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Flood Impact Assessment in Kota Bharu, Malaysia: A Statistical Analysis

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Abstract: Floods are common natural disaster occurring in most parts of the world. It is considered to be one of the weather-related natural disasters. The assessment of flood effects in urban areas requires the analysis of direct and indirect impacts. Direct impacts concern damages caused by the physical contact of floodwaters with commodities and are therefore related to the physical deterioration of such commodities. Indirect impacts are much more complex to deal with. They originate from inconveniences caused to the community by flooding events. Each household, with its specific social, economic and location characteristics suffer different flood impacts and react differently. The results are recorded in damage to human life and deterioration of environment. Recently, in the year 2006, 2007 and 2008 heavy monsoons rainfall have triggered floods along Malaysia's east coast as well as in different parts of the country. The hardest hit areas are along the east coast of peninsular Malaysia in the states of Kelantan, Terengganu and Pahang. The flood cost nearly millions of dollars of property and many lives. This paper presents construction of a flood susceptible map for presumptive flood areas around at Kelantan river basin in Malaysia. An attribute database was also constructed from field investigations and historical flood areas reports for the study area. A questionnaire was developed based on the three stages effect of flood to people an environment which is primary, secondary and tertiary effect. One hundred and sixty questionnaires were distributed to the people at the study area and 85.63% of them stated that there are impact of every year flood to the community with 76.25% stated that the depth of flood is more than 1 meter.

Key words: Impact · Flood · People · Environment · Kota Bharu

INTRODUCTION

Natural disasters are beyond control of human beings and cannot be predicted accurately when it occurs. Major natural disaster like floods, earthquakes, landslides and droughts when they happen, it result in threat of human life, loss of property; affect infrastructure, agriculture and environment. The impact of disaster is different due to its intensity and coverage area. Natural disasters are happened every year and their impact and frequency seem to have greatly increased in recent decades, mostly because of environmental degradation, such as deforestation, intensified land use and the increasing population [1]. Problems related to flooding have greatly increased and there is a need for an effective analysis of flood impact to understand the problem and mitigate its disastrous effects. Human activities such as unplanned rapid settlement development, uncontrolled construction of buildings in general and major land-use changes can influence the spatial and temporal pattern of hazards. There are several factors contributing to the flooding problem ranging from topography, geomorphology, drainage, engineering structures and climate. Most floods are caused by storms in which a lot of precipitation falls in a short period of time, of both types of rainfall, convective and frontal storms. Intensity and duration of the rain are the most influencing factors for flood hazards.

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Over the past century, flood leaves huge effect and causes suffering to human life and loss of materials and properties [2]. Floods are the most common occurring natural disasters that affect human and its surrounding environment [3]. It is more vulnerable to Asia and the Pacific regions. There are many occurrence of flood in China, the worst flood in China 1998 affected 223 million people, 3004 people reported dead, 15 million were homeless and the economic loss was over US$ 23 billion for that year. Due to heavy flood in Cambodia and Vietnam during year 2000, 428 people reported dead and estimated economic loss of over US$250 million. In 1991, 140,000 people across the world were reported dead and in 1998, it affected 25 million lives [4]. For the last 10 years due to frequent occurring of floods thousands of people have been affected due to flood in India, Pakistan, Korea, China and Bangladesh with their agricultural field, residential areas i.e. livelihood and food. An effect of floods in less developed countries is more vulnerable. It has lot of problems with emergency response and early warning preparation. Human involvement to control flood disaster by immense use of different technology can facilitate stakeholder to have an early warning for flood and know what impact are likely to be caused by flood [5].

Floods are among the most frequent and costly natural disasters in terms of human and economic loss. As much as 90 percent of the damage related to natural disasters in Malaysia is caused by flood. Average annual flood damage is as high as US100 millions. These flooding have caused considerable damage to highways, settlement, agriculture and livelihood. In Malaysia, floods are caused by a combination of natural and human factors. Malaysians are historically river dwellers as early settlements grew on the banks of the major rivers in the peninsula. Coupled with natural factors such as heavy monsoon rainfall, intense convection rain storms, poor drainage and other local factors, floods have become a common feature in the lives of a significant number of Malaysians. Monsoon rains have a profound influence on many aspects of the lives of the people in the east coast of Peninsular Malaysia [6]. While the rains are needed for agriculture, particularly wet rice cultivation, they are also largely responsible for bringing seasonal floods. Recently, in 2006 and 2007 heavy monsoons rainfall triggered floods along Malaysia's east coast as well as in southern state of Johor. The hardest hit areas are along the east coast of peninsular Malaysia in the states of Kelantan, Terengganu and Pahang [7]. However, there are some more related studies have been conducted to highlight on various flood issues in Malaysia. These are among others [4, 5]

The objective of this study is to analyse the flood impact to people at the study area. This assessment aims is to quantify the extent of damage and displacement caused by the floods and their immediate impact on flood occurrences, frequency of flood, depth of flood water, types of losses and average losses. It also identifies disease spreading, electric disruption and river changes.

Flood Studies in Malaysia: Malaysia is fortunate to be freed from natural disaster such as earthquakes, volcano and typhoon. The most severe natural disaster experiencing in Malaysia is flood. Two major type of flood occur in this country are monsoon flood and flash flood. The monsoon flood occur mainly from Northeast Monsoon which prevails during the months of November to March with heavy rains to the east coast states of the Peninsula, northern part of Sabah and southern part of Sarawak. Some of the recorded flood experiences in the country occur in 1926, 1931, 1947, 1954, 1957, 1963, 1965, 1967, 1969, 1971, 1973, 1983, 1988, 1993, 1998, 2001, 2006, 2007 and 2010. Report from Department of Irrigation and Drainage stated that about 29,000 sq. km or 9% of total land area and more than 4.82 million people (22%) is affected by flooding annually. Damage cause by flood is estimated about RM 915 million. While monsoon flood is governed by heavy and long duration rainfall, more localized flooding which covers a large area has been reported in recent years. Flood of October 2-6, 2003 that affected a large area in the northwestern part of the Peninsula covering states of Kedah, Penang and Northern Perak. Flash flood is reportedly occurring quite rapid such as two events occur in April 2002 and October in Kuala Lumpur which has been recognized due to uncontrolled development and activities within the catchment and flood plain [8]. Large floods had damaged properties, public utilities, cultivation, lost of lives and also caused hindrance to social and economic activities. Average annual flood damage is as high as RM100 millions. In February, 2006 Shah Alam was heavily flooded due to poor drainage system caused by surrounding development activities. In October 2006, Kelang areas as well as Kedah and Perlis were severely flooded which was reported caused property damage and a lot of millions of Ringgit. Figure 1 illustrates the flood prone areas in Malaysia.

Floods in the study area are mainly causes by heavy rainfall brought by the monsoon and categorized as annual flood as it occurs every year during the monsoon season. The study area faces Northeast monsoon from November to March every year (Figure 2). The Northeast monsoon brings heavy rain to east coast states of

Fig. 1: The flood prone areas in Malaysia [8]

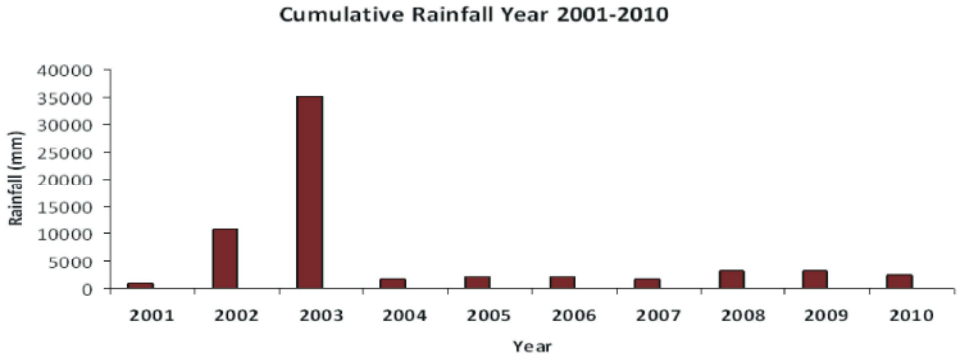

Fig. 2: Cumulative rainfall data from rainfall station in Jeti Kastam, Kota Bharu [2]

Peninsular Malaysia and western Sarawak, whereas the Southwest monsoon normally signifies relatively drier weather. Due to its geographical characteristics, unplanned urbanization and proximity to the South China Sea, Kota Bharu has become extremely vulnerable to monsoon flood every year. The unprecedented in November 2005 which was triggered by monsoon, has been described as one of the worst natural flood in the history of Kota Bharu.

In recent years, severe flooding has occurred in several parts of Malaysia, both as localised flash floods and as basin-wide floods on major river systems. Some of the badly affected areas are situated at the river basins in Penang (Juru River Basin), Pahang (Pahang River Basin), Terengganu (Setiu River Basin) and Perak (Kinta River Basin). By their nature, floods are generated by the random coincidence of several meteorological factors but man's use of the river catchment also has an impact upon the severity and consequences of the events [9].

Study Area: Kelantan is located at east coast of peninsular Malaysia with latitude of 06°10'N and longitude of 102°20'E. The study area, Kota Bharu is one of the main districts in Kelantan and become the capital city of Kelantan which was the main location of commercial centre and state management office. Kelantan River Basin is selected as a pilot area because it represents typical basins and flood plains that are prone to annual monsoon floods in Malaysia. Kelantan River is the major river in Kelantan state and emerges at the confluence of the Galas river and Lebir river near Kuala Krai and meanders over the coastal plain until it finally reached into the South China Sea, about 12 km north of Kota Bahru. The main reach of the Kelantan River has some further larger tributaries downstream. However, the Galas and the Lebir rivers themselves have many branches, which provide the majority of the flow in the main Kelantan River. These tributaries rise into the forested mountains of peninsular Malaysia. The basin covers 85 percent of the state's surface area. The river only drops 10 meters from the coast up to Guillemard Bridge with the distance of 60 km. The main river comprises of seven major Subcatchments (Kota Bahru, Gullimard, Pergau, Kuala Krai, Galas, Lebir and Nenggiri) that covers a drainage area of 13,170 km. Four major towns are located along the river: Kota Bahru, Pasir Mas, Tumpat and Kuala Krai. Kota Bharu is the main city and centre of commercial trade and administration in the Kelantan state. Due to its geographical characteristics; unplanned urbanization; and proximity to the South China sea, Kota Bharu has become extremely vulnerable to monsoon floods every year. The unprecedented flooding of November 2005, triggered by monsoon rains, has been described as one of the worst natural flood in the history of Kota Bharu. The total land area of Kota Bharu is about 394 km². It consist of fourteen major states which was Badang, Kemumin, Panji, Bandar Kota Bharu, Sering, Kota, Kubang Kerian, Banggu, Pendek, Kubang Kerian, Banggu, Pendek, Limbat, Peringat, Beta, Kadok and Ketereh which was separated by other district by Kelantan River on the west side, South China Sea on the north side and district boundary on the east and south side and Figure 3 illustrates the location map of the study area in Kelantan [10].

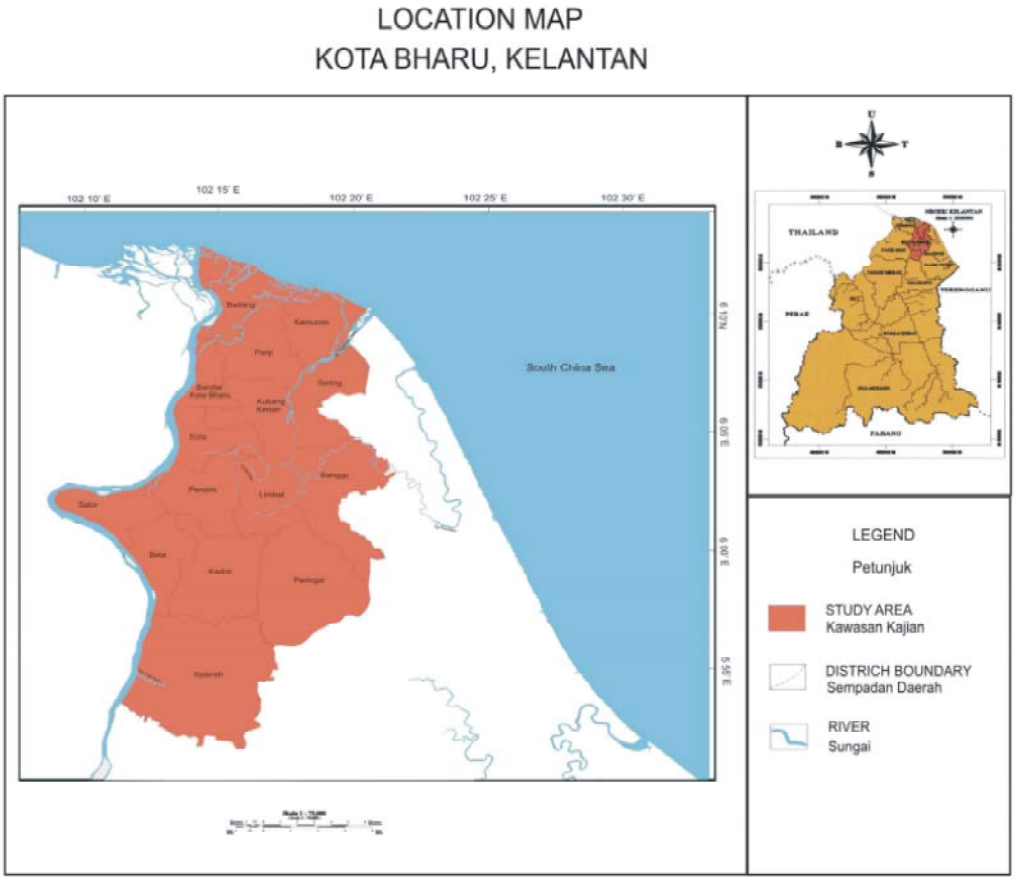

Fig. 3: Location map of the study area [10]

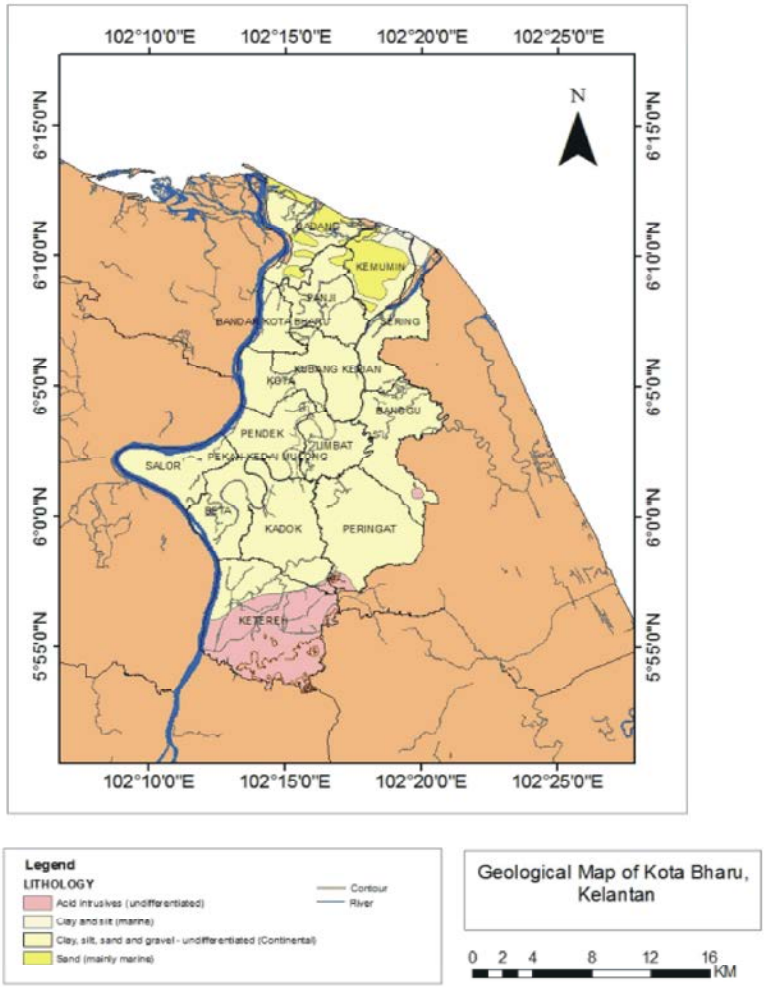

Fig. 4: Geological map of Kota Bharu, Kelantan

Kelantan River Basin has a tropical climate receiving rainfall throughout the year. In general, while localized flooding is mostly due to convectional rain storms, most of the extensive and severe floods in peninsular Malaysia are associated with the onset of the monsoon seasons. Seasonal floods c aused by heavy rains during the North-East monsoon period are termed "monsoon floods". Consequently, it is not surprising that in terms of flood frequency and magnitude, the four east coast states are the most susceptible to flooding, each experiencing various magnitudes of flood occurrence almost every year. As a result of seasonal floods occurring almost annually in one part of the peninsula or another, flood losses in terms of loss of lives and damages to properties are substantial.

Geology: The study area is mainly consist of Quarternary alluvium from fluvial and marine which formed by sand, gravel, silt and clay and underlain by granite and meta-sedimentary rock (Fig. 4). The platform of Kelantan River which is the major river in the study area is floodplain. The bedrock cropping out in the Central Ranges and lying beneath the river basin comprises granites, metamorphic rocks and minor tuff of Paleozoic identified as phyllite. The bedrock underlying the basin in the study area to the east of the Kelantan River is mainly consist of granite but changing to phyllite towards the opposite west. Phyllite and other metamorphosed sediments are fine grained and mostly weathered to clay and silt. Some siliceous metamorphic rocks such as schist and quartzite are hard rocks that give rise to sand and gravel detritus [11].

MATERIALS AND METHODS

Data Description: A few sessions of structured questionnaire and face to face interview were conducted to local people in the study area with different location according to the different district in Kota Bharu.

The survey was conducted between February to March 2012 after the flood event for this year. The questionnaire was developed based on three most common impact classifications which was primary, secondary and tertiary impact beside general information about the respondent including name, types of resident, period of resident and also general information about the flood in their residential area. The people were asked about the impact just after the flood such as loss of properties to analyze the primary impact of the flood. While the secondary impact was obtained from the question of sickness the respondent and family had after the flood and also electric and phone disruption. The change to the nearest river was also been asked to the respondent to analyze the tertiary effect of the flood.

Description of the Questionnaire
General Information:

- No.:
- Date:
- Name:

Location Respondent:

- Address:
- Job::
- Residential code:

1) House 2) Shop Lot 3) Others

Flood Occurrences:

- Period of residence: _____ Years
- Flood Occurrence a) Yes b) No
- Frequency of Flood:
  a) Every year b) Rarely
- Water depth during flood: _____ m

Primary Impact of Flood:

- Types of loss during flood:
  a) Properties b) Life c) Others
- Average amount of loss

(RM): _____

Secondary Impact of Flood:

- Is there any disease after the flood to you and your family?
  a) Yes b) No

Please state if your answer is a: _____

- Is there any electric or phone disruption after the flood?
  a) Yes b) No

Tertiary Impact of Flood:

- Is there any earth surface change to your area?

a) River become wider?
a) Yes b) No
b) Is there any landslide in your area?
a) Yes b) No
c) Others: Please state _____

Statistical Analysis: The data recoded were analyzed through descriptive statistics data analysis using Microsoft Excel. By this analysis, the frequency and percentage of the questions can be identified.

RESULTS

The characteristics of the respondents as shows in Table 1, comprises of 70% male and 30% female while the age is ranged between 0 to 80 years old. The highest group of age ranged from 41 to 60 years old with the percentage of 47.5% then followed by the group age of 21 to 40 years old with the percentage of 36.3%. The respondents in the study area also can be categorized based on their economic status which shows that 46.3% of all the respondent are in poor economic status while 43.1% can be classify in moderate economic status and the others are in very poor and good economic status. 30.4% of the respondents have lived in the study area for the ranged of years from 0 to 20 years while 27.6% of them lived for the range of 21 to 40 years. The others lived there for 41 to 60 years and 61 to 80 years with the percentage of 24.9% and 5.5%.

Impact on Flood through Descriptive Analysis
(a) Impact on Flood Occurrences: One hundred sixty effective answers were collected out of 200 questionnaires distributed to the selected people in the study area.

The 137 respondents out of 160 show (85.63%) positivity and stated that there are impact of the frequency of flood every year on the community.

The 75 respondents out of 160 i.e., (46.88%) stated that there are impact on the community due to flood occurences in the study area.

Table 1: Characteristics of the respondent

		Respondents, n (%)	
		n	%
Gender	Male	112	70
	Female	48	30
Age	0 - 20	7	4.4
	21 - 40	58	36.3
	41 - 60	76	47.5
	61 - 80	19	11.9
Economic Status	Very Poor	11	6.9
	Poor	74	46.3
	Moderate	69	43.1
	Good	6	3.8
Residential Code	Shop Lot	20	12.5
	House	115	71.9
	Others	25	15.6
Period of residence (years)	0 - 20	55	30.4
	21 - 40	50	27.6
	41 - 60	45	24.9
	61 - 80	10	5.5

Code	Answer	Frequency	Percentage
1	Yes	137	85.63%
2	No	23	14.38%
Total		160	100%

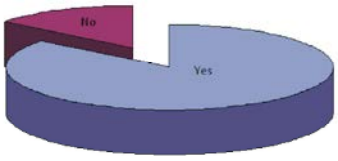

Fig. 5: Pie diagram showing the impact on flood occurences

(b) Impact on Ferquency of food

Code	Answer	Frequency	Percentage
1	Every year	75	46.88%
2	Rarely	85	53.13%
Total		160	100%

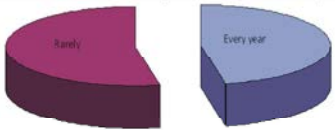

Fig. 6: Pie diagram showing the impact on frequency of flood occured

The 122 respondents out of 160 i.e., (76.25%) stated that there are great impact on the community due to depth of flood which is more than 1 meter in the study area.

The 139 respondents out of 160 i.e., (86.88%) stated that they are largely affected in terms of property losses due to flood in the study area.

(c) Impact on Depth of Flood Water

Code	Answer	Frequency	Percentage
1	>1 meter	122	76.25%
2	< 1 meter	38	23.75%
Total		160	100%

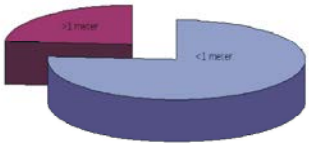

Fig. 7: Pie diagram showing the impact on depth of flood water

(d) Impact on Different Types of Losses

Code	Answer	Frequency	Percentage
1	Properties	139	86.88%
2	Others	21	13.13%
Total		160	100%

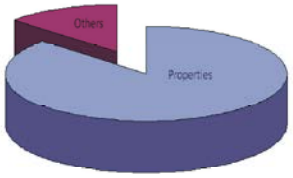

Fig. 8: Pie diagram showing the impact on different types of losses

(e) Impact on Average Losses

Code	Answer	Frequency	Percentage
1	<RM1000	91	56.88%
2	>RM1000	22	13.75%
3	Others	47	29.38%
Total		160	100%

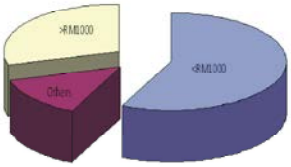

Fig. 9: Pie diagram showing the impact on average losses

The 91 respondents out of 160 i.e., (56.88%) stated that they are largely affected in terms of money losses upto the level RM 1000; (13.75%) are affected more than RM 1000 and (29.38%) are affected in other losses due to flood in the study area.

The 20 respondents out of 160 i.e., (12.50%) stated that they are affected by different types of disease due to flood in the study area.

(f) Impact on Disease Spreading

Code	Answer	Frequency	Percentage
1	Yes	20	12.50%
2	No	115	71.88%
3	Others	25	15.63%
Total		160	100%

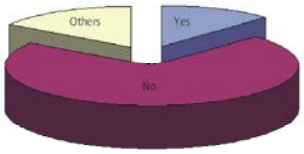

Fig. 10: Pie diagram showing the impact on disease spreading

(g) Impact on Electric Disruption

Code	Answer	Frequency	Percentage
1	Yes	66	41.25%
2	No	69	43.13%
3	Others	25	15.63%
Total		160	100%

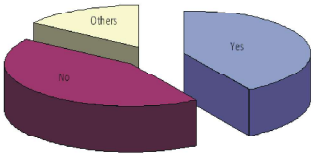

Fig. 11: Pie diagram showing the impact on electric disruption

(h) Impact on River Changes

Code	Answer	Frequency	Percentage
1	Yes	54	33.75%
2	No	78	48.75%
3	Others	28	17.50%
Total		160	100%

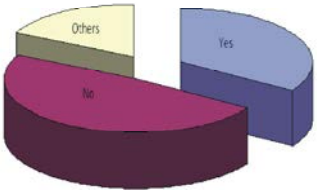

Fig. 12: Pie diagram showing the impact of river changes

The 66 respondents out of 160 i.e., (41.25%) stated that they are faced problem in electric disruption and (15.63%) faced other than electric disruption problem due to flood in the study area.

The 54 respondents out of 160 i.e., (33.75%) stated that the direction of river changes due to flood in the study area.

DISCUSSION

The analysis of eight questions in the questionnaire shows the different results in terms of frequency and percentage data. From this analysis, 86.53% of them are affected by the flood occurrences with 46.88% of them stated that the flood occur every year in the monsoon seasons. 23.75% of the respondents face the depth of flood of below 1 meter while the rest face the depth of water more than 1 meter. The primary impact of flood can be identified when 86.88% of the respondent losses their properties with 56.88% of them losses less than RM1000 every year during the flood event. Of all the respondents, 12.50 % of them or their family had to bear with the disease problem such as fever, skin problem, cholera and etc. and 41.25 % of the respondents said they had electric and phone disruption after the flood event which shows the secondary impact of flood. Then, 33.75% of them observed the change in the river such as river expansion, change in colour of the floodwater and slightly increasing in flood level which shows the tertiary impact of flood is getting worse in every flood event. The analysis shows that flood leaves a great effect on the people at the study area which had changes their standard of life for over centuries.

CONCLUSION

The questionnaire analysis shows that in the period of residence of range 40 years, there is possibility for the occurrence of annual flood. The average depth of flood is 1 meters. The analysis also shows that the property is the most effected with average of losses below RM1000. The disease spreading is still low in rate because of immediate action taken by the local authorities and government to prevent it. Although the electrical and phone disruption is still happen in every flood season but the occurrences is still low. Most of the respondents admitted that there was slightly river changing during the flood event and future research should be conducted with more focusing on the main river to identify the changes and prevent it from being the causes of flood in the area.

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