USM REDAC
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River Engineering and Urban Drainage Research Centre
Universiti Sains Malaysia
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National Launching Of Bio-Ecological Drainage System (BIOECODS) 4th February 2003, USM Engineering Campus, Seri Ampangan, Penang

Arrival of His Excellency the Governor of Penang

VVIPs and Guest of Honours

Launching Plaque Signing

MOU Signing Ceremony

Presentation to His Excellency the Governor of Penang

Official launching of BIOECODS was performed by his Excellency the Governor of Penang at the University Hall followed by a ceremonial release of Lampan Jawa fry into BIOECODS Ecological Pond

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Foreword

By **Associate Prof Dr Nor Azazi Zakaria**, REDAC Director

This issue of REDAC Bulletin highlights major achievements attained throughout the past three year (October 1999 to September 2002) of the signing of Memorandum of Understanding (MoU) between Universiti Sains Malaysia (USM) and the Department of Irrigation and Drainage (DID) Malaysia. The national launching of the Bio-Ecological Drainage System (BIOECODS) by His Excellency The Governor of Penang, Tun Dato' Seri (Dr.) Haji Abdul Rahman Abbas, on 4th February 2003 represents the successful implementation of the MoU including the establishment of REDAC on 1st May 2001. A continuation of the MoU was further established during the national launching of BIOECODS with the signing ceremony for another three years (October 2002 to September 2005) of a smart partnership between USM and DID. Besides developing R & D activities, the MoU also provides capacity building for the DID staff including further study at MSc and PhD levels.

BIOECODS combines three engineering techniques to manage storm water based on "Control-at-Source" approach namely infiltration, storage and conveyance through the use of swales, underground drainage modules, dry ponds and constructed wetland. BIOECODS is an example of an innovative sustainable drainage systems that will help restore the natural environment, maintain river flow and control ground subsidence. By integrating storm water utilities with the green away and landscape, the drainage system will also enhance the Healthy Campus Concept in USM Engineering Campus. The application of BIOECODS in a new development attempts to solve three major problems commonly encountered in Malaysia namely flash flood, river pollution and water scarcity during dry period. It is hope that new developments in Malaysia will implement BIOECODS to achieve DID's aim of "Zero Flash Flood" by 2010 and help preserving the natural characteristics of the existing rivers in line with the national "Love Our Rivers" campaign.

The completion of the construction of BIOECODS at the end of December 2002 will be followed by a 10-year data collection programme (2003 to 2012) covering quantity and quality aspects of the drainage system made up of drainage components and ecological pond systems (wet pond, detention pond, wetland, wading river and recreational pond). The BIOECODS project has also received a number of international visitors throughout 2001 and 2002 from several countries including USA, Japan, Germany, Australia, and UK. Collaboration will be established in the near future with several established international research centers to study the efficiency of BIOECODS as an urban drainage system.

In this issue of REDAC Bulletin, our activities at international level such as paper presentation at international conferences organized by the International Association for Hydraulic Engineering and Research (IAHR) are also highlighted. Abstracts based on the published journal article and international conference papers attended are included representing the on-going research at REDAC. Also, two articles by the DID engineers who are furthering their studies at REDAC, and an article from Prof. Mohamad Isa Abdul Majid, a REDAC's Council Member from National Poison Centre, are included.

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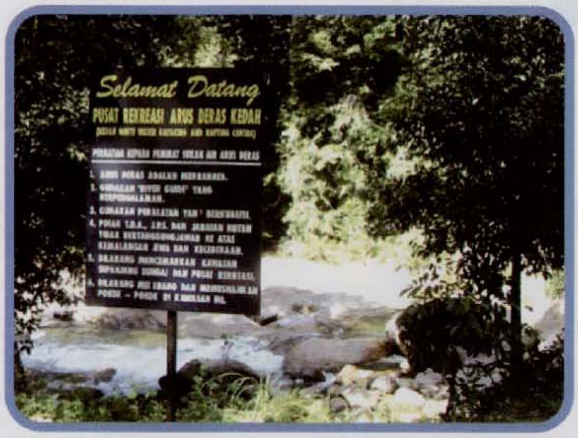
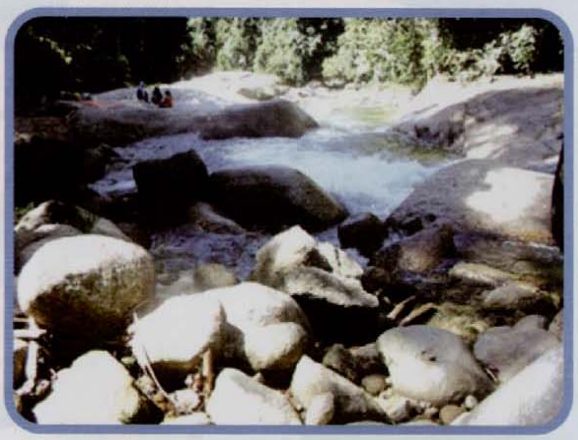
Love Our Rivers

River Front Beautification, Kerian River, Parit Buntar, Perak





Natural Scenic View of Sedim River, Kulim, Kedah

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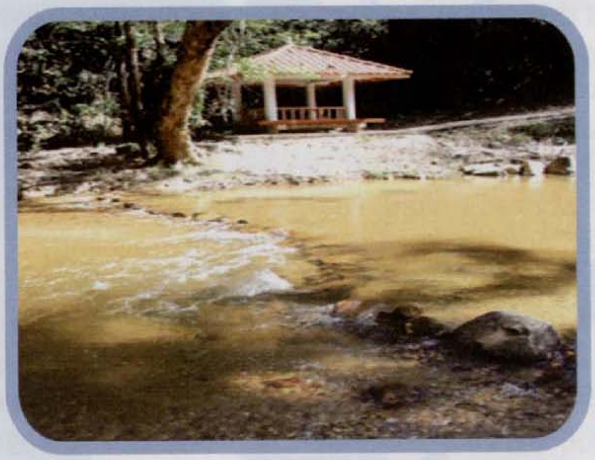
Meandering Reach of Kampar River, Gopeng, Perak



Recreational Site, Ulu Paip River, Kulim, Kedah

Name : Anita Ainan(Msc Candidate),
Department of Irrigation And Drainage Malaysia

Project Title : Peak Flow Attenuation Using BioEcological Drainage System (BIOECODS)

Effective Date of Candidature : 15 October 2001 - 15 September 2004

Supervisors : Assoc. Prof. Dr. Aminuddin Abdul Ghani
Assoc. Prof. Dr. Nor Azazi Zakaria.

Introduction

Urban development is necessary to meet the increasing growth of Malaysia and these will result in further increased paved surface. An increase of impervious area will lead an increase in surface runoff and a decrease of infiltration into the ground. A given rainfall now will give more greater runoff volume than before. Therefore incidences of flash flood in urban areas are on the rise. An increase in surfaced runoff will affect flood hydrograph by increasing peak discharges (Qp) and shortening the flow time concentration(Tc) . Before urbanization rainfall is either intercepted by the vegetation or infiltrate into the ground and take longer time to travel into the rivers. With urbanization, rainfall is swiftly collected from roofs and other paved grounds into drains which quickly and efficiently carries the water to the nearest river. Unfortunately, existing river section is inadequate to cope with this spillage of surface runoff and therefore flooding occurs frequently.

Since Malaysia has to continue in development and urbanization, the flood areas and associated problem will continue therefore there is a need to seek holistic and sustainable solutions not only to mitigate the existing flood problem but also to prevent the occurrence of such problem in new areas to be developed. Realising this, storm water management in urban area needs to change from rapid conveyance to control at source method. In line with this a new Urban Storm Water Management has been introduced by the Department of Irrigation and Drainage effective 1st January 2001. Control at source method is also known as zero peak uncontaminated contribution discharges which requires the developer to control the quantity and quality runoff before entering to the river system.

The design of drainage system in Universiti Sains Malaysia, Engineering Campus used the control at source concept rather than conventional drainage system. The system consist of structural BMP's facilities such as swale, dry pond and wetpond which is expected to have a capability to attenuate flood peak hydrograph and remove pollutant. However, the effectiveness of swale and dry pond in reducing flood peak hydrograph and runoff pollutant has to be studied before it can apply widely in Malaysia as the main conveyance of runoff for both minor and major storm event. Data collected such as rainfall, discharges and water quality at Bio-Ecological site can be a guideline to design Bio Ecological Drainage in the future.

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OBJECTIVE

The main objective of this research is to quantify effectiveness Bio-Ecological Drainage System in term of peak flow attenuation process to achieve the development area perpetual from the quantity and water quality runoff aspect before and after the development.(zero peak uncontaminated contribution discharges). Therefore the research aim is to study the

i) The effectiveness Bio-Ecological system component especially swale and dry pond in term of peak flow attenuation.
ii) The usage of Storm Water Management Model to study the effect of peak flow attenuation to reduce flood risk.
iii) To study the effectiveness of swale in term of pollutant removal.

METHODOLOGY

There are various factors affecting flow attenuation in a swale as a conveyance. Among them are roughness of conveyance, slope of the conveyance, storage and travel time. Time of water inundation at the surface area also has a great impact on attenuation of flow.

The effectiveness of swale as a Best Management Practice(BMP) depends on the design characteristic of the swale. Design parameter e.g length of the swale, longitudinal of slope and the existence of check dam which give greater influence on hydraulic retention time will have an impact on stormwater treatment.

The Storm Water Management Model (XP-SWMM) is used to model the hydrologic catchment processes and simulate the hydraulics of BIOECODS. The characteristic of the catchment and system components of BIOECODS which include bio-ecological swale, dry pond and bio-ecological pond system have been modeled in the XP-SWMM using the link-node concept. The frequent storm of minor event with 60 minute duration and 10 year ARI has been used as a basis to gauge the performance of BIOECODS.

Three monitoring stations were established to measure flow discharge and water quality impacts. Five more stations were established at dry ponds to check the time required for the dry pond to empty.

EXPECTED RESULTS

- Design parameter of swale, dry pond
- Water quality treatment efficiency

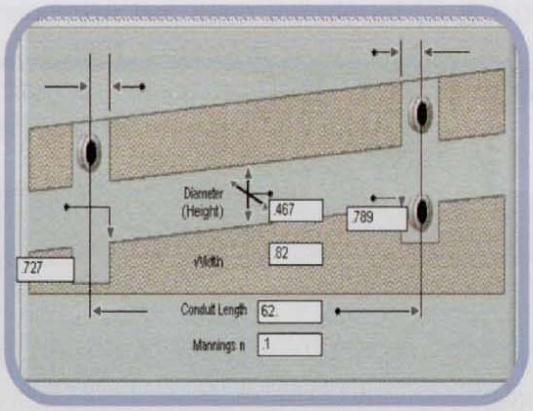
Water Quantity and Quality Monitoring Station
No 1: Ecological Swale Type A

Water Quantity and Quality Monitoring Station No2: Ecological Swale Type B

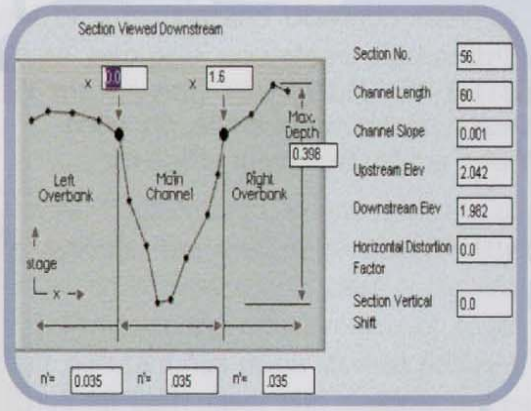
Water Quantity and Quality Monitoring Station No 3 Ecological Swale Type C

Dry Pond Monitoring Station Site No 1

Dry Pond Monitoring Station Site No 2



Modeling of Ecological Swale using XP SWMM for Sub Surface Drainage (modules)



Modeling of Ecological Swale using XP SWMM for Surface Drainage (swale)

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Flood Risk Mapping For Pari River Incorporating Sediment Transport
Shanker Kumar Sinakaudan, Aminuddin Ab. Ghani, Mohd Sanusi S. Ahmad and Nor Azazi Zakaria
Environmental Modelling & Software, Volume 18, Issue 2, March 2003, Pages 119-130

Geographic Information Systems (GIS) are an efficient and interactive spatial decision support tool for flood risk analysis. This paper describes the development of ArcView GIS extension -- namely AVHEC-6.avx -- to integrate the HEC-6 hydraulic model within GIS environment. The extension was written in an Avenue Script language and Dialog Designer with a series of `point and click' options. It has the capability of analyzing the computed water surface profiles generated from HEC-6 model and producing a related flood map for the Pari River in the ArcView GIS. The user-friendly menu interface guides the user to understand, visualize, build query, conduct repetitious and multiple analytical tasks with HEC-6 outputs. The flood risk model was tested using the hydraulic and hydrological data from the Pari River catchment area. The required sediment input parameters were obtained from field sampling. The results of this study clearly show that GIS provides an effective environment for flood risk analysis and mapping. The present study only concentrates on the flood risk within the boundary of the bunds.
Keywords: GIS; River; Flood Risk Mapping; Sediment Transport; System Integration

Integrated Triangular Irregular Network (ITIN) Model For Flood Risk Analysis Case Study: Pari River, Ipoh, Malaysia
Shanker Kumar Sinakaudan, Aminuddin Ab. Ghani, Chang Chun Kiat, Mohd Sanusi S. Ahmad and Nor Azazi Zakaria
13th Asia and Pacific Division Congress of International Association of Hydraulic Engineering Research on Hydraulic and Water Resource Engineering in early 21st Century.
Singapore,August 6-8, Volume2, pp.656-660

Accurate river channel and flood plain representation plays vital part in flood risk analysis. Terrain models such as TINs and DEMs are normally used to represent floodplains. But unfortunately finding a terrain model with a high density of stream channel elevation points that are sufficient for hydraulic modeling is not a easy task. However for years engineers and researchers have developed a high-resolution cross-section data for hydraulic modeling from field surveys, photogrametries and topographic maps. This research presented here introduces the procedures for creating integrated multiresolution TIN (ITIN) models for high-resolution flood plain representation for flood risk analysis. The high-resolution river channel geometric data stored in HEC-6 hydraulic model and low-resolution flood plain data in the form of DEM created in ArcView GIS 3.2a were integrated by resolving the coordinate incompatibility in the both system. An integration procedure (ArcView extention) namely AVHEC6.avx has been developed between HEC-6 Hydraulic Model and ArcView GIS 3.2a to visualize model outputs in a more presentable manner through 3D capabilities of GIS.
Keywords: ITIN; DEM; GIS; HEC-6; Flood Risk.

Flood Inundation Analysis Using HEC-6 And Arcview GIS 3.2a
Shanker Kumar Sinakaudan, Aminuddin Ab. Ghani, Chang Chun Kiat
5th International Conference on Hydro - Science & - Engineering, Warsaw University of Technology, Poland, September 18 - 21, 2002

An integration procedure namely AVHEC6.avx has been created between ArcView GIS 3.2a and HEC-6 hydraulic model to perform flood inundation analysis. The procedure was tested using hydraulic and hydrological data for Pari River channel and floodplain with the reach approximately 4 km long. HEC-6 Model was simulated using Yang sediment transport equation with four flood hydrograph in 12 difference flooding scenarios and subsequent flood inundation maps were produced. The flood plain visualization was further enhanced using the ArcView Spatial Analysis and 3D Analysis. The results of these research clearly show that incorporating floodplain geometric data besides river channel data in the modeling process can produce more accurate flood plain maps. GIS is proven to provides an effective environment for flood inundation mapping and analysis. The research has further extended in the development of an embedded floodrisk analysis model that has fully operates in the GIS environment.
Keywords: Flood; Inundation; GIS; HEC-6; Flood Risk.

Presentation by Assoc. Prof. Dr. Aminuddin Ab Ghani

Presentation by Mr. Shanker Kumar Sinnakaundan

Assoc. Prof. Dr. Aminuddin Ab Ghani with Prof. Pierre Y. Julien, Colorado State University, USA

Assoc. Prof. Dr. Aminuddin Ab Ghani with Prof. Zhao Yin Wang, Tsinghua University, China

Delegates from Malaysia, USA and Singapore

Conference Lunch

13th Asia and Pacific Division Congress, International Association of Hydraulic Engineering And Research (IAHR)
6th - 8th August 2002, Singapore

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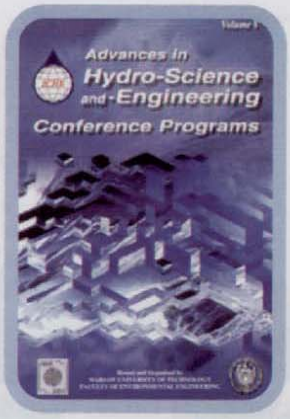

Conference Proceeding

Presentation by Mr Shanker Kumar Sinnakaudan

Good Times with Session Chairman

Mr Shanker Kumar with XXX IHR Congress Chaiman, Prof. J. Ganoulis

Mr. Shanker Kumar with Professor Marian Kwietniewski - ICHE-2002 Secretary General

Mr Shanker Kumar with Prof. Abdul Khan and Prof. Viera

5th International Conference "Hydro science and Engineering", IAHR 16 - 22 September 2002, Warsaw, Poland

Name : Ahmad Darus (Msc Candidate),
Department of Irrigation And Drainage Malaysia

Project Title : Conservation and Restoration of Urban Rivers.
: Case studies of Raia River & Pari River

Effective Date of Candidature : 1 April 2001 - 31 March 2003

Supervisors : Assoc. Prof. Dr. Aminuddin Abd. Ghani
Assoc. Prof. Dr. Nor Azazi Zakaria

INTRODUCTION

As a result of increasing economic growth of the country, areas within river catchment are being developed into new commercial, industrialization and housing purposes. This rapid urbanization has accelerated its impact on the hydrology and geomorphology. These developments have caused dramatically increase in the surface runoff and the behaviour of their sediment output hence resulting higher sediment yield.

Recently, hydraulics engineers are faced with the new challenges in channel design of evolving environmental considerations. The major trend at present is to stay away from totally lined channels for the sake of ground-water recharge, preservation of a more natural section and aquatic habitat and so forth.

Since any flood mitigation works would likely affect channel modification so knowledge of predicting the geometry changes as well as its interaction which involves the sediment transport movement to maintain the channel stability and design capacity or to establish a stable design section by using appropriate method are significant and necessary

OBJECTIVE

The objectives of this research are as follows;

- To assess the processes, mechanisms and problems involved in river width adjustment which affects bank stability and others form of bank failure.
- To evaluate the existing design methods including regime theory, maximum velocity, maximum tractive forces and mathematical model (FLUVIAL-12) approaches for designing a stable natural channel.
- To identify the appropriate design method which capable of producing stable design channel on maintaining the maximum section capacity and high bank stability.

METHODOLOGY

Comparison on several empirical design methods including regime theory and extremal hypothesis with mathematical model (FLUVIAL-12) using field's data were carried out in order to specify the appropriate method/model which will minimize the morphological changes in river channel as well as producing stable design section based on maintaining the maximum section capacity and high bank stability (refer Figure 1).

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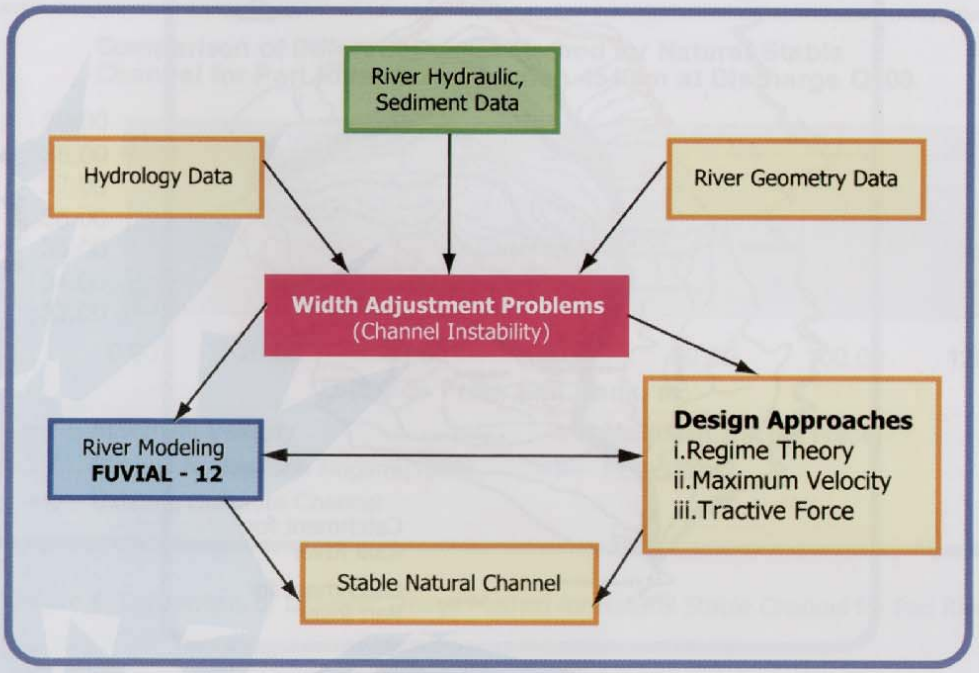

Figure 1: Methodology Procedure for Identifying, Analyzing and Modeling Instability Problems.

CASE STUDY

Two river reaches in Kinta District i.e Raia and Pari River were selected for this study (Figure 4). Possible solution was carried out to identify the appropriate channel geometry in maintaining the existing natural channel section.

A reach of Raia River in Kinta District went through significant changes and was badly damaged by the January 1999 flood (Figure 2). The natural channel configuration was distorted prior to recent flood events and also by man's activities such as sand mining at the upstream section.

Figure 2: Flood Event of Raia River on 6 Jan 1999 (DID Kinta/ Batang Padang, 2002)

Figure 3: Flood Event of Pari River on 3 Jun 1991 (DID Kinta/ Batang Padang, 1991)

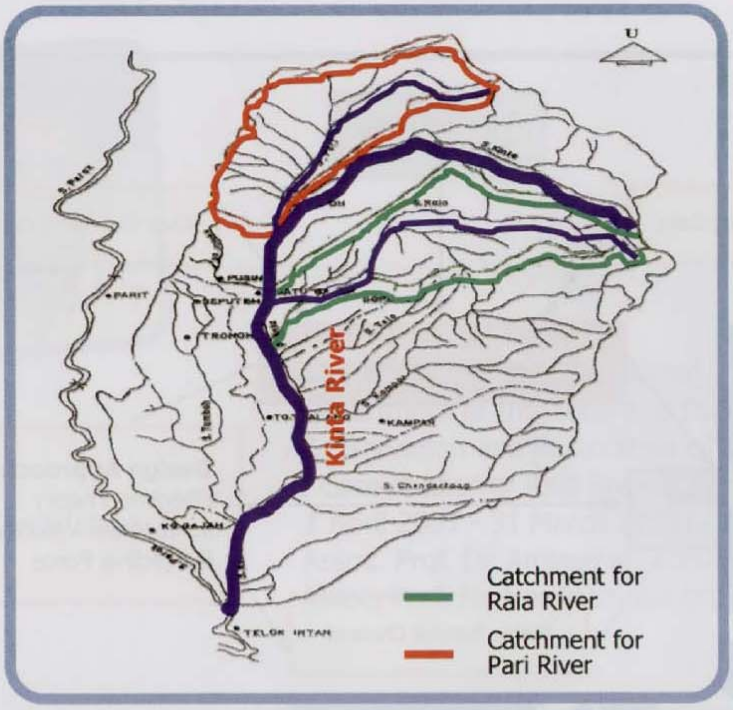

Figure 4: Catchment for Raia and Pari River (DID, Perak).

Similarly, a reach of Pari River (Figure 3) was channelized for flood control in 1997 due to severe damage by recent flood. Low lying areas along the river were inundated due to stagnant water effect from the existing river which could not cater the increasing discharge from the nearby development. The design channel is a rigid bank concrete and leaving the bed as natural (sand).

SIMULATION RESULTS

Figure 5 and 6 demonstrates different method of designing natural stable channel and FLUVIAL-12 seem to produce and agreements with the measured cross section at site.

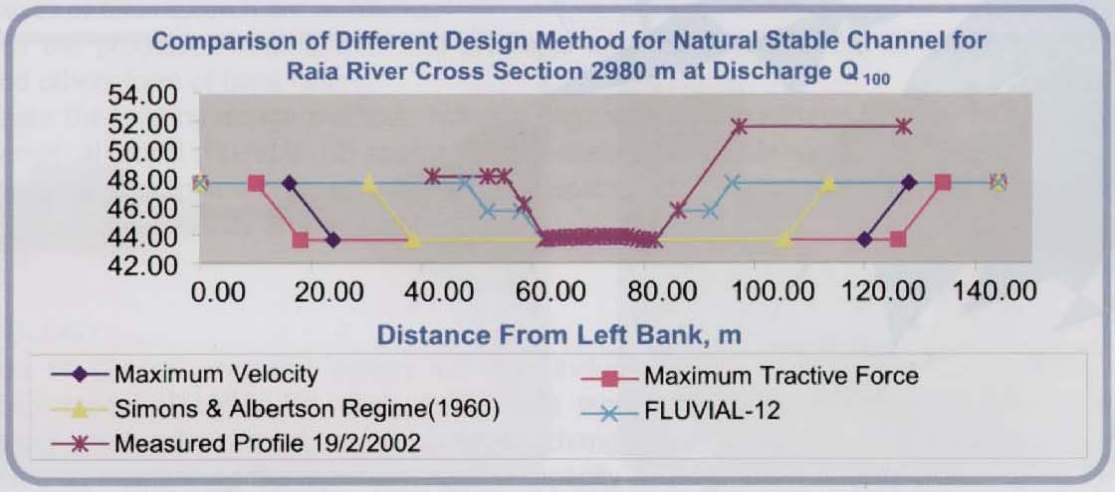

Figure 5: Comparison of Different Design Method for Natural Stable Channel for Raia River

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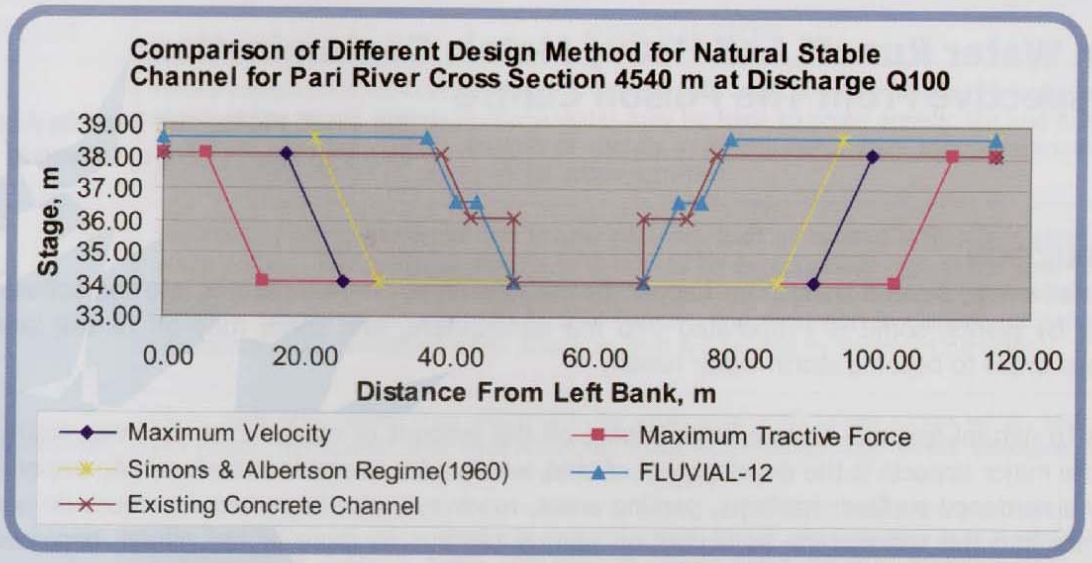

Figure 6: Comparison of Different Design Method for Natural Stable Channel for Pari River.

SUMMARY AND CONCLUSIONS

A mathematical model for water and sediment routing (FLUVIAL-12) through alluvial channels was employed to simulate cross section changes and instability problem during specified flow, thereby providing the necessary information for bank protection works or whether a river section can still be maintained in a natural state in order to carry maximum discharge.

These simulated results show that Raia River can still be maintained as natural condition while for Pari River few options can be implemented in order to restore the natural cross section. As for Pari River, chances of restoring to it natural state by reducing the flow resistance to the value of Manning's n = 0.025.

PUBLICATIONS

Darus, A., Ab. Ghani, A., & Mohd Sidek, L. Effect of Canalization on Alluvial River. Proceeding of R & D Colloquim on River Engineering and Urban Drainage, August 14 - 15, 2001.

Darus, A., Ab. Ghani, A., Abdullah, S., Zakaria, N.A.Z., Abdullah, R., & Mohd Sidek, L. Scour and Deposition in Rivers: Malaysian Perspective. Proceeding of National Conference on Hydraulics, Hydrology and Sustainable Water Resources Management, 24 - 25 September 2001.

Darus, A., Ab. Ghani, A., Abdullah, S., Zakaria, N.A.Z., Abdullah, R. Evaluation of Alluvial River Stability for River Restoration: Case Study of Raia River and Pari River. East-Asia Regional Seminar on River Restoration, 13 - 15 January 2003, Legend Hotel, Kuala Lumpur.

Darus, A., Ab. Ghani, A., Abdullah, S., Zakaria, N.A.Z., Abdullah, R. Evaluation of Alluvial River Stability: Case Study of Raia River. Water & Drainage 2003 Conference: Managing our Water Resources - The Changing Value of Water, 28 - 29 April 2003, Putra World Trade Centre, Kuala Lumpur.

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Storm Water Runoff And Heavy Metals Contamination: A Perspective From The Poison Centre

By: **Prof. Mohamed Isa bin Abd. Majid,**
National Poison Centre, Universiti Sains Malaysia

INTRODUCTION

In a rainfall event, several things can happen to the rainwater. Some infiltrates into the soil surface, some is taken up by plants, some is evaporated into the atmosphere, and some runs off of the land surface and impervious areas to become storm water runoff.

Changes to natural features have a large impact on the amount of rainfall that becomes storm water runoff. One of the major impacts is the development of land, which adds impervious surfaces. An impervious surface is basically a hardened surface: rooftops, parking areas, roadways, etc. Impervious surfaces do not allow rainfall to infiltrate into the soil surface as occurs on natural terrain; so more of the rainfall becomes storm water runoff.

Storm water runoff can have a number of impacts. As development and imperviousness increase in an area, the natural capacity of the soil and vegetation to take up rainfall decreases and more rainfall becomes storm water runoff. This can produce negative impacts by causing erosion of land areas and stream banks, by causing or increasing flooding, and also by carrying pollutants to surface waters. As development activities occur and human activities increase in an area, various pollutants are deposited on surfaces where they can be picked up and carried by storm water runoff. This is especially true on impervious surfaces where pollutants can easily be collected and washed off.

IMPACT OF POLLUTANTS IN STORM WATER RUNOFF

Table 1 below summarizes common storm water pollutants and also provides information on potential sources of these pollutants and types of impacts they may cause.

Storm water runoff may be carried through natural or man-made drainage ways or conveyance systems. In some cases storm water runoff leaves a site spread out over a large dispersed area as "sheet flow." It may also be conveyed through natural ditches, swales, and natural drainage features. In most developing and urbanizing areas storm water is conveyed through a system of catch basins and pipes commonly referred to as a storm sewer system. Unfortunately everyone is not currently aware. As an example, many times people assume that storm water runoff that enters a storm sewer system is being routed to some type of treatment process before it makes its way to our surface waters. In a lot of cases this is not occurring and the storm sewer system is designed simply to capture the storm water and convey it to the nearest surface water.

CONTROL MEASURES IN MANAGING POTENTIAL POLLUTANTS FROM STORM WATER RUNOFF

In order to manage the risks associated with pollutants from storm water runoff, various measures can be incorporated to minimize the risks of such agents. Generally, mechanisms for controlling storm water runoff impacts can be grouped into a couple of categories of activities:

- Preventative measures - These measures work to reduce the impacts of storm water runoff through changes in design, operation, or management to minimize or prevent the generation of runoff and the contamination of runoff from pollutants. Preventative measures include land use management practices, which look at methods to do better planning of the way land uses are located within a jurisdictional area or on a specific project site to avoid impacts, and source reduction practices, which focus on locating the sources of pollutants and implementing design and operational changes that minimize or completely remove these sources. Preventative measures can be very efficient and effective because they are implemented in a manner that will keep pollutants from ever getting into storm water.

Table 1 : Stormwater Pollutants

COMPONENT	DESCRIPTION
Heavy metals	Heavy metals such as lead, arsenic, chromium, zinc and cadmium may be typically found in urban storm water runoff. Metals in storm water may be toxic to some aquatic life and may accumulate in aquatic animals. Urban sources of metals in storm water may include automobiles, paints, preservatives, motor oil, and various urban activities.
Sediment	Sediment is often viewed as the largest pollutant load associated with storm water runoff in an urban setting. The loadings have been shown to be exceptionally high in the case of construction activity. Sediment is associated with numerous impacts in surface waters, including increased turbidity, effects on aquatic and benthic habitat, and reduction in capacity of impoundments. A number of other pollutants often attach to, and are carried by sediment particles.
Toxic substances	Many toxic substances may potentially be associated with urban storm water, including metals, pesticides, herbicides, and hydrocarbons. Toxic compounds may affect biological systems, and accumulate in bottom sediments of surface waters
Nutrients	The nutrients most often identified in storm water runoff are phosphorus and nitrogen. In surface waters, these nutrient loads can lead to heavy algae growth, eutrophication (especially in impoundments), and low dissolved oxygen levels. Nutrients are input into the urban system in a variety of ways, including landscaping practices (commercial and home) and leaks from sanitary sewers and septic systems
Organic matter	Various forms of organic matter may be carried by storm water in urban areas. Decomposition of this material by organisms in surface waters results in depleted oxygen levels. Low levels of dissolved oxygen severely impact water quality and life within surface waters. Sources of organic matter include leaking septic systems, garbage, yard waste.
Bacteria	High bacterial levels may be found in storm water runoff as a result of leaking sanitary systems, garbage, pet waste and etc. The impacts of bacteria on surface waters may affect recreational uses and aquatic life as well as presenting possible health risks.

• Control measures - These are devices that are put in place to capture storm water flows and provide management of the storm water through filtering, infiltration, detention, or some related process that works to remove pollutants from the storm water. These measures may be limited in their ability to remove some pollutants efficiently and may be fairly costly. Control measures also require commitment to long-term operation and maintenance to assure that the measures continue to function properly.

KNOWN RISKS ASSOCIATED WITH POTENTIAL POLLUTANTS ARISING FROM UNPROPER MANAGEMENT OF STORM WATER RUNOFF

For the purpose of highlighting the improper management of storm water runoff, the effects of heavy metals are further illustrated, as these elements are known to adversely affect the human health. Two typical heavy metals, which are known to be detrimental to human being, are arsenic and lead.

Arsenic

Arsenic, the 33rd element on the periodic chart, occurs in organic (arsine) and inorganic (arsenites, arsenates, and elemental arsenic) forms. Most arsenic in the terrestrial environment is found in rocks and soils. Arsenic in the surface and ground water is mostly a mixture of arsenite and arsenate. Arsenic is widely distributed in seafood (especially shellfish). Combustion of coal, nonferrous metal smelting, and burning of agricultural wastes produce arsenic. Herbicides, fungicides, wood preservatives, desiccants, cattle and sheep dips, and dyestuffs all contain arsenic. Arsenic is also used in glass and ceramics as a metal alloy and in semiconductors and other electronic devices.

As a summary, it is found in the following environment: rocks and soils, foods, human activities and industry.

Historically, uses of arsenic date back to ancient Greek and roman times. Hippocrates prescribed paste-containing arsenic for treating ulcers. In the 1800s, a solution containing arsenite (Fowler's solution, 1% arsenite) was used to treat leukemia, psoriasis, and asthma. More than 1000 arsenic-containing compounds were produced for the treatment of syphilis.

In poisoning cases of arsenic, symptoms appear within 30 minutes of absorption. However, they may be delayed if the arsenic was ingested with food. Presenting symptoms are nonspecific and include headache, weakness, nausea, vomiting, and colicky abdominal pain. Hypotension and tachycardia are also common early signs. Diarrhea of arsenic poisoning is described as "rice-water" or "cholera-like" stools. Of the more specific physical findings, a garlic odor has been reported on the breath of individuals. Within a few hours, dark urine may be seen. Jaundice ensues in 1-2 days.

- Central nervous system (CNS). Symptoms include delirium, seizure, coma, and death. Arsenic also causes cortical atrophy resulting in encephalopathy.
- Parasympathetic nervous system. Peripheral neuropathy may appear 1-2 weeks after exposure. It mostly affects the lower extremities.
- Cardiovascular. A variety of electrocardiogram (ECG) changes occur, including conduction blocks, QT interval prolongation, and T wave changes. Myocarditis and pericarditis have been reported in chronic arsenic poisoning. Arsenic also causes a dilation of blood vessels and endothelial damage, resulting in hypotension and third spacing of fluids. This results in progressive hemodynamic compromise and shock.
- Pulmonary. Pulmonary edema, acute respiratory distress syndrome (ARDS), and respiratory failure from muscle weakness occur in conjunction with acute arsenic toxicity.
- Gastrointestinal. Dehydration, thirst, and corrosion of mucous membranes result in hemorrhagic gastritis. A toxic hepatitis may also occur.
- Hematopoietic. Hemolysis occurs after acute poisoning. Panycytopenia may result, and an absolute eosinophilia may manifest.
- Dermatologic. Cutaneous signs occur after systemic exposure. Erythema followed byhyperpigmentation, hyperkeratosis, brawny desquamation, and exfoliative dermatitis ensues. The hyperpigmentation is most pronounced on the eyelids, temples, neck, axilla, nipples, and groin.

Lead

Lead is a natural constituent of the earth's crust. It may be found in drinking water, soil and vegetation. The most common lead sources are those that settle in soil and water. Due to its properties, it has been used for myriad purposes that are considered to be not intrinsically dangerous.

However it can enter and re-enter the human environment in potentially hazardous form when it is incorrectly applied or removed. This could occur in the burning of storage battery casings, improper use of ceramics glazes and burning or sanding of old leaded paint. As combustion of leaded gasoline may also contribute to the external sources of lead, the recent `Use Unleaded Fuel' campaign seems to be a good measure to curb disposition of lead into the atmosphere.

Lead has no biological value in human body even in trace amounts. It displaces other metal from the normal binding sites of cells to produce various biochemical effects. Thus, the ideal whole blood lead level is 0 pg/dL. Until recently, whole blood lead levels as high as 30 pg/dL were considered acceptable. However, disturbances in biochemical functions are demonstrable at concentrations below that figure. From prospective studies, it is obvious that a level between 10-15 pg/dL and above may impair the psychomotor development of young children. Children run the greatest risk being poisoned because lead is easily incorporated into their growing bodies. Its accumulation in growing bodies could disrupt the normal growth pattern of cells. Even without direct contact to environmental lead, unborn child can be affected. Lead poisoning should be considered in any illness with gastrointestinal (GI), neuromuscular, and central nervous system manifestations, particularly in children. Under continuous exposure of lead into a child's body, it is known to cause

- Decreased intelligence
- Behavioral and learning disorders
- Deficits of verbal abstraction, perceptual integration, and visual motor function.

A pregnant woman that has been exposed to enough lead tends to have a high lead storage in her bones. The metabolic changes that occur in the body during pregnancy may cause the stored lead to be released into the blood, thus exposing the unborn. At this critical stage of foetal development, the most likely system to be disrupted is the neurogical system of the developing unborn child.

Young children are the most widely exposed group due to their "hand-to-mouth" attitude since they tend to put almost anything into their mouths. Children absorb a higher percent of ingested lead than adults do.

In the adult, 10% of an administered dose is absorbed. In the child, it is estimated that 50% of ingested lead is absorbed and that absorption is further enhanced if the child is malnourished. Thus, when a child is exposed to the same amount of lead as that exposed to an adult, the potential damage is even greater.

Over the years, lead has appeared to be still a significant health hazard to children. Most people, including children, are exposed to lead that has been dispersed in air, dust and soil by natural or external sources. Other low sources of lead that may be damaging to children may also appear in food and drinking water.

Children are exposed to lead in drinking water primarily from contamination of the water supply system such as from lead pipes or from leachable lead solder. Children are also at risk of ingesting lead-based paint as well as lead-bearing soil and house-dust contamination by the deterioration of lead-based paint. Dust and soil in children's play areas that are contaminated principally by automotive exhaust and deterioration of old lead paint may contribute to the intermediate dose exposure of lead.

Lead concentration in urban soil and air is often much higher than in rural areas. In more polluted areas where lead content of dust is much higher, it is often associated with a significant elevation in children's blood lead levels.

When dust and soil are the only sources of exposure to lead, symptoms of lead poisoning are rarely encountered. In this situation, accumulation of smaller amount of lead for a long period of time in a child's body may result in damage that does not become visible until the child is old enough to express learning abilities.

The lead dust that form from lead-based paint chips are the most detrimental towards children. This lead can get on carpets, floors, furniture, toys and other objects as well as on the hand of children and adults in the home. As children are most confined to the house compound, they are most susceptible to lead exposure.

Additional lead sources may also come from other activities in the home. These may include pottery and ceramic glazing and re-painting activities. Precautionary measures must be practiced when removing of lead-based paint from older houses during renovation. Pregnant women, infants and children should be kept-away from the house until the deleading is completed and clean up has been accomplished.
Another source of lead is improperly soldered cans, particularly those containing acidic foodstuff. Food should not be heated in such cans as heating increases the dissolution of lead.

Domestic burning of lead-painted wood and newspaper also cause additional hazard to the environment. It was found that the amount of lead in a sample of ash from burning of black-ink newsprint was less than 5mg/kg while a sample of ash from burnt colored-ink newsprint was approximately 58mg/kg. In order to minimize this hazard, re-cycling is always recommended.

CONCLUSION

It must be remembered that many of our daily activities have the potential to cause storm water pollution. Any situation in which activities can add to the types of pollutants that may be picked up and carried by storm water runoff is an area that should be considered in our attempts to minimize these impacts. Among others, it must include the design of a new construction to prevent or minimize runoff and storm water pollution which consider and manage potential storm water problems and incorporating good housekeeping practice by keeping areas clean of potentially harmful pollutants.

National Launching Of Bio-Ecological Drainage System (BIOECODS) 4th February 2003, USM Engineering Campus, Seri Ampangan, Penang

Guests at Ecological Pond System

Arrival of His Excellency at Ecological Pond

Tun Dato' Seri (Dr.) Hj Abdul Rahman Abbas His Excellency the Governor of Penang

Dato' Ir. Hj. Keizrul Abdullah
DID Director General

Prof. Dato' Dzulkifli Abd. Razak
USM Vice Chancellor

The Ceremonial Release Of Lampam Jawa Fry At BIOECODS Ecological Pond Made Up Of A Constructed Wetland, A Wading River And A Man-Made Recreational Pond.