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Impact of the Flood Occurrence in Kota Bharu, Kelantan Using Statistical Analysis

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Abstract: Over the years, flood has become one of the most destructive phenomena all over the world. It's included Malaysia and the study area which located at the east coast of Peninsular Malaysia. Flood in Kota Bahru, Kelantan is mainly caused by heavy rainfall brought by the Northeast monsoon starting from November to March every year. It is categorized as annual flood as it occurs every year during the Monsoon season. The flood in the study area has become the most common natural hazard which caused a lot of damage for every time, during the flood event. People in the affected area had to bear with this event where they need to be evacuated and moves their private and belongings to the safe area. In this study, about 200 questionnaires were distributed to the people in the affected area after the 2010/2011 flood event. After that, the questionnaires were selected to undergo two kinds of statistical tests that were used to analyze the association of flood with the condition of flood in the study area such as frequency of flood, water depth, type of loss, total loss (in Malaysian currency, RM), health problem, electric/phone disruption and river expansion which was chi-square and bivariate correlation tests. The results of chi-square test shows that there is association between flood occurrence and the condition of flood such as frequency of flood, water depth, type of loss, average total loss, disease and psycology effect, electric/phone disruption and river expansion while the results of correlation test shows that most of the condition of flood has negative strong relationship with the flood occurrence. Overall study shows that the flood occurrences have decreased the impact of flood to the people in the affected area from years to years based on statistics of flood damage and also on victims experience.

Key words: Flood, statistical analysis, Kota bharu, flood occurrences, condition of flood, flood impact, Northeast monsoon

INTRODUCTION

Natural disasters interfere with economy and destroy infrastructure, resulting in a disruption of livelihoods, normal services and health care. Floods can be particularly disruptive, leading to widespread collapse of infrastructure. They are the leading cause of deaths from natural disaster worldwide with 6.8 million deaths in the 20th century. South-East Asia is the most flood-affected region, accounting for nearly 50% of flood-related fatalities in the last 25 years (Mooney, 2010). Recently, heavy monsoons rainfall triggered floods along Malaysia's east coast as well as in southern state of Johor in 2006 and 2007. The hardest hit areas are along the east coast of peninsular Malaysia in the states of Kelantan, Terengganu and Pahang (Pradhan, 2009). Floods and their impact are likely to increase in the future due to urbanization and land use changes, high concentrations of poor and marginalized populations and a lack of regulations and preparedness efforts (Berz, 2000). Department of Irrigation and Drainage (DID) through a detailed study, issues the results that about 29 000 sq. km or 9% of the total land area and more than 4.82 million people (i.e. 22% of the population) are affected by flooding annually and the flood damage was estimated to be ranging from RM915 million (about £160 million) per year (Ghani *et al.*, 2009).

Multivariate statistical techniques provide an opportunity to simultaneously scrutinize multiple factors. These techniques are used extensively in community ecology and seek to reveal structure and pattern in multi-species data sets (Gauch, 1982). Analyses such as classification (cluster analysis), ordination and Analysis of Similarity are used to identify sites, samples or conditions that have similar community composition (Clarke and Warwick, 1994). Analyses such as Principal Axis Correlation (Belbin, 1993) and BIO-ENV (Clarke and Warwick, 1994) used to identify factors associated with underlying compositional variation among sites, samples or conditions. These associations are not causal but rather, they provide an indication of the mechanisms that may be generating overall patterns and

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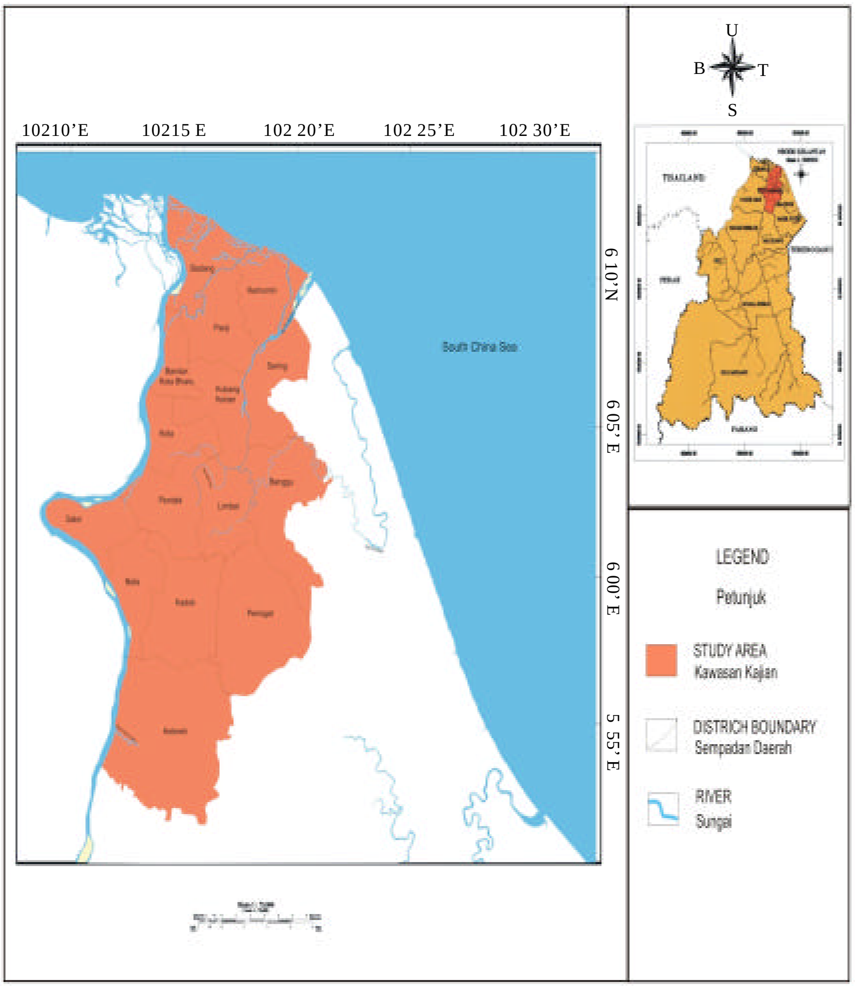

Fig. 1: Location map of the study area (DSM, 2005)

processes. This information can subsequently be used to generate hypotheses for further testing.

The general impact of floods has been previously described (Mooney, 2010; Pradhan, 2009; Berz, 2000; Ghani *et al.*, 2009) but there is little information on the medium-term impact and recovery from flood events. 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. The novelty, we take into consideration in the analysis of flood impact is that chi-square and bivariate correlation tests. The purpose of this study is to characterize the impact of the 2010/2011 floods on the Kelantan, Malaysian people. This study explores how predictors such as age, gender, economic status, residential type, residential area, sickness the respondent and family, electric and phone disruption. In order to analyze the primary impact of the flood among the affected population, it is examined to get better understanding how this influenced post-flood living and household conditions in Kelantan.

Study area: The study area, Kota Bharu is located in Kelantan state at the east coast of Peninsular Malaysia with the latitude of 06°10'N and the 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 also government and private office. The total land area of Kota Bharu is about 394 km^2. It consist of fourteen major districts which was Badang, Kemumin, Panji, Bandar Kota Bharu, Sering, Kota, Kubang Kerian, Banggu, Pendek, Kubang Kerian, Banggu, Pendek, Limbat, Peringat, Beta, Kadok and Ketereh (Fig. 1).

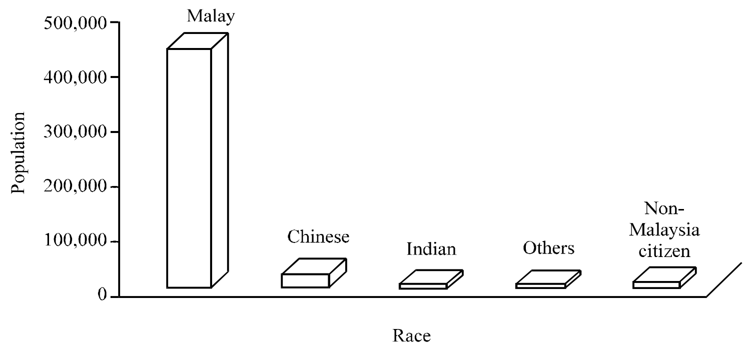

Fig. 2: Population in Kota Bharu (DSM, 2010)

The rapid development of Kota Bharu rises the city as it become the main focus of people all over the world. Kota Bharu is categorized as the highest population district in Kelantan because of its role as the main city of Kelantan. It is recorded that in the year of 2010, the total population in Kota Bharu reaches 468,438 people from different race such as Malay as the majority, Chinese, Indian and other non-citizen and the number keep increases year by year (Fig. 2). The major land use in the study area is mainly agriculture and paddy is the main crops grown here other than mixed horticulture, rubber and orchards. The main river channel in Kota Bharu is Kelantan River which occupies approximately 12,700km^2 or 85% of the state.

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. 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 west. Phyllite and other metamorphosed sediments are fine grained and mostly weathered to clay and silt.

Flood: Heavy rainfall brought by the monsoon has become the main cause of flood in Kota Bharu and because of the trend of annually flood, the flood in Kota Bharu was 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 (Fig. 3). The Northeast monsoon brings heavy rain to east coast states of 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.

Peninsular Malaysia faces the most extensive flood damage in the history of Malaysia where in the year of 1926, a severe flood with strong winds destroyed most of the state in Peninsular Malaysia including the study area. Flood event in the year of 1988 also is a one of the most destructive flood in history of Malaysia where 55 lives were loss due to the impact of the disastrous flood. After that, the numbers of evacuees leave the region and death is decreasing because of the improvement in precaution and mitigation by the government (Fig. 4-6).

METHODOLOGY

Questionnaires survey: A few sessions of face to face interview were conducted in the month of February and March 2012 after 2011-2012 flood event where 200 samples of questionnaires were distributed to about 200 local people in the research area. From all the questionnaires, only 160 effective answers were selected and analyzed using statistical analysis (Collection rate: 80%). 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, age, gender, economic status, residential type, period of residents 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.

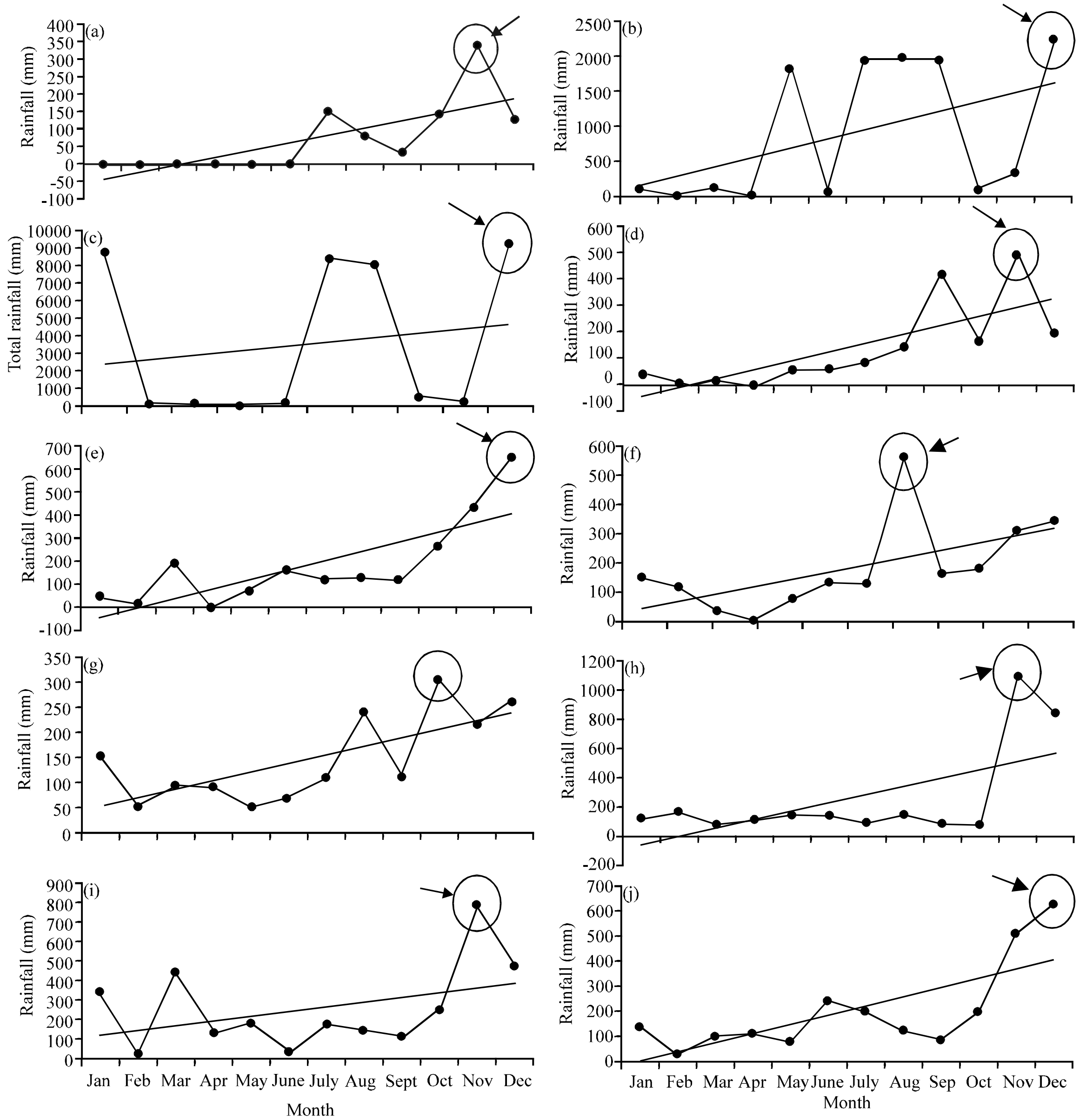

Fig. 3(a-j): Rainfall data from rainfall station in Jeti Kastan, kota Baharu (DDIM, 2011), Rainfall distrubution (a) 2001, (b) 2002, (c) 2003, (d) 2004, (e) 2005, (f) 2006, (g) 2007, (h) 2008, (i) 2009 and (j) 2010

The change to the nearest river was also been asked to the respondent to analyze the tertiary effect of the flood.

Statistical analysis: The statistical analysis was conducted for the purpose to see the association between variables and also to analyze the strength of relationship between flood occurrence and all the variables and the correlation of all the other variables. Two types of statistical analysis were conducted which is cross tabulation and correlation. In cross tabulation, chi-square test was used to analyze the questionnaires.

RESULT AND ANALYSIS

Pre-flood living conditions: After the questionnaires distribution, only 160 effective answers were collected out of 200 questionnaires. Descriptive result shows general information about the respondent such as gender, age, economic status and etc.,

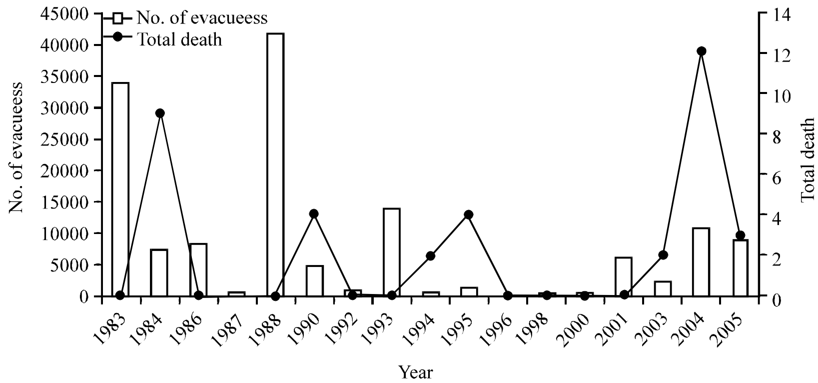

Fig. 4: No. of evacuees and total death for 1983 to 2005 flood event

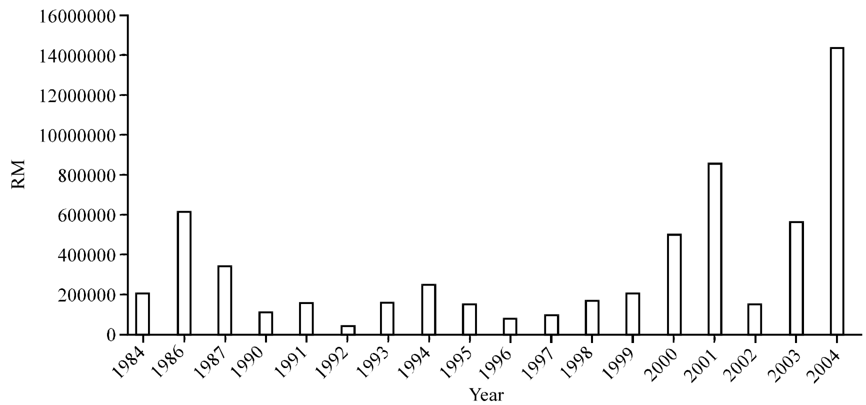

Fig. 5: Total loss for 1983 to 2004 flood event

Fig. 6: Double storey house build by the people to faces the flood

Table 1: Characteristics of respondents

	Respondents, n (%)	
	No.	Percentage
Gender		
Male	112	70.0
Female	48	30.0
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		
House	20	12.5
Shop lot	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

the characteristics of the respondents as shown in Table 1. Describe that the respondent 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 percenage 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 of flooding

Test 1 (Chi-Square): In determining the association between the variables it must be considered the null hypothesis, H_0 which means that there is no association between the variables while H_1 means that there is an association between the two variables. p-value is an estimate of the probability that a particular result could have occurred by chance, if the null hypothesis were true. Its also measure the credibility of the null hypothesis. If something is very unlikely to have occurred by chance it means that the variables are statistically significant. If $p<0.001$ = statistically significant. A large p value ($p = 0.23$) means that there is no compelling evidence on which to reject the null hypothesis and accept the H_1. Table 2 showed the association of flood occurrence with all the other variables considering the p value. The results shows that all the other association of flood occurrence has the p value less than 0.001 but only the association between flood occurrence and water depth showed otherwise which is p value greater than 0.001. So, in the other association of flood occurrence with the variables, the H_0 is rejected and H_1 is accepted which is there is an association between flood occurrence and all the variables. But in the case of association between flood occurrence and water depth, the H_0 is accepted which stated that there is no association between flood occurrence and water depth.

Test 2 (Correlation): The correlation test was conducted to measure the strength and direction of the relationship between two quantitative variables. Correlation can be define as the number between -1.0 and +1.0 where the positive number indicates the prefect positive relationship between the two variables while the negative correlation indicates the perfect negative relationship between the variables. Zero correlation indicates that no linear relationship at all between the variables. The closer to +1.0 or -1.0, the stronger the relationship, whereas the closer to 0, the weaker the relationship is. The results in Table 3 show that the value of "Sig" for all the correlation is less than 0.05 which means that the H_0 is rejected and accept H_1. So, the correlation test shows that all the correlation is statistically significant. All the correlation also shows negative relationship between each other except for the correlation between flood occurrence and type of loss.

Table 2: Association between flood occurrence and other variables

		Flood occurrence
	n (%)	p-value
Flood occurrence		
Yes	137 (85.63)	
No	23 (14.38)	
Frequency of flooding		*
Every year	75 (46.88)	
Rarely	85 (53.13)	
Water depth (m)		**
<1 meter	122 (76.25)	
>1 meter	38 (23.75)	
Types of loss		*
Properties	139 (86.88)	
Others	21 (13.13)	
Average total loss		*
<RM1000.00	91 (56.88)	
>RM1000.00	22 (13.75)	
Others	47 (29.38)	
Disease/Psychology effect		*
Yes	20 (12.50)	
No	115 (71.88)	
Electric disruption		*
Yes	66 (41.25)	
No	69 (43.13)	
River expansion		*
Yes	54 (33.75)	
No	78 (48.75)	

Chi-square test was used, *p<0.001,**p>0.001

Table 3: Correlation between flood occurrence and other variables

	Flood occurrence		
	r-value	Significant	Correlation
Flood occurrence			
Yes			
No			
Frequency of flooding	-.732	.000	- ve
Water depth (m)	-.217	.006	- ve
Types of loss	.621	.000	+ ve
Average total Loss	-.235	.003	- ve
Disease/psychology effect	-.857	.000	- ve
Electric disruption	-.730	.000	- ve
River expansion	-.704	.000	- ve

Bivariate correlation test was used

DISCUSSION

From the analysis it shows that there is association between the flood occurrence and other variables which means that the flood occurs every year in the Monsoon seasons with the average depth ranged less than 1 meter. The major loss in every flood event is properties while the loss of life is decreasing due to the awareness of the people in the affected area. The total loss also decreasing due of the precaution step taking by the people where most of them build double storey house so that, it would be easier for them to moves their belongings such as furniture, electrical equipment and etc to the upper part of the house so that it would not be destroyed during the flood event. Health effect like fever, skin problem, diarrhea and also psychology impact such as trauma, amnesia and etc., were less affected the people (Kunii *et al*., 2002). This is probably because the people in the affected area have prepared themselves for the worst situation during the flood event due to their prohibited at the place for so long. There is also some slight changes in the morphology of the major river in the study area but it still minor changes.

Previous reports have looked at specific health-related effects of the 2010 Pakistan floods including infectious diseases, malnutrition (Mooney, 2010), malaria (Siva, 2010a), cholera and other water born diseases (Siva, 2010b); however, to our knowledge none have explored the overall household impact of the floods, the variance and magnitude of the impact between urban and rural settings, or the recovery from the impact at six-months.The flood caused relatively few direct deaths (1/10,000 affected) and injuries considering but indirect and long-term health problems were widespread with 77% of households reporting flood-related injuries or illnesses. These findings are similar to 2005 post-earthquake health needs in Pakistan when 68% of elderly people in rural areas experienced an overall worsening of health (Chan and Griffiths, 2009) but our percentage is higher than the injuries and illnesses reported by 31% of households after floods in Nepal in 2009 (Holland, 2012). The extensive damage to homes, economy and infrastructure identified in our study is consistent with reports on the impact of floods in Nepal in 2008 (IASC, 2008). However, the widespread damage in Pakistan did not lead to as much distant migration; while nearly 90% of households were forced to leave their homes and a third moved at least twice, less than 20% moved away from their original geographic region. Only half of the affected households lived in an organized camp at any time since the flood which would suggest that alternative sites such as other family members' homes may have been used. However, we found that the average size of both urban and rural households changed minimally at 6 months, contrary to prior reports, where floods and other disasters have been shown to cause a change in household size (Davis and Baulch, 2011).

There has been limited research on the differential effects of disasters in rural vs. urban populations (Davis *et al*., 2010; Nigg, 1995). This study demonstrates significantly worse impact and a slower recovery for rural settings after the flood, including greater impact on their income, sanitation and electricity supply and less frequent economic recovery at six months. Rural households were also more likely to have moved to an entirely different geographic area and less likely to have been able to return to their original home after six months. Rural areas are more difficult to target in a disaster response because of the dispersed nature of the population but in Pakistan rural households accounted for almost 90% of the total affected. Rural families need increased resources and targeted programs by national and international humanitarian and disaster response agencies.

CONCLUSION

In this study, a structured questionnaire with 200 samples was conducted to the people on the 2010/2011 flood event affected area. Two types of statistical tests like Chi-square and Correlation tests were used to analyze the association of flood with the condition of flood in the study area such as frequency of flood, water depth and total loss of money (in Malaysian currency RM), health problem, electric/phone disruption and river expansion. If compares the effect of flood for the 2010/2011 flood event with the previous flood event it shows some decreasing in the conditions of flood probably due to the increasing in self awareness of the risk of flood to the people so that they have taken so many precaution step to reduce the risk of flood to themselves and their properties.

The respondents in the study area is 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. From the results it is observed that there is an association between flood occurrence and all the other economic variables. But from the test of hypothesis it is recorded that there is no association between flood occurrence and water depth. From the correlation test, the findings show negative relationship between each other except for the correlation between flood occurrence and type of loss.

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