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ORIGINAL ARTICLE

Flash Flood and Community's Response at Sg. Lembing, Pahang

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ABSTRACT

Most flash flood studies in Malaysia focus in urban areas because this is where flash floods occur. However, this study is unique in that it was conducted in a rural area in the state of Pahang. Since the the late 1990s, Sg. Lembing which is located at the confluence of Sg. Kenua and Sg. Kuantan experienced an increase in the frequency of flood. The result of the hydrograph separation analysis shows an increase in quickflow. This indicates that the magnitude of flood has increased significantly. The nature of flood has also changed from monsoonal type to flash flood and its frequency has increased over the years. The result of social survey carried out at Sg. Lembing pointed to land use changes in the surrounding area as the source of flash flood. This study also shows that the tangible loss resulting from flash flood, based on respondents' estimation, was in the region of RM105,000. Each household in Sg. Lembing experienced an economic loss of about RM1166. The loss may seem small. But looking at the low income level of the people in this area, it may be very high. This explains their inability to make necessary adaptation to flood events. About one fifth of the respondents made only slight adaptation to their house structure in an effort to mitigate the impacts of flood.

Key words: flash flood, Sg. Lembing, frequency, magnitude, perception

Introduction

Physical development process has always resulted in land-use changes in river basins which can bring about water and soil disequilibrium. Water quality and volume may change and this may result in several environmental risks (Bedient and Huber, 1988; Lazaro, 1990). Flash flood is an example of environmental hazard that resulted from water cycle imbalances, usually associated with an increase in build-up areas and weaknesses in urban drainage system (Schueler, 1994). Needless to say, flash flood can cause undue hardships to the community living in the flood plains.

This paper examines the nature of flood in Sg. Lembing area from the 1980s to 2000s. Since the 1980s, Sg. Lembing area was experiencing rapid land-use changes as large-scale agricultural developments enveloped this area.This altered the nature of floods which in turn brought out negative impacts on the local people living in Sg. Lembing town. Besides determining the causes of changing flood behaviour in this part of Pahang state, this study also documents the responses of the local people towards the flood which they face every year with increased frequency and magnitude.

Review Of Related Literature:

Malaysia's traditional society has always been influenced by river system. Almost all traditional settlements, urban or rural, were located at the river mouths or along the major rivers (Sulong *et al*. 2005). In 2000, approximately 2.5 million Malaysians lived on the flood plains (Noorazuan *et al*. 2003).People have always attracted to city's living, and therefore major Malaysian urban places have experienced unprecendeted growth since independence in 1957. Because of this geographical association between rivers and urban places, many people living in the cities are exposed to unpredictable events, particularly flood .

The Malaysian Drainage and Irrigation Department (DID) (DID 2000a) has classified flood into two types, i.e. flash flood and monsoon flood. From hydrological aspect, a stark difference between these two events is the period taken by river-flow to recede back to the normal level. Flash flood takes only few hours to return to the normal water-flow level, whereas monsoon flood can last for a month (Noorazuan, 2006).

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Flash flood can be triggered by natural causes such as local weather known as line-squalls and non-natural causes like inefficient urban drainage system and an increase in urban built-up areas. Most flash floods in Malaysia's Klang Valley are the results of these factors (DID 2000a). The increase in urban built-up areas has been reported by many studies ((Lazaro, 1990; Noorazuan dan Siti Aisah, 2006) as a dominant factor in causing rapid river flow which is a direct consequence of reduced vegetation cover.

According to Chan (1996), the risk and exposure of Malaysian urban dwellers to flash floods has increased lately. This is due to an increase in impervious surfaces as more roads, buildings and parking spaces are being built. Flash flood has brought about tangible and intangible losses to urban societies living on flood plains. Usually, losses resulting from floods depend on the socio-economic status of the people in those geographical areas. Chan (2000) highlighted that the economic consequences of flood are more severely felt by the low-income flood-plain dwellers. With low level of income, they can do very minimal to mitigate the impact of floods.

Materials And Methods

Sg. Lembing area has been chosen as the study area for determining flood frequency and magnitude and also people's adaptation to flood events. At the confluence of Sg. Kenau and Sg. Kuantan nested Sg. Lembing town, once a prosperous tin-mining place. Since 1984, mining operation has ceased owing to falling tin price in the international market (Sulong *et al*. 2008). Tin mining was operated by a British company known as Pahang Consolidated Company Limited (PCCL) from 1904 to 1984. From mid-1980s it became a ghost town, where many of its mining settlers left the town to look for employment elsewhere. But with the coming of tourists following the opening of the Sg. Lembing Muzeum in 2001, this place gradually becomes a tourist town. Thus it experiences some kind of rejuvenation.

Earlier in the 1980s, modern agricultural development spread to Sg. Lembing area. This was followed by a change in the flood behavior in this area. It is for this very reason that a study was conducted since 2005 to examine the changing nature of flood in the Sg. Lembing area and the people's responses to it.

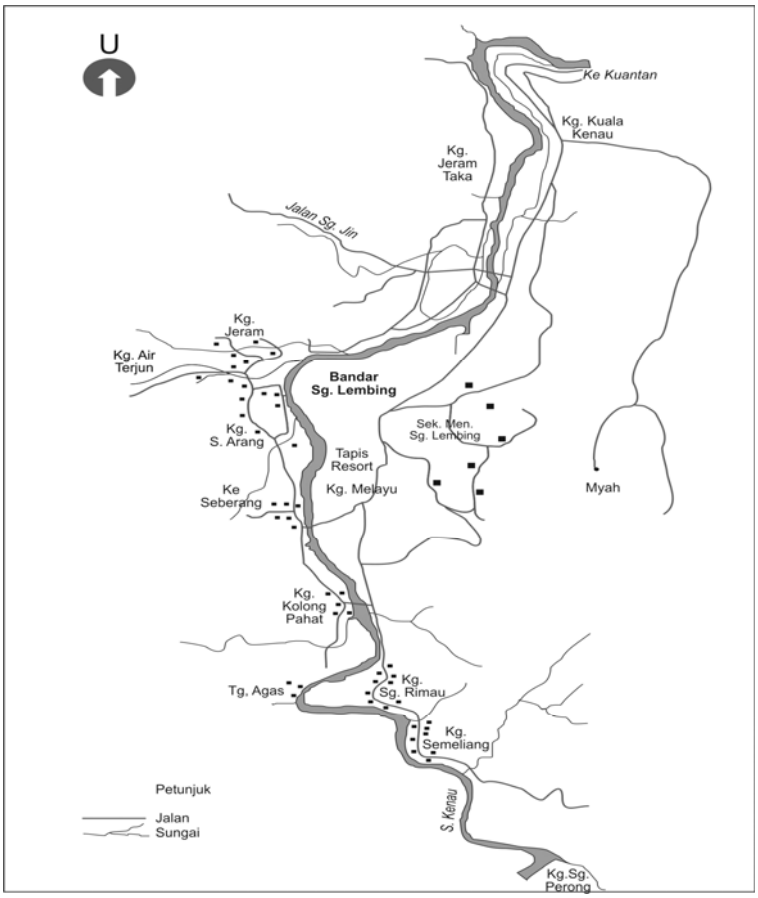


Fig. 1: Location of Sg. Lembing town and its environs

For the above purposes, data on daily flow of Sg. Kuantan from 1975 to 2005 were obtained from the Kenau DID station. These data were used to derive quickflow component by using hydrograph separation method. Hydrograph separation is the process of separating the time distribution of baseflow from the total runoff hydrograph to produce the surface runoff hydrograph (McCuen, 1998; Bedient & Huber, 1988). Quickflow is a hydrological indicator that shows flash flood occurrences in a particular area.

There are several methods of deriving the values for quickflow and baseflow. The quickflow and baseflow separation model used in this study is called 'inclined line separation' technique as proposed by Chow *et al*. (1988) (see also Bidin & Greer, 1997). However, this study does not measure the baseflow component. In this method, in order to get the separation line between quickflow and baseflow, it uses baseflow value that increases at a rate of 0.0055 liter s^{-1} ha^{-1} h^{-1} (Chow *et al*., 1988).

Data for this study were also gathered through social survey and in-depth interviews with key persons who experienced floods that occurred within the past ten years. The social survey was carried out from 24 to 26 August 2005 with the help of 24 Third Year Geography students from Universiti Kebangsaan Malaysia who had been trained in social survey technique. A total of 90 respondents had been selected randomly from ten villages that were frequently exposed to flash flood events in order to obtain information on the people's perception on, and their adaptation to flood. The questionnaires were administered directly to the respondents by the students. In-depth interviews were conducted, among other, with the Lembin Resort operator, business operators and village heads.

Discussion:

Changes in the nature of flood:

The people of Sg. Lembing reported to us that the type of flood in their area has changed markedly since the end of 1990s. Before this, the flood was of monsoonal type with long period of inundation. With the coming of the 21st century, the nature of flood changed from the former to one of a flash flood, the duration of which was short. It ended as quickly as six to 12 hours (Figure 2). An interesting aspect of flash flood in Sg. Lembing is that it occurred in non-urbanised and non-densely populated area as commonly true of such a flood.

The magnitude of flood was also getting bigger. The 2001 flood was reported by the people of Sg. Lembing as the biggest ever happened in the Sg. Lembing area (DID Pahang, 2001). During this flood, all shophouses located along the main road beside Sg. Kenau were inundated as high as 4m. It happened at mid-night and subsided 12 hours after that. The above was the perception of the local people as documented by DID Pahang.

In our calculation, there was a significant change of quickflow, especially at the end of the 1991-2001 period. Its value reached 50m^3 s^{-1} day^{-1} (Table 1). This was a big increase compared to the value during the 1980-1985 period which was recorded at 30m^3 $s^{-1}day^{-1}$. This data revealed that the magnitude of flood in the Sg. Lembing area has increased since then.

Table 1: Total quickflow (m^3 s^{-1} day^{-1}) for flow station at Sg. Kuantan

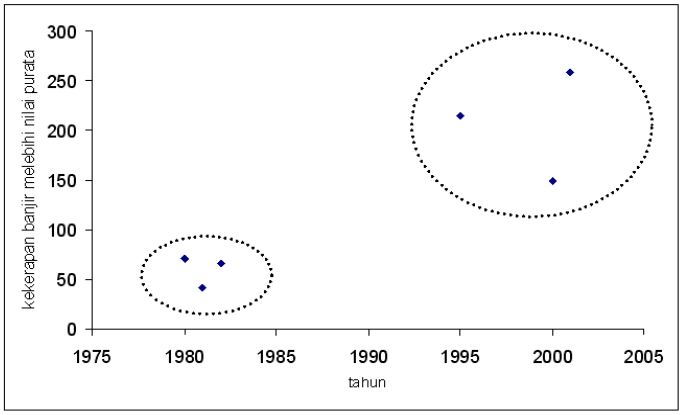
Year	Total quickflow (m^3 s^{-1} day^{-1})
Period 1	
1980	8.1
1981	5.2
1982	6.6
1983	12.0
1984	14.4
1985	29.2
	Annual Average 12.5 m^3 s^{-1} day^{-1}
Period 2	
1993	49.8
1994	48.6
1995	19.5
1996	10.2
1997	34.6
1998	15.1
1999	12.5
2000	37.9
2001	29.2
	Annual Average 28.6 m^3 s^{-1} day^{-1}

Source: DID (1980-2001)

The frequency of flood at Sg. Lembing has increased significantly over the years (Fig 2). This study looks at two periods, that is the 1981-1983 period and the 1995-2001 period. These two periods were selected for two reasons, i) because of data error and ii) because of incomplete daily data. The frequency of flood with a magnitude of over 16.8m, that is the normal river flow, is shown in Figure 3. It was found that the flood

frequency value above normal river flow had increased to about three times the frequency value of the flood for the1981-1983 period.

The changes in the nature of flood as described above were mainly due to deforestation in the surounding area. Since the 1980s, a large track of forest land has been cleared in order to make way to modern agriculture and resettlement. It was developed mainly by FELDA, a federal agency responsible for land development in frontier regions. Table 2 shows the area that has been cleared by the said agency for agriculture and resettlement purposes. According to the local people, changes in the land use were also partly due to illegal logging.



Source : DID Pahang (1975-2005)

Fig. 2: Change in flood frequency at Sg. Lembing

Table 2: Land use changes in Sg. Kuantan basin (1990-2002)

Land use changes (ha)				
Types of land use	1990 (ha)	1995 (ha)	2000 (ha)	2002 (ha)
Urban	120	120	513	482
Cash crops	295	218	269	262
Permenant crops	-	107	2238	2223
Grass field	574	481	700	727
Newly cleared land	340	-	227	496
Forest	51066	50802	43978	41603
Disturbed land	486	598	4905	7061
Wetland	22	577	73	49
Total	52903	52903	52903	52903

Source: Noorazuan (2008)

This study has shown that at the end of 1990s there were marked changes to the flow behaviour of Sg. Kuantan that leads to changes in flood duration, frequency and magnitude at Sg. Lembing.

Perception and adaptation:

This section examines the perception and responses of local population towards the changing nature of flood at Sg. Lembing. From our social survey, it was found out that about 90 percent of the respondents were permanent residents of the study area. Almost all of them were aware of the changing behaviour of the flood in their area. Most of them had stressed that the flood frequency and magnitude had increased significantly lately. However, only 50 percent of them said that they were not ready to move to safer places when flood occurred. This meant that there was no alternative avenue for them to get protection during flood. Their inability to move to safer place and to seek protection is related to their low socio-economic level.

The population of Sg. Lembing is intimately associated with flood. This is evidenced from the response of one of our respondents who said that:

“In the 1970s when the British were still here, flood was infrequent and small in scale. That was why the PCCL built two-storey shophouses along the Sg. Kenau. The flood never reached the shophouses. After the mining operation stopped in 1984, flood occurences became more frequent. Its scale was bigger than before. Last year, the flood level nearly reached the second floor of my shop”.

Almost 47 percent of the houses were located less than 5m from Sg. Kenau. This explained why the majority of the people in the Sg.Lembing town were prone to flood and exposed to flood risk, especially late at night.

The DID flood warning system was ineffiecent according to 50 percent of the respondents. They complained that the warning time was too short that they did not have enough time to prepare themselves for evacuation. Table 3 shows the perception of the local population towards flood behaviour, especially those that pertained to flood frequency and magnitude from 2001 to 2004. This study reveals that the 2001 flood was the worst. Almost 80 percent of the respondents said that the 2001 flood occurred more than once. No less than 36 percent of the respondents experienced critical flood, one with water level above 2m.

One interesting aspect of flood behaviour is time taken to subside. More than 70 percent of the respondents reported that floods subsided in less than eight hours. This means that floods in Sg. Lembing were flash floods because subsidence period for monsoon floods is more than 10 days. The perception of the local people on the flood behaviour is in accordance with the measurement taken by DID.

Table 3: Perception of local people on flood behaviour at Sg. Lembing

Flood behaviour	Year			
	2001	2002	2003	2004
Duration of flood (less than eight hours) (%)	71.1	40.0	48.9	58.9
Flood frequency (more than one per year) (%)	78.0	49.0	63.0	68.0
Flood magnitude (more than 2 m) (%)	35.5	36.7	44.5	51.1

Source: Social survey 2005

Flood Control And Adaptation:

This section reports on economic loss experienced by local people and measures taken by them to mitigate the damages resulting from floods. A total of 36 percent of the respondents said that they experienced heavy losses during the recent flood. They reported that the flood had damaged their kitchen utensils and electrical goods. These items were the most affected by flood. The kitchens located at the ground floor were also badly affected. The economic losses as reported by respondents were estimated at RM105,000 or at RM1,166 for every household. Taken into account their income level, the loss was significant.

About 42 percent of the respondents were compensated by the state government. But the amount of compensation was small. A total of 80 percent of respondents did not have any insurance policy, and therefore they did not get any benefit from the insurance company.

Only 21 percent of the respondents made necessary mitigation to their house structures. The rest did nothing for the lack of fund.

Of the total respondents who made structural adjustment to their houses, more than half raised the floors of their kitchen so that there are above flood level. They paid special attention to this section of the houses because kitchen is very important in their daily life, and therefore should be protected from flood. In addition, the construction cost is minimum compared to the cost of changes to other structures of the house.

Table 4: Perception on changes in magnitude and frequency of flood

Perception on flood	Percentage (%)		
	Agree	Disagree	No response
The effects of flood were more severe since five years ago	68.9	13.3	17.8
Flood occurred more frequently since five years ago	65.6	26.7	7.7
The flood magnitude was bigger since five years ago	63.3	22.2	14.5
Mud flood occurred more frequently since five years ago	57.8	15.6	26.6

Source: Social survey 2005

Our study on the perception of the magnitude and frequency of floods has shown that changes in flood behaviour occurred since five years ago (Table 4 and Table 5). Almost 70 percent of respondents agreed that floods had worsened. Several factors contributed to the changing nature of flood in the Sg. Lembing area (Table 5).

Table 5: Perception on the factors contributing to the increased frequency of flood in Sg. Lembing

Contributing factors	Percentage (%)		
	Agree	Disagree	No response
Heavier rainfall now than before	67.8	24.4	7.8
River siltation	66.7	23.3	10.0
Logging activities upstream	64.4	25.6	10.0
Drainage clog	23.3	51.1	25.6
Sand mining	23.3	53.3	23.4
Land clearing for agriculture	10.0	55.6	34.4
Infrastucture development	4.4	60.0	35.6

Source: Social survey 2005

In terms of flood control, almost 80 percent of respondents wanted DID to deepen the river channel as soon as possible. This is because there were many sand bars in the river channel. This physical feature was formed because of active silt deposition due to land clearing in the upper basin. In addition, about 60 percent of respondents also wanted the same department to construct flood-control dam. However, the dam proposal should be examined more thoroughly, taking into account the environmental impacts.

Conclusion:

In summation, flooding seems to be an environmental issue that often leads to social and economic difficulties faced annually by the people in Sg. Lembing town since the late 1990s. This is due to rapid land conversion from primary forest to agricultural land use. As a result, there is disruption to water catchment areas which in turn lead to flash flood. This is evidenced from quickflow measurement of data taken at the river gauging station. The increase in flood frequency and magnitude has caused intangible and tangible losses to the local community. However, due to low income level and short duration of flood, the local community makes minimum adjustment to their building structures in an effort to mitigate flood impacts.

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