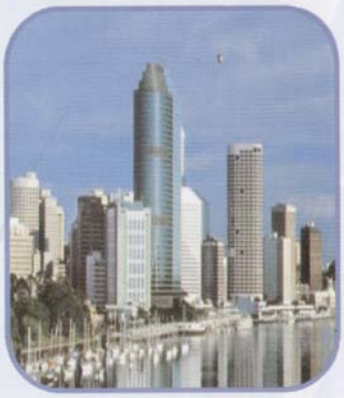
SPECIAL TECHNICAL SESSION
BIOECODS
6TH ICHE'04, BRISBANE, AUSTRALIA

A pilot project on Sustainable Urban Drainage System (SUDS) as highlighted in the new Urban Stormwater Management For Malaysia (MSMA) namely Bio-Ecological Drainage System (BIOECODS) will be presented in an invited Special Technical Session of the 6th International Conference on Hydro-Science and Engineering (http://www.ncche.olemiss.edu/iche2004/index.php) to be held at Brisbane, Australia from 30th May- 4th June 2004.The Special Session will include six (6) papers presenting the latest finding on BIOECODS. These papers are:

"MSMA -- A New Urban Stormwater Management Manual for Malaysia",
"Bio-Ecological Drainage System (BIOECODS): Concept, Design and Construction",
"Peak Flow Attenuation Using Ecological Swale and Dry Pond",
"BIOECODS Modelling Using SWMM",
"Stormwater Purification Capability of BIOECODS",
"Application of BIOECODS for a Government Complex: A Case Study"

These papers will be presented by Assoc. Prof. Dr. Nor Azazi Zakaria, Assoc. Prof. Dr. Aminuddin Ab. Ghani, Assoc. Prof. Dr Rozi Abdullah from REDAC, Universiti Sains Malaysia, Ir. Lariyah Mohd Sidek (Universiti Tenaga Nasional, UNITEN) and Ms. Anita Ainan (Department of Irrigation and Drainage, DID). The ICHE series was founded in the early 1990's with the inaugural conference ICHE-1993 held in Washington, DC, USA. The conference is organised by University of Mississippi , USA and International Association of Hydraulic Engineering and Research (IAHR)



Brisbane



Constructed Ecological Swale



Module placement Sand bedding Grass planting

Ecological Swale Construction

Constructed Wetpond

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Foreword

By Associate Prof Dr Nor Azazi Zakaria, REDAC Director

Since its inception in May 2001, REDAC has moved forward towards achieving its founding objectives especially with regard to become a Centre Of Excellence in River Engineering and Urban Drainage. As a result REDAC has launched its postgraduate research programme beginning the Academic Year 2003/2004 in June 2003. The programme encompasses four major topics including River Management, Urban Drainage Management, Hydro informatics, and Environmental Hydraulics Management. Even though the programme has just started, REDAC has already six postgraduate students coming from different background namely engineers, lecturers and researchers from government and private agencies. REDAC welcomes potential postgraduate candidates from local and overseas to explore the on-going research that REDAC is involved including Sustainable Urban Drainage System (Bio-Ecological Drainage System or **BIOECODS**), Sediment Transport In Rivers And Drains, Development of A GIS-Based Software for Flood Risk Mapping (**SEDFlood**), and Development of A GIS-Based Urban Stormwater Management Software (**URBANStorm**).

REDAC's major on-going research namely BIOECODS continues to receive visitors from government and private agencies including researchers from overseas. A Special Technical Session on BIOECODS will be organized at the 6th ICHE, Brisbane, Australia. An article on BIOECODS has also been published in the newly launched International Journal River Basin Management (**JRBM**). Recent major flood event (50-year return period) in October 2003 has also proved the effectiveness of BIOECODS in attenuating peak flow resulting in a flood free campus although the surrounding area of USM Engineering Campus was inundated with floodwater from the nearby Kerian River. A 10-year data collection programme (2003 to 2012) covering quantity and quality aspects of BIOECODS' components has also started in June 2003. Meanwhile "The Blue Water Lake" at the most downstream end of BIOECODS has already attracted water activities such as kayaking achieving the stated objective as a recreational pond. The constructed wetland has also attracted wetland birds on its way to **Kuala Gula Bird Sanctuary** in Taiping, Perak. BIOECODS has so far proved that it is not only a drainage system but also a recreational facility in line with the launching of **"University in A Garden"** by the USM's Vice Chancellor on 10th January 2004.

A major conference, **RIVERS' 04** - International Conference on Managing Rivers in The 21st Century : Issues and Challenges will be organized from 21st to 23rd September 2004 at the Mutiara Beach Resort, Teluk Bahang, Penang. All researchers, engineers and planners are invited to share their experience to achieve sustainable river management. A short course on Urban Stormwater Management Manual (Manual Saliran Mesra Alam or **MSMA**) will also be conducted in April, June, August and November 2004 at USM Engineering Campus.

In this issue of REDAC Bulletin, an article on **SEDFlood** and another on **Sustainable River Management** by Prof. Chan Ngai Weng, a REDAC's Council Member, are also included. A Technical Visit to Langkawi Island was also conducted in March 2003 including a visit to the Langkawi Office of Department of Irrigation and Drainage (DID), the first DID office to construct the Ecological Swale similar to BIOECODS'. We would like to acknowledge the help of Ir. Hj Mohd. Bakar Othman, District Engineer of Langkawi DID during our visit to Langkawi including a visit to Singa Besar Island and Langkawi Island Tour via Sea.

Contact Number
Director,
River Engineering and Urban Drainage Research Centre (REDAC)
USM Engineering Campus, Seri Ampangan
14300 Nibong Tebal, Pulau Pinang, Malaysia
Tel: 604 - 594 1035 Fax: 604 - 594 1036
e-mail : redac01@eng.usm.my
www1.eng.usm.my/redac

CONTENTS

Research Update

Publication

International Journal River Basin management (JRBM)

An article "Bio-Ecological Drainage System (BIOECODS) For Water Quantity and Quality Control" has been published in Issue 3, Volume 1 2003 of the International Journal River Basin Management now available on line, at the web page: www.jrbm.net

Postgraduate Studies

REDAC Postgraduate Research Programme (Since June 2003)

REDAC offers a graduate programme encompassing several areas pertaining to River Management at the Master of Science or Doctor of Philosophy levels. These areas are River Management, Urban Drainage Management, Hydro informatics and Environmental Hydraulic Management. This programme is open to all Students of USM or other universities, local or international, who are qualified to pursue their gradute studies through research mode.

The subtopics for each area are described as follows:

River Management

River Morphology, Sediment Transport, Stream Conservation & Restoration, Flood Plain Management, Stream Bank Control Using Bioengineering, Riparian Vegetation Management, Biological Impacts of River Canalization, River Modeling, Intergrated River Basin Management.

Urban Drainage Management

Runoff Quantity Control (ConstructedDetention/Retention), Source Control BMPs, Treatment Control BMPs (Gross Pollutant Trap, Constructed Ponds & Wetlands), Subsoil Drainage, Storm Water Modeling, Intergrated Storm Water Management, Bio-Ecological Drainage System (BIOECODS)

Hydro informatics

Flood Risk Mapping Using GIS, Infiltration Mapping Using GIS, Intergrated River Management Decision Support System

Environmental Hydraulics Management

Environmental Management Plan (EMP), Erosion Sediment Control Plan (ESCP), Surface Water Quality Modeling, Groundwater Quality Modeling.

Details of the research programme can be obtained from the following website:
http://www1.eng.usm.my/redac

New Staff

Mr. Mas Lockman Ousin Mas Haris

Assistant Admin officer

Ms. Khairul Rahmah Ayub

Environmental Science Officer

Ms Siti Norlaila Ahmad

Typist

Mr. Othman Zainuddin

Driver

Ms Noor Hasliza Wan Chik

Personal Assistant

Mr. Rosman Osman

Account Clerk

Mr. Abdul Rahim Ghazali

Assistant Research Officer

Ms Intan Faezah Darul Izham

Draftperson

Mr. Rashid Man

General Admin Officer

Activities

Technical Visits

Visit To Langkawi
16 March 2003

Visit To Singa Besar Island
15 March 2003

Thanksgiving Day

BBQ
22 March 2003

Kayaking

Engineering Career Week
29 December 2003

Bioecod's Recreational Pond

Name: Shanker Kumar Sinnakaundan (PhD Candidate),
National Science Fellowship Scheme (NSF MOSTE)

Project Title : Hydraulic Modeling and Flood Risk Analysis Incorporating Sediment Transport

Supervisors: 1. Assoc. Prof. Dr Aminuddin Ab Ghani
2. Dr Mohd Sanusi S. Ahmad

Present Status : Completed (December)

INTRODUCTION

Most computer models used in the flood risk analysis of rivers have inadequate functions in its spatial analytical capabilities and without sediment transport simulation capacity or suitable equations to represent correctly in-situ hydraulic processes. As a result, the current research presents the development of a new total bed material load equation using multiple linear regression analyses that is applicable for rivers in Malaysia.

$$C_v = 1.811*10^{-4}\left(\frac{VS_0}{w_s}\right)^{0.293}\left(\frac{R}{d_{50}}\right)^{1.390}\left(\frac{\sqrt{g(S_s - 1)d_{50}^{\ 3}}}{VR}\right) \qquad (1)$$

Equation 1 is best suited for rivers having uniform sediment size distribution with a d50 value within the range 0.37 mm and 4.0 mm and performs better than the commonly used Yang, Graf and Ackers-White total bed material load equations. It was developed and embedded as a modified version of HEC-6 model and named SEDFlood model (Figure 1.0). The original source codes of HEC-6 model were obtained from Hydraulic Engineering Center (HEC), United States of America.

SEDFlood DEVELOPMENT

A user-friendly, menu-driven GUI (Fig. 1) for two and three-dimensional (2D & 3D) digital floodplain delineation was developed based on HEC-GeoRAS Ver.30, AVRAS Ver 1.0 through ArcView GIS and SEDFlood tight coupling procedure. SEDFlood is capable to produce quick analysis (snapshots) at any desired discharge time steps in flood risk mapping procedure.

Fig. 1. SEDFlood Model Graphic User Interface

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SEDFlood APPLICATION

The feasibility of simulating a flood event along a river channel and floodplain was tested for Pari River catchment's area located in Ipoh, Malaysia (Fig. 2).

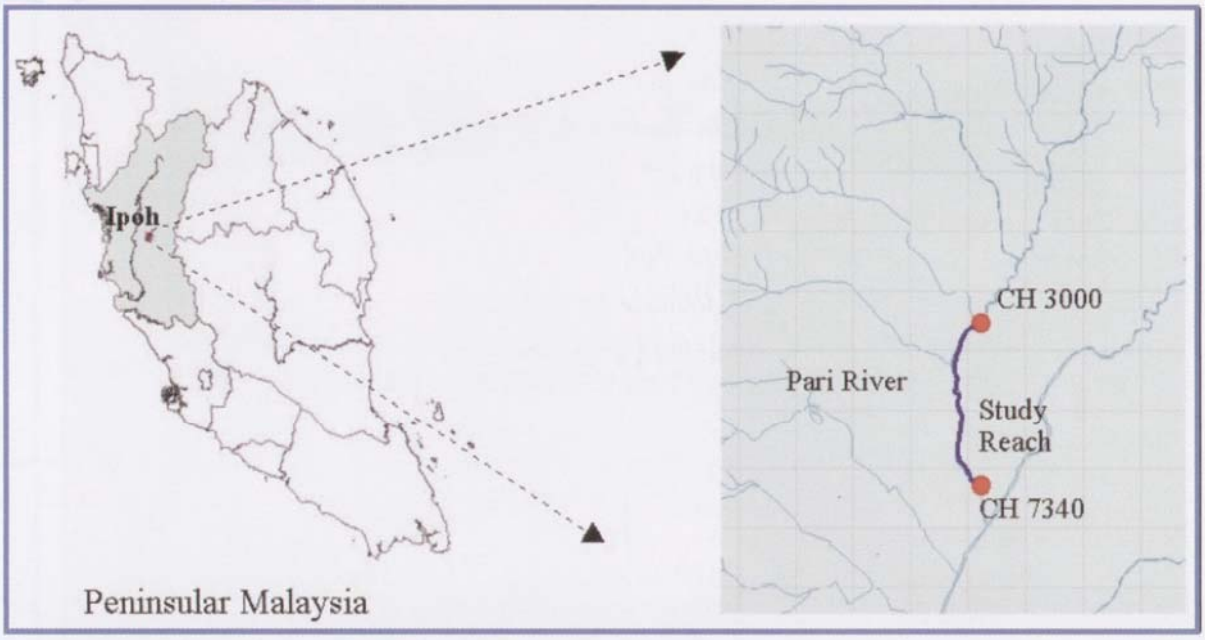
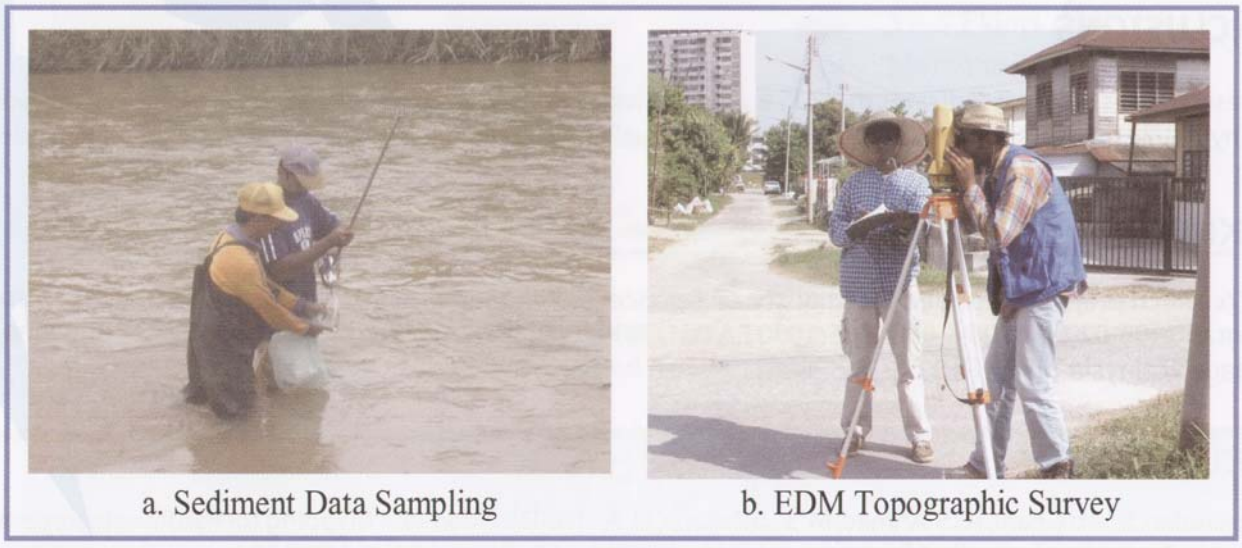


Fig. 2 Study Area: Pari River, Ipoh

Field measurements were carried out to validate the hydraulic setting and the accuracy of model outputs (Fig 3). Pari River was channelized for flood control in 1997 due to severe damage by recent flood. (Fig. 4)

Flood risk analysis were conducted for the design flood events of 10, 50, 100-year Average Recurrence Interval (ARI). The design rainfall durations of 30, 60 and 120 minutes for the present and future land use conditions (year 2020) were considered in the simulation scenarios.



a. Sediment Data Sampling

b. EDM Topographic Survey

Fig. 3 Field Data Measurement

The design rainfall distribution for durations of 120 minutes and subsequent design discharge are shown in Fig.5 and Fig.6 .Flood risk maps were produced for all the design flood scenarios. The flood risk area for the year 2020 land use conditions is shown in Fig.7.

Fig.4 Flood Event of Pari River on 3 June 1991 (DID Kinta/ Batang Padang, 1991)

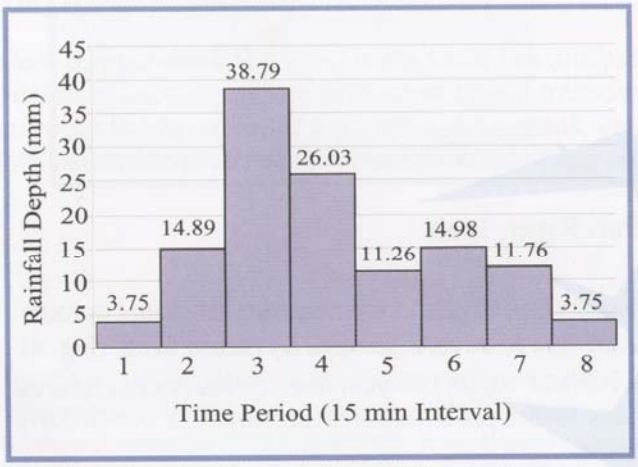


Fig.5 100-year ARI storm with 120 Minute Storm Duration

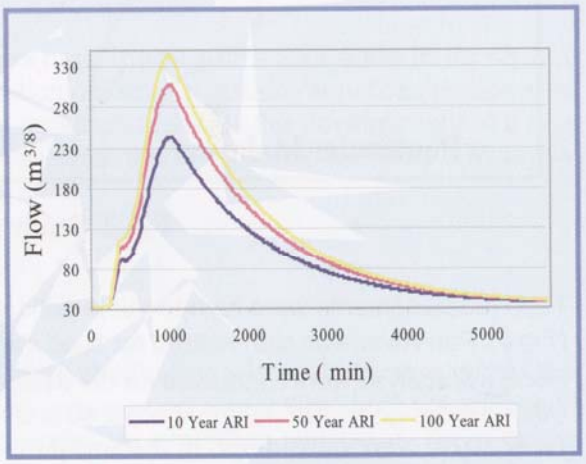


Fig.6 Computed Hydrographs for year 2020

CONCLUSIONS

The result of this research indicates that GIS is an effective environment for floodplain analysis and its integration with hydraulic model is not only feasible but also mutually beneficial for both GIS users and hydraulic modelers.

ACKNOWLEDGEMENT

This research project is funded by Ministry of Science Technology and The Environment (MOSTE) through IRPA grants (08-02-05-6006 & 09-02-05-1030 EA 001) and a contract research by Department of Irrigation and Drainage Malaysia (JPS (PP) / SG/ 2/2000)

PUBLICATIONS

Sinnakaudan, S ,.Ab Ghani, A , S Ahmad, M S., & Zakaria, N, A (2003) Flood Risk Mapping for Pari River Incorporating Sediment Transport, Journal of Environmental Modeling and Software. 18(2), 119-130.

Sinnakaudan, S., Ab Ghani, A., S. Ahmad, M. S., & Zakaria, N, A. (Under Review). Total Bed Material Load Equation for Malaysian Rivers. Journal of Hydraulic Engineering.

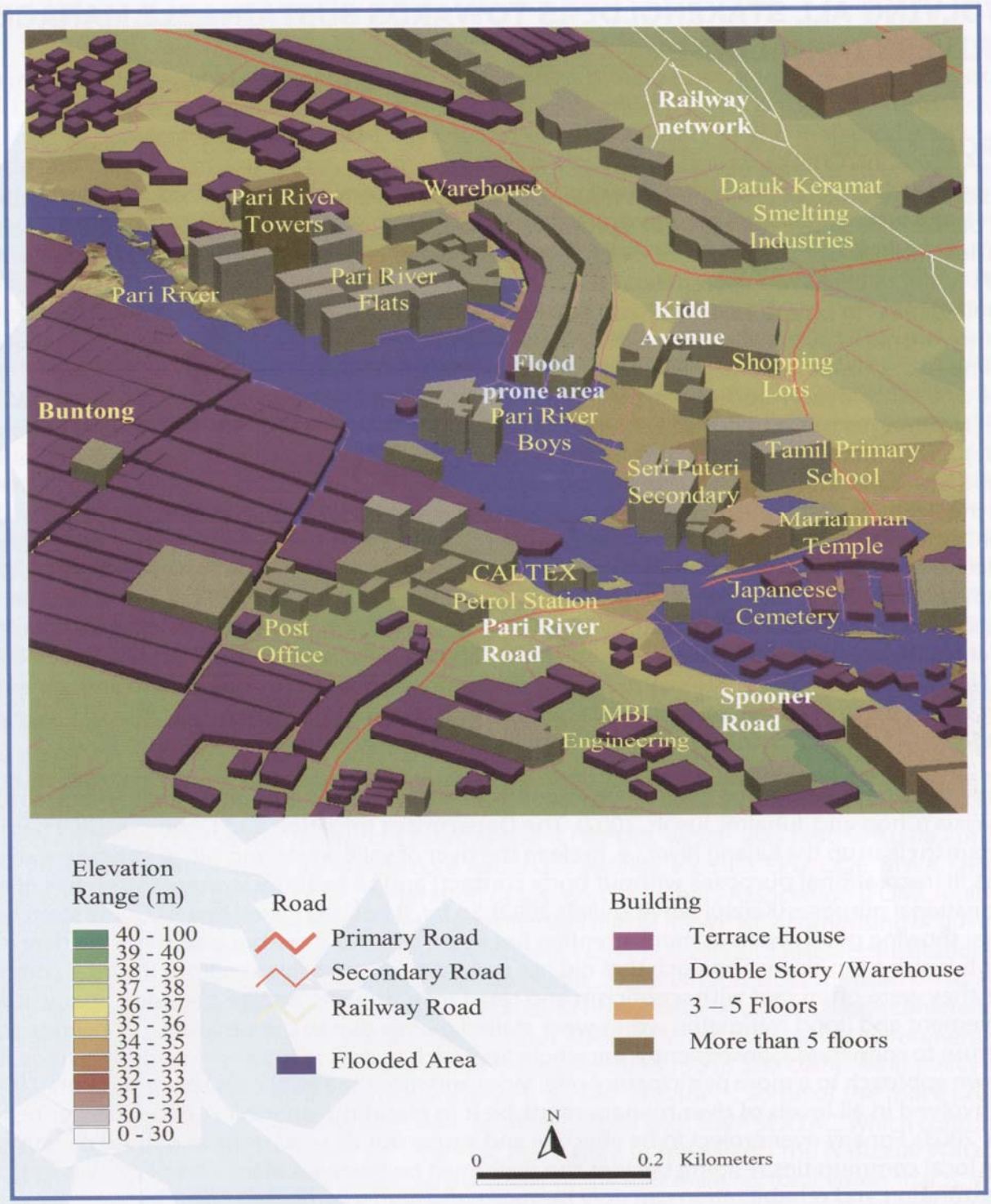


Fig 7 3-D Flood risk map for D120, ARI 100 years (Q = 343.0 m^3/s)
Year 2020 land use conditions

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Article

INVOLVING ALL STAKEHOLDERS TOWARDS SUSTAINABLE MANAGEMENT OF RIVERS IN MALAYSIA

BY: **Chan Ngai Weng, PhD**
Professor Of Geography
Universiti Sains Malaysia

INTRODUCTION

Rivers are the cradles of civilisation as major civilisations have developed on river banks, estuaries and flood plains. Rivers have always held a prominent place in human society. It is at the banks, confluence, estuaries and floodplains of major rivers that many great civilisations emerged. The majority of the world's major rivers have survived the vicissitudes of time, witnessing the rise and fall of great civilisations on their banks. In Egypt, historical records indicate that not only do Egyptians worship the Nile but they also worship Hapi, the presiding spirit of the Nile (Butzer, 1976). In ancient Mesopotamia, the Babylonians worshipped the Euphrates and the Tigris as gods, both with practical value (irrigation and water resources) as well as their spiritual role (Ponting, 1991). In India, the Ganga River is sacred so much so that pilgrims make pilgrimages there to cleanse themselves (Das, 2001). In China, the Hwang Ho and Yangtze Rivers are not just the foci of civilisations but also the "sorrows" that bring massive destruction (Zhang et al., 2000). Malaysia is no different. During historical times, rivers were the hub of life with not only the major settlements lining the banks but rivers also play an important role in the economic and social life of the people (Nik Hassan Suhaimi Nik Abdul Rahman, 1998a and 1998b). Despite their vital importance, humans have largely neglected, abused and mismanaged rivers all over the world. According to Ismail Serageldin, Chairman of the World Commission on Water for the 21st Century, more than one-half of the world s major rivers are being seriously depleted and polluted, degrading and poisoning the surrounding ecosystems, thus threatening the health and livelihood of people who depend upon them for irrigation, drinking and industrial water (www.worldwatercommission.org). All over the world, overuse and misuse of land and water resources in river basins (both in advanced industrial countries and developing countries) is the main reason for the degradation of rivers, contributing to about millions of environmental refugees in 2001.

Currently there have been some fragmented efforts from the authorities for river restoration and rehabilitation in Malaysia (Chop and Juhaimi Jusoh, 2002). The Department Irrigation and Drainage (DID) has initiated a program to clean up the Kelang River, i.e. to clean the river of solid waste and silt, to improve water quality to Class III (recreational purposes without body contact) and to beautify strategic stretches of the river for recreational purposes (Keizrul bin Abdullah, 2002). So far, it has had mixed results. Some stretches in the cities are showing good results as more attention has been focussed there but elsewhere the river is as dirty as ever. It is also a top-down approach that did not involve much participation from the local communities. Hence they were often met with scepticism and resistance. To substantiate the point many urban river improvement and flood mitigation works were stalled mainly due to the resistance of riverine squatters who refuse to cooperate. Consequently, the whole approach to river restoration needs to change from this top-down approach to a more participatory one. More and more, the public and environmental NGOs have to be involved in all levels of river management, be it in planning, operation, education or restoration (Parish, 2003). For any river project to be effective and successful, this end users and those directly affected, viz. the local communities residing besides the river must be involved. Many recent studies indicate that river restoration and rehabilitation can only be successful with a combined effort between government, NGOs and the local communities working together to ensure the cleanliness of the rivers (Chan, 2003; Low, 2003).

Based on the above introduction, it is the opinion of the author that in order for river management to work most effectively, in general for most countries and in particular for Malaysia, the following ingredients are necessary:

P - Public participation - NGOs, NPOs, Statutory Bodies, Semi-Government Agencies, etc;
E - Environmental Conservation;
O - Ordeals: Management of Floods and Droughts;
P - Politics and Pollution Management;
L - Learning, Education and Awareness; and
E - Equity and Economics.

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PUBLIC PARTICIPATION

There are many examples of government-people partnerships that have worked. In the area of restoration, rivers can be restored and rehabilitated given the right kind of efforts. River conservation and restoration is not the sole responsibility of government. In order for rivers be conserved and managed effectively,the role of NGOs and ordinary citizens are becoming increasingly important (Rasagam and Chan, 2002). As a good example of a model for community participation in the management of rivers, Water Watch Penang (WWP) is currently carrying out "The Sg Kluang Neighbourhood Park, Penang". The Sg. Kluang is an important river which passes through the residential areas of Bayan Baru and Bukit Gedong as well as the Bayan Lepas Industrial Zone before it drains into the Western Channel near Pulau Jerejak. WWP is going into partnership with the DID, the Penang Development Corporation (PDC) and the local residents to develop a riverside park that will cater for the recreational needs of the Bayan Baru population as well as provide a mechanism for community participation in river management. The project consists of providing minimum landscaping, basic recreational amenities and a cycle track within an approximately 4 km stretch of the drainage reserve of the river. An administrative mechanism for community support and management of the park is also proposed which requires the support of the DID and PDC. Benefits expected from this project are much needed park and recreational facilities in Bayan Baru, considerable enhancement of the river landscape and improved access for river maintenance and a reduction in the amount of waste thrown into the river along this stretch. Other benefits include a cycle and jogging track linking Sg. Ara to the coastal sea front which can also be connected to the new residential areas in the north such as Bayan Bay and the Gold Coast development. Future phases can include extending the proposal upstream to improve the water quality of the river through a catchment management programme. So far, all parties appear enthusiastic about the project as it is probably the first time such a project is jointly undertaken by government, statutory body, NGO and the public.

Realising the advantages and benefits of public participation in river management ,the authorities have formed the Malaysian Water Partnership (MyWP) (http://didnet.moa.my/mywp/). Though this is strictly not a river management body, it is nevertheless very closely related as many of its activities deal with rivers. MyWP was officially registered with the Registrar of Society Malaysia on 7 January 2003.MyWP is the national consultative body on the water sector and was formed out of a recommendation made at the National Consultation on Integrated Water Resources Management (IWRM), which was held in Kuala Lumpur on November 29, 1997. MyWP is made up of nine core national agencies, viz. DID, EPU, DOE, MWA, UPM,FMM, Wetlands International Asia Pacific (WIAP), Federation of Malaya Consumers Association (FOMCA), and Indah Water Consortium Sdn.Bhd.(IWK). The total institutional membership of MyWP is67,comprising of government agencies, private sectors, water user groups, non-governmental organisations and research institutions. There are many individual members from the NGOs and the public. From what is documented on its website (http://didnet.moa.my/mywp/), MyWP has conducted a series of many national consultations,conferences, and workshops among all stakeholders (both public and private) involved in the water and environment sectors. Participation in these meetings were encouraging and average around 150 to 200 comprising policy-makers, professionals, academics, NGOs, water users, consumers, service providers. Some of the more prominent activities include: (i) Water sector mapping and vision in collaboration with GWP SEATAC, which contributed to the identification of gaps and the needs for strategic assistance in IWRM and the National Water Vision (June28, 1999); (ii) A consultation to deliberate on the drafts of the four main sectoral vision that is, Water for People, water for Food and Rural Development, Water and Nature, and Water in Rivers (December 18, 1999); (iii) From vision to action; to formulate the framework for action to realise the vision. The representatives from the "Water in Rivers" and "Gender and Water", also addressed the meeting (February 18, 2000); (iv) Gender analysis in the water sector to address the gender disparities in access and control of water and the contribution of women in water resources management. The meeting was led by Ms Kusum Athukorala, the Gender Ambassador from the World Water Vision to South East Asia and South Asia (Febuary 21,2000);(v) Dialogue on Water, Food and Environment - Sector Level - 6 March 2003; (vi) Regional Forum on Capacity Building for IWRM in Southeast Asia - 10December 2002 to 14 December 2002; and(vii) The National Dialogue On Effective Water Governance In Malaysia was organised from 6 - 7 October 2003 in Kuala Lumpur. This involved stakeholders from all areas of water management. NGOs were invited not only to participate but also to present papers.

ENVIRONMENTAL CONSERVATION

The river environment needs to be conserved in order to enable the river to perform all its natural functions as drainage conduits, flood control, and as a habitat for riverine flora and fauna. In their natural undisturbed condition, rivers play an important role in maintaining the ecological balance of the river basin. Through its self-purification abilities, the river is able to absorb and cleanse itself of wastes and impurities, thus maintaining a threshold of river water quality that is able to enrich the natural beauty and to support an abundance of flora and fauna (Keizrul bin Abdullah, 2002).

Conservation of the river environment must necessarily involve the concept of Integrated River Basin Management (IRBM). Theoretically, the river basin covers the entire area demarcated by its natural hydrological boundaries (usually along mountain ridges) such that rain falling in the basin will all flow first into the river's tributaries and finally into the main river. Thus, all activities within the basin will impact on the river. For example, upstream activities such as logging and industries will produce pollutants that eventually impact upon the quality and quantity of the river water at downstream stretches. Hence' the deforestation for housing agriculture logging industry and mining amongst others, will impact negatively on rivers. Industries located near to rivers will inevitably degrade water quality in the river, unless they have good effluent water treatment facilities. As rivers flow into towns and cities, they also pick up a lot of pollutants, both point and non-point. Hence, urbanisations and developments and townships need to be properly planned to preserve the natural beauty and functions of the river. Integrated river basin management (IRBM) is the holistic approach to managing the river basin with the objective of protecting and preserving the river and its ecosystem. (Keizrul bin Abdullah, 2002).

Environmental conservation of rivers is important in the sustainable development of the river basin (Figure 1). Without conservation, river resources will not be sustainable. As human society puts increasing pressures on river resources, unsustainable use will jeopardise both river ecosystem and human society. Ideally, the use of river water and its resources has to be able to support a prosperous human society and yet not having to undermine the integrity of the river's regime or the ecological systems in the river basin that depend on it. According to Keizrul bin Abdullah (2002),human society must strike a balance by keeping the demands on the river basin within its "carrying capacity" as failure to do so will ultimately impact on Man's future and his sustainable use of these resources. Figure 1 is an interactive model linking river management, development and environmental conservation. In this model, the benefits of sustainable river management will be enormous and sustained when the development is prudently planned in a sustainable manner. On the other hand, if the push is for rapid exploitation, little forward planning and environmental protection, then the results would be disastrous not only for the river environment and the river system but also for human society.

ORDEALS: MANAGEMENT OF FLOOD AND DROUGHTS

According to Chan (2002b), water hazards are the only major hazards and disaster affecting Malaysia. In fact, Keizrul bin Abdullah (2002) points out that the two most significant natural hazards in terms of economic losses are water related, that is floods and drought. The DID estimates that about 29,000 sq. km. or 9 % of the total land area in Malaysia is flood-prone, and most of these areas are located in the riverine, estuary and coastal areas exposed to the North-east monsoon.The DID further estimated that about 12% of the population or nearly 3million are frequently exposed to floods. Malaysia represents one of the "Tiger Economies" of Asia that is rapidly developing, industrialising, and urbanising. However, like all other Asian economies, the country is plagued by seasonal environmental hazards (mostly floods) that significantly reduce its GDP and deplete its annual budget on development. Flood loss has not only caused loss of life but also resulted in enormous economic. The DID has confirmed that significant costs have been incurred in rescue and flood relief operations and rehabilitation works, and whilst the total flood damage suffered varies from year to year, the average annual flood damage has been estimated to be RM100 million at 1980 price levels.

In terms of flood management, Malaysia's predominant official strategy is based on a technology-centred approach emphasising the application of new technologies such as the use of remote sensing in flood forecasting and telemetry and automatic warning gadgets in flood warning and evacuation systems (Chan, 1995). Effective flood management in many developed countries involves employing both engineering and non-engineering measures. Engineering (structural) measures must be complemented by non-structural measures such as legislation and enforcement, watershed management, land use planning controls, community participation, education and awareness campaigns, control of runoff at source, etc. Since the government is currently actively encouraging public participation in almost all areas, including river management, it is timely that flood management should also be opened to public participation.

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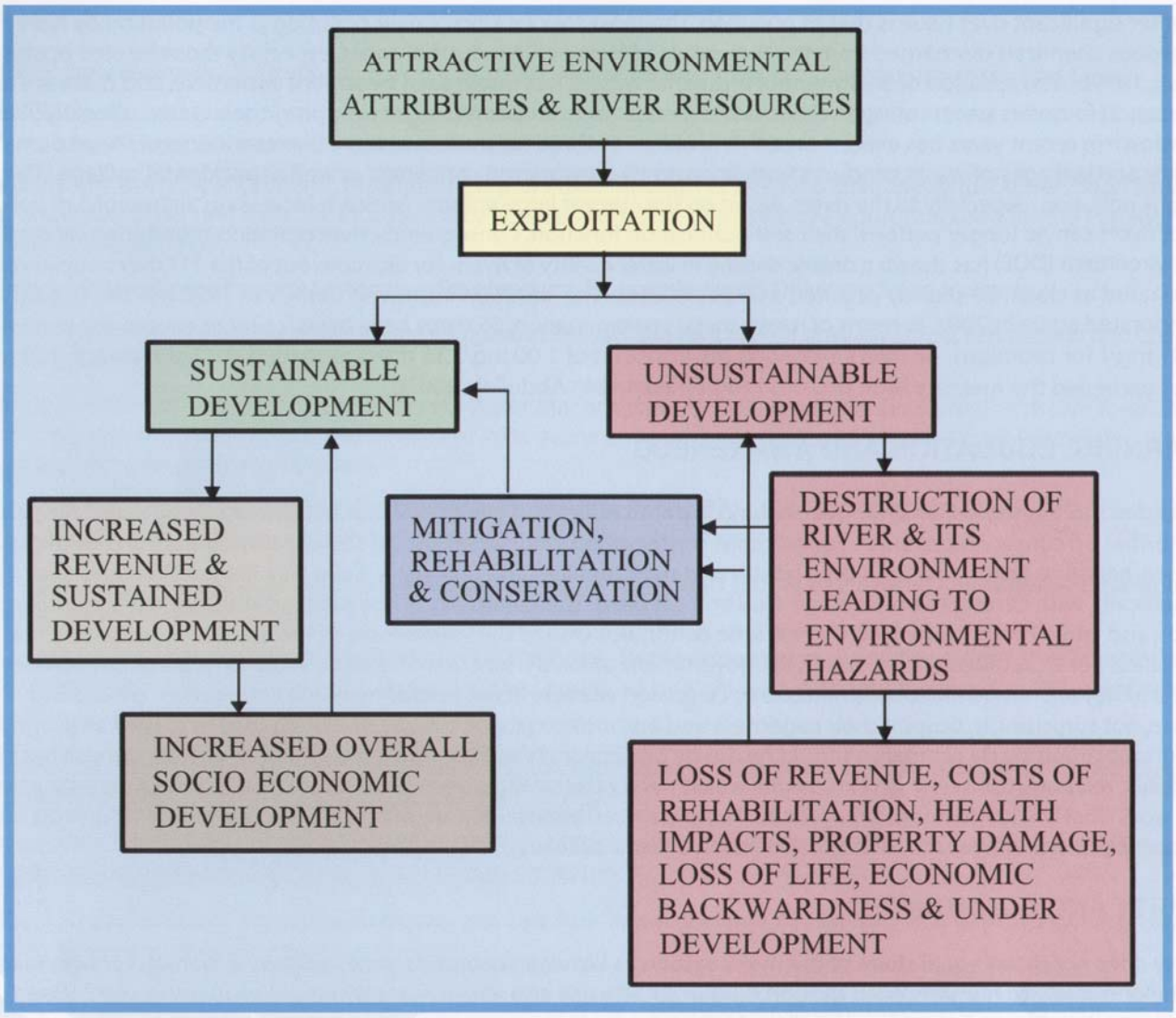

Figure 1: A Model of Sustainable River Management.

POLITICS AND POLUTION MANAGEMENT

Rivers have always been the bone of contention between the Federal and State Governments. While the Federal Government oversees regional development, it is not able to control development of rivers and their adjacent land since land and rivers belong to the States. Other than this problem, it is also obvious that there are currently too many government agencies (at the Federal, State and Local levels) that are either directly or indirectly concerned and involved with river management. The Director General of the DID, Dato' Keizrul bin Abdullah (2002) acknowledges that there is no formal mechanism to integrate and co-ordinate activities within a river basin and this is one weak point that has to be addressed if river management is to be improved. He stresses further that there are currently many ministries, departments and agencies having functions related to the river or impacting on the river. Often, each of these agencies may be carrying out their own agendas without consultation with others, and some agencies may even have conflicting objectives. Although it is widely accepted that the DID is the authority on rivers, there is still no single agency entrusted with the function and authority (and more importantly the jurisdiction) of managing fully the river covering all the related functions of river in an integrated and holistic manner. Consequently, it is not surprising that this situation has given rise to a lot of politicking and disputes between the various levels of government, viz. Federal, State and Local.

Over the various Malaysian Plan periods, it can be seen that the amount of development expenditure on flood management has increased significantly from a mere RM16.5 million in the Second Malaysia Plan to a 60-fold increase of close to RM 1 billion in the Seven Malaysia Plan (Keizrul bin Abdullah, 2002). Over the period from 1971 to1995, a total of RM 930 million has been spent on flood mitigation programmes, mainly for engineering measures. The amount spent over the Eight Malaysia Plan is expected to be increased many folds, but the question remains whether merely spending more money on expensive large-scale structures (e.g. a dam or a giant flood diversion canal) is the smart way to solve our flood woes or spending it wisely on more economical, more people-friendly, more quickly implemented non-structural measures.

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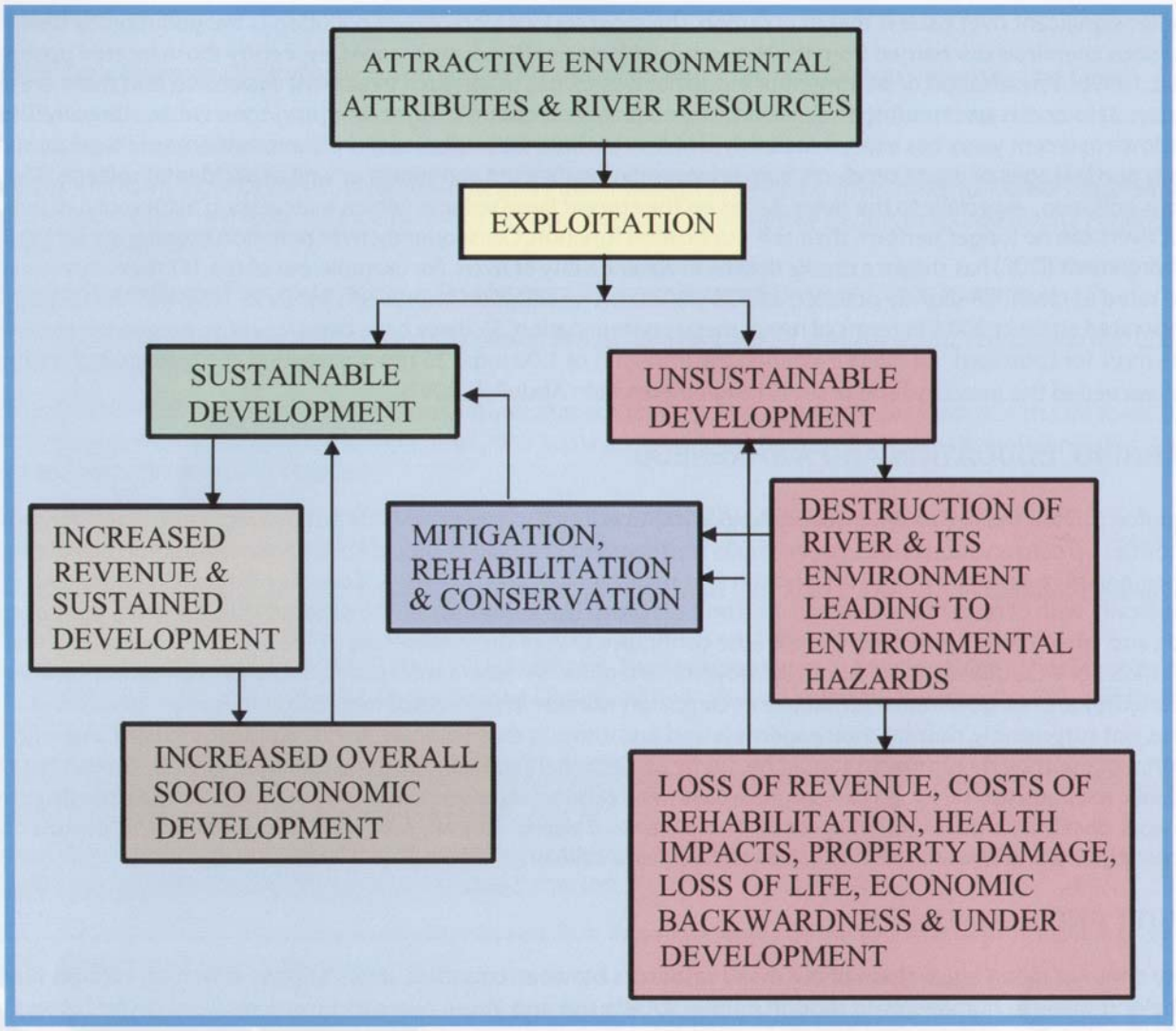

Figure 1: A Model of Sustainable River Management.

POLITICS AND POLUTION MANAGEMENT

Rivers have always been the bone of contention between the Federal and State Governments. While the Federal Government oversees regional development, it is not able to control development of rivers and their adjacent land since land and rivers belong to the States. Other than this problem, it is also obvious that there are currently too many government agencies (at the Federal, State and Local levels) that are either directly or indirectly concerned and involved with river management. The Director General of the DID, Dato' Keizrul bin Abdullah (2002) acknowledges that there is no formal mechanism to integrate and co-ordinate activities within a river basin and this is one weak point that has to be addressed if river management is to be improved. He stresses further that there are currently many ministries, departments and agencies having functions related to the river or impacting on the river. Often, each of these agencies may be carrying out their own agendas without consultation with others, and some agencies may even have conflicting objectives. Although it is widely accepted that the DID is the authority on rivers, there is still no single agency entrusted with the function and authority (and more importantly the jurisdiction) of managing fully the river covering all the related functions of river in an integrated and holistic manner. Consequently, it is not surprising that this situation has given rise to a lot of politicking and disputes between the various levels of government, viz. Federal, State and Local.

Over the various Malaysian Plan periods, it can be seen that the amount of development expenditure on flood management has increased significantly from a mere RM16.5 million in the Second Malaysia Plan to a 60-fold increase of close to RM 1 billion in the Seven Malaysia Plan (Keizrul bin Abdullah, 2002). Over the period from 1971 to1995, a total of RM 930 million has been spent on flood mitigation programmes, mainly for engineering measures. The amount spent over the Eight Malaysia Plan is expected to be increased many folds, but the question remains whether merely spending more money on expensive large-scale structures (e.g. a dam or a giant flood diversion canal) is the smart way to solve our flood woes or spending it wisely on more economical, more people-friendly, more quickly implemented non-structural measures.

Another significant river issue is that of pollution. The most serious kind of river pollution is the pollution by heavy metals and hazardous chemicals discharged from the thousands of factories in industrial zones, especially those located upstream of rivers (Chan, 1999b). Privatisation of treatment of industrial wastes has made such treatment expensive, and there are a significant number of factories not treating their wastes. Some have even been caught dumping their wastes illegally. The economic slowdown in recent years has exacerbated this problem as there are more and more been incidents of illegal dumping of toxic wastes and leakages of waste products from improperly constructed containers as well as accidental spillage. This has caused serious pollution, especially to the rivers. Based on the current large volume (which is increasing alarmingly) of pollutants of all sorts, rivers can no longer perform their self-purification function. Consequently, river pollution monitoring by the Department of Environment (DOE) has shown a drastic decline in water quality of rivers. For example, out of the 117 rivers monitored in 1997, 24 were rated as clean, 68 slightly polluted and 25 polluted. The situation improved slightly in 1998 but the conditions of rivers deteriorated again in 2002. In terms of heavy metal contamination, 55 rivers have been found to exceed the maximum limit of 0 001 mg/l for cadmium 44 rivers exceeded the iron limit of 1 00 mg/l 36 rivers exceeded the lead limit of 0 01 mg/l and 24 rivers exceeded the mercury limit of 0.0001 mg/l (Keizrul bin Abdullah, 2002).

LEARNING, EDUCATION AND AWARENESS

Education is often the key to almost everything. Without education, people will not behave responsibly and cooperate with the authorities on conservation issues. For example, conservation campaigns should show riverine communities the severe effects of their negative actions on their own health and their families The DID has a "Love Our Rivers" Campaign but it is run only periodically, with certain rivers selected on a one-off basis. The continuity of the programmes depends on the availability of funds, and when funds are lacking there is little continuity. One of the weaknesses of the above programme is that it is run by DID officers or DOE officers all of whom are government officers who are well qualified as engineers or environmental/science officers. They are not qualified as facilitators or campaign workers in the field of mass communication, advertising or education. Hence, not surprisingly, despite their eagerness and enthusiasm, these officers do not do justice to the campaign. Ideally, this important countrywide campaign should be run by professionals and not any government or agencies which has no expertise on public relations. Conservation campaigns would need positive inputs from NGOs who should provide constructive criticisms and work closely with government agencies. There is a need also to educate politicians and government servants involved with the management of river about the conservation aspects of rivers.

EQUITY AND ECONOMICS

Equity does not mean equal share of the river's resources between countries, states or people/human communities. Rivers do not belong solely to humans, even though human society use and abuse rivers without consideration for "others" who share the rivers. According to Keizrul bin Abdullah (2002), "Man, being just one of many stakeholders, must accept that his wants must not be at the expense of the needs of others". The others here refer to the myriad aquatic flora and fauna that inhabit the river and its adjacent environment. Even the river itself has a rightful claim to its resources. For example, over-abstraction of water from rivers has resulted in extreme low-flows and such flows have rendered rivers unable to "cleanse" themselves. Low flows also make pollutants highly concentrated, resulting in poor water quality that will ultimately impact upon human society. Hence humans need to ensure that rivers get a fair share of its water. The bottom line is that water abstraction must not exceed the minimum level that is required for the river and its inhabitants to function effectively. This minimum level has to be ascertained via extensive research. As is the case with all other natural resources, which hitherto have been monopolised by humans, human society need to fully comprehend the significance of sharing equitably the resources of the river basin, not just amongst all the human stakeholders but more importantly amongst all stakeholders (including the river itself, flora, fauna etc). As Keizrul bin Abdullah (2002) remarks, "...the many components and elements that make up a river basin must be viewed as part of an inter-dependent whole, where no one component or element is superior or inferior to the others".

CONCLUSION

There is no doubt that rivers and their management will be a central issue in the 21st Century, particularly as more than half the world's rivers are "dying". As rivers become more and more polluted, water becomes scarce. More importantly, we must start taking proactive actions, even sacrifices, to protect, conserve and restore our rivers so that their waters can be sustained for future use. This is where people from all levels ranging from politicians, policy makers, private companies, NGOs to individuals can play an important part. Finally, more efforts and funding need to be injected to sustain the river clean-up programme. More importantly, the programme needs to be extended to all other rivers in the country. Government should also explore the option of working together with NGOs and the people in the cleaning and restoration of rivers.

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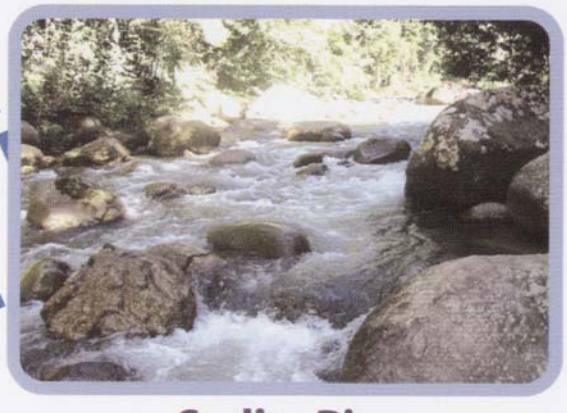
LOVE OUR RIVERS



Kampar River

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Wetlands and water quality treatment	Rural and urban catchments hydrology
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