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FLOOD RISK MANAGEMENT: AN INTEGRATED APPROACH IN SUSTAINING HUMAN AND ENVIRONMENTAL SURROUNDING

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ABSTRACT

Human environmental interaction exists in almost every part of the world. This illustrate that humans need the environment to survive and to carry out activities. This need can also be expressed through the exploitation process of a single area in the environment. The exploitation process performed by humans can either occur sustainably or unsustainably. Therefore, this paper aims to explore how the "flood risk management approach" helps to preserve the social surrounding and the environment, specifically in the context of the natural flood plains exploitation. To achive the objectives of this study, the analysis includes a review of the characteristics and causes of floods in urban areas and flood plains, the types of flood management approaches implemented in Malaysia and how the "flood risk management approach" is considered an integrated and sustainable approach to be used in flood plains. In Malaysia, the "flood protection approach" is used as a medium to manage floods in urban areas that developed due to urban imperviousness. Unfortunately, this approach is unsuitable to be applied in all types of area, especially in natural flood plains. This is because, besides being unsustainable, this approach also typically fails to prevent flooding occurence in flood plains. The characteristics and causes of floods in flood plains differ from urban areas. Therefore, the "flood risk management approach" which combines the paradigm of "keeping the water away from people" and "water-based lifestyle" is found to be more integrated and sustainable to be applied in all areas including natural flood plains.

Keywords: Flood management, flood plains, hydrology, hazard management, disaster management, Malaysia

Introduction

Every man dreams of a harmonious, safe and prosperous life. That includes from the aspect of the availability of basic resources. Human needs food, settlement areas, economic resources and so on to survive. All these resources were naturally available around us in the form of unexploited environment. This situation illustrates that human beings are highly dependent on environmental entities to continue their survival by exploiting the environment. Therefore, proper planning and management regarding the exploitation of the environment is very much demanded and must be done wisely to achieve a sustainable environment. In the context of this study, sustainable conditions will be achieved when there is a "win-win" situation. In other words, human beings must be able to exploit the environment and at the same time maintaining a certain balance while using those natural resources.

However, in many cases of exploitation performed by humans still fail to achieve sustainability resulting a “win-lose” situation to exist between human and environmental entities. Among those situation is through the exploitation done in areas of natural flood plains for settlement purposes. The impact of improper flood disaster management which was carried out has caused the ecosystem as well as the landscape of the flood plains to change resulting in environmental damage and extinction of wildlife. Not only that, improper flood mitigation measures carried out in those area can sometimes fail to protect the people from floods. People of the affected will then have to face the impact of this situation in a multi-form of losses and damages towards the insfrastucture, building, bridges, water vessels, large-scale agricultural crops (Qiang et al., 2015), loss of life, injury, infection (Zhang et al. , 2002) and trauma (Haryati et al., 2011).

This situation ultimately leads to the deterioration of the people’s well-being and harmony in life. According to Shah et al., (2015), the level of well-being and harmony of the people is highly influenced by interference facing three aspects, namely economy, safety and health. Due to that, the level of well-being and harmony of the people is also directly related to sustainable development. Therefore, this paper is intended to explore how the flood risk management approach is very useful in dealing with this problem, especially for natural flood plain areas.

Flood Phenomenon In The Context Of Urban Ecosystem And Flood Plains Ecosystem

Floods generally occur naturally or as a result of human activity (Smahi Mohamed et al., 2017). Flood plains are areas that usually experience natural flooding even before the interference of man. This is due to the natural topographic factors of the area which is almost flat (Davies et al., 2008) and located adjacent to rivers, lakes, swamps or other low-lying areas so that water flow cannot

flow quickly when there is rain (Department Of Natural Resources , 2006). The morphology of the flood plains are usually formed widely at the downstream areas of the basin, which are close to the estuary of river or sea (Federal Emergency Management Agency, 2005). Due to the morphological formation of the wider flood plains in areas that are close to the sea, floods that occur in those area are strongly influenced by the tide phenomenon.

During the tide phenomenon, the water catchment flow of the river will be blocked and cannot be drained out to the sea (outlet) completely. In situations like this, even the smallest amount of rainfall can cause flooding due to rapid increase in river discharge. The flood plains in Beaufort for example, often suffer from low-topographic flood occurrence (Waidi Sinun & Jadda Suhaimi, 1996). During the high tide phenomenon, most of the land in the district area of Beaufort has a height that is almost equivalent to the sea level (Johan Aziz, 2016). The natural physical characteristics of flood plains areas with low topography and are close to the water basins can indirectly affect the nature and time period of the floods in those area. According to Norazuan Md Hashim & Siti Aisah Shamsudin (2006), flood phenomenon in flood plain areas that were caused by the monsoons will usually take up a month to fully recedes.

Flood phenomenon caused by human activities usually occurs in urban areas. This is due to the high rate of increase in urban imperviousness done as a result of development and deforestation activities (Noorazuan Md Hashim & Siti Aisah Shamsudin, 2006). Urban landscapes typically does not have high water permeable surfaces due to the lack of greenery and the used of asphalt, cement and concrete to cover the lands. This situation then, disrupts the process rate of water infiltration and interception which is important in controlling surface runoff when it's raining (Adi Jafar, 2013). According to Yayasan Idep (2007), the infiltration rate of areas with high water permeable surfaces is six times better than in urban areas. Thus, it is not surprising that an increase of 60 percent of the urban imperviousness due to development activities will result in a 10 times increase in peak discharge (Ladson, 2004). This is because, the increase in the peak of the discharge is directly proportional to the increase in the amount of surface runoff (Adi Jafar et al., 2016).

The vulnerability or inefficiencies of the urban irrigation system is also one of the factors causing flood (Schueler, 1994). Channel system such as drains and rivers which are too shallow and clogged due to the deposition of solid waste or soil into it contributes to the problem as well (Noorazuan Md Hashim et al., 2011). Besides that, shallow channel system also reduce the traction capacity of the input either in the form of runoff or trough flow (Adi Jafar, 2013). This situation is a catalyst for the the occurrence of excess discharge during downpour. Urban areas with saturated built-up characteristics and inefficient channel system will usually face problems such as flash flood. In flash flood situations, discharge peak usually rises and falls rapidly (Dust Mukherjee, 2016). According to Noorazuan Md Hashim et al., (2011), flash floods will only take a few hours to recede to normal levels. Examples of areas experiencing flash floods due to the increased of urban imperviousness and inefficient channel system are in Chennai, India (Dust Mukherjee, 2016).

Therefore, the causes and nature of flood occuring in a certain area is affected by the differences in the ecosystem. Contributors to the occurrence of floods in the context of urban ecosystems is dominantly influenced by human activities whereas the occurrence of flood in flood plain areas are usually caused naturally. Thus, the causes and nature of different flood events should also be addressed or managed using different strategies. This is because, there is no one type of flood management strategy that is perfect and can achieve optimal effectiveness for all flood situations at any time (Slobodon, 2012). On the other hand, there are some situations that require the combination of several types of flood management strategies to obtain optimal results as applied through the flood risk management approach (Raadgever et al., 2018).

Flood Disaster Management in Malaysia

In other developed and developing countries including Malaysia, the early history of the flood disaster management system begins with the flood protection approach (Tuan Pah, 2009). Countries such as Hungary, the Netherlands and the United Kingdom, for example, have applied this approach as early as the 13th, 14th and 15th centuries respectively (Samuels et al., 2010). The flood protection approach is formed from a combination of prevention strategies and defence strategies. This approach is considered non-holistic because it only focuses on reducing flood hazards with the goal of keeping the water away from people (Raadgever et al., 2018). The implementation of prevention strategies is usually oriented to two mechanisms, namely rapid disposal or rapid flow and resource control. Both of these mechanisms are designed specifically to overcome the problem of floods caused by the increase in the amount of runoff and the reduction of the flow capacity of the riverbed due to the increase in urban imperviousness.

The rapid removal mechanism is applied through the Urban Drainage Manual which is Planning and Design Procedure No. 1: Urban Drainage Design Standards and Procedures for Peninsular Malaysia. This manual serves as a guideline in designing drainage systems in urban areas covering aspects of planning, basic designs, open drainage design, structure, storage, erosion control and deposition. This manual was the first to be used in Malaysia and was printed by Drainage and Irrigation Department (DID) in 1975. However, the implementation of the Urban Drainage Manual through rapid evacuation mechanism has increased flash floods in new development areas. This is because, the rapid removal mechanism cannot accommodate the amount of surface runoff resulting from the active development activities carried out (Lariah Mohd Sidek et al., 2002). Besides, this mechanism is only short-term and not comprehensive because it only transfers the problem of flooding from one area to another. The application of this mechanism also involves large costs and is not conducive and holistic to the environment (Selangor State Irrigation & Drainage Department, 2020).

In 2001, the Urban Strom Water Management (MSMA) Manual was introduced to improve the existing manual due to the rapid evacuation management mechanism which could not keep up with the urban development rate, causing the increase in flash floods incidents (Lariyah Mohd Sidek, 2002). MSMA uses resource control mechanisms in managing floods by emphasizing the process of containment, infiltration and purification among others through the dry ponds and wet ponds method, detention ponds, rainfall catchments, swale and driveways drainage (MSMA 2nd Edition, 2012). This mechanism helps curb the increase in the

amount of runoff produced in development areas. By implementing this mechanism, the amount of runoff will continue to remain the same as the amount of runoff before any development was done (Sharifah Meryam Shareh Musa, 2013).

Therefore, everything discussed above reflects that the flood disaster management in Malaysia is more focused on solving the flood problem caused by the increase in urban imperviousness and development activities. There is no manual specifically designed to manage flood problems in natural flood plain areas. Whereas, flood management strategies applied through existing manuals may not be applicable to solve flood problems in all conditions, especially in natural flood plain areas. The situation is further complicated by the increase in the population living in the floodplain area from time to time. This situation cause public exposure to flood disasters that lead to losses is expected to increase (Noorazuan Md Hashim et al., 2011). Therefore, it is not surprising when the average total loss due to floods is RM 100 million per year (Siwar et al., 2009). Globally, Malaysia ranks 51st out of 162 countries that have suffered economic losses due to floods (Tuan Pah Rokiah Syed Hussain et al., 2008).

Flood Risk Management: An Integrated Approach

Risk management is seen as an effective and efficient approach to maximize the benefits of limited resources (Raadgever et al., 2018). Nowadays, European countries implement such approaches through flood management policies (Samuels et al., 2010). This paradigm is also increasingly gaining attention in the context of flood disaster management research (Hall et al., 2003). Environmental and regional policies in most countries are beginning to shift from using flood protection approaches to flood risk management approaches (Schanze et al., 2006). Flood risk management approach is more dynamic, holistic, comprehensive and practical to implement because it combines several strategies or approaches in managing floods. The main point of this approach is to reduce flood risk using integrated approach (Mei Ling, 2012) by taking into account various factors such as exposure and vulnerability community threat.

The paradigm of the flood risk management approach is based on the understanding that the risk cannot be eliminated but can be minimized. Along with that, the implementation of flood risk management is to reduce the impact of floods by reducing the level of danger, reducing exposure, reducing vulnerability and increasing the capacity of response through various measures (FLOODsite, 2009). The STAR-FLOOD project, for example, has introduced five flood risk management strategies, namely flood risk prevention mechanisms, flood defence, flood risk mitigation, flood preparation and flood recovery strategies as shown in Figure 1. The uniqueness of this approach, not only focuses on the aspect of reducing flood hazards alone but also emphasizes how to enable people to adapt to floods or referred to as water-based lifestyle (Emma, 2011). In other words, the flood risk management approach is based on integrated disaster management because it combines the paradigm of keeping the water away from people and water-based lifestyle.

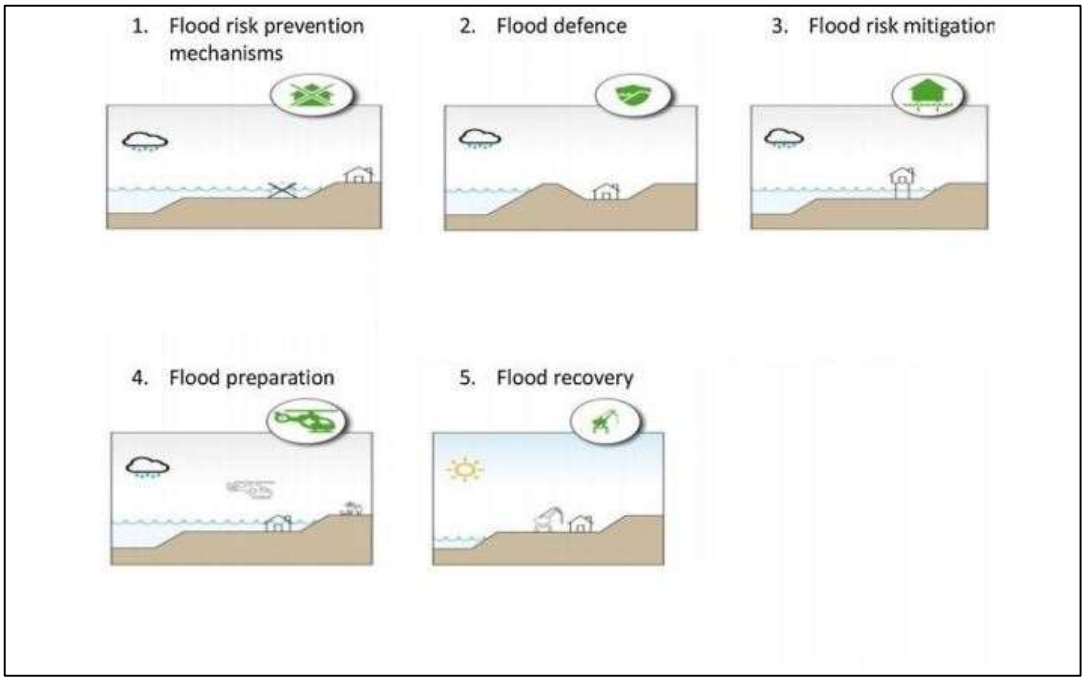

Figure 1.0 Flood Risk Management Strategies

Source Raadgever et al., (2018)

Flood Risk Management as a Support for Environmental Sustainability

An increase in total of population from time to time will result in the opening of new areas for various purposes to meet basic human needs including settlement area (Agrianita et al., 2011). The opening or exploiting activities done in new areas to be used as settlement purposes is sometimes carried out in areas with higher geo-disaster risk. Flood plain areas are one of those places. Besides Malaysia, the population growth that inhabits in flood plain area, globally is also increasing (Loucksjery & Stedinger, 2007).

However, flood disaster management in flood plain areas using flood protection approaches with the goal of keeping the water away from people often fails. The main focus of this approach is to control the occurrence of floods as well as make each area flood-free by widening the river, deepening the river, straightening the river, building fortifications and river diversions. However, the occurrence of floods is a natural phenomenon that must exist in the area of flood plains to maintain the ecosystem balance of the area as a habitat to a variety of species of flora and fauna. Furthermore, in flood plain areas, flood phenomena existed before the interference humans. Therefore, human beings must be wise to adapt to the original state of the ecosystem.

As we all know, the ecological system in flood plain areas is suitable for the habitat of some species of fish and wildlife that are categorized as endangered species and difficult to find elsewhere. In addition, flood plain areas are also suitable for breeding grounds as well as places to find food. In addition to that, the flood plain serves as a natural water source area through the process of replenishing underground water. Not only is it very important to the ecological system of the environment, but the flood plain is also important for human consumption used. According to Green et al. (2000) the ecological resources of flood plains are among the most valuable on this earth. Therefore, it is less appropriate for flood protection approaches to be implemented in flood plain areas. This is because, only humans benefit from this approach while the environment will experience negative effects such as extinction of flora and fauna. In other words, this approach is biased because it only benefits humans but not the environment.

Therefore, a flood risk management approach that not only focuses on defence strategies but also at the same time implements adaptation strategies is seen as the best measure to overcome this problem. The combination between two paradigms, keeping the water away from people and water-based lifestyle through this approach allows people (local communities) to stay in the area without any serious loss and at the same time, the flood plain ecosystem is preserved. In other words, a 'win-win' situation will be reached between human entities and environmental entities. This is because the adaptation method carried out does not change the properties or characteristics of the existing flood. For example, adaptation methods that are commonly carried out in floodplains such as zoning, boat ownership (Emma, 2011), traditional house design *"rumah berkolong"* (Huda, 2016), house with attics and so on.

Effectiveness of Adaptation Strategy by Flood Plain Community in Minimizing Flood Loss Risk

One of the areas that implement the flood adaptation method is Bekalau Village. Bekalau Village is located within the flood plains in Beaufort District, Sabah (Jafar et al., 2020). Among the adaptation methods carried out in the village are the ownership of private canoe or 'sampan' and the design of houses. In December 2014, there was a series of major floods in the area due to heavy rains that occurred non-stop for two consecutive days. At that time, the depth of flooding in some areas in Bekalau Village reaches up to four meters (Talata, 2014).

A survey was conducted involving 87 respondents (heads of the household) living in Bekalau Village. The total sample is equivalent to 40 percent of the total population (heads of household) found in Bekalau Village. A total of 82.6 percent of the total respondents interviewed stated that during the flood seasons (December 2014), their basement was flooded to a height of more than 1.5 meters. The remaining 16.2 percent and another 1.2 percent were flooded at the height of 0.55 meters to 1.5 meters and less than 0.5 meters. According to Cancado et al. (2008), flood depth levels with a height of less than 0.5 meters are classified as low danger levels, while those with a depth of 0.5 meters to l.5 meters and more than 1.5 meters are categorized as medium and high danger levels respectively. According to Cancado et al. (2008) high levels of flood danger tend to destroy building infrastructure and cause death. Meanwhile, Komi et al. (2016) also agreed that floods at a depth of one meter to two meters can result in property damage, death, or injury.

Uniquely in Bekalau Village, although the vast majority (82.6 percent) of the villagers experienced floods to a depth of more than 1.5 meters, the losses faced by them are very minimal. This is because the flood stagnation does not reach the floor height of their house. Thus, any property loss can be avoided. Some respondents further stated that although the height of the flood had exceeded the height of the floor of their house, the level of losses faced is still under control. Almost half (47.1 percent) of the total respondents do not suffer any form of economic loss. The remaining respondents, which is 49.5 percent, suffer a financial loss of less than RM 1200. Only 3.4 percent of the respondents suffer economic losses in the range of RM 1201 to RM 2100 (refer to Table 1).

Table 1: Level of loss faced by Belakau's village residents in the 2014 flood

Total loss	Percent (%)	
No losses	47.1	47.1
Less than RM301	11.5	49.5
RM 301 - RM 600	14.9	
RM 601 - RM900	6.9	
RM901 - RM 1200	16.1	
RM 1201 - RM 1500	2.3	3.4
RM1801 - RM 2100	1.1	
Total	100	100

Source: BPPN, 2007

The value of loss due to damage was measured not only based on the damage to the infrastructure of the house, but also it took into account the aspects of damage to furniture, home appliances, and even clothing found in the house (BPPN, 2007). National Development Planning Agency (BPPN) 2007, classifies the level of damage or loss of a house due to flooding into two, namely heavy damage and light damage. The level of light damage is RM 1392, while the value to heavy damage is RM 5568. Based on this classification, only a small percentage which are 3.4 percent of respondents are categorized as losses at the level of mild damage and the rest below the level of mild damage.

Apart from the flood depth factor, the height level of the basement of the house also greatly affects the level of loss faced by the residents of Bekalau Village. Generally, the higher the basement of the house being built, the less risk the floor of the house is flooded. Table 2 shows the height level of the basement built are more than 1.5 meters high, which is when the depth of the flood danger level is in the high category. The remaining 34.4 percent have a basement height level between 0.5 meters to 1.5 meters. The design of the high house basement is very helpful to reduce the level of losses faced during the floods even with high magnitude at the same time can increase the level of life safety. This is because the work of this method is dedicated to prolonging the time following the flood to reach the floor level of the house. Logically, the occupants of a house will be more prepared and have more time to save their belongings from becoming victims of floods if the time following the flood to reach the floor level of the house is longer (Jafar et al., 2022). From the aspect of mental safety, there are no residents of Bekalau Village who lost his life in the flood tragedy.

Table 2 : Level of height basement of the house in Bekalau Village

Level of height (Feet)	Percent (%)		Level of danger
1	0	0	Low (<0.5 meters)
2	0		
3	13.8	34.4	Medium (0.5 meters – 1.5 meters)
4	5.7		
5	14.9		
6	20.7	65.6	High (>1.5 meters)
7	12.6		
8	11.5		
9	13.8		
10	3.4		
11	0		
12	3.4		

The average (85 percent) of the respondents interviewed also own a private canoe or 'sampan'. The remaining 15 percent do not own a boat. Table 3 shows the perception of Bekalau Village on the level of importance of the canoe they use as a means of transportation during the floods. Based on the diagram, as many as 96.6 percent of the total respondents interviewed gave a positive response to the level of importance of having a canoe during the floods. Only 3.4 percent think that the use of canoes in flood situations as less important.

Table 3**:** Perceptions of the Kg Bekalau community on the level of importance of a canoe as a means of transportation during floods

Level of importance	**Percentage (%)**	
Not important	0	3.4
Less important	3.4	
Important	34.5	96.6
Very important	62.1	
Total	100	100

A canoe or *'sampan'* serves as the main means of transportation to increase Bekalau Village's level of accessibility when floods occur. It is one of the flood adaptation methods that has also been applied by the urban poor in the Manila City area (Emma, 2011). The privately-owned canoe will make it easier for the villagers to travel to the desired location, such as sending their children to school, going to work, doing shopping activities, when facing a flood situation. It was found that more than half of the total

respondents stated that no problems interfere with their ease in traveling to other areas, even at a flood depth level of more than one and a half meters. Most (17 percent to 21 percent) think the inconvenience caused is at a very mild level (Table 4). This shows the importance of using a canoe when mitigating floods. Therefore, it can be concluded that the strategy of adaptation by having a private canoe is an added value to the residents of Bekalau Village in increasing the level of accessibility during floods.

Residents of Bekalau Village is aware that the area they live in was originally a natural flood plain area. Therefore, floods in their residential areas are common. The adaptation method applied has increased their resilience to the adverse effects of the floods. At the same time, the flood plain ecosystem can be preserved because the adaptation method carried out does not change the properties or characteristics of existing floods. In other, a 'win-win' situation has been reached between human entities and environmental entities. It enables humans to live in the area without any form of serious loss, and at the same time, the flood plain ecosystem is still preserved.

Table 4: Smooth movement of canoe based on the flood depth at a high level of danger

Depth level / Stranded movement	1.5 meters (%)	2 meters (%)	2.5 meters (%)
No problem	72.4	63.2	59.8
Very light	18.4	20.7	17.2
Medium	5.7	11.5	14.9
Serious	3.4	4.6	4.6
Very serious	0	0	3.4

Conclusion

Generally, clashes between humans and the environment are inevitable. It will happen when humans want to exploit one area at a time. In this situation, human wisdom in managing nature by exploiting it sustainably is very important to practice. Especially in areas that are sensitive to interference by human activities such in flood plain areas. Furthermore, if exploitation activities are carried out unsustainably then there will be an imbalance in terms of the benefits obtained by human entities and environment entities. One of them will definitely face negative effects as a from unsustainably exploitation activities. In other words, there is no 'win-win' situation between human and environment. However, the opposite happens if exploitation activities are carried out sustainably. Arising from this, the flood risk management is seen as a sustainable and integrated approach that can be applied in the management of floods in Malaysia, especially in the context of natural floodplains. Not only in the context of urban ecosystem, this approach also seen to be able to reduce the risk of losses faced by floodplains communities and at the same time to maintain environmental sustainability.

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