



## Research Paper

# Integrated river basin management approach to support flood disaster strategies for the Pahang River Basin, Malaysia

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## ABSTRACT

Flood is the most significant natural disaster in Malaysia in terms of frequency, area extent, population affected and damage. Heavy rainfall during North East Monsoon affecting the east coast of Peninsular Malaysia (widespread flood). Intense rainstorms during inter monsoon periods of April-May and August-October cause flash floods in major towns in Malaysia. Recently, Pahang State has been affected by extreme flood that had different phenomena as annual flood events in this area. Thus far, different types of flooding and causes of flooding in Malaysia have been identified, such as extensive basin flood (riverbank overflow), inundation basin flood (backwater effect from tidal influence affecting lower reaches), inland flood (poor drainage from inland flood prone area) and urban flash flood (inadequate drainage and storage systems to cater for rapid urbanization). However, these characterizations are very general and they are not intended for an integrated approach for a holistic flood disaster management in any river basin so as Pahang River Basin. This study focuses on Integrated River Basin Management approach to support flood disaster strategies for the Pahang River Basin in Malaysia. It describes the root cause and nature of flood in Pahang River Basin, the flood impact and some management and mitigation approaches or strategies for this basin. The Pahang River basin is continuously facing environmental disaster in spite of the river disaster strategy that has been implemented through planning and development program. This implies that the existing governance is not effective and if participation of stakeholders with social learning is included in the governance, a more effective reduction of environmental disaster risk in the basin will be achieved.

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## INTRODUCTION

The study on Integrated River Basin Management Approach to Support Flood Disaster Strategies for the Pahang River Basin, Malaysia is carried out as part of Transdisciplinary Research Grant Scheme (TRGS) on Integrated Water Resources Management approach for Supporting Integrated Flood Disaster Management Decisions, funded by the Ministry of Education Malaysia as a proactive action to prevent and mitigate issues related to floods in Malaysia. Flood is the most significant natural disaster in Malaysia in

terms of frequency, area extent, population affected and damage. Major flood recorded was in 1926, followed by 1949 and 1971. It has been estimated that 9% of land area (29, 800 km<sup>2</sup>) in the country is prone to flooding, 22% of the population (4.82 million) is affected by floods and the average annual flood damage is about RM 1 billion. Heavy rainfall during North East Monsoon affects the east coast of Peninsular Malaysia. Intense rainstorms during inter monsoon periods of April-May and August-October causing

flash floods in major towns in Malaysia (Abidin 2004).

So far, several types of flooding and causes of flooding in Malaysia have been identified; they are extensive basin flood (riverbank overflow), inundation basin flood (backwater effect from tidal influence affecting lower reaches), inland flood (poor drainage from inland flood prone area) and urban flash flood (inadequate drainage and storage systems to cater for rapid urbanization (Nasly et al., 2013). However, these characterizations are very general and they are not intended for an integrated approach for a holistic flood disaster management in any river basin so as Pahang River Basin. Hence, there is a need to focus on Integrated Water Resources Management (IWRM) as well as Integrated River Basin Management (IRBM) approach to support flood disaster strategies for the Pahang River Basin in Malaysia.

IRBM is a holistic approach to manage entire river basins. It is the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximise the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems (GWP, 2000). The best approach to conserving the world's freshwater resources is through managing river basins sustainably; balancing/maintaining resource use with the dynamic, living systems in the long term.

The Pahang River Basin is formed with hill forests, plain land forests, wetland with rich biodiversity. Continuous anthropogenic development such as logging, earth cutting, construction works and so on throughout the river basin has been opening up with the top soil. Associating with natural factors such as huge rainfall runoff from upstream with rapid erosion cause frequent natural disaster like flood. Water related problems can only be effectively dealt with, through a collaborative effort by many stakeholders together with inputs from many technical disciplines. There is a need to use IRBM as an approach towards understanding the characteristics of the whole basin and covers the water resource management including social, environment, biodiversity conservations and economic activities.

Flooding is a major hazard in Pahang River Basin and it has been a central focus of the federal state and local government of Malaysia for many decades. In December 2014, Pahang State has affected by extreme flood that had different phenomena as annual flood events in this area. The prolonged flood (2014-2015) in Malaysia affected a great number of people's livelihood, socio-economic wealth and country's natural ecosystem along the East Coast of Peninsular Malaysia. The Pahang River basin is continuously facing the environmental disaster in spite of the river disaster strategy implemented through planning and development program (DID, 2015). This implies that the existing governance is not effective and if participation of stakeholders with social learning is included in the

governance, a more effective reduction of environmental disaster risk in the basin will be achieved.

## **METHODOLOGIES**

### **Research initiatives**

Government of Malaysia has taken significant measures to tackle this threat through an integrated and multi-sectorial manner. Ministry of Education Malaysia called for proposals to deal with this issue through fundamental and trans disciplinary problem solving holistic research. Initiative taken by the IWRM Research Group of UKM to carry out Trans-Disciplinary Research called Trans-Disciplinary Research Grant Scheme (TRGS) focused on Integrated Water Resources Management Approach to support integrated flood disaster management decisions for the Pahang River Basin in Malaysia. The integrated approach within the context of IWRM incorporated a number of important disciplines to provide necessary information and research endpoints in order to develop a decision making process for a holistic and integrated flood risk management in the Pahang River Basin. This integrated approach is very important while the traditional approach mainly through structural measures failed to reduce risk of flood disasters in many river basins such as Pahang River Basin in Malaysia as shown in Figure 1.

### **Research objectives**

The objectives of this study are (i) to understand the basin characteristics of Pahang River Basin and identify the source of flood disaster; (ii) to estimate pre and post environmental impact of flood disaster as a part of good governance for disaster risk reduction in this area towards safe habitat for human community and other biodiversity; and (iii) to develop an integrated framework, strategies, information and communication system for Pahang River Basin in order to raise awareness and the involvement of all stakeholders in Pahang River Basin.

### **Study area**

The Pahang River basin is located in the eastern part of Peninsular Malaysia between latitude N 2° 48' 45" and N 3° 40' 24" and between longitude E 101° 16' 31" and E 103° 29' 34". The catchment of Pahang River lies in the state of Pahang, Malaysia. Basin area is about 29,300 km<sup>2</sup> which 27,000 km<sup>2</sup> lies within Pahang (about 75% of the state) and 2300 km<sup>2</sup> is located in Negeri Sembilan (Yasuto et al., 2004). The maximum length and breadth of the catchment are 205 and 236 km, respectively. Pahang River is the longest river in Peninsular Malaysia of about 440 km long.

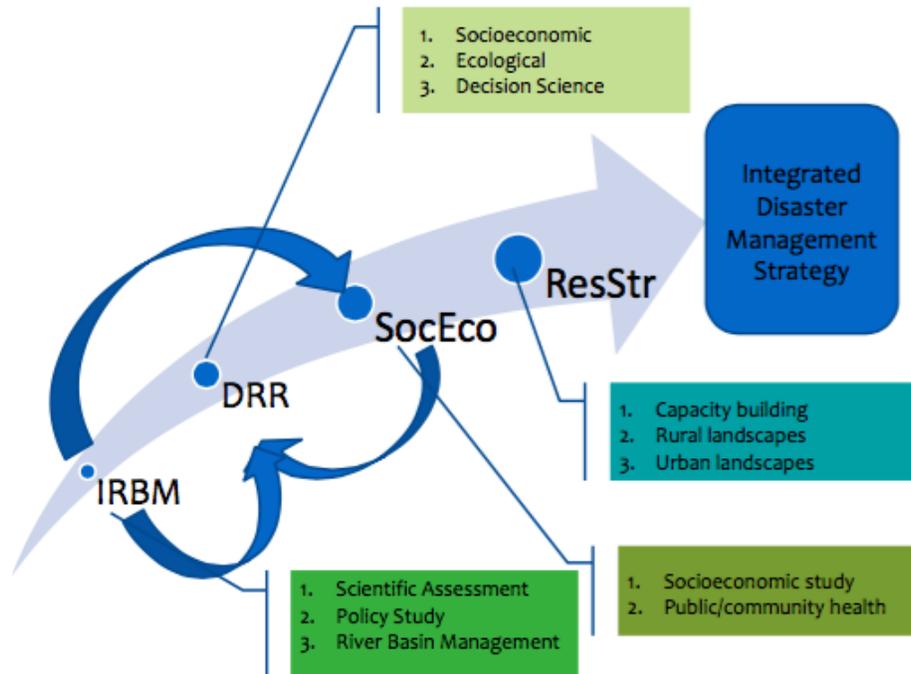


Figure 1: Integrated disaster management strategy.

Pahang river comprises a myriad of tributaries draining into the main river channel.

This study focused on three main districts in Pahang River Basin, Malaysia which are Jerantut (upstream), Temerloh (midstream) and Pekan (downstream) as shown in Figure 2. Water related problems can only be effectively dealt with through a collaborative effort by many stakeholders together with inputs from many technical disciplines. Integrated River Basin Management (IRBM) is an approach towards understanding the characteristics of the whole basin and covers the water resource management including social, environment, biodiversity conservations and economic activities. Basin Characteristics of Pahang River Basin is shown in Table 1. The Pahang River Basin is very influenced to support many source of works and connecting major districts in Pahang.

### Research methodologies

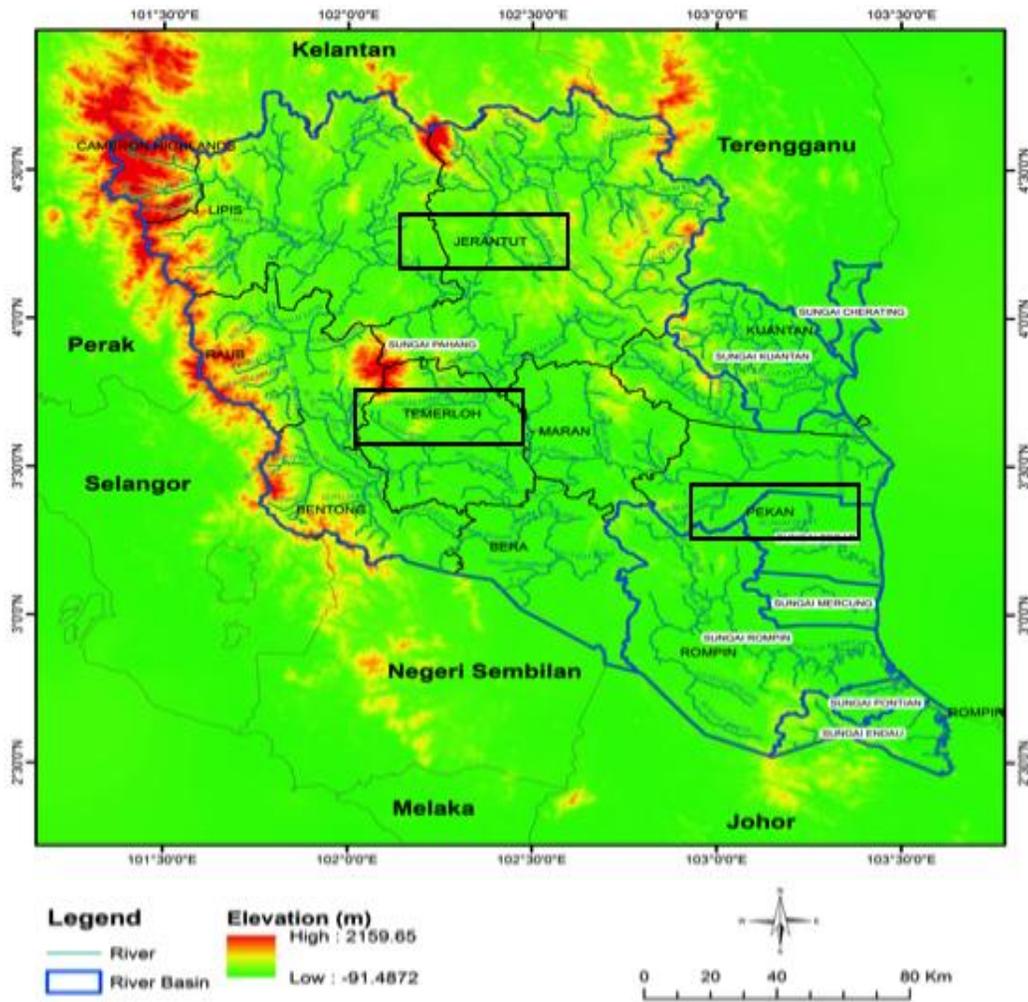
The overall research methodologies are shown in Figure 3 which include (i) Data collection from literature review and basin characteristics in Pahang River Basin; (ii) Site visits and Interview including site survey, observation, interview to gather more information and verify the issues, causes, impacts and other related factors; (iii) Stakeholder consultation workshop to get responses and opinions from the community and stakeholders, exchange information, and raise awareness; and (iv) Integrated Framework Development which includes development of strategies, information and communication system.

### RESULTS AND DISCUSSION

Data collection on flood issues and basin characteristics in Pahang River Basin were done. Data and information gathered from previous studies such as Flood Report, Hydrological data (Rainfall, Sediment, Water Level, Water Discharge) allowed for identification of the root causes of changes in Pahang River Basin. From the series of site visits and interview of District Officers, Hydrology Officers of DID, Chief District, and community conducted in Pahang River Basin managed to identify and verify the issues, factors or main causes, as well as proposed some actions that can be taken to overcome those issues as shown in Table 2 and Figure 4.

The stakeholders consultation workshop was conducted in order to consult relevant stakeholders (including community) in Pahang River Basin and verify previous collected data on Pahang Flood Disaster, to gather more data and information from various stakeholders related to Pahang Flood Disaster for IRBM Study on Pahang River Basin, and to develop good cooperation and research collaboration with Pahang related stakeholders such as Jabatan Pengairan dan Saliran (JPS), Jabatan Perancangan Bandar dan Desa (JPBD), Majlis Keselamatan Negara (MKN), Jabatan Pertahanan Awam (JPA) and local authorities. From the stakeholders' consultation workshop, responses and opinions from the community and stakeholders are summarized as shown in Table 3.

Analysis of the questionnaire distributed during the workshop (Figure 5) showed that the flood management issues in river basin are mostly critical after the flood



**Figure 2:** Study Area at Pahang River Basin - Covers 3 areas, that is, Jerantut (Upstream), Temerloh (Midstream) and Pekan (Downstream).

**Table 1:** Basin characteristics.

River characteristics	Description
Location	Latitude N 2° 48' 45" - N 3° 40' 24", E 101° 16' 31" - E 103° 29' 34"
Maximum length	205 km
Maximum breadth	236 km
Catchment area	25,600 km <sup>2</sup>
Main geological features	Shale, Mudstone, Limestone and rock
Main tributaries	Tembeling river (5050 km <sup>2</sup> ), Jelai river (7320 km <sup>2</sup> )
Main reservoirs	Southern Abu bakar Dam of TNB, Chini Lake & Bera Lake
Mean annual precipitation	2170 mm
Land use	Virgin jungle, rubber, paddy, Oil palm, agricultural crops, urban

Source: Saher et al. (2012).

occurred (Issues A-I) rather than before or during the flood (the most critical issues are water level decreases, sedimentation and river banks changes). Very different situation for issue J (workshop participants felt that there is

no party managing the river) whether before or after flood (in fact the worst or reduced during flood). While for issue K (Community involvement level), there was highest score during flood and after flood compare with before flood. It is



Figure 3: Methodology.

Table 2: Main issues from Site Visits and Interview.

No.	Main issues	Factors	Proposed Actions
1	Stagnant water slowly receded	Area that should hold the water have been developed	Avoid development in the 'hold-water' area in the future
		Bad irrigation	Improve irrigation system
2	High flood water level	Bad drainage and irrigation system	Improve drainage & irrigation system
3	High flood water current	Loss of forest area to absorb the heavy rainfall	Law enforcement on the responsible party who did the logging
4	Flood caused by overflow	The river received water more than its carrying-capacity from heavy rainfall and also due to high sea tide	Build dam or structure that can help the river to hold the water
5	Difficulty in maintaining the drainage and irrigation of flood area	Flood occur every year & high-cost maintenance	Community should involve in the maintenance of the river to cut cost
6	Shallow river	High sedimentation	River deepening
7	Some people refused to move early	The community think that the water level will not be too high & take it for granted	Increase awareness among the community
8	River bank erosion	Loss of big trees along the river bank	Build wall at the river bank, plant ecologically-resistance plants that can strengthen the banks
9	Damaged fishery area	Flood water washed out	Move the fishes to more appropriate place before the flood event

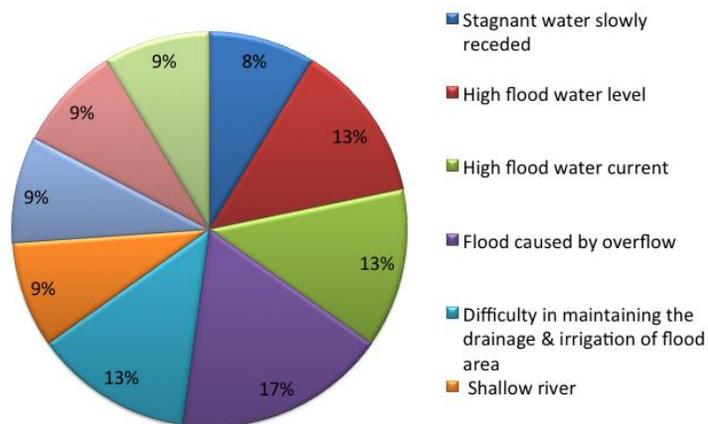
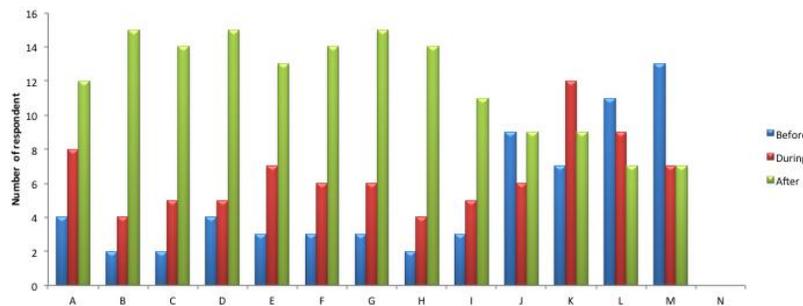


Figure 4: Flood main issues from the site visits and Interviews.

**Table 3:** Main issues from stakeholders consultation.

Main Issues	Factor	Proposed Action
1 Development on swamp areas	High human growth population	Avoid development in the 'hold-water' area in the future
2 Heavy rainfall at upstream of Pahang river	Heavy rainfall caused by monsoon season	Build dam or structure that can help the river to hold the water
3 Telemetry system problem	No maintenance	Increase maintenance
4 Blockage in the river	Heavy rainfall carry the trees into the river due to loss forest area to absorb the heavy rain	Law enforcement on the responsible party who did the logging
5 Lack of clean water resources	Non-functioning pump system caused by clogged sediments	Improvise the pump system
6 Lack of allocation	High-cost maintainence	Increase the allocation for flood mitigation



**Figure 5:** Workshop questionnaire analysis on flood management Issues on River Basin.

Note:

- A : Water pollution/ Quality decreases
- B : Water level decreases
- C : Erosion
- D : Sedimentation
- E : Surrounding vegetation changes
- F : Aquatic life/Wildlife changes
- G : River banks changes
- H : Bridges/Road structure changes
- I : Building structure changes
- J : No party managing the river
- K : Community involvement level
- L : Preparation of management in dealing with the flood
- M : Flood warning system functions
- N : Others

also found that preparation of management in dealing with the flood as well as the flood warning system functions (Issues L & M) are most problematic before the flood which will need to improve in the future in order to avoid the occurrence of same issues in Pahang River Basin and ensure the safety and security of community wellbeing.

In term of issues faced by community in Pahang River Basin(Figure 6), they mostly faced most difficult situation during the flood as compared with before and after flood (Issues A-G & K-M), especially on Food supply issue (most critical) followed by medical supply and personal safety

issues. Only for issue H (Sources of income changes) is more problematic after the flood (where some of them have lost their jobs and businesses or source of incomes). In term of Information network to community (Issue I), community faced more problem during and after the flood. Lastly, community faced more significant issue on flood warning system understanding (Issue J) before and during flood.

The overall issues and strategies, as well as actions need to be done by specific stakeholders that were identified during this study in Pahang River Basin for integrated

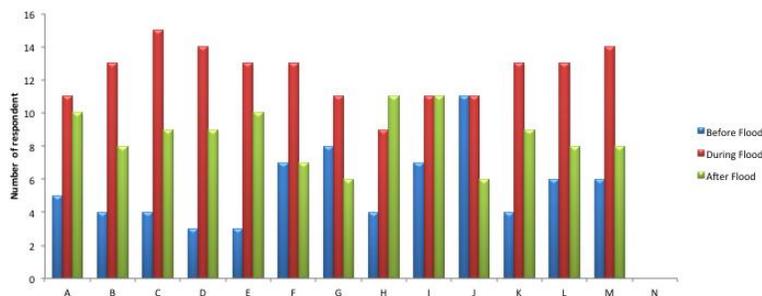


Figure 6: Workshop questionnaire analysis on issues faced by community.

Note:

- A : Clean water supply
- B : Power supply
- C : Food supply
- D : Medical supply
- E : Clothes supply
- F : Toilet facilities
- G : Availability of things/ stuffs for flood preparedness
- H : Sources of income changes
- I : Information network to community
- J : Flood warning system understanding
- K : Availability of flood relief center
- L : Property safety
- M : Personel safety
- N : Others.

**Table 4:** Proposed issues and strategies for each stakeholder in Pahang River Basin.

Stakeholders	Issues	Strategies
Government/ management agency	<ul style="list-style-type: none"> <li>• Lack of allocation</li> <li>• No site visit from responsible person</li> </ul>	<ul style="list-style-type: none"> <li>• Provide more allocation</li> <li>• More site visit from responsible person</li> </ul>
Private agency/donator	<ul style="list-style-type: none"> <li>• Lack of food supply</li> <li>• Lack of cooperation</li> <li>• Lack of awareness event</li> </ul>	<ul style="list-style-type: none"> <li>• Continue and increases in supplying the needs</li> <li>• Deal more with management</li> </ul>
Non-Government Organization (NGO)	<ul style="list-style-type: none"> <li>• Lack of cooperation</li> <li>• Lack of involvement after flood</li> </ul>	<ul style="list-style-type: none"> <li>• Increases in supplying the needs</li> <li>• Give more cooperation</li> </ul>
Researcher/ University	<ul style="list-style-type: none"> <li>• Research done was not comprehensive</li> <li>• No input</li> </ul>	<ul style="list-style-type: none"> <li>• Give more input</li> <li>• Give more concern</li> </ul>
Local Authority (PBT)	<ul style="list-style-type: none"> <li>• No maintenance on involved area</li> <li>• No discussion with community</li> <li>• Not enough evacuation equipment e.g. boat</li> </ul>	<ul style="list-style-type: none"> <li>• Do proper maintenance</li> <li>• Do discussion with community and responsible agency</li> <li>• Provide more boat</li> <li>• Give more allocation</li> </ul>
Land & District Office (PDT)	<ul style="list-style-type: none"> <li>• Lack in flood management</li> <li>• Not enough allocation for flood relief</li> </ul>	<ul style="list-style-type: none"> <li>• Improve and enhance the flood management</li> <li>• Give more allocation</li> </ul>
Community	<ul style="list-style-type: none"> <li>• Lack of cooperation</li> </ul>	<ul style="list-style-type: none"> <li>• Be more alert &amp; give good cooperation</li> </ul>

management and development in the future (Table 4).

### CONCLUSIONS AND RECOMMENDATIONS

Natural flood disaster has been really common occurrence

in Pahang. However, the effects of this phenomenon are getting worst judging from recent floods. The management of water resources should be handled in appropriate ways based on policies and strengthened institutional arrangements. Under the concept of IRBM, the whole river

basin should be planned in an integrated manner and all factors are taken into consideration when a certain development plan was proposed.

The study has lot of potentials for significant contribution to reduce environmental hazard and improve the habitat and natural characteristics of this basin. Effective flood management requires a coordinated, integrated approach that uses structural defenses at the edge of the floodplain as well as wise land use planning and restraints on construction within floodplains. Quantitative assessment of the benefits of land use planning and building regulation requires detail resource intensive analyses that can be prohibitive for many communities.

Observation from the site visits showed that the Pahang riverbanks were getting smaller and weak to support the big trees. Thus, the wall and riverbanks need to be restructured to reduce the environmental impacts and soil damaging. The stakeholders responsible for the management of the Pahang river basin should discuss the issues in an organized workshop. Information collected through the stakeholders consultation workshop conducted has shown a great response from community and stakeholders to work together and better prepare for any flood disaster events in the future. Stakeholders' consultations and involvement are the keys to successful IRBM approach to achieve targets of this project.

There is a need for integrated stakeholders and community engagement to deal with flood related issues. For a flood risk management plan to be successful, it needs an integrated participation from various stakeholders and community, hence it needs to involve a vast range of stakeholders and to inform and involve the public.

There is a need to strike a balance between structural and non-structural measures in order to gain the most successful long-term flood risk management strategies, hence development and implementation of River Basin Management Plans need to be developed.

The study also identifies the necessity for capacity building for stakeholder and community in Pahang River Basin, hence it needs to raise public awareness about the key issues linked to its implementation, as well as the need to identify root cause and nature of flood in Pahang River Basin, the flood impact and some management and mitigation approaches or strategies for this basin. The understanding, the required resources, and the best and

worst case scenarios are pertinent in making better decisions.

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