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Design and Development a Mechatronic Harvester for Harvesting Pepper in Typical Terrains	Ir. Dr. Mohammad Shahril Osman	Mr. Shahrol Mohammaddan, Mr. Noor Hisyam Noor Mohamed, Mr. Aidil Azli Alias, Ms. Siti Nor Ain Musa, Ms. Shamsiah Suhaili, Mr. Abg. Mohd Nizam Abg. Kamaruddin, Ms. Nur Tahirah Razali, Ms. Maimun Huja Husin, Ms. Kasumawati Lias	Malaysian of Pepper Board (RM95,000.00)
Hydrosystems for Integrated Control of Flood and Low Flow for a River Basin in Sarawak	Mr. Charles Bong Hin Joo	Prof. Salim Said, Prof. Frederik Josep Putuhena, Mdm. Rosmina Ahmad Bustami	MOSTI e-Science (RM197,302.00)

An Investigation into the Stabilization of Peat Soil and Application of Lightweight Foundation

by
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The state of Sarawak is crossed by deep rivers and contains extensive freshwater wetlands and salty mangrove swamps. Black water streams flow out of peat-swamp forests, which cover a large area of the state. The rainforest creates a green carpet that covers all but the wettest or poorest soils from hills to mountain slopes. Almost 13% of Sarawak land areas are covered by peat lands, which contribute to difficulties in construction industries. High rain intensity of 120 inches per year makes peat become extremely soft and wet. Figure 1 shows the distribution of peat lands in Sarawak.

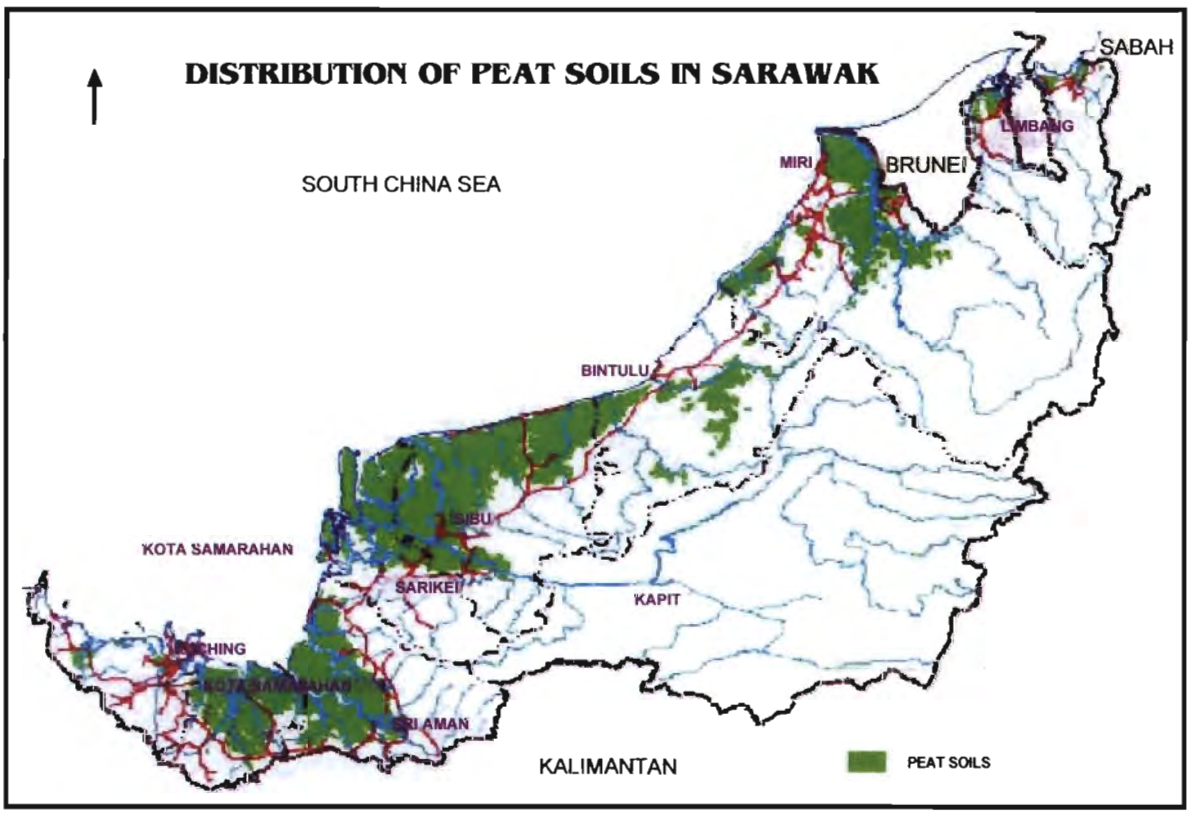

Figure 1: Distribution of Peat Lands in Sarawak.

Peat lands can be divided into two types: shallow peat wetlands and deep peat wetlands. About 90% of wetlands in Sarawak are classified as deep peat, which is as deep as 1.5 m to 21 m. Peat or highly organic soil is a major problem in the infrastructure development of the coastal areas in Sarawak. Peat soils are generally considered as problematic soil in any construction projects, because of its high compressibility and very low shear strength. With the rapid industrialization and population growth, construction is scheduled almost everywhere including peat-land area. With respect to construction on soft soils, selection of an appropriate method is governed by a number of factors such as:

- Type and classification of roads
- Design settlement criteria imposed
- Type and thickness of peat deposits
- Time and adequate fill material sources availability for construction
- Availability of monetary fund allocated for the project

Case history revealed that several construction methods have been applied in Sarawak particularly and Malaysia generally. Some of these cases reported significant success with high financial reward while others reported failures and settlement problem after several years of completion. Among the commonly available methods are:

- Displacement method
- Replacement method
- Stage-loading and surface reinforcement method
- Pile supported embankment method
- Lightweight fill raft
- Deep in-situ chemical stabilization
- Thermal precompression

In this study, an attempt is made to propose a new method of construction which is a combination of some of the above. Soil stabilization can be defined as a means of permanently altering soil properties to increase its strength and bearing capacity, and decrease its water sensitivity and volume change potential. Soil stabilization can eliminate the need for expensive borrow materials, expedite construction by improving wet or unstable soil, or allow reduced pavement thicknesses by improving subgrade conditions.

Several researchers have studied the stabilization of clay or soft soil by cement such as Andersson et al. [1], Trzebiatowski et al. [2], and Kok and Kassim [3]. However, most of the studies concentrate on the stabilization of mineral soil such as clayey soil, silty clay and dispersive soil.

There are few studies, such as Huttunen et al. [4], that discussed on the stabilization of highly organic soil or peat. The present study concentrates on the stabilization of the highly organic soil samples, collected from Matang, Sarawak, with different types of admixtures (i.e. cement, fly ash, and lime) and their various combinations.

Finite Element Geotechnical Engineering software will be used to study the behavior of peat soil. Currently there are two types of specialist geotechnical engineering software available in the market namely PLAXIS and CRISP. PLAXIS was developed by the Delft University, Holland and CRISP by the Cambridge University, UK. The suitability of both software in simulating peat soil have not yet been well tested.

This study, therefore, aims to find the suitable stabilizer and the optimum mixing quantity for stabilizing the local peat soil from Matang. In addition the stabilized peat is complemented by lightweight foundation (foam concrete) in which a construction guideline is formulated based on numerical and field studies.

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A Trickling Filter with Spherical Hollow Perforated Plastic Medium in Hexagonal Closest Packed (HCP) Arrangement

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Malaysia Environmental Quality Act and Regulation states that the allowable Biochemical Oxygen Demand (BOD) level in sewage and industrial effluent discharge is 50.0 mg/L or less [1]. Based on Malaysia Interim National Water Quality Standards, water bodies of good quality (Class IIB) compliance limits for Ammoniacal-Nitrogen (NH_3-N) and Biochemical Oxygen Demand (BOD) are 0.3 mg/L and 3.0 mg/L, respectively [1].

Removal of Ammoniacal-Nitrogen (NH_3-N) and organic matters from wastewaters can be achieved by biological process. As wastewater passes over or trickles down the trickling filter medium covered with biological film or slime layer (approx. 0.1 to 0.2 mm thick) with attached microorganisms (such as aerobic, anaerobic, and facultative bacteria; fungi, algae and protozoa), organic matters would be adsorbed and degraded [2, 3]. Bacterial population in trickling filter would carry out nitrification process that would sequentially oxidize ammonium to nitrate with intermediate formation of nitrite by nitrosomanas and nitrobacter. These organisms are considered autotrophic because they obtain energy from the oxidation of inorganic nitrogen compounds. The two steps in nitrification process can be expressed as follows [2, 3]:

1. Ammonia is oxidized to nitrite (NO_2-) by Nitrosomanas bacteria.

$$2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$$

2. The nitrite is converted to nitrate ($N0_3$-) by Nitrobacter bacteria.

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

Once the nitrate is formed, wastewaters would flow to a clarifier and continue on through a denitrification process to reduce the nitrate to nitrogen gas that is released into the atmosphere. The proposed trickling filter consists of spherical hollow perforated plastic medium (40mm in diameter) in hexagonal closest packed (HCP) arrangement over which wastewater is distributed to trickle through. This novel system is believed to provide a relatively more cost-effective process for treatment of wastewaters.

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A Study on the Long-term Deflection and Debonding Behavior of Reinforced Concrete Beams Strengthened with FRP Sheets

by
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Serviceability of concrete can be defined as satisfactory performance under service load conditions, which in turn can be described in terms of two basic parameters namely cracking and deflection. Deflections constitute one of the important serviceability criteria in the design of concrete structures. To keep the deflection of reinforced concrete (RC) members within allowable limits, in addition to appropriate design and construction procedures, the use of appropriate materials like short fiber reinforcements to provide higher beam stiffness and better crack control, have been recommended by ACI Committee 435 (1995). Recent studies have shown that external bonding of Fiber Reinforced Polymer Sheets (FRPS) is an effective method to strengthen and retrofit deteriorated or damage reinforced concrete or prestressed concrete structures. However, the long-term serviceability of such FRP-strengthened beams is still a concern due to lack of long-term performance data. Another problem which limits the full utilization of the material strength is the premature failure due to debonding of FRP sheets.

In this research project, both the theoretical and experimental study will be carried out to investigate the debonding and the short and long-term performances of FRP sheet strengthened Reinforced Concrete (RC) beams. The main focus of this research is to gain proper understanding on the debonding and long-term behaviour of the FRP sheet strengthened concrete structures and also to develop reliable analytical modelling technique in agreement with the experimental results. The availability of the component materials especially the fiber sheet and the suitability of such strengthening technique with respect to the local context will also be investigated.

Progress:

Milestone	Progress
Literature review and material collection	On going
Analytical and numerical development	On going
Construction of specimen and completion of experiments	Not available
Analysis of results	Not available
Report writing and publications	On going

Papers/publications related to this project:

[1] Ehsan Ahmed. A Study on the Long-term Deflection of Externally Bonded FRP Sheet Strengthened Beams. International Seminar on Civil and Infrastructure Engineering, 11-12 June 2008, Faculty of Engineering, Universiti Technologi Mara Malaysia, Shah Alam, Selangor, Malaysia.

[2] Ehsan Ahmed, ALM Mauroof and M. Ibrahim Safawi M.Z. Concrete Beams with Externally Bonded Flexural FRP Reinforcement: An Investigation of Time-Dependent Deformation. 2nd Engineering Conference on Sustainable Engineering Infrastructures: Development & Management, December 18-19, 2008, Kuching, Sarawak, Malaysia.
(*Full paper accepted*)

Theoretical Development of Fuzzy Logic-based Assessment Model for Failure Evaluation Problem in Manufacturing

by
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Fuzzy set related methods have been used to provide assessments to situations/objects in subjectivity evaluation problems [1]. For example, evaluation of creditworthiness of a customer in a bank, car comfort evaluation [2], evaluation of risk in Failure Mode and Effect Analysis (FMEA) methodology [3, 4], academic assessment [5], evaluation of characteristics of a set of sites as potential scientific research reserves and land suitability assessment [6], etc. From logical point of view, a fuzzy logic-based assessment model should include and fulfill several theoretical properties such as validity and compatibility amongst others [7]. In reality, however some experiments have shown the failures of fuzzy logic-based assessment model to fulfill those properties [4, 7] and it causes fuzzy logic-based assessment models to give illogical assessment results.

In this research, we propose to investigate theoretical properties, associated to fuzzy inference system (FIS)-based assessment models, in giving logical and meaningful assessment results. We propose to define and to formulate these properties mathematically, and derive the conditions for FIS assessment models to fulfill these properties using mathematical approach. From the mathematical derivation results, a novel procedure for fuzzy logic-based assessment models construction is expected to be proposed.

To verify the derivations and the proposed procedures, experiments will be conducted with data collected from manufacturing processes, and failure risk evaluation model, i.e. Bowles Fuzzy RPN model, will be applied. A prototype for FMEA with Bowles Fuzzy RPN model [3, 4] will be developed using Matlab. With the prototype, information in "If-Then Rules" format will be collected from engineers at Motorola Technology (M) Sdn. Bhd, Penang. Assessment results will then be simulated. With the help from the engineers, we will further evaluate the simulation results. In addition, ability of the proposed novel procedure to fulfill these proposed properties will be tested.

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Design and Development of a Solar-based Pepper-berries Dryer

by
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This research project concentrates on the design and development of a solar-based dryer for the pepper-berries drying application. The project can be divided into two stages, which are the design and the development stages. During the first stage, critical parameters such as the properties, characteristics and the drying-curve of the pepper-berries are to be determined. These parameters can aid in the design of a more suitable dryer in the later stage. A computational fluid-dynamics solver can then be utilized to perform computational simulation on the dryer, to ascertain the appropriateness of the final dryer design. The computational solver can perform the simulations to obtain visual presentations such as the air-flow patterns and transfer of heat within the solar-based dryer. These presentations or plots can also further assist in the determination of the most appropriate dryer design. In the second stage, the development and fabrication will be carried out based on the established parameters and the dryer design. In this manner, an optimized solar-based pepper-berries dryer can be constructed. This finalized dryer will then be applied in the sub-rural and rural plantations or farms as means of helping the farmers in processing their pepper-berries.

Design and Development of a Mechatronic Harvester for Harvesting Pepper in Typical Terrains

by
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Pepper vines are usually found on hilly terrain as they grow well in such condition. This makes the pepper harvesting process laborious, hazardous and time consuming. This project aims to design and develop a mechanized pepper harvester that will be used at Pepper Plantation. The said design will employ robot technology as the project aim is to mechanise the process. The design will consist of a chassis that forms the body of the robot. The chassis also housed a manipulator arm that will be designed to cope with a 4 metre length as this is the height of an average pepper vines. The manipulator will be connecteded to end-effectors that will be specially design for this purpose.

Figure 1 shows a preliminary conceptual design for the Pepper Harvester. First, the design was detailed out using Axiomatic Design concepts to ensure the proper functions and requirements are in place. In addition, information regarding the problems associated with pepper harvesting were conducted through surveys and interviews with farmers and the Malaysia Pepper Board (MPB) agency official. Once all the parameters were acquired, Computer Aided Design (CAD) software was engaged to outline the detail. Current concept employs the use of flexible wheels, such that it can be replaced to mount the chassis on a rail.

Figure 1: Preliminary Design of a Mechanise Pepper Harvester.

Hydrosystems for Integrated Control of Flood and Low Flow for Sarawak River Basin

by
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Hydrosystems is a term which describes collectively the technical areas of hydrology, hydraulics and water resources including the application of economics, optimization, probability, statistics and management [1]. In other words, to achieve integrated water resources management in Sarawak River Basin, the approach is to see the basin as a system. By understanding the characteristics and components of this system, only then effective sustainable development and management could be implemented in the basin. Figure 1 depicts the components for the integration concept for Sarawak River Basin. This research project is focusing more on the water resource component for the Sarawak River Basin. It can be seen as the first initiative towards integrated management and development of Sarawak River Basin. Thus, the main objective of this project is to understand the high flow and low flow characteristics of the basin through flooding frequency and low flow analysis and to develop a framework or interface for the integrated management of the water resource in the basin so that the excess water during high/flood flow could be better utilized especially during the dry season/low flow.

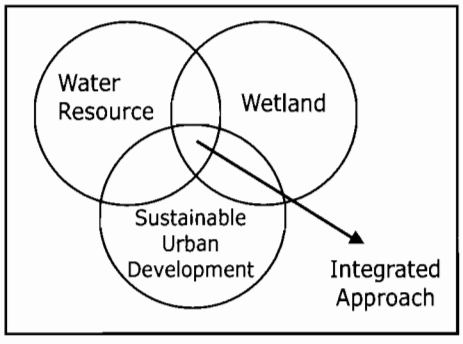

Figure 1: Integration Concept for the Sarawak River Basin [2].

Progress:

In terms of understanding the characteristics of high flow of the basin, the research team has performed rainfall frequency analysis for 23 rainfall stations in the basin based on Daily Maximum Rainfall (DMR) by using Extreme Value Type I distribution in reduced varied (Figure 2). The result is a graph of Daily Maximum Rainfall (DMR) divided by Average Daily Maximum Rainfall (ADMR) versus reduced variate that could be used for flood estimation in the basin based on the regionalization map and formula developed by Selaman [3].

The low flow analysis is still an on-going study. Though the basin does not face much problem in terms of water requirement during the drier month, records have shown that severe drought had occurred six times in the basins between the year 1963 to 2001. With the current growing development in the basin, where the population continues to increase and also the possibility of climate change in the basin (the research team have noticed some trend in the low-flow data collected between 1960 to 2007, though it is still under further investigation), it is necessary to have a low flow study in this basin so as to better prepare for the low flow situation in the near future. One of the ways of preventing low flow period from influencing the routine activities in the basin is to have a long storage where excess water during high flow could be stored in a stretch of the river and used during low flow.

The research team is currently looking into a suitable location along the basin for this purpose. The development of a simulation model could help in modeling the excess water and the impact of storing this excess water to the basin as a whole. To accomplish that, the research team have developed a hydrologic model of the basin using ArcGIS and Infoworks RS softwares (see Figure 3). A test run on the software has been done but it still need some calibration and validation to refine the model. The research team is currently working on the refinement of the model.

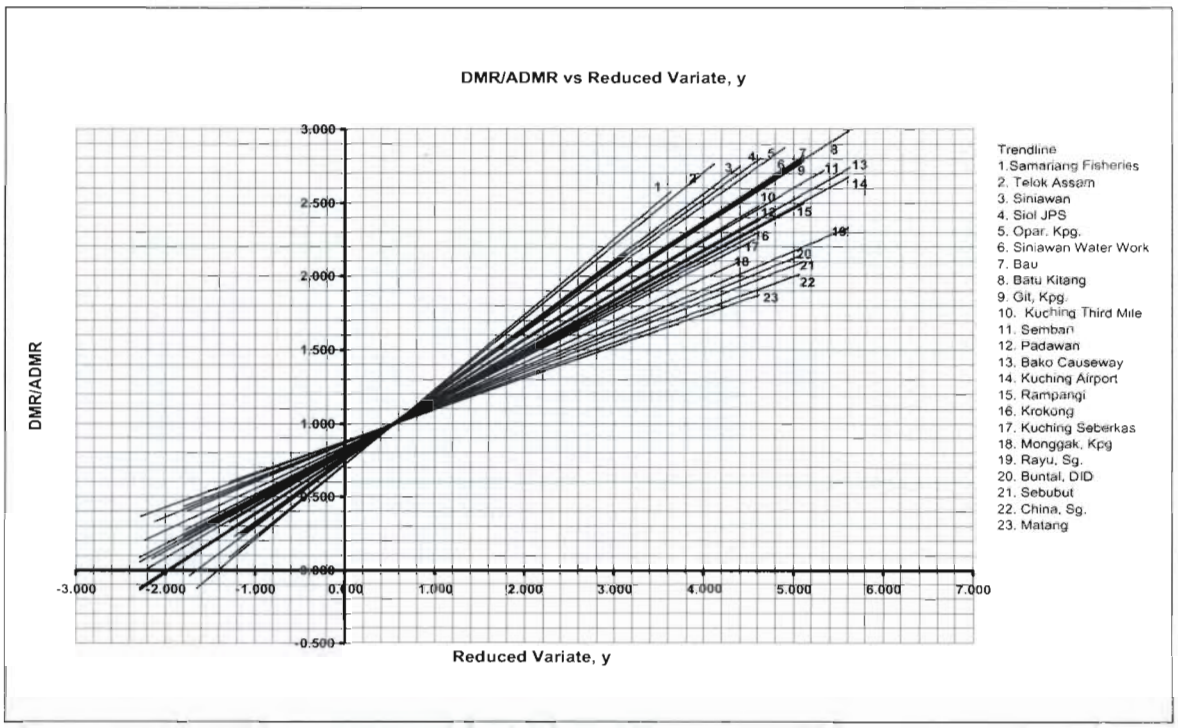

Figure 2: Trendlines for DMR/ADMR versus Reduced Variate for the 23 stations in Sarawak River Basin.

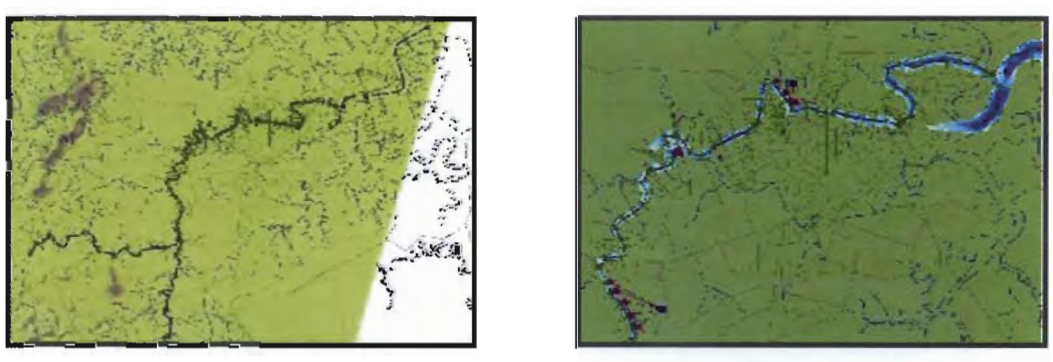

Figure 3: The Basin Wide Model of the Sarawak River Basin (left) and the Test Run using the February 2003 Flood Data (right).

In the research team effort to initiate integrated water resource management in the basin, the team plan to conduct a workshop involving the stakeholders involved in the basin so as to have a common goal and objective in managing and developing the basin. Logical framework has been proposed by the research team as the tool to communicate between these various stakeholders and a sample showing part of the logical framework is shown in Table 1. With this logical framework, it is hope that it could be used as the interface or common platform for sustainable development and management of the basin, thus achieve the third and final objective of this project.

Table 1: Logical Framework Matrix for Water Supply in the Sarawak River Basin [4].

Objective Summary	Objective Indicator	Mean of Verification	Assumption
Ultimate Goals 1. Improving standard of living and sustainable development.	1. Sarawak River cleanliness is maintained 2. Balanced water supply and demand	1. River Water Quality Monitoring Reports 2. KWB Annual Report	
Objectives 1. Sufficient water supply from Batu KitangWater Treatment Plant (WTP) and salinity intrusion prevented 2. Dam Bengoh in operation	1.1 Clean Water quality standard is fulfilled, and 1.2 Raw water quality fulfil the Interim National Water Quality Standard (INWQS), also for 3. 2. A number of new WTPs to increase capacity up to 1965 MLD for supplying beyond 2030	1.1 KWB Annual Report 1.2 River Water Quality Monitoring Report 2. WTPs Specification and KWB Annual Report 3. See 1.2 2.1 Laws of Sarawak 2.2 KWB report	**Objectives to ultimate goals** 1. Joint operation rule for Weir and Dam Bengoh to reduce upstream flood in conjunction with Weir Kiri crest level of 1.5 m above MSL, and the use of navigation lock at Weir Kiri for sediments flushing can be set up. 2. See 1 above, and fulfilment of EIA requirement
Outputs 1. Weir in operation 2. Construction of Dam Bengoh	1.1 Batu Kitang WTP capacity increased to 484 MLD for supplying beyond 2010 1.2 Raw water quality fulfill the Interim National Water Quality Standard (INWQS) 2 Estimated Fund of RM 226.1 millions and Tender Document	1.1 Brief Notes (Ref.1) 1.2 Water Quality Monitoring Report 2. Proposed Bengoh Dam (Ref.2) and Construction Supervision Report	**Outputs to Objectives** 1.1 Appropriate weir operation rule; 1.2 Operation of Navigation Lock at Kuching Barrage can be adjusted (due to the decreasing demand in inland navigation) to reduce saline intrusion; and 1.3 Riparian wetlands are conserved 2. Funds is available
Activities 1. Construction of Weir Kiri 2. Planning and design of Dam Bengoh 3. Clean River Water Movement 3.1 Sewage and Wastewater Treatment Planning and Implementation 3.2 Restoration of abandoned gold mine at Town of Bau	**Inputs** 1. Estimated budget of RM 22 millions 2. Budget required 3. Budget required 4. Budget required 5. Other pre-condition requirement for 1, 2, 3, and 4	1. Brief Notes (Ref.1) 2. Proposed Bengoh Dam (Ref.2) 3. The Study of Arsenic and Mercury Pollution of Tasik Biru and the Catchment of Bau and Siniawan Water Intake (Ref.3)	**Activities to Outputs** 1. Fund is available (also for 2, 3, and 4) 2.1 Approval of detail design 2.2 Relocation few villages can be settled 2.3 Environmental concern with vegetation removal and construction of dam is applied as addressed in EIA

Papers/publication related to this project:

[1] Bong, C.H.J. and Putuhena, F.J. (2008). Logical Framework for Managing Sarawak River Basin through Integrated Hydrosystem Approach. Bulletin of the Institution of Engineers, Malaysia, Bil. 2008, No.6, pp. 16 -19 (ISSN: 0126-9909).

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