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BAHAGIAN 4: TRANSDISCIPLINARY RESEARCH GRANT SCHEME (TRGS)

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PROJECT 1 : IMPROVING FORECASTING SKILL OF EXTREME RAINFALL AND FLOOD EPISODES AND LEGAL FRAMEWORK FOR EFFICIENT GOVERNANCE BETWEEN ALL RELEVANT AGENCIES FOR FLOOD WARNINGS, MITIGATION AND RELIEF

1.1: IMPROVING WEATHER NOWCASTING AND FORECASTING CAPABILITY OF THE MALAYSIAN METEOROLOGICAL DEPARTMENT THROUGH COMPREHENSIVE CASE STUDIES OF HEAVY/EXTREME RAINFALL EPISODES IN EAST COAST OF PENINSULAR MALAYSIA DURING NOVEMBER AND DECEMBER 2014 OF THE NORTHEAST MONSOON

Project Information

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1.0 Introduction

Based on the long-range weather outlook from the ECMWF (European Centre for the Medium-Range Weather Forecasts) and local climatological rainfall record, the Malaysian Meteorological Department (MMD) issued a rainfall distribution outlook, indicating that areas of heavy rainfall would be concentrated along the coastal region of east coast of Peninsular Malaysia during November and December 2014. Unfortunately, extreme rainfals unexpectedly fell over the inland and mountainuous areas instead, leading to massive floods and the resultant loss of lives and extensive property damages. This research project is to transform comprehensive and detailed case studies results into valuable information. From the understanding of the atmospheric features and limitations of weather forecast model output with respect to observations, the nowcasting and forecasting skill as well as the model output guidance can be improved to provide better forecasts and warnings for risk reduction and better disaster management.

2.0 Methodology

Surface and upper air reanalysis data at 00 UTC from the European Centre for Medium-Range Weather Forecasts (ECMWF) for November and December 2014 are used. These reanalysis data are complemented with a wide range of satellite observations, such as the 3-hourly TRMM (Tropical Rainfall Measuring Mission) precipitation, and selected daily/hourly gridded Multi-functional Transport Satellite -2 (MTSAT-2) Infrared Channel 1 (IR1) data.

To identify heavy/extreme rainfall periods and their distributions, precipitation data from meteorological stations at Kota Bahru (6^o 10'N 102^o 17'E, 4.6 m above sea level(ASL)) , Kuala Krai (5^o 32'N 102^o 12'E, 68.3 m ASL)), Kuala Trengganu (5^o 23'N 103^o 06'E, 5 m ASL)), Kuantan (3^o 47'N 103^o 13'E, 15 m ASL)) and Mersing (2^o 27'N 103^o 50'E, 43.6 m ASL) in the east coast of Peninsular Malaysia are used.

To detect all the surge-induced events due to the cold air outburst from the Siberian high towards the equatorial South China Sea, cold surge index which is chosen as the averaged 925 hPa meridional wind between 110^o and 117.5^{o}E along 15^{o}N is used. In addition, an easterly surge (zonal wind surge due to strengthening or equatorward movement in the subtropical ridge of the northwestern Pacific as a result of Siberian high outbreak) index is also adapted as the averaged 925 hPa zonal wind between 7.5^o and 15^{o}N along 120^{o}E. A surge event occurs when either one of these indices exceeds 8 m s^{-1}. The surge intensity is classified into weak, moderate and strong categories for a surge index between 8 and 10 m s^{-1}, 10 – 12 m s^{-1}, and greater than 12 m s^{-1} respectively.

3.0 Results and Discussion

During November and December of the northeast monsoon, a series of cold air bursts out from intense Siberian highs towards the China coast in response to the development and movement of the 500 hPa trough. The resultant strong low level northwesterlies turn into northeasterlies across the South China Sea as "cold surges". On interacting with the near-equatorial trough, mesoscale convective systems form north of the trough, giving rise normally to heavy downpours and severe floodings mainly along the coastal stretch in the east coast states of Peninsular Malaysia. In November 2014, one week-long episode of heavy downpour of more than 800 mm occurred along the coastal stretch of northeastern Peninsular Malaysia. In December 2014, two episodes of extreme rainfall occurred mainly over inland and mountainous areas of northeastern coast of Peninsular Malaysia. These two unusual events which lasted a total of 11 days with more than 1100 mm precipitation had resulted in extreme and widespread floodings as well as extensive damages in many inland areas. These were due to the combined factors of the stronger wind surges from the South China Sea resulting from very intense cold air outbreaks of the Siberian high and the developing cyclonic rainstorms in the northeastern Indian Ocean in response to the propagation of a 500 hPa short-wave trough across the Indian Sub-Continent towards China.

4.0 Conclusion

4.1 2014 was an ENSO neutral year. Siberian Highs were particularly intense and the associated strong cold air bursted out not only southwards but also eastwards.

4.2 Near equatorial trough was anchored around 3^{o}N across Peninsular Malaysia. The strong wind surges resulted in deep cyclonic shears upon interacting with the trough, leading to the development of intense and prolonged convective storm clusters. In addition, the strong wind momentum was sufficient to overcome surface discontinuity to lodge the storms in inland and mountainous areas.

4.3 The sustenance of the storms over inland and mountainous areas was further aided by the developing and westward moving cyclonic storms over the northeastern Indian Ocean.

References

C.-P. Chang, P.A. Harr, H.-J. Chen. 2005. Synoptic Disturbances over the Equatorial South China Sea and Western Maritime Continent during Boreal Winter. *Monthly Weather Review.* **133:** 489-503.

Juneng, L., F.T., Tangang and C.J.C. Reason .2007. Numerical case study of an extreme rainfall event during 9-11 December 2004 over the East Coast Peninsular Malaysia. *Meteorology and Atmospheric Physics*. 10.1007/s00703-006-0236-1

Lim Joo Tick, Azizan Abu Samah. 2004. *Weather and Climate of Malaysia*. University of Malaya Press.

Ooi, S.H. 1999. *Impacts of ENSO on Monsoons over Malaysia.* ESCAP/WMO Typhoon Committee Annual Review 1998. World Meteorological Organization, Geneva, 153-173.

1.2: POST-FLOOD 2014: KNOWLEDGE AND PRACTICES REGARDING TO THE WATER AND VECTOR BORNE DISEASES AMONG COMMUNITY IN KELANTAN RIVER BASIN

Project Information

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1.0 Introduction

Vector-borne and water-borne diseases disease is one of the most significant public health concerns in Malaysia. The disease is closely related to human activities. Floods in December 2014 has increased the risk of incidents and outbreaks of vector-borne and vector-borne throughout the region For the effective prevention and control of diseases associated with vector-borne and water-borne diseases, it requires a comprehensive and systematic strategy involving various organization including local communities and health authorities, particularly the Ministry of Health Malaysia. The participation of local communities is deemed to be a key factor for the successfulness of prevention and control of infectious diseases. Therefore, this study aimed to explore the level of Knowledge and Practice among the Kelantan River basin community with regards to the prevention and control of vector-borne and water-borne infectious diseases.

1.2 Research hypothesis

1. The level of Knowledge and Practices in relation to the prevention and control of water-borne and vector-borne infectious diseases are generally good among the community.
2. Mass media, especially televison is the main source of information about the knowledge and practices in relation to the prevention and control of water-borne and vector-borne infectious diseases
3. The level of Knowledge and Practices are varies according to the level of education.
4. The Knowledge and Practices level can be enhanced by the involvement of local communities, health authorities, local governments and NGOs.

1.3 Objective (s) of the Research

1. To explore the Knowledge and Practice among the community with regards to the prevention and control of water-borne and vector-borne infectious diseases.
2. To explore the source of knowledge and practice of prevention and control of water-borne diseases and vector-borne
3. To assess level of Knowledge and Practices among comunity base on their lavel of education
4. To propose appropriate measures to raise the level of Knowledge and Practices among local residents.

2.0 Methodology

Conceptually, the information gathered in this research will be drawn from various primary, secondary and spatial data. Questionnaire surveys and field work is the main techniques implement in order to gather the primary data. The level of Knowledge and Practices study will focus on the level of understanding of the disease and preventive measures to avoid the risk of this disease. The source of knowledge and practice of prevention and control of water-borne diseases and vector-borne also be observed in this study. This study will be carried out by questionnaires process. A total of 2,700 residents will be selected as respondents. To carry out this questionnaire process, 6 Field workers/numerators would be used for a period of 45 days. Questionnaire process will be conducted at 16 locations covering the entire area of Kelantan River Basin.

3.0 Results and Discussion

Water and vector-borne disease is a public health problem that is most important. Risk for the occurrence of this disease is higher among young people, especially after the flood. Floods which occurred at the end of December 2014 in the state of Kelantan has caused great damage to the population. After the flood, the treatment system and water supply systems throughout the country have been affected. Sewerage system has also suffered damage. This situation is causing people have to rely on alternative water supply sources are quite limited and possibly contaminated, particularly water supply from wells. This situation will increase the risk of incidents and outbreaks of waterborne infectious diseases. The flood events in the December 2014 also led to the waste management problems and is unable to be handled by the local authorities and even by the public itself. This situation has encouraged the breeding of vectors that can cause a variety of infectious diseases, especially rodents, mosquitoes and flies.

Health agencies are not able to handle all issues related to public health, especially after the flood. Society must also cooperate to resolve this issue. Human knowledge and human behavior have each been reported to play an important role in the tramsmission of the disease. In the case of Kelantan river basin, the flood has increased the risk of water and vector borne diseases for the whole area. The objectives of this research are to explore the Knowledge and Practices among the community with regards to the prevention and control of water and vector-borne diseases. Methods of population surveys and field studies will be used in this study. This study will provide information on population knowledge and practices related to water and vector borne diseases in the study area. This information could help health authorities to plan and implement early prevention of water and vector borne infectious diseases.

4.0 Conclusion

4.1 A cross sectional survey was conducted on a random sample of 1500 subjects with a structured interview on knowledge, practices and also on demographic and epidemiological aspects.

4.2 There is a very significant association ($p<0.0001$) between the level of education and knowledge about the diseases. About 87.1% of respondents in the respective level of education have a better knowledge towards water and vector-borne diseases.

4.3 Significance difference between practices and these four level of education ($p<0.0001$) was also reported. Majority of them (95.6%) had a positive practices with regards to water and vector-borne diseases.

4.4 Knowledge and practices related to water and vector-borne diseases are important for the implementation of effective prevention programs. Therefore, knowledge and practices of the population concerned must be taken into account in the design of interventions against water and vector borne diseases transmission..

4.5 Integration between health education programme and community participation is necessary to improve their understanding, awareness and impact of these diseases.

References

Ayyamani UD, Gan CY, Ooi GS. (1986). A knowledge, attitude and practice (KAP) study on dengue/dengue hemorrhagic fever and the *Aedes* mosquito. Med J Malaysia, 41(2), 108-15.

Hairi, F, Ong, C.H., Suhaimi, A., Tsung, T.W., Anis Ahmad, Sundaraj, C, *et al*. (2003). A knowledge, attitude and practices (KAP) study on dengue among selected rural communities in the Kuala Kangsar district. Asia-Pac J Public Health, 15(1), 37-43.

Hunter, P.R. (1997). Waterborne Diseases: Epidemiology and Ecology. New York: JohnWiley.

Leong, T.K. (2014). Knowledge, attitude and practice on dengue among rural communities in Rembau and Bukit Pelanduk, Negeri Sembilan, Malaysia. Int J Trop Dis Health, 4(7), 841-848.

MOH. (2014). Management guidelines of malaria in Malaysia. Kuala Lumpur: Malaysia. Putrajaya: Ministry of Health Malaysia.

1.3: GENERATION OF FLOOD HAZARD MAPS BY INTEGRATING HYDROLOGICAL AND SPATIAL DATA

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1.0 Introduction

The recent floods which strikes in December 2014 covering a large areas in Kelantan, Terengganu, Pahang and Perak has trigger an immense national interest. This study is conducted in order to study and understand the causal effect and characteristics of the flooding events, to integrate the spatial information systems with the hydrological information and to utilize the flood map as a guide to propose future development plans.

The non-structural approach has been implemented using the new and existing datasets. Flood plain information is important for corrective and preventive measures of reducing flood damage and immediate rescue. Precipitations and river flows are seasonal and highly variable. Combination of hydraulic, hydrological and mapping tools using spatial information has become an inevitable tool in producing the flood map. Visualization the severity of the flood and formulating the rational land use planning can be done using flood maps. Flood map describes the characteristics of the flood event from information on the geographical extend of the flood inundation areas, water depth based on the watermark and the velocity of flow of the flood water.. There had never been a need for a flood safety plan as the water levels in the river had not risen past the danger mark in 20 years. This method is affective to reduce the flood induced disaster. Stakeholders can use this map as a decision making tool for the resources administration, mitigation plan development, save and rescue emergency response plan formulation, and proposed recovery action plan. This study considered the river geographical locations and contributions of several rivers namely Sungai Lebir, Sungai Galas and Sungai Kelantan in devastated 2014 flood disaster.

2.0 Methodology

The site visits to Sungai Lebir, Sungai Galas and Sungai Kelantan in Kuala Krai in order to see the flood extend in Kuala Krai district have been performed. GPS observation for geo- location in Sungai Lebir, Sungai Galas and Sungai Galas and ground sampling for region of interest (ROI) was conducted during the site visit. Spatial data were collected from National Antarctic Research Centre (NARC). The data period is on normal event in Kelantan including remote sensing image, GIS data and topographical map. Hydrological data were collected from Malaysia Department of Drainage (DID) which contain rainfall, water level and stream flow data.

Using the GIS software , the DEM, land use, and soil (Spatial data) were pre-processed based on the same standard characteristics layer of GIS format including clipping to Kelantan state boundary shape file and transforming it into standard projection of Malaysian Kertau RSO. Delineation of the river was implemented using the Mapwindow GIS. DEM was used to calculate elevation, slope and drainage pattern in Kuala Krai, Kelantan. The process consisted of delineating the cross section of the river and stream flows. Land use and soil map were then integrated in the ArcGIS. Using ArcGis as main tools, the spatial data that has been pre- processed into vector format were assembled into the data layers.

The HEC-RAS was used to simulate the flood inundation extent and depth as well as peak flow propagation along the river channel. The topographic map and DEM images were used to determine the geographic location of the required geometric data necessary to perform hydraulic computations using the HEC-RAS. The model requires an input file which consists spatial and watershed contours, hydrology of the watershed and hydraulics of the rivers. These include the location of stream, elevation profiles, river length, longitudinal and local slopes, rainfall and discharge patterns, river cross section and the roughness of the river section. The limitation of some important data has delayed the modelling progress, and this has some effects on the output generated. The output from the HEC-RAS was transferred to GIS software for the process of flood mapping. Figure 1 below shows the flowchart of the methodology.

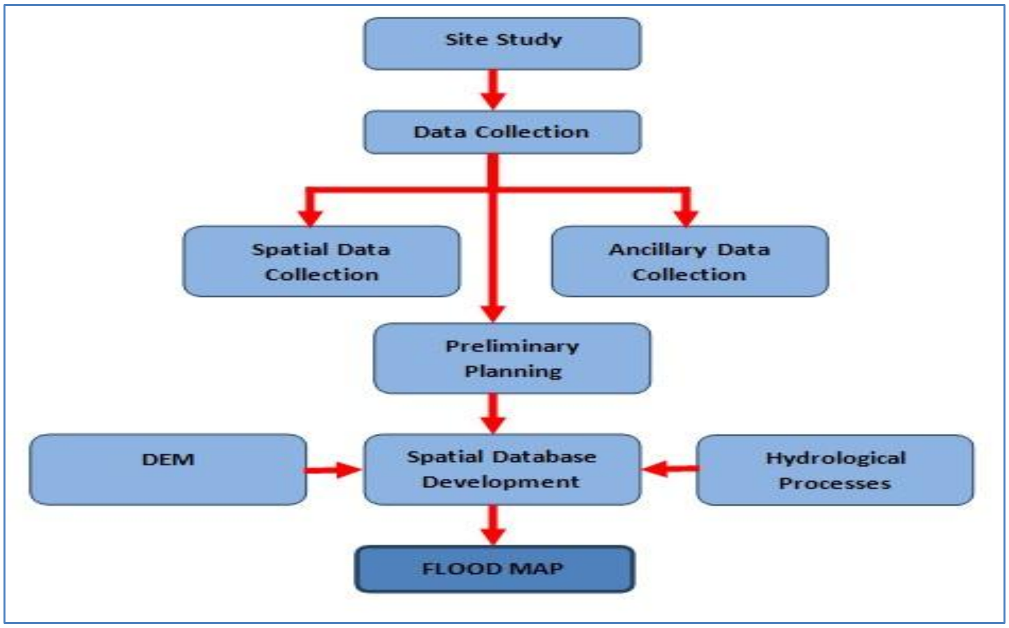


Figure 1: Methodology flowcharts

3.0 Results and Discussion

The findings of the study are discussed below. It is divided into two main categories, namely the causal effect and flood map generation.

3.1 Causal effects

High amount of rainfall and water level

It was mainly due to the continuous heavy rainfall starting from 14 December 2015. The catchment area was saturated and most of the rainwater becomes surface runoff, which increased drastically the volume of the flood water. As can be seen from Table 1, the amount of rainfall in 10 days at all three stations exceeded the average of rainfall in December by 1.4 to 2.7 times. Subsequently, the water level started to rise and exceeded the danger level since 17 Dec 2014. Teh water level reached the highest level of 22.7 m as recorded in 26 December 2014. (Figure 2). Table 2 gives the highest water level in 2014 in comparison with the highest water level in previous years.

Table 1: Rainfall period

Station	Amount of rainfall 10 days (mm)	Average raifall of December (mm)	Comparison of average rainfall of December
Gunung Gagau	1,898	698	2.7 times
Kuala Krai	848	585	1.5 times
Kusial	1048	757	1.4 times

Table 2: Water level at catchment

No.	Catchment	Station Name	Highest Level in 2014 (m)	Highest recorded water level (m)	Danger Level (m)
1.	Sungai Galas	Dabong	46.39	42.05 (1979)	38
2.	Sungai Lebir	Tualang	42.17	39.92 (2004)	35
3.	Sungai Kelantan	Tangga Krai	34.17	29.48 (2004)	25
4.	Sungai Kelantan	Jambatan Guillemard	22.78	21.18 (1988)	16
5.	Sungai Kelantan	Tambatan DiRaja	6.94	7.00 (2004)	5
6.	Sungai Golok	Jenob	25.10	25.61 (2008)	23.5
7.	Sungai Golok	Rantau Panjang	10.84	11.56 (1997)	9
8.	Sungai Semerak	Pasir Putih	2.67	2.43 (2012)	3

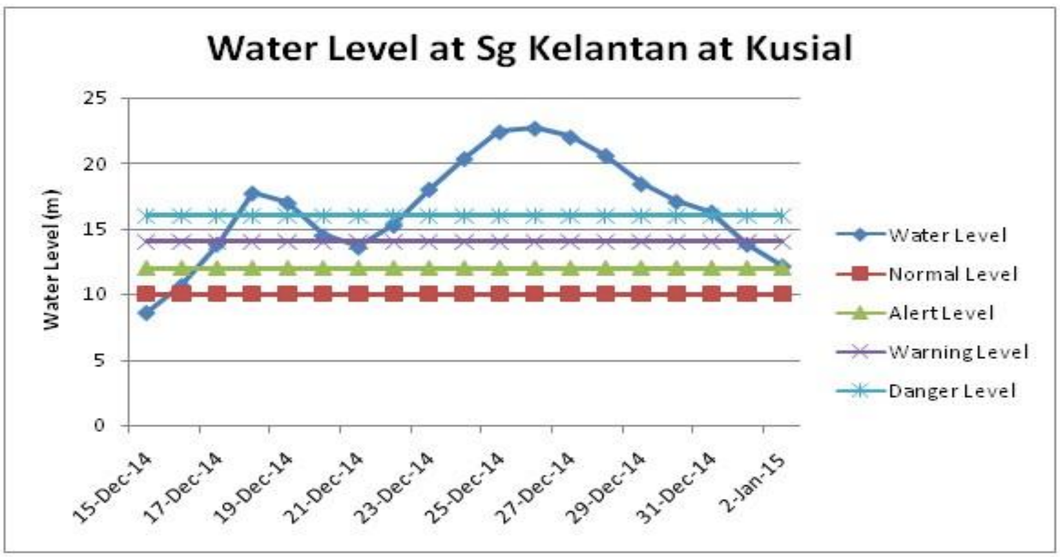


Figure 2: Water level at Sungai Kelantan di Kusial

Land elevation

The topography of the area also contributes to the flood events. The upper basin is an area of high ground which has steep slopes and narrow river valleys. The downstream side is undulating, sloping and almost flat in the coastal plain and delta. The land elevation which river flows in Kuala Krai is between 10m to 30m and it is surrounded by hilly land ranges between 300m to 500m – slope between lowland and highland in Kuala Krai is steep. Its physical properties contribute to the formation of a torrent with large discharge from the upper basin will collide in the middle of the basin, which is narrower (Figure 3). This implies great vulnerability to flooding.

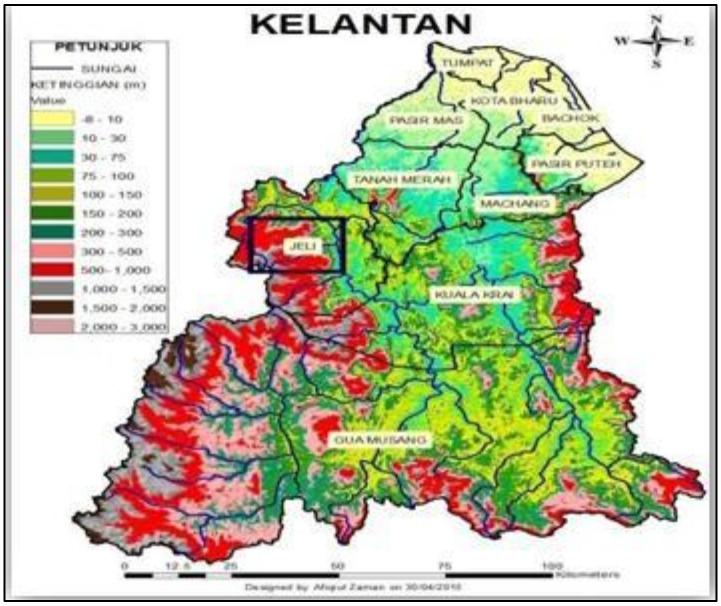


Figure 3: Land elevation at Kelantan

Land uses changes

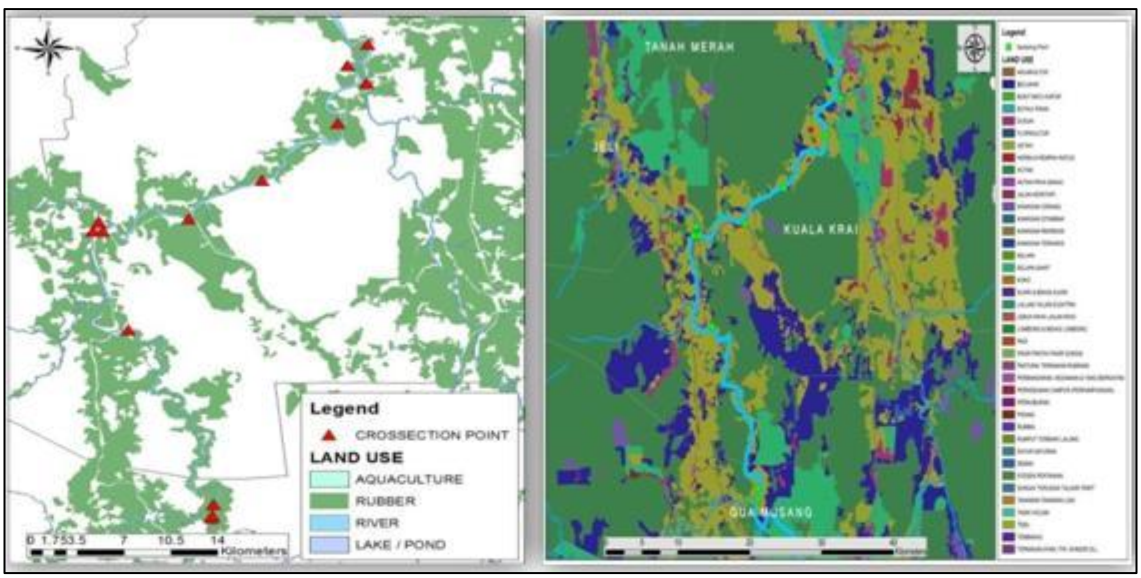
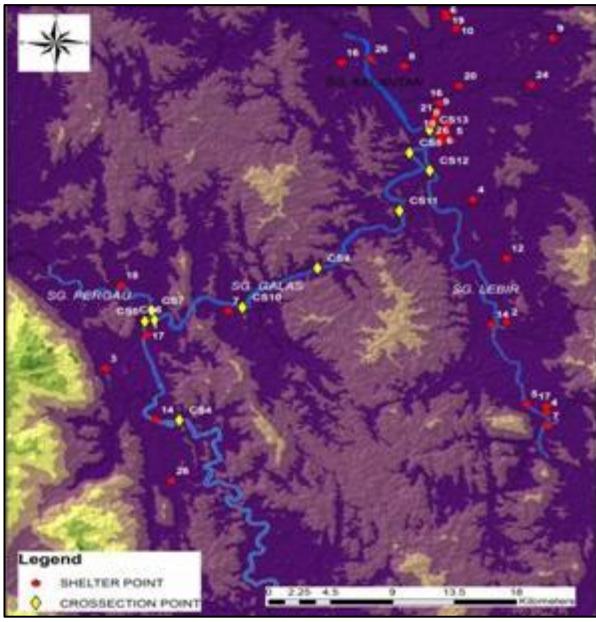


Figure 4: Land use map of Kuala Krai

Changes in land use from natural rain forest area that has the capacity to accommodate high rain water to agriculture (mainly rubber, oilpalm,etc), logging and settlement that reduces the capacity in accommodating rain water

3.2 Generation of flood map

Figure 5 shows a map of the river generated from the Hec-RAS simulation, GIS information, and shelter information. The dark blue color indicates the original radius of the river prior to the flooding event. After the flooding event, the radius of the river expanded to the point which is represented by the light blue color in the map. It can be seen from the figure that some shelter points are located very close to the river. As presented by Figure 6, some of the shelter points are very close to the river. This proximity data can be used in the future to relocate each shelter point if the flood reoccurs in that area.



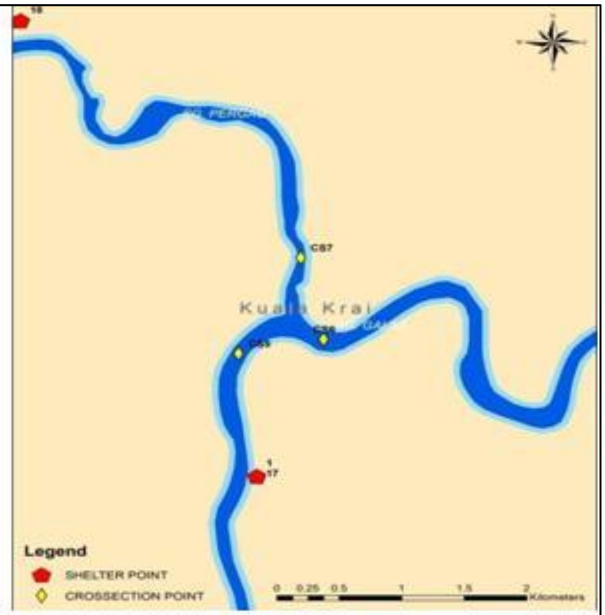


Figure 5: Flood map with DEM
Figure 6: Close-up of the shelter points at Dabong

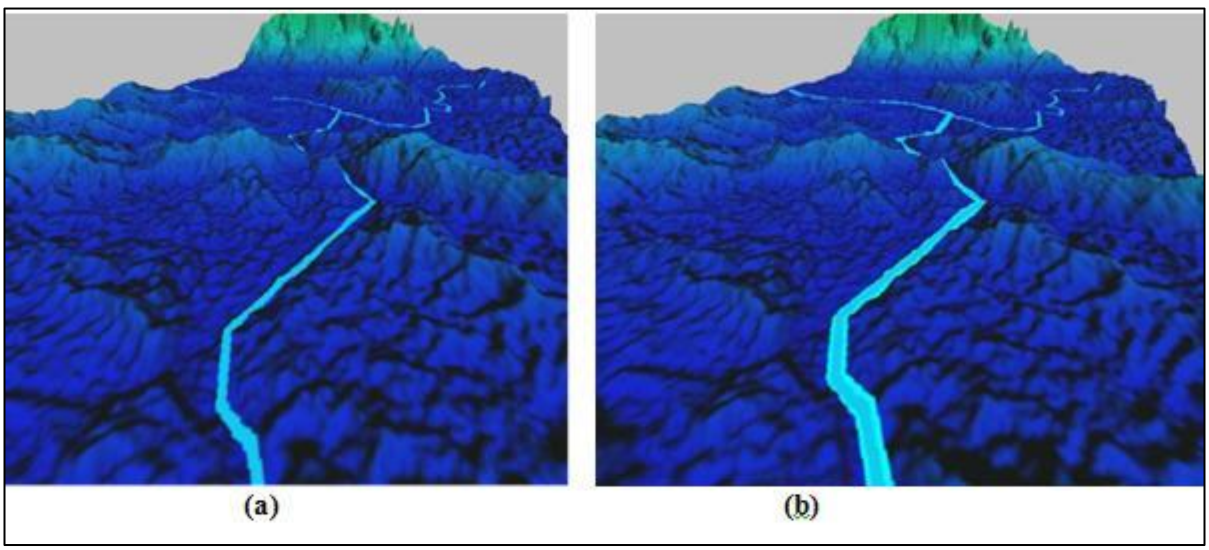


Figure 7: 3-D view of flood map during a) normal condition and b) flooding event

4.0 Conclusion

There are several reasons that contributed to the flooding in Dec 2014; namely heavy rainfall, geologic and geomorphology factor, as well as the changes of land use. This study provides a description on the integration of GIS and Hec–Ras in combination of DEMs in delineating the flood extent of each revenue district of the study area. The flood map was produced based on the availability of the data and current information. The results obtained in this study provide essential information for planners and administrators to analyze and manage the flood, which then allows the formulation of remedial strategies to overcome the recurring flooding problem involving the same area. However, the flood map can be improved provided that more data are available, to include the hazard or risk factor. A more comprehensive flood hazard map can be generated if more time is given and inclusive/in- depth data is available. Furthermore, there is one thematic area that should be factored into the flood modeling which is the ease of evacuation of lives and property in the event of a flood. This theme considers the access routes to and from flood zones in a flooding event. This factor, however, is not included in the main proposal due to time constraint and insufficient data.

References

Department of Irrigation and Drainage Malaysia (2009).*Flood management manual vol 1*.

Department of Drainage of Malaysia, 2015.*Extreme Flooding In the East Coast of Malaysia 14 – 26December 2014*. Presented in Workshop on Extreme Weather & Flood: Preliminary Investigation on the Recent Flood in the East Coast of Malaysia, University Malaya.

Kuala Krai District Council Extracted on 23 March 2016 from http://www.mdkkrai.gov.my/en/latarbelakang-kualakrai?p_p_id=56_INSTANCE_pU9J&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-content&p_p_col_count=1&page=1

Malaysia Meteorological Department 2015.*The Observation & Forecast of Heavy Rainfall Episodes during 2014/2015 Winter Monsoon Season*.Presented in Workshop on Extreme Weather & Flood: Preliminary Investigation on the Recent Flood in the East Coast of Malaysia, University Malaya. National Flood Risk Assessment. December 2011.

1.4: SPATIAL AND TEMPORAL ANALYSIS OF RAINFALL VARIABILITY AT KELANTAN RIVER BASIN

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1.0 Introduction

The widespread flooding which occurred in Kelantan from November to December 2014 contributed to around RM 2.81 billion losses to the country. The flood that drowned most of the areas in Kelantan is seen as the most disastrous flood event in the history of Malaysia which caused 14 deaths and 319,156 victims evacuated to safety. Thus, it is important to further investigate the chances of heavy flood to occur especially during monsoon seasons. The analysis of rainfall variability, particularly on the precipitation amounts, the sequence of wet days is becoming important in managing water resources not only in Malaysia but also throughout the world. Identifying the persistency of wet spells in daily rainfall behaviour specifically during the peak period provides useful information in predicting future climatic events since these variables are closely related to extreme weather events such as floods and landslides.

The application of Markov chain models in determining the persistency of wet and dry spells received great attention among researchers in the field of study. Any model which is found to describe the daily rainfall occurrence successfully should also be able to represent the distribution of wet (dry) spells well. The studies on identification of the best order of the Markov chain models to describe the distribution of wet and dry spells have been carried out by a number of researchers at various locations, as in the case of Fleming (2007) and Hui et al. (2000) for Canada; Tolika and Maheras (2005) for Greece; Deni et al (2009) for Peninsula Malaysia.

Rainfall has a seasonal variation which caused frequent changes in rainfall parameters and rainfall amount throughout the year. The variations could be handled by deriving separate parameter sets for each month of the year. Unfortunately, this would cause a large number of parameters to be estimated in the models. Based on some previous studies by Jimoh and Webster (1999) for Nigeria and Woolhiser and Pegram (1979) for USA data set, the Fourier series was found to be the best method in smoothing the model parameter of periodic function. This would then help to describe the rainfall pattern and its temporal variation concisely.

Gamma distribution is commonly used in modeling rainfall amount of wet days. The parameter of gamma distribution may change throughout the year. The comparison of rainfall patterns between stations on the east and west coasts of Peninsular Malaysia using Fourier series had been conducted by Suhaila and Jemain (2009). The findings indicated that the western areas have a bimodal pattern and best described with two harmonics. On the other hand, four harmonics of Fourier series are required for the stations located in the eastern area which exhibit unimodal pattern of rainfall. Unfortunately, none of the rainfall stations under their study involved Kelantan region which was the most disastrous areas during the flood event occurred in Peninsular Malaysia recently.

Thus, further analysis on investigating the seasonal rainfall peaks which contributes to flood event at Kelantan will be conducted in this study. In order to model time of dependence throughout the year using Fourier series. A generalized linear model (GLM) will be used to model those rainfall distributions which vary as a function of time of year. Daily rainfall amount as well as mean rainfall per rainy day will be analyzed and the results on different harmonic of the rainfall patterns and seasonal peak periods will be compared based on three different regions at Kelantan such as inland, river and coastal areas. In addition, the analysis of persistency of wet spells will also be identified during the anual basis as well as monsoon season by using Markov chain models for two levels of threshold, 10 mm and 30 mm.

2.0 Methodology

This section explains on the study area and the methodology used to analyze daily rainfall data, identifying the persistency of wet spells and the optimum order of Markov chain models. Moreover, the identification of seasonal rainfall peaks will also be carried out by evaluating the deviances.

2.1 Fitting Daily Rainfall Occurrence using Markov Chain model

Daily rainfall data from the selected fifteen rain gauge stations at Kelantan were collected from Malaysia Department of Irrigation and Drainage for the period of 1975 to 2014. A wet day is defined as a day with a rainfall at least 10mm or 30mm.

Let $X_1, X_2, \ldots, X_t, \ldots, X_n$ denote n binary variables to represent the sequences of wet and dry events in the daily rainfall occurrence for n–arbitrary days, indicated as 1 and 0, respectively. The sequence of a wet (dry) day is assumed to follow a Markov chain model of the first order in the events of wet or dry at time *t*, when X_t, depends on the previous event X_{t-1}. Let P_{10} denotes the conditional probability of a wet day following a dry day and P_{11} denotes the conditional probability of a wet day following a wet day. Then these two conditional probabilities can be given by

$$P_{10} = P(X_t = 1 \mid X_{t-1} = 0) \quad \text{and} \quad P_{11} = P(X_t = 1 \mid X_{t-1} = 1) \qquad (1)$$

For the Markov chain model of m[th] order, the stationary transition probabilities are given by

$$P_{i_{m+1},\ldots,i_1} = P(X_t = i_{m+1} \mid X_{t-1} = i_m, \ldots, X_{t-m} = i_1; \qquad i = 0,1 \qquad (2)$$

In order to obtain the optimum order of the Markov chain model, AIC and BIC can be applied. Both criteria are based on the log-likelihood functions for the transition probabilities of the fitted Markov chain models.

2.2 Fitting Rainfall Amount using Fourier Series

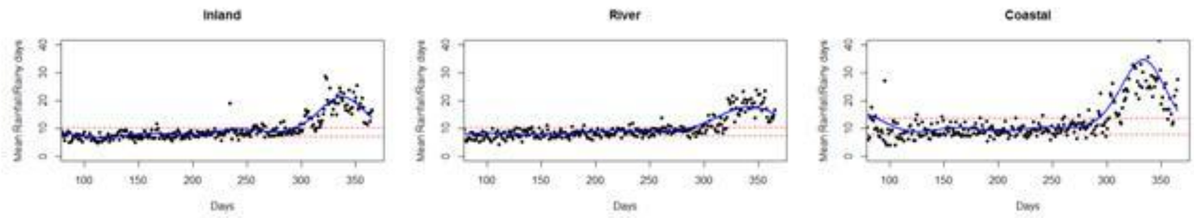
Fourier series are always chosen as the smoothing function due to its capability in fitting both the unimodal and bimodal seasonal pattern (Jimoh and Webster, 1999). Moreover, the fitted curves are able to connect at the beginning and end of the year. The independent variables are the functions of the time of year and the dependent variables are the parameters for the gamma distributions for rainfall amounts. The Fourier series is expressed as follows:

$$g(t) = A_0 + \sum_{j=1}^{m} \left(A_j \sin(jt') + B_j \cos(jt') \right) \qquad (3)$$

where j is the harmonic, m is the maximum harmonic required for the series, A_j and B_j are the parameter estimates for Fourier series obtained by using the maximum likelihood method. The performance of the Fourier series in describing seasonal behaviour can be assessed using deviance.

3.0 Results and Discussion

The conditional probabilities of a wet event at each station are estimated for both levels of threshold and averaged out according to the areas and stations. When the levels of persistence of wet spells are compared based on the two levels of threshold, the persistence of wet spells is found to be higher for the threshold 10mm. The difference between the successive conditional probability of wet days for both thresholds reduces for some station after the fourth day. As expected the lower threshold will produce slightly a longer duration of wet periods. Further analysis shows that during October until December for all the three areas, the conditional probability of a wet given the previous day was wet, P111, is also substantially higher than the probability wet, P11, for all stations. When the levels of persistence of wet spells are compared based on anual basis and during monsoon season, the persistence level is found to be higher during the season between October to December. The difference between the successive conditional probability of wet days for both thresholds reduces for some station after the fourth day. The findings indicate that the persistency of wet spells for higher threshold during Oct-Dec produces slightly a longer duration of wet periods. Moreover, the analysis indicated that the third order is found optimum in all stations.



$g(t)=.256 + 0.207\sin(t) - 0.279\cos(t) - 0.133\sin(2t) + 0.108\cos(2t) + 0.142\sin(3t) - 0.004\cos(3t) - 0.140\sin(4t) - 0.048\cos(4t)$

$g(t)=.\ 2.287 + 0.156\sin(t) - 0.259\cos(t) - 0.115\sin(2t) + 0.133\cos(2t) + 0.105\sin(3t) - 0.034\cos(3t)$

$g(t)=2.530 + 0.139\sin(t) - 0.352\cos(t) - 0.231\sin(2t) + 0.028\cos(2t) + 0.246\sin(3t) + 0.097\cos(3t) - 0.177\sin(4t) - 0.045\cos(4t)$

Figure 1:Observed (dots) and fitted (curves) rainfall for rainy days with the coefficient of the Fourier series at each of the three regions at Kelantan

Figure 1 describes the fitted curves for the observed mean rainfall values per rainy day at each of the three areas in Kelantan. The quartile thresholds of 25th percentile and the 75th percentile obtained from the fitted curves are used to distinguish between the dry and wet periods. The values that are smaller than the lower quartile could be considered as the dry period, while the values that are greater than the upper quartile are assumed as the wet period. Referring to Fig. 1, the coastal area exhibits larger variation of mean rainfall per rainy day where more extreme cases occurred towards the end of the year.

Table 1: The estimated wet period, the date and value at peak of mean rainfall per rainy day and the actual flood events

Area	Station	Wet Period Duration	Date at Peak	Value at Peak	Actual Flood Event	
					2013/2014	2014/2015
Inland	Gua Musang	28 Aug-17 Nov	13 Oct	14.33	-	2nd wave : 14 Dec–3 Jan
	Ldg Lapan Kabu	28 Oct-26 Jan	9 Dec	31.47	2nd wave : 30 Nov–11 Dec	2nd wave : 14 Dec–3 Jan
	JPS Machang	1 Nov-30 Jan	21 Dec	26.91	2nd wave : 30 Nov–11 Dec	2nd wave : 14 Dec–3 Jan
	K'api Bukit Panau	24 Oct -22 Jan	8 Dec	20.90	2nd wave : 30 Nov–11 Dec 3rd wave : 9 – 14 Jan	2nd wave : 14 Dec–3 Jan
	Gunung Gagau	22 Oct-20 Jan	8 Dec	20.18	-	2nd wave : 14 Dec–3 Jan
	Kota Bahru	30 Oct -29 Jan	10 Dec	44.65	-	2nd wave : 14 Dec–3 Jan
	Overall *(Inland)*	19 Oct-14 Jan 30 Aug-2 Sept	3 Dec	21.31		
River	JPS Kuala Krai	4 Nov-2 Feb	19 Dec	24.81	2nd wave : 30 Nov–11 Dec	2nd wave : 14 Dec–3 Jan
	Kg Laloh	19 Oct-12 Jan	5 Dec	22.06	2nd wave : 30 Nov–11 Dec	2nd wave : 14 Dec–3 Jan
	Dabong	13 Oct-12 Jan	1 Dec	15.12	-	2nd wave : 14 Dec–3 Jan
	Kg Aring	6 Sept-5 Dec	21 Oct	16.29	-	2nd wave : 14 Dec–3 Jan
	Kg Jeli	1 Nov-30 Jan	13 Dec	21.34	-	2nd wave : 14 Dec–3 Jan
	Ibu Bekalan Tok Uban	10 Oct-16 Jan	7 Dec	30.55	2nd wave : 30 Nov–11 Dec 3rd wave : 9 – 14 Jan	2nd wave : 14 Dec–3 Jan
	Overall (*River*)	19 Oct-18	6 Dec	15.60		

		Jan				
Coastal	Jbtn Pertan. Bachok	20 Oct-31 Dec	27 Nov	40.82	-	2nd wave : 14 Dec–3 Jan
	Kg Beris	17 Oct-15 Jan	29 Nov	38.26	2nd wave : 30 Nov–11 Dec	2nd wave : 14 Dec–3 Jan
	Stsn K'api Tumpat	24 Oct-2 Jan	28 Nov	25.66	2nd wave : 30 Nov–11 Dec 3rd wave : 9 – 14 Jan	1st wave : 17-23 Nov 2nd wave : 14 Dec–3 Jan
	Overall (*Coastal*)	22 Oct-2 Jan 6 Mac 23 Mac	29 Nov	34.63		

Table 1 shows the estimated wet period duration, the date and the value at peak of mean rainfall per rainy day and the actual date of flood events occurred during 2013/2014 and 2014/2015 which consists of three and two wave phases, respectively. The flood events brought about heavy losses, including loss of life in many areas in Kelantan. The findings show that the date at the estimated rainfall peak based on the results of Fourier series falls during the duration of the actual date of flood event at almost all stations except Gua Musang station. There are three stations, Keretapi Bukit Panau, Ibu Bekalan Tok Uban and Stesen Keretapi Tumpat, which experienced having floods during the two waves phases for the past two years of flood events. Therefore, there is a high possibility of flood event to occur at these stations in the future. The findings obtained here are very useful for monitoring and predicting the extreme future climatic event such as flood and landslides.

4.0 Conclusion

The analysis on daily rainfall behaviour at fifteen rainfall stations which comprises of inland, river and coastal areas in Kelantan are compared in determining the persistency of wet spells and also identifying the seasonal rainfall peaks. Important findings of the study are summarized as follows:

4.1 The persistency of wet spells is much higher during the monsoon season, October to December, than throughout a year. Moreover, the persistency of wet spells is also to be found higher for the threshold 10mm compared to the higher threshold. The difference between the successive conditional probability of wet days for both thresholds reduces for some station after the fourth day.

4.2 The analysis of Markov chain model indicated that the third order is found optimum in all stations. Thus, the results may provide evidence that the higher the order of the chain, the greater the consideration of the persistence of wet events which is closely related to extreme events such as flood.

4.3 Further analysis on fitting the Fourier series describes the seasonal variation of the model parameters as well as determining the number of harmonics required at each region in Kelantan. Four harmonics are appropriate for the inland and coastal areas, meanwhile the river area is more suitable with three harmonics model of Fourier series.

4.4 The estimated wet period, the dates and values at rainfall peaks and the probability of amounts falling that exceed certain threshold values are identified and then compared with the actual flood events during 2013/2014 and 2014/2015. In terms of wet periods, October until the early January can be considered as the wettest months with the peak periods are around the end of November until the middle of December. The findings indicate that duration of wet periods obtained from the results of best fitting justifies the flood event in 2014/2015. Moreover, the coastal area of Kelantan also shows the highest probability of rainfall amounts exceeding 30mm.

References

Deni, S.M., Jemain, A.A., Ibrahim, K. “Fitting optimum order of Markov chain models for daily rainfall occurrences in Peninsular Malaysia.” Theoretical and Applied Climatology 97(2009): 109-121

Fleming, S.W. “Climatic influences on Markovian transition matrices for Vancouver daily rainfall occurrence.” Atmos Ocean 45 (3)(2007):163–171

Hui, W., Xuebin, Z., Elaine, M.B. “Stochastic modeling of daily precipitation for Canada.” Atmos Ocean 43(1)(2000):23–32

Jimoh, O.D., Webster, P. “Stochastic modeling of daily rainfall in Nigeria: intra-annual variation of model parameters.” Journal of Hydrology 222 (1999): 1–17.

Suhaila, J., Jemain, A.A. “A Comparison of the rainfall pattern between stations on the East and West coasts of Peninsular Malaysia using the smoothing model of rainfall amounts.” Meteor. Appl. 16(2009): 391-401.

Tolika, K., Maheras, P. “Spatial and temporal characteristics of wet spells in Greece.” Theor Appl Climatol 81(1–2)(2005):71–85

Woolhiser, D.A., Pegram, G.G.S. “Maximum likelihood estimation of Fourier coefficients to describe seasonal variations of parameters in stochastic daily precipitation models.” Journal of Applied Meteorology18(1)(1979): 34–44.

PROJECT 2 : SEDIMENT TRANSPORT, EXTREME FLOODING AND SOCIETAL IMPACT: CASE STUDY FOR SUNGAI KELANTAN

2.1: LINKS BETWEEN FLOOD FREQUENCY AND ANNUAL WATER BALANCE BEHAVIORS: A BASIS FOR FLOOD ESTIMATION AND MITIGATION

Project Information

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1.0 Introduction

Among the natural hazards, flood (either monsoonal and flash flood) is the most common and devastating threat in Malaysia which affects thousands of people every year and causes the loss of life and economy (Ghani et al., 2009). Flash flood is caused by the combination of anthropogenic activities and topographic changes which results into high runoff and hence river's structural changes (Creutin et al., 2013 andŠpitalar et al., 2014). The effects of these factors on downstream flood are to be quantified to understand flood pattern and control thereof. Global climate changes and extensive human induced land use land cover (LULC) changes are major concern of recent research which include rise in global temperature. Rising temperature causing uneven hydrological cycle includes increase in intense precipitation while spatial-temporal changes leading to expose soil surface which increase rate of soil erosion when it comes in direct contact with high rainfall erosivity. Therefore, climate and LULC change must be consider together to know the area of high soil erosion.

Climate change has both direct and indirect effects upon soil erosion. Direct effects are due to changes in the amount, erosive power and temporal pattern of rainfall. The soil system tends to react nonlinearly to such changes, so even small increases in rainfall amount or intensity can result in dramatically increased rates of soil loss, especially if rainfall occurs on unprotected soil surfaces resulting from land use change. Climate change could lead to a temporal shift in both the vegetation cover and the rainfall pattern. If this leads to heavier rainfall on less protected soils, large increases in erosion rates are to be expected. Conversely, if rainfall tends to occur during periods of greater soil protection due to vegetation, lower soil erosion will happen. Indirect effects result from the effects of increased atmospheric CO2 concentrations on crop growth and more dramatically from climate-driven changes in land use. Increased carbon dioxide has a fertilizing effect on many crops. However, increases in rainfall during the vulnerable period of early growth will readily overcome this ameliorating effect. The most dramatic increases in erosion are likely to result from a change in land use to more erosion-prone crops and less protective vegetation (Simonneaux et al, 2015).

Remote sensing and Geographic Information System (GIS) is very effective tool for initial studies. High resolution data can provide accurate results but in data sparse environment, the freely accessible data such as Landsat and MODIS are the better option to know the topographic changes. MODIS has some limitations such as its coarse resolution which limits its ability in detecting small changes (Jin and Sader, 2005), which is necessary in detecting anthropogenic activities (Zhu and Woodcock, 2014). While Landsat data has some advantages over MODIS such as long record of continuous measurement, spatial resolution, and near nadir observations (Pflugmacher et al., 2012, Wulder et al., 2008 and Woodcock and Strahler, 1987). But its disadvantage is low temporal frequency and cloud cover problem. However, the mosaic of multi temporal images with less cloud cover can provides accurate results (Zhu and Woodcock, 2014). Kibret et al., 2016 and Zhu and Woodcock, 2014 used Landsat in their studies and conclude that the Landsat data is very useful in the analysis of spatio-temporal LULC changes.

There are two methods of classification of LULC which can be done by using remote sensing and GIS. The visual classification technique has advantage in terms of accuracy over automatic or supervised classification in heterogeneous LULC classification which is based on the expert knowledge (Zhang et al., 2014).

The main objectives of this preliminary study of flood analysis are:

i. To get accurate results of LULC by analysing the freely accessible data through an integrated approach of remote sensing and GIS of whole Kelantan in Peninsular Malaysia.
ii. To find out the effect of upstream LULC changes on downstream of the area.
The result of this study will be helpful in further enhancement of the technology and identifying the causes of downstream flood by using modelling techniques.

2.0 Methodology

Topographic map was geo-referenced in ArcGIS 10.2. Area boundary and district boundaries were demarcated on the basis of watershed with the help of ASTER GDEM and topographic map of Kelantan. The area was clipped with the satellite data in the GIS environment to extract area's raster image. Spatio-temporal LULC change map of 2005 (Fig. 2) and 2015 (Fig. 3) were prepared in GIS environment through visual classification method on the basis of spectral reflectance of different classes such as dense forest, forest, mixed horticulture, uncultivated land, scrub, settlement area, palm oil, water body and waste land.
Random ground truth points were taken in Google Earth of each class and then overlaid the points on visually classified map to know the accuracy. 100 points were taken of all the classes except wasteland (40 points) due to its low spatial extent and then manual accuracy assessment was done. Area (in square kilometre) and other calculations were carried out in ArcGIS 10.2 and MS Excel. Finally, both the maps (2005 & 2015) were overlaid together for the change detection analysis.

3.0 Results and Discussion

The Spatial and Temporal LULC change by Landsat 5 TM (2005) and Landsat 8 OLI_TIRS (2015) were used to analyse the spatio-temporal LULC changes at upstream (8235 km^2), midstream(5004.01km^2) and downstream (1874.53 km^2). The results of visually interpreted classes from satellite images are as follows:

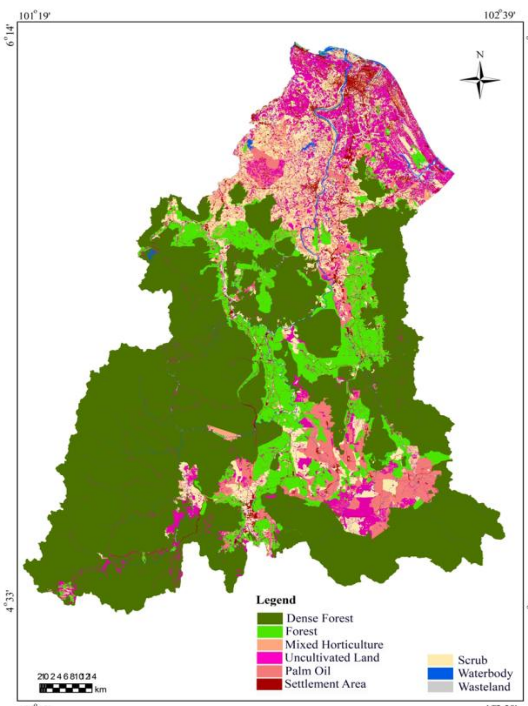

Fig. 2. LULC map of 2005

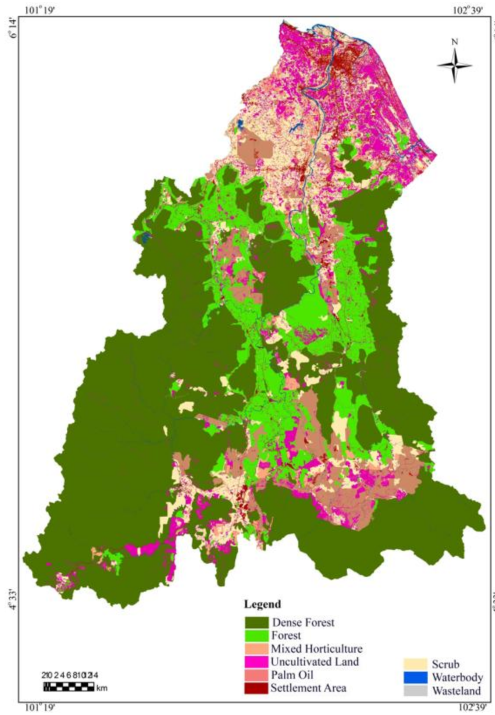

Fig. 3. LULC map of 2015

3.1 Dense Forest

The eastern and western part of upstream and midstream are mostly covered with dense forest. It was found that the dense forest at upstream, midstream and downstream are 6067.95 km^2 (73.68 %), 2487.09 km^2 (49.70 %) and 52.59 km^2 (2.81%) respectively in 2005 while it reduces to 5689.31 km^2 (69.09 %), 2068.92 km^2 (41.35 %) and 50.51 km^2 (2.69 %) respectively in 2015. It was found that the reduction of the dense forest more at midstream (418.17 km^2) than upstream (378.64 km^2) causing a total area reduction of dense forest up to 5.30 %. It converted into plantation activities either palm oil or mixed horticulture, scrub and few kilometres into forest. While at midstream, it changes into forest and palm oil. A few mountain braking activities was also observed at midstream which results increase in wasteland of 2.5 km^2 in ten years. The changes detection results shows that all the dense forest is converted into forest, plantation activities and slightly into scrub and wasteland.

3.2 Scrub

The results show that the scrub increases from 333.45 km^2 (4.05 %) at upstream, 544.62 km^2 (10.88 %) at midstream and 562.21 km^2 (29.99 %) in 2005 to 482.18 km^2 (5.86 %) at upstream, 565.54 km^2 (11.30 %) at midstream and 583.18 km^2 (31.11 %) in 2015. From change detection analysis, it was observed that the scrub is mostly changes at upstream may be for plantation activities along the river bank. The changes were also observed near palm oil plantation, settlement areas and uncultivated land. Furthermore, few kilometres increment in scrub at both mid and downstream was observed due to transformation from forest. Total increment of the area is 1.33% in ten years.

3.3 Forest

Mostly all the forest are situated in middle of the area and some are at the eastern part of midstream. It was 680.20 km^2 (8.26 %) at upstream, 1020.40 km^2 (20.39 %) at midstream and 46.07 km^2 (2.46 %) at downstream in 2005 while increases to 694.35 km^2 (8.43 %) at upstream, 1414.71 km^2 (28.27 %) at midstream and 54.43 km^2 (2.90 %) at downstream in 2015. It was observed that the forest increases in each stream but more in midstream due to the transformation of dense forest into forest mostly along the river bank. Total increase in area is 2.75 % in ten years.

3.4 Uncultivated Land

Uncultivated lands which include plastic covering at upstream (called lojing) because it was very difficult to differentiate between in 30 m resolution imagery as shown in Fig. 4.It increases in both upstream (0.57%) and midstream (0.82%) due to deforestation and plantation activities but decreases at downstream (1.06%) due to palm oil plantation. The overall increment of uncultivated land in ten years is 68.33 km^2 (0.45%). The increment at both up and midstream can cause direct contact of rainfall with soil which could results soil erosion and hence transportation of sediments into the rivers. This could lead river over flow at downstream where river depth would be decreased due to deposition of sediments. Thus, this could be one of the main causes of flash flood in the area.

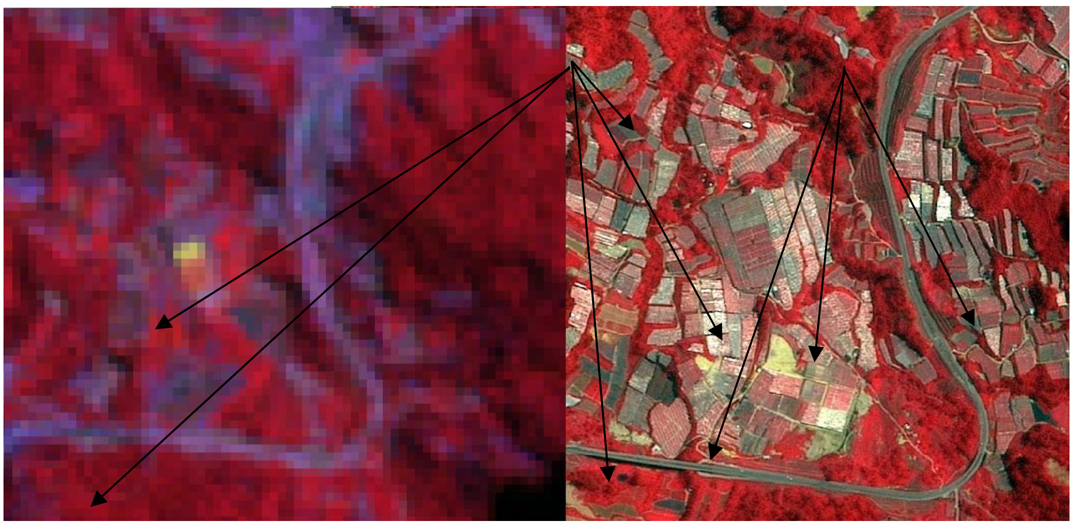

Fig.4. (a) Landsat imagery 30 m resolution and (b) SPOT 5 imagery 2.5 m resolution

3.5 Mixed Horticulture

The mixed horticulture, also includes rubber plantation at upstream because of same reason as in uncultivated land except large area, is slightly increased in area of 8.88 km^2 (0.11%) at upstream due to rubber plantation but decreased in both midstream and downstream in area of235.87 km^2 (4.71%) and 36.35 km^2 (1.94%) respectively due to increase in palm oil plantation followed by slightly increment in settlement area and uncultivated land.Overall, mixed horticulture decrease in area is 263.34 km^2 (1.74%). This drastic decrease of mixed horticulture at midstream could also be a cause of exposure and detachment of soil which could results soil erosion due to same reason as discussed above.

3.6 Palm Oil

Remarkable increase of palm oil was found in area of 159.51km^2 (1.94%) and 191.29 km^2 (3.82%) in both upstream and midstream respectively while slight increment in area of 21.86 km2 (1.17%) is seen at downstream. It was also found that there is cutting of palm oil trees and replantation (observed in both upstream and midstream) which can increase in erosion of sediment and deposition in river due to direct contact with high rainfall.

3.7 Settlement Area

Overall, more increment was observed in area of 11.47 km^2 (0.61%) at downstream along the river bank. It could be a cause of flash flood because of high runoff or river overflow due to decrease in river depth as discussed above and hence loss of human life, agriculture and economy. Furthermore, total increase in area of settlement of 15.82 km^2 (0.04%) was observed.

3.8 Water Body

There is no such effect on water body in ten years except few meter extension at midstream due to shifting of rivers may be at that place where two rivers are meeting. Furthermore, few meters shifting were also observed due to sediment deposition at the inner bank in some part of study area at both mid and downstream.

3.9 Wasteland

It was 1.47 km^2 (0.02%) at upstream, 7.07 km^2 (0.14%) at midstream and 20.46 km^2 (1.09%) in 2005 while 1.18 km^2 (0.01%) at upstream, 9.57 km^2 (0.19%) at midstream and 16.57 km^2 (0.88%) at downstream in 2015. The only increment of few kilometres was observed at midstream due to anthropogenic activities such as deforestation and mountain breaking. Overall, there is a slight decrease of 1.68 km2 in area due to increase in uncultivated land and settlement area.

Analysis of each stream (up, mid and down) instead of that of whole catchment shows better results. Variations in up, mid and downstream due to plantation and deforestation expose the soil surface and detaches the particles resulting in the soil erosion during rainfall. However, the amount of erosion depends upon the intensity and duration of the rainfall. The erosion is followed by the transportation of sediments and their deposition where the stream power would reduce (may be at the downstream). The decrease in the river depth thus results in river overflow during or after heavy rainfall at downstream.

In this preliminary flood analysis, the topographic changes affecting the flood in the study area are considered. The class and combination of classes affecting the flood requires more accurate analysis by incorporating hydrological and hydrogeological parameters data as an input for modelling techniques. This can give the detailed insight about the nature and amount of the sediments transported and deposited by rivers and will also provide the qualitative information about the class and combination of parameters contributing to the devastated flood.

4.0 Conclusion

In this study, spatio-temporal LULC changes (2005-2015) were analyses in Kelantan, Peninsular Malaysia at up, mid and downstream separately. Nine LULC classes such as dense forest, forest, scrub, uncultivated land, mixed horticulture, settlement area, palm oil, water body and wasteland were identified. Major changes was reduction in dense forest in both upstream and midstream, mixed horticulture in mid and downstream due to transformation into forest and palm oil plantation respectively. While increment in forest at midstream and scrub at upstream due to transformation from dense forest, uncultivated land and palm oil plantation activities in both upstream and midstream was observed. These changes clearly indicate that more changes were occurred at upstream and midstream which can cause increase in runoff and land degradation that could result in decrease in river depth and hence river overflows and flash flood at downstream. The accuracy assessment shows that the study was accurate with overall accuracy 91.4 % and kappa value 0.990621.

Exposure of soil, in descending order, would be more in uncultivated land, waste land, mixed horticulture, palm oil plantation, scrub, settlement area, forest and dense forest. Further studies should focus soil erosion estimation according to the exposure of soil and intensity of precipitation.

References

J. D. Creutin, M. Borga, E. Gruntfest, C. Lutoff, D. Zoccatelli, & I. Ruin 2013, A space and time framework for analyzing human anticipation of flash floods, Journal of Hydrology, 482, 14-24.

A.A. Ghani, N. Zakaria, R. Falconer 2009. Editorial: River modelling and flood mitigation; Malaysian perspectives, Proceedings of the ICE-Water Management, 162(1), 1-2.

S. Jin, S.A. Sader 2005. MODIS time-series imagery for forest disturbance detection and quantification of patch size effects, Remote Sensing of Environment, 99(4), 462-470.

K.S. Kibret, C. Marohn, G. Cadisch 2016. Assessment of land use and land cover change in South Central Ethiopia during four decades based on integrated analysis of multi-temporal images and geospatial vector data, Remote Sensing Applications: Society and Environment, 3, 1-19.

D. Pflugmacher, W.B. Cohen, R.E. Kennedy 2012. Using Landsat-derived disturbance history (1972–2010) to predict current forest structure, Remote Sensing of Environment, 122, 146-165.

V. Simonneaux, A. Cheggour, C. Deschamps, F. Mouillot, O. Cerdan, and Y. Le Bissonnais 2015. Land use and climate change effects on soil erosion in a semi-arid mountainous watershed (High Atlas, Morocco). Journal of Arid Environments, 122, 64-75.

M. Špitalar, J.J., Gourley, C. Lutoff, P.E., Kirstetter, M. Brilly and N. Carr 2014. Analysis of flash flood parameters and human impacts in the US from 2006 to 2012, Journal of Hydrology, 519, 863-870.

C.E. Woodcock, A.H. Strahler 1987. The factor of scale in remote sensing, Remote sensing of Environment, 21(3), 311-332.

2.2: CONTRIBUTIONS OF RAINFALL RUNOFFS, TOPOGRAPHIC CONDITIONS, LAND USE LAND COVER ON SEDIMENT YIELD INTO RIVER AND POTENTIAL FLOOD OCCURRENCE

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1.0 Introduction

During the last two decades, flooding event occurred more frequent compared to before 1990s and shown in Table 1. Surprisingly, the amount of rainfall recorded has shown no significant increase in the past decades to present year. This statement is incompatible with common perception that high amount of rainfall is the main factor lead to flooding. This has given rise to the possibility of other environmental factors contributing to the frequent flooding. It given rise to one of the objectives is to determine the interrelationship between stream flow, water level, suspended sediments and rainfall.

Table 1.Comparison of Flooding Disaster Record and Mean Annually Rainfall in Different Range of Year [1]

Year Range	Total Flooding Disaster Occurrence In Malaysia	Total Flooding Disaster Occurrence around Pahang	Total Flooding Disaster Occurrence around Kelantan	Mean Annually Rainfall (mm) at RF 4120064 (Pahang)	Mean Annually Rainfall (mm) at RF 4819027 (Kelantan)	Mean Annually Rainfall (mm) at RF 5120025 (Kelantan)
1960-1969	2	0	2	2295.51	-	-
1970-1979	2	0	0	2180.12	-	-
1980-1989	4	0	3	2566.60	2306.14	1798.71
1990-1999	4	2	1	2336.80	2326.91	2400.13
2000-2009	23	8	8	1970.39	2219.73	1835.63
2010-2013	2	1	2	2449.00	1808.50	2104.00

Reference : D. Guha-Sapir et al. (2015]

RULSE are widely used by Malaysian researchers in predicting the soil erosion followed by the application of remote sensing and geographical information system (GIS) to illustrate the predicted results on erosion risk map. However, the prediction done by the researchers in their studies produced different results which have shown huge differences among the studies. Kamaludin et al. (2013] predicted that the annual soil loss in Pahang River Basin was in the range of 0-95.5 ton ha^{-1} yr^{-1}. Agele et al. (2013] carried out the same study and predicted range obtained was 0-364 ton ha^{-1} yr^{-1}. Approximate difference of 363% between the maximum range in these two studies was discovered. A more accurate model is needed to develop which can be used when lack of sufficient rainfall data based on recommended equation used in RUSLE equation. Few research studies were found regarding the effects of changes of land use, topographic conditions (slope length and slope gradient) and land cover on the rate of soil erosion as well as flooding event due to accumulated sediment brought by eroded soil particles. It brings out another two objectives in this study is to determine the accumulated sediment in a riverbed due to the changes of land use and topographic condition and to determine the effect of accumulated sediment in rivers on the occurrence of flooding events as a result of no sediment removal practices. In this study, Excel and statistical software (SPSS) will be used in this study to determine the interrelationship between stream flow, water level, suspended sediments and rainfall. Recommended RUSLE equation which is develop by Renard et al. (1997] and Sediment Delivery Ratio (SDR) recommend by Wischmeier and Smith (1978] used to build up modified sediment yield equation. Amount of calculated sediment yield will display in form of sediment map by using ArcGIS with different conditions of land use, land cover, slope length and slope gradient. The effect of accumulated sediment in rivers in the period of 5 years, 10 years and 15 years on the flood occurrence also shown in map form by ArcGIS.

2.0 Methodology

RUSLE is an erosion model designed to predict the long-term average annual soil loss from specific field slope in specified land-use and management systems. [6]. RUSLE is equation to calculate soil erosion which is comprised six factors representing rainfall and runoff erositivity (R), soil erodibility (K), slope length (L), slope steepness (S), cover and management practices (C), and supporting conservation practices (P) [6] [5]. The equation will become:

$$A = R \times K \times L \times S \times C \times P \qquad (1)$$

Where A is the computed spatial and temporal average soil loss per unit of area. R is the rainfall value reflecting the energy factor multiplied by the intensity factor. K is the soil erodibility factor. The value for the subsoil condition, usually encountered in construction sites, can be determined based on soil texture (relative percent of sand, silt and clay) for a specified soil as measured on a unit plot, which is defined as a 72.6-ft length of uniform 9-percent slope continuously in clean-tilled fallow. L is the horizontal length of slope. It is the point of origin where water will begin flowing down the slope to the point where concentrated flow begins, such as where water flows in to a ditch, or deposition occurs and water disperses. S is slope gradient. C is the factor to reflect the planned cover over the soil surface. P is the factor that represents management operations and support practices on study area. [7].

Sediment Yield (SY) was calculated using the Sediment Delivery Ratio (SDR) where

$$SDR=0.51A^{-0.11} \qquad (2)$$

Where A is the area in km^2
Using the SDR value from Equation 2, SY values can be calculated using the formula by [5] is

$$SY = SDR*SE \qquad (3)$$

Where SY = sediment yield (ton ha^{-1} yr^{-1}), SDR = sediment deliver ratio and SE = annual potential soil loss (A) (ton ha^{-1} yr^{-1}).

3.0 Results and Discussion

Due to incomplete data (sediment and streamflow data) in Kelantan River Basin, hydrological data (rainfall, sediment, streamflow and water level) that needed in this study are using monitoring station at Cameron Highlands in preliminary study. Monthly rainfall data from the rainfall monitoring station (RF 4120064), monthly total suspended sediment data from sediment monitoring station (SD 4121513), mean monthly water level and streamflow data from monitoring station WL 4121413 and SF 4121413 respectively was extract and shown in

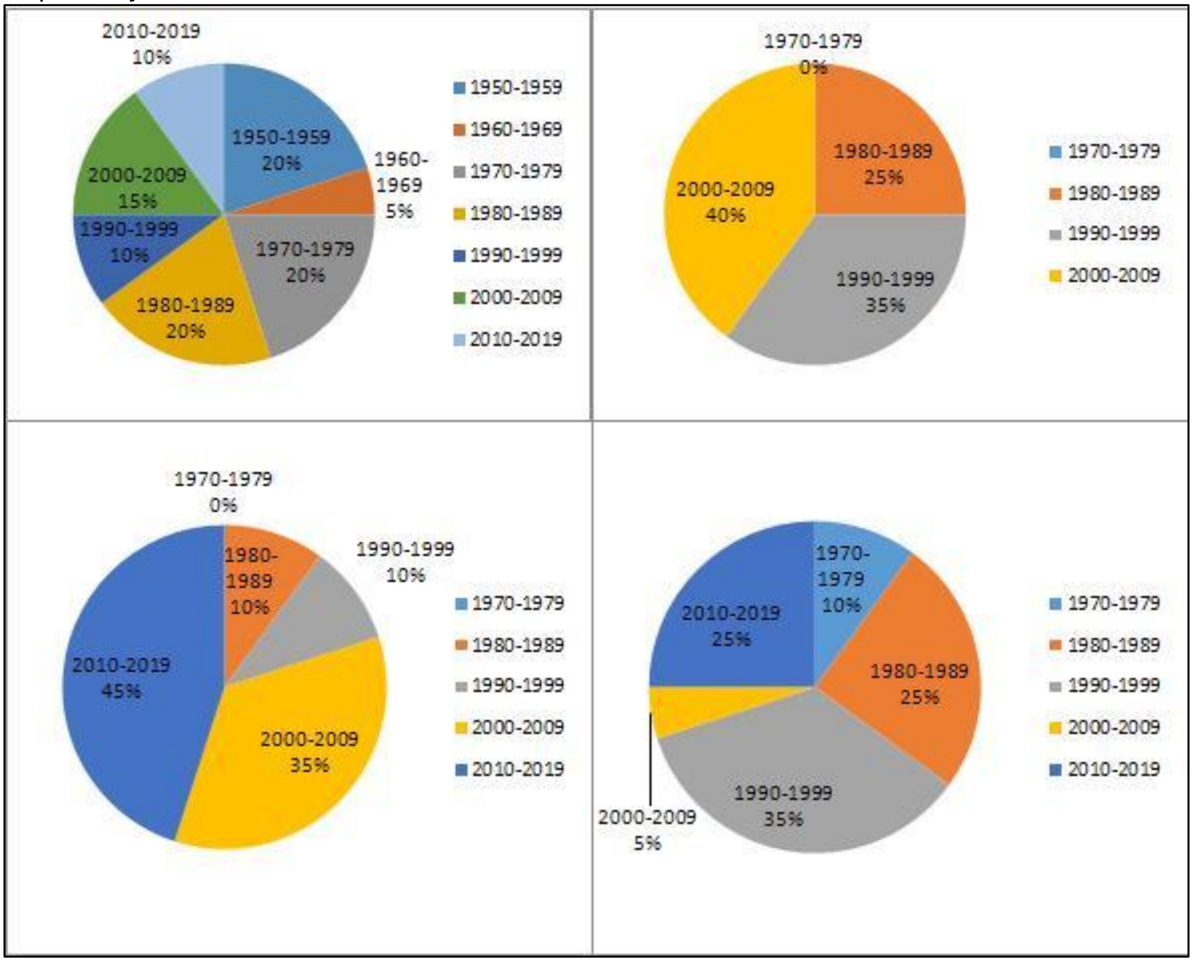

Figure 1. From the

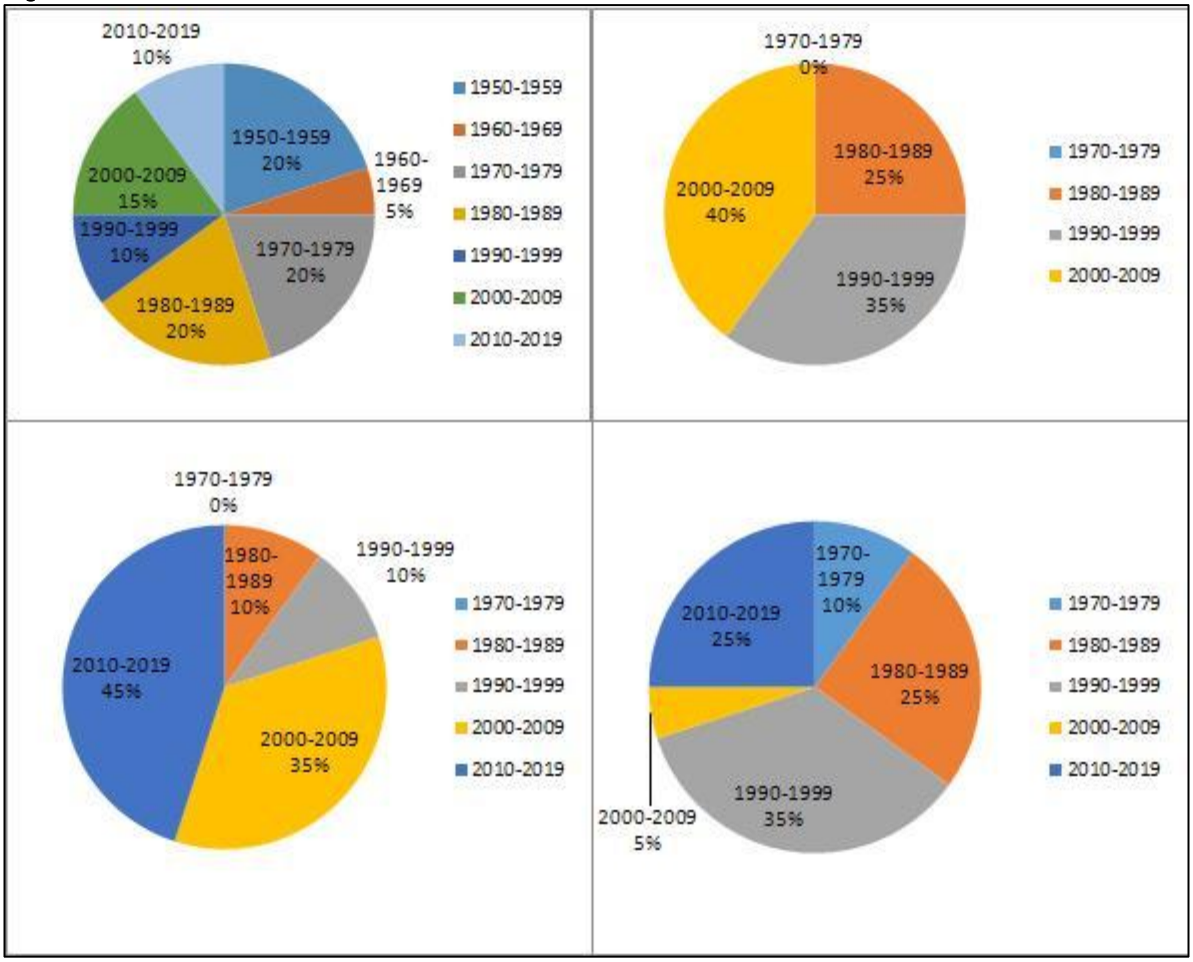

Figure 1, it observed that the 20 highest monthly rainfall were evenly distributed every range of year and this prove that the high rainfall is not the main factor for the occurrence of flooding event. Instead, 20 highest monthly sediment and 20 highest mean monthly water level are most distributed in the range of year 2000 to year 2009 in which the range of year have highest record of flooding disaster event. This provide a preliminary proof that sediment accumulated and water level are significantly affect the occurrence of flooding event.

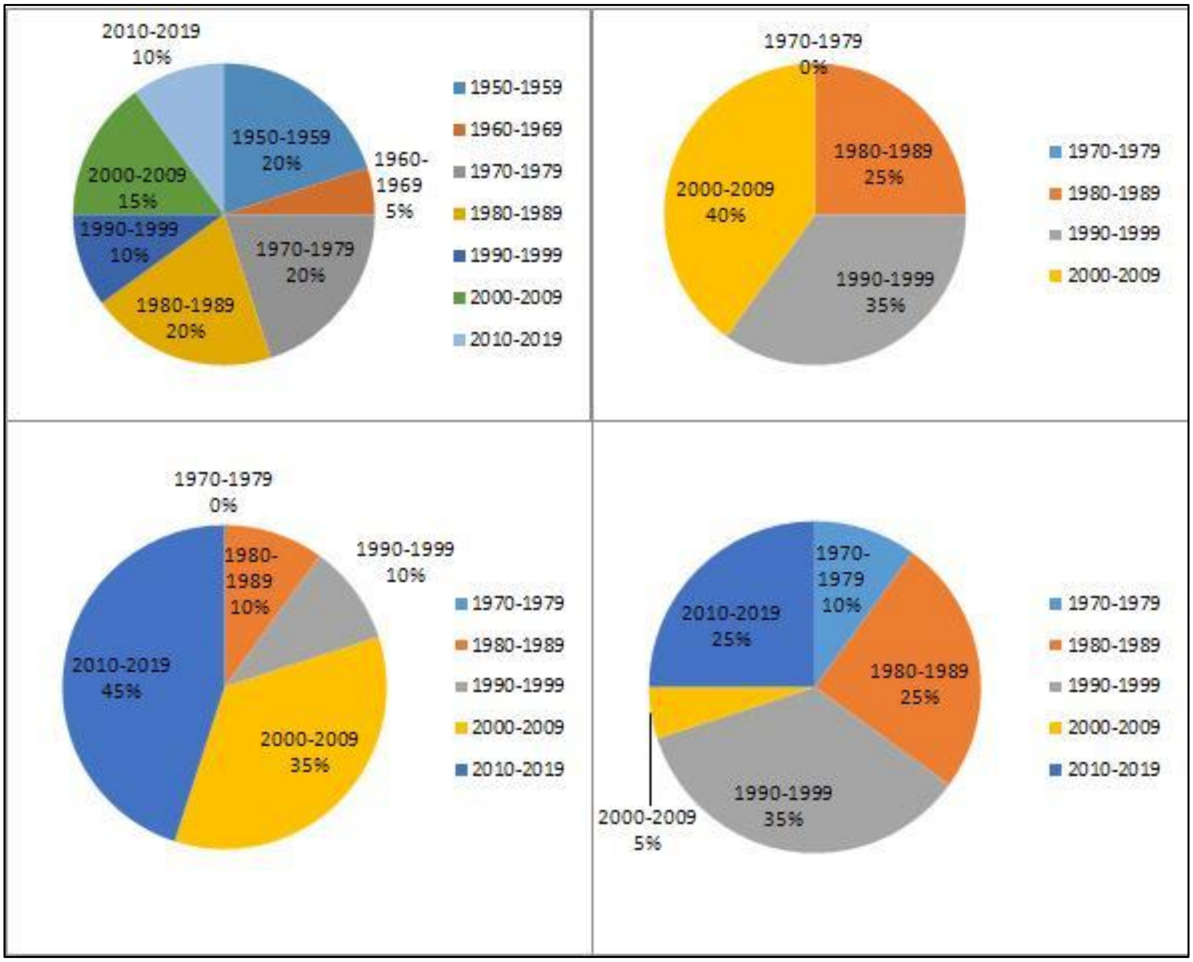

Figure 1 Distribution of the frequency occurrence for each hydrological parameter in different range of year

Mean monthly from all the years for each hydrological parameter show in Figure 2. From the Figure 2, it shows that the sediment, streamflow and water level have strong correlation to each other whilst rainfall have weaker correlation with other three hydrological parameter. It is supported by the correlate analyse using the SPSS and the correlation between each hydrological parameter show in Table 2. Relationship between the hydrological parameters with the occurrence of flooding disaster were analysed by SPSS software and shown in

Table 3. From

Table 3, it observed that the occurrence of flooding disaster was significantly dependent on sediment and water level.

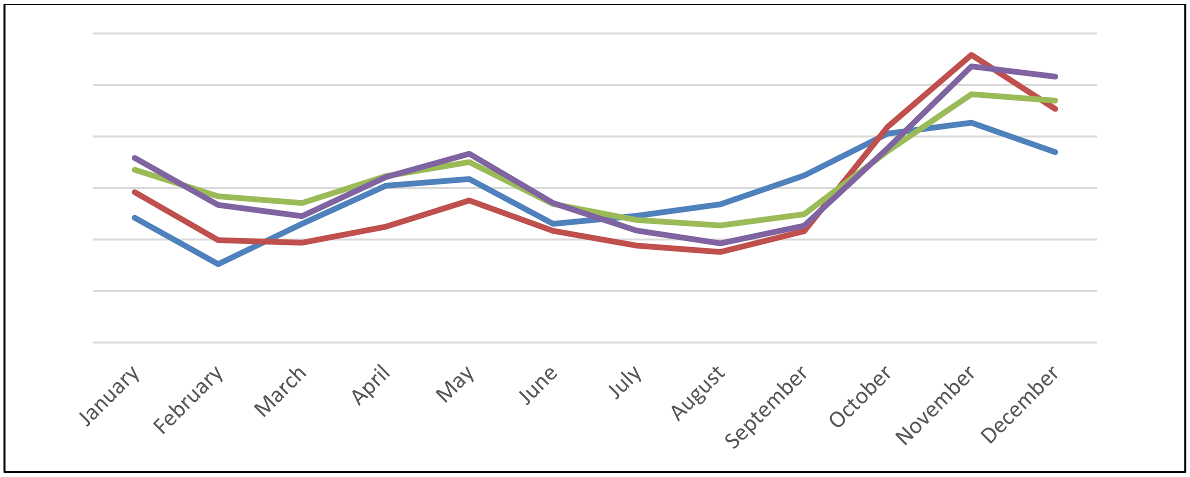

Figure 2 Interrelationship between rainfall, sediments, streamflow and water level.

Table 2 Correlation between hydrological parameter.

		Mean_RF	Mean_SD	Mean_SF	Mean_WL
Mean_RF	Pearson Correlation	1	.820**	.723**	.705*
	Sig. (2-tailed)		.001	.008	.011
	N	12	12	12	12
Mean_SD	Pearson Correlation	.820**	1	.946**	.941**
	Sig. (2-tailed)	.001		.000	.000
	N	12	12	12	12
Mean_SF	Pearson Correlation	.723**	.946**	1	.996**
	Sig. (2-tailed)	.008	.000		.000
	N	12	12	12	12
Mean_WL	Pearson Correlation	.705*	.941**	.996**	1
	Sig. (2-tailed)	.011	.000	.000	
	N	12	12	12	12

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 3 Correlation between the hydrological parameter with occurrence of flooding disaster

		Mean_RF	Mean_SD	Mean_SF	Mean_WL	Occurencce_Flood
Occurence_Flood	Pearson Correlation	.070	.405*	-.076	.500**	1
	Sig. (2-tailed)	.711	.026	.690	.005	
	N	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

From the above analyse, it is clear that the common perception that the huge rainfall is the main factor to trigger the occurrence of flooding disaster are incorrect. Accumulated sediment and high water level are believed is the main factors to cause the flooding event. We can make an assumption for the correlation between the hydrological parameter. When the rainfall precipitates on land surface, kinetic energy of the raindrop causes the some soil particles are detached from land surface and eroded soil particles will flow into river as the suspended sediment. If the rainfall precipitates on impervious surface, runoffs formed which flow into river and cause higher streamflow. High kinetic energy stored in high streamflow cause the suspended or deposited sediment flow up and bring to deposited in downstream. This is explain high correlation between streamflow and suspended sediments. These deposited sediment accumulate in the downstream in every rainfall event and the depth of riverbed become more and more shallow if no sediment removal practice in this area. This will cause higher mean water level compare to before.

Using the mean annual rainfall data from all the station together, the development of regional model has been resulted respectively in Equation 4, 5 and 6.

$$R_{estimated} = 1.1305P + 1631.2 \quad (4)$$
$$R_{estimated} = 1413\ln(P) - 7000.1 \quad (5)$$
$$R_{estimated} = 1965.2e^{0.0003P} \quad (6)$$

$R_{estimated}$ = Estimated Rainfall erosivity factor (MJ mm ha^{-1} h^{-1} yr^{-1})
P =Average of Mean Annually Precipitation from all station (mm)

Comparison of R values (MJ mm ha^{-1} h^{-1} yr^{-1}) for Pahang and Kelantan calculated by recommended equation [4] and developed equation 4, 5,and 6 was shown in Table 4

Table 4 R value computed from different equation

State	Average of Mean Annually Precipitation from all station (mm)	R value calculated by recommended equation [4]	R value calculated by equation (4)	R value calculated by equation (5)	R value calculated by equation (6)
Pahang	1416.554	3232.558	3232.615	3232.773	3012.533
Kelantan	2258.992	-	4184.990	3912.038	3870.143

From Table 4, the estimated R value for Kelantan are 4184.990 MJ mm ha^{-1} h^{-1} yr^{-1}, 3912.038 MJ mm ha^{-1} h^{-1} yr^{-1} and 3870.143 MJ mm ha^{-1} h^{-1} yr^{-1} by equation (4), equation (5) equation (6) respectively. Due to insufficient data for Kelantan River Basin, verification for developed equation cannot carried out and need investigated in future research. These equation have limitation that these three equation is only calculate the average effect in whole River Basin and unsuitable use in respectively station and need further research to overcome this limitation.

4.0 Conclusion

This article developed three modified equation for easier calculating the R value in RUSLE equation. The modified equation is just needed average of mean annually rainfall data. The modified show in good calculate average R value in whole river basin. Admittedly, the developed equations still have several limitation, including developed equation unsuitable calculate R value in respectively station, verification working cannot carried due to insufficient data for Kelantan River basin. It need future research in addressing these limitation.

References

D. Guha-Sapir, R. Below & Hoyois, P. EM-DAT: The OFDA/CRED International Disaster Database. Available: www.emdat.be Université Catholique de Louvain. Brussels (Belgium)

Kamaludin, H., Lihan, T., Rahman, Z. A., Mustapha, M. A., Idris, W. M. R. & Rahim, S. A. (2013). Integration of remote sensing, RUSLE and GIS to model potential soil loss and sediment yield (SY). *Hydrology & Earth System Sciences Discussions* 10 4, 4567-4596.^

Agele, D., Lihan, T., Sahibin, A. R. & Rahman, Z. A. (2013). Application of the RUSLE model in forecasting Soil Erosion at downstream of the Pahang river basin, Malaysia. *Journal of Applied Sciences Research* 9 1, 413-424.^

Renard, K. G., Foster, G. R., Weesies, G. A., McCool, D. & Yoder, D. (1997). *Predicting soil erosion by water: a guide to conservation planning with the revised universal soil loss equation (RUSLE). U.S. Department of Agriculture, Agriculture Handbook No. 703.*

Wischmeier, W. H. & Smith, D. D. (1978). *Predicting rainfall erosion losses-A guide to conservation planning. U.S. Department of Agriculture, Agriculture Handbook No. 537.*

Renard, K. G. & Freimund, J. R. (1994). Using monthly precipitation data to estimate the R-factor in the revised USLE. *Journal of Hydrology* 157 1–4, 287-306.^

Frederick, B. G. & Donald, W. L. (2004). Revised Universal Soil Loss Equation (RUSLE). *In:* CONSERVATION, N. Y. S. D. O. E. (ed.) *New York Standard and Specifications for Erosion and sediment control.* New York: Empire State Chapter Soil and Water Conservation Society.

2.3: INCORPORATING FLOOD RISK STUDY AND ITS IMPACT ON SOCIETY IN THE ENVIRONMENTAL IMPACT ASSESSMENT

Project Information

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1.0 Introduction

EIA is an essential process in minimizing the adverse environmental impact and to ensure sustainable land use. In Malaysia, under Section 34A, Environmental Quality Act 1974, the EIA was made compulsory for any project that can be a threat to the environment. All EIA reports require approval from the Department of Environment prior to the project commencement. This study argues that land use change for agriculture and logging in Kelantan has a direct connection on the approved EIA. Even though the EIA is a part of important measurement tool in helping to reduce adverse impact on the environment, widespread approval with limited regular monitoring, had contributed to the vulnerability of the environment, especially forests and catchments area. An environmental impact assessment is a study that identifies potential impacts arising from proposed development by looking at the surrounding existing environment, baseline data, regulations, activities, its potential impacts and measures to mitigate. Determination of soil erosion, soil loss, and sediment yield are compulsory; however these are not annexed to flood occurrence. Hence flood risk assessments in support of planning applications for developments in locations where potential risk of flooding should be identified. Policies on development in flood prone areas must be revised and if benefit of these policies is to be achieved, there is a need for a more robust evidence base surrounding flooding and flood risk. It is important to discover what precisely are the social impacts of being flooded or living in a flood risk area. How important are less tangible issues such as feeling secure in one's own home compared to the more easily quantified economic costs. Flood assessment in the EIA should demonstrate how flood risk from all possible water sources to a development site should be managed. Changes in flood risk to offsite locations, as a consequence of development, should be considered with recommendations provided to avoid increasing such risk.

2.0 Methodology

This study has conducted on preliminary analysis of EIA documents in Kelantan, which has been approved by the Department of Environment Kelantan from 2000 to 2015. A total of 222 EIA documents approved during the period. The EIA document covers the entire project listed under Section 34A of the Environmental Quality Act 1974, and covers the entire territory in Kelantan (*DOE 2015*). At the same time, a total of 500 participants (flood victims) from 14 villages (32 villages) were directly involved in this study by using questionnaires. The selection of the study area have been through the list of names of villages found in the EIA documents approved in Kelantan during the period 2000 to 2015 (42 selected documents). These villages are located within radius 5km from project site. These villages that have been selected were among the villages that were badly affected by floods in December 2014. The types of village that were involved were a traditional village, organized village, temporary settlements; native village as well as FELDA and FECRA land schemes. Analysis of descriptive and inferential (chi-squared) was used for comparison determining the dimensional of perception and knowledge and socio economic impact of the flood victims towards causes of the flood.

3.0 Results and Discussion

The results showed a notable increment in the approval trend of EIA reports. 149 conducted EIA projects are fall within the territory of Gua Musang. Majority of the approvals are granted to agriculture and logging projects. Majority projects have passed over the area of secondary forest, oil palm and rubber plantations, permanent reserve forest and the watershed of tributaries of Sungai Kelantan. Land-clearing activities for agriculture and logging on a large scale have a significant impact to environmental change in Kelantan.

This disaster had resulted in huge amount of money loss as well as traumatize the victims in which can be felt to this day. Since that incident, there were various points of view and different perceptions in finding the cause of the disaster occurred. Besides that, the study found that the level of perception and knowledge as to the cause of the disaster is different in the internal context (individual characteristics). This difference has a significant influence on the awareness of the causes of the floods that occurred in the external context. Significant relationships at the level of $p < 0.05$ has existed between perception and knowledge of the causes of the disaster victims affected by environmental changes in the last 10 years. This indicates that although the victim is aware of the physical environment changes happening around them, but all that is seen as not a major contributing factor to the cause of the floods in Kelantan in 2014.

4.0 Conclusion

4.1 To date, a total of 222 EIA reports have been approved in Kelantan. Preliminary studies on EIA reports found a high growth of EIA submission since 2000 to 2015.

4.2 A total 149 conducted EIA projects are fall within the territory of Gua Musang and majority of the approvals are granted to agriculture and logging projects.

4.3 Majority projects have passed over the area of secondary forest, oil palm and rubber plantations, permanent reserve forest and the watershed of tributaries of Sungai Kelantan. Land-clearing activities for agriculture and logging on a large scale have a significant impact to environmental change in Kelantan.

4.4 Agricultural projects, logging and quarrying are dominating 78% of overall approved EIA reports that received by the Department of Environment Kelantan.

4.5 Majority of the affected area are hilly, water catchment areas and the main tributaries of Sungai Kelantan. The results of this study clearly indicate that the clearing of forest on a large scale with the approval of EIA may also be associated with the floods in Kelantan recently.

4.6 Since that incident, there were various points of view and different perceptions in finding the cause of the disaster occurred.

4.7 The study found that the level of perception and knowledge as to the cause of the disaster is different in the internal context (individual characteristics). This difference has a significant influence on the awareness of the causes of the floods that occurred in the external context.

4.8 Significant relationships at the level of $p < 0.05$ has existed between perception and knowledge of the causes of the disaster victims affected by environmental changes in the last 10 years.

4.9 This indicates that although the victim is aware of the physical environment changes happening around them, but all that is seen as not a major contributing factor to the cause of the floods in Kelantan in 2014.

References

Ayla Bilgin, 2015. Analysis of the environmental impact assessment (EIA) Directive and the EIA decision in Turkey, Environmental Impact Assessment Review, 53: 40–51.

DOE., 2015. "Portal rasmi: Prosedur EIA." http://www.doe.gov.my, [access 23 July 2015]

Glasson, J., Therivel R., & Chadwick, A. 2012. *Introduction to environmental impact assessment*, 4th ed., 30, Oxford Brookes University, London

Katarina Pavlickova & Monika Vyskupova, 2015. A method proposal for cumulative environmental impact assessment based on the landscape vulnerability evaluation, Environmental Impact Assessment Review, 50: 74–84.

Mohan B. Dangi, Deanna Fernandez, Upendra B. Bom, Shashidhar Belbase & Rameshwor Kaphle,. 2015. Evaluation of environmental impact assessment report preparation and public participation in landfill projects in Nepal, Habitat International, 46: 72–8.

2.4: AN ENVIRONMENTAL FORENSIC STUDY OF FLOOD AFTERMATH IN KELANTAN: STABLE ISOTOPE CONSTRAINTS

Project Information

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1.0 Introduction

Flooding occurs annually in Malaysia, however in December 2014, was the most severe one and extreme particularly in Kelantan [1]. Current monitoring system has provided good services for routine database and up-to-date hydrological event in Malaysia. However, the recent flood in Kelantan (2014) disclosed limitations in flood protection measures, suggesting poor understanding of flood dynamics in Malaysia. Changing in land use due to deforestation or the abandonment of terraces in hilly landscapes have been shown to affect the evapotranspiration, infiltration and groundwater storage, hence the flood generating process [2]. Not to mention, it also caused in soil erosion thus gives huge impact to Kelantan watershed when the river becoming shallower and water quality declining [3, 4, 5]. Such factors made the watershed vulnerable to natural hazard [6] and becoming the main caused of frequent flooding [7, 8] in Kelantan. This can be evidenced when floods hit Kelantan in 2014 was a “tsunami like disaster” [9].

Generally, evapotranspiration accounts for ~60% of the major flux of hydrologic components, highlighting the importance of vegetation as a regulator of regional water balance [10]. Negligence in considering evapotranspiration as a major component in hydrological cycle may undermine the ecosystem capacity to regulate the water balance in a tropical region. From the isotopic fingerprint of $\delta^{18}O$ and $\delta^{2}H$ in tropical precipitation results suggested most likely, the flood was due to climate factor (extra rainfall). Whereas result from $\delta^{13}C$ showed that C_3 plants appear as the major plant type (-27.88‰ to -23.13‰) in the catchment. For $\delta^{15}N$, the results are overlap where the source of sediments showed it is due to deforestation (-2‰ to +16‰), agriculture (-2‰ to +5‰) and land settlements activities are more pronounced. Our approach will help the government to mitigate the soil erosion in a better strategies thus stakeholders should create a new way that is not only cost effective but also environmental friendly.

2.0 Materials and methods

2.1 Precipitation Analysis

Stable isotope analyses of $\delta^{18}O$ and $\delta^{2}H$ were performed using SERCON GEO 20–20 Continuous Flow Isotope Ratio Mass Spectrometer (CF–IRMS). The δ values are calculated using by Eq. (1), in this case, for deuterium:

$$\delta^{2}H \text{ (in ‰)} = \frac{R\ Sample - R\ Standard}{R\ Standard} \times 1000 \qquad \text{……………….Equation (1)}$$

where *R* represents the ratio of heavy to light isotope ($^{2}H/^{1}H$), and *R Sample* and *R Standard* are the isotope ratios in the sample and the standard respectively.

Samples for $\delta^{2}H–H_2O$ and $\delta^{18}O–H_2O$ analyses were treated in the SERCON Water Equilibration System (WES) prior to analysis through the IRMS. Only 0.5 ml of water samples in a vial were used for each analysis. The $\delta^{18}O–H_2O$ values were measured via equilibration with CO_2 at 50°C for 8 hours, and $\delta^{2}H–H_2O$ values were measured via equilibration with H_2 and its reaction with the Platinum stick catalyst at 50°C for 1 hour. In the $\delta^{2}H–H_2O$ analysis, a platinum catalyst stick was used to accelerate the reaction, and gas exchange equilibrium took place between the introduced pure H_2 gas and water vapour. This gas exchange equilibrium caused the water vapour to emit a signature to the introduced pure H_2 gas, which represents the isotopic composition of the water before the H_2 gas is analysed by the IRMS.

2.2 Sediments Analysis

Stable Isotope analysis, raw isotope ratios from the analysis were normalized to the international scales using USGS-40 and USGS-41 reference materials (~0.5 mg, respectively) assayed with the unknown samples. Variations in stable isotope ratios were reported as parts per thousand (‰) deviations from internationally accepted standards which are Vienna Pee Dee Belemnite (VPDB) for carbon, atmospheric nitrogen (AIR) for nitrogen, in the delta (δ) notation. The δ notation is defined using the following Equation (2),

$$\delta\ (‰) = (\ R_{sample} / R_{standard}\ – 1)\text{……………………………………Equation (2)}$$

where R_{sample} is the isotope ratio ($^{13}C/^{12}C$ or $^{15}N/^{14}N$) of the sample, and $R_{standard}$ is the isotopic ratio of the international reference materials.

3.0 Results and Discussions

3.1 Tropical Precipitation Fingerprint

Isotopic Trends in Malaysian Precipitations

The mixture of vapour and condensation in clouds tend to preserve isotopic equilibrium and the meteoric relationship between $\delta^{18}O$ and deuterium and thus equilibrium fractionation with the vapour controls the isotopic composition plotted on the Local Meteoric Water Line (LMWL) (Figure 1). In context of Malaysian LMWL, the monsoons are more pronounced on the isotopic fingerprint of $\delta^{18}O$ and deuterium, affect both deuterium and the slope of LMWL.

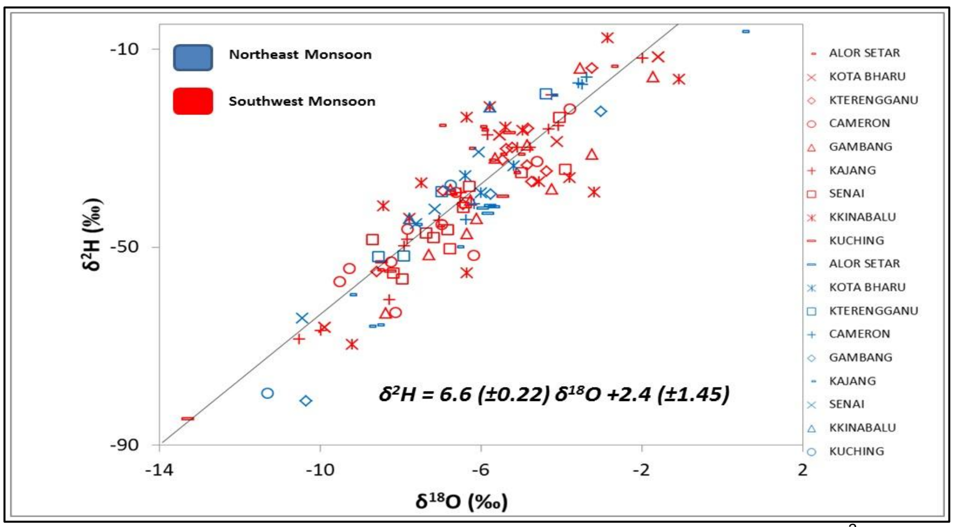

Figure 1: Composite Local Meteoric Water Line (LMWL) of Malaysian precipitation defines $\delta^2H=6.6(\pm0.22).\ \delta^{18}O + 2.4(\pm1.45)$ ‰

Isotopic Trends in Kelantan Precipitation

δ18O and δ2H values of rainfall in the Kelantan watershed (Figure 2), collected between May 2013 and December 2014, plot around the LMWL of δ2H= 7.1(±0.4). □18O+3.7(±1.8) ‰. The NEM- 2013 rainfall was plotted along the LMWL ranging from -10‰ to -1‰, reflecting the dynamics of moistures during the Northeast Monsoon. During the earlier Northeast Monsoon (Figure 2), the air mass follows a trajectory from its vapour source area to terrestrial region of Peninsular Malaysia, condenses as precipitation towards inland. Isotopically enriched rain is forming (Oct 2013) and falling from a diminishing vapor mass and the residual vapor becomes isotopically depleted (Nov 2013). The rainout process continues with more moisture supply resulting in enriched precipitation (Dec 2013). Given that 18O and 2H are the heavier isotopes; these continual condensation events cause the progressive depletion of the residual atmospheric moisture reservoir in 18O and 2H. However, the δ18O and δ2H samples for NEM-2014 show a somewhat more restricted isotopic range (-5‰ to -7‰) with respect to NEM-2013 of Kelantan rains, suggesting a consistent moisture supply from the northeast monsoon, resulting in extra amount of rainfall at such particular time.

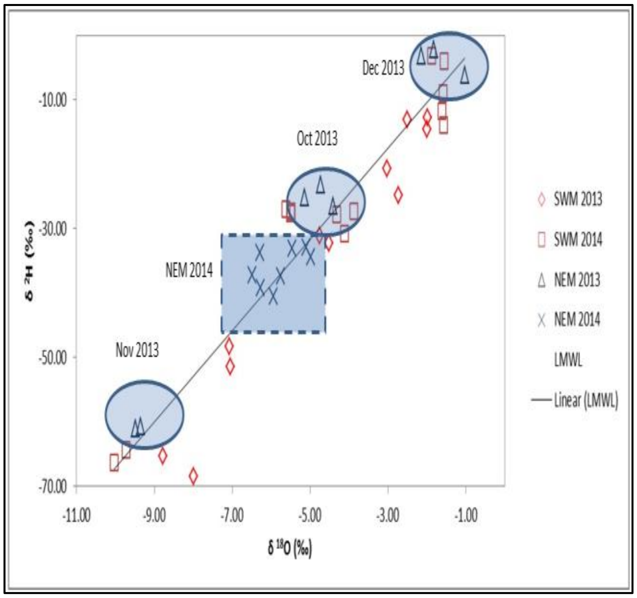

Figure 2: Local Meteoric Water Line (LMWL) of Kelantan precipitation defines $\delta^2H = 7.1(\pm0.4).\delta^{18}O+3.7(\pm1.8)$ ‰

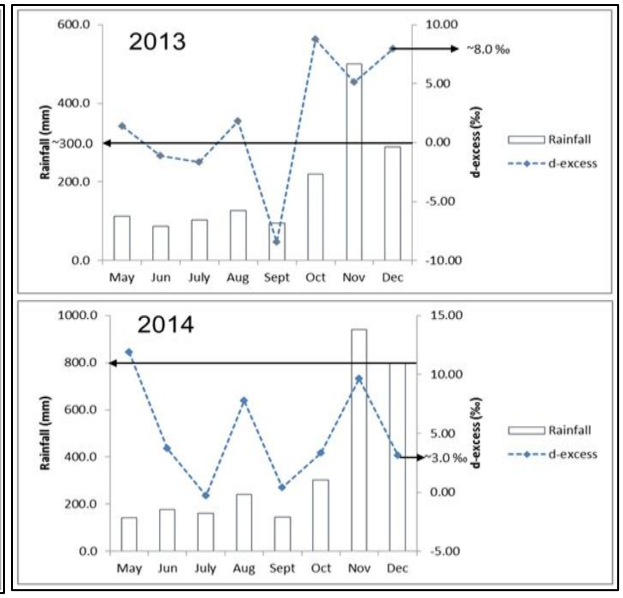

Figure 3: Lower d-excess in 2014 (~3‰) relative to 2013 suggesting more Moisture Supply from the Northeast Monsoon Resulting in Extra Amount of Rainfall

Deuterium Excess (*d*)
In the case of Kelantan watershed, Deuterium excess *(d)* derived from the linear model is relatively lower with respect to the Northeast monsoon (NEM) in 2013, suggesting more moisture supply for the NEM precipitation in 2014 (Figure 3).

3.2 Kelantan River sediments Fingerprint

$\delta^{13}C$ (‰) in soil sediment at different catchment area in Kelantan
$\delta^{13}C$ of Kelantan river sediments were plotted in Figure 4. The results showed that the value ranged from -27.88‰ to -23.13‰, which represent C_3 type plants. Variations of $\delta^{13}C$ values provide clues for further investigation on environmental condition and land use activities in the watershed [11] [12].

$\delta^{15}N$ (‰) in soil sediment at different catchment area in Kelantan
The average values of $\delta^{15}N$ for Brok, Betis, Nenggiri are 8.70‰±1.80, +9.82‰±1.35 and 8.54‰±1.81, respectively, enriched in $\delta^{15}N$ (Figure 5), indicate more nitrogen source mainly from anthropogenic activities [13]. Land settlement may affect the nitrogen concentration in the sediments due to improper wastewater and sewage systems [13]. The average values of $\delta^{15}N$ for Galas River, Pergau River and Lebir River are 6.90‰±3.54, 4.02‰±2.34, 3.15‰±3.49 respectively. As there were matured oil palm and rubber plantations around the catchments and the values of $\delta^{15}N$ are relatively low, indicate significant fingerprint of chemical fertilizer [14] as well superimposed the natural sources fingerprint [13] in the sediments. The $\delta^{15}N$ fingerprints suggest that plants, land organism, synthetic fertilizer, organic nitrogen, ammonium, nitrate, effluent and manure, [14] are the main factors marked in the sediments (Figure 6). Isotopic of $\delta^{15}N$ fingerprint showed synthetic fertilizer was traced at Lebir and Pergau sediments where matured oil palm and rubber plantations are the major land use

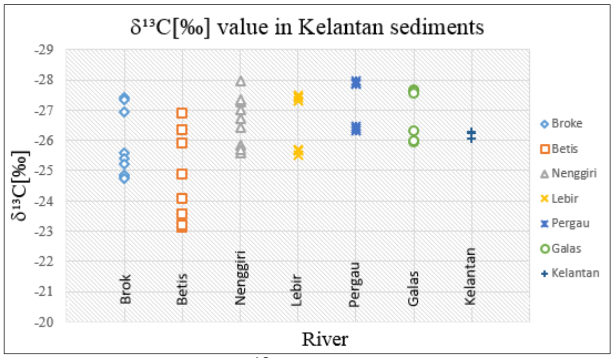

Figure 4: Scatter plot $\delta^{13}C$[‰] sediments at different catchment

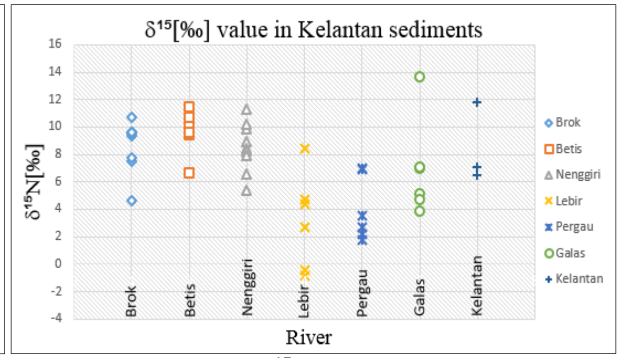

Figure 5 : Scatter plot $\delta^{15}N$[‰] sediments at different catchment

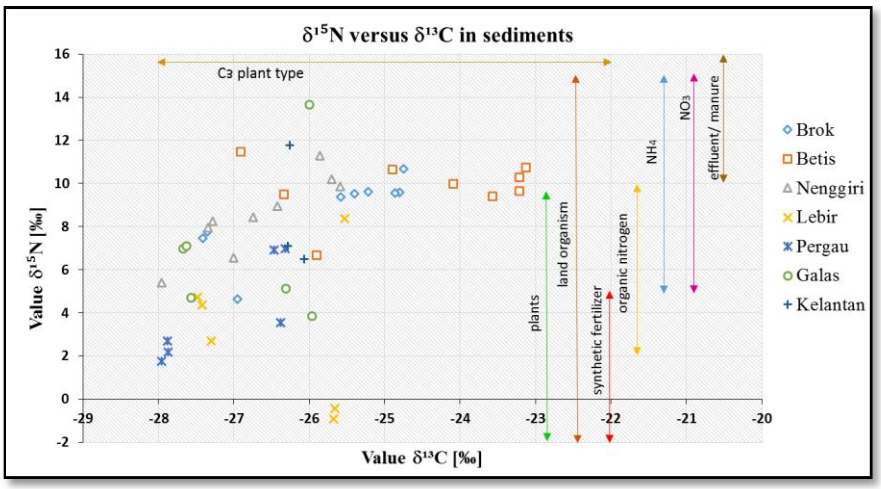

Figure 6 : Scatter plot of $\delta^{13}C$[‰] versus $\delta^{15}N$[‰] in Kelantan catchment sediments [14]

3.2.3 $\delta^{13}C$[‰] versus $\delta^{15}N$[‰] in soil sediments at different catchment area in Kelantan

$\delta^{13}C$ results showed that C_3 plants (terrestrial plant, natural forest, oil palm, rubber, banana and tapioca) are the major plant type in the catchment. The isotopic constraints of $\delta^{15}N$ suggested that deforestation, agriculture and land settlement are the major land use activities contributed to sedimentation [15], [16], [17] that deteriorating environment sustainability.

4.0 Conclusion

In the context of Peninsular Malaysia, due to absence of a distinct dry period, the $\delta^{18}O$ and $\delta^{2}H$ values in precipitation depend mainly on the source of atmospheric moisture, the Northeast and Southwest monsoon. Lower d-excess in 2014 suggested that more moisture supply from northeast monsoon resulting in extra amount of rainfall. $\delta^{13}C$ showed C_3 plants appear as major plant type that contributed to the Kelantan river sediments. Major factors for sedimentation in Kelantan are deforestation, agriculture and land settlement which evidenced in the fingerprints of $\delta^{15}N$, in agreement with the water quality results.

References

Faridah Anum. (2015), *Resolusi Persidangan Pengurusan Bencana Banjir Negeri Kelantan 2015, Persidangan Pengurusan Bencana Banjir Negeri Kelantan 2015*. Dewan Utama Universiti Sains Malaysia Kampus Kesihatan, Kubang Kerian, Kelantan. Centre for Global Sustainability Studies, 14-16 Februari 2015, pp. 6-22.

Hall, J., Arheimer, B., Borga, M., Brázdil, R., Claps, P., Kiss, A., Kjeldsen, T.R., Kriauciuniene, J., Kundzewicz, Z.W., Lang, M. et al. (2014), *Understanding Flood Regime Changes in Europe: A State of the Art Assessment*. Hydrology and Earth System Sciences, 18 (7), 2737.

PROJECT 3 : HEALTH AND SAFETY: ASSESSING HEALTH IMPACTS OF FLOOD DISASTER IN KELANTAN TOWARD DEVELOPING EFFECTIVE PREPAREDNESS & RESPONSE PROGRAMMES

3.1: ELUCIDATING THE NUTRITIONAL AND IMMUNOLOGICAL FACTORS AS THE CONTRIBUTING TO HEALTH STATUS AMONG FLOOD VICTIM IN KELANTAN

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1.0 Introduction

Massive flood that hit Kelantan in December 2014 due to heavy monsoons rainfall and climate change issues was the worst in the history affected more than 150 000 in the state. The food has left a trail of destruction to the community including their health and socio-economic status. Improper oral consumption during post flood might lead to nutritional and immunological changes.

The notation that progression of disease can be influence by stressful life experiences and psychological state has existed for many centuries, despite a paucity of evidence. Earlier study demonstrating a suppression of humoral and cellular immune responses in individual exposed to psychological stress [1]. In healthy individuals, the changes in immune response following exposure to an acute psychological stressor are generally evaluated as an evolutionary adaptive process, indicating that immune response are highly sensitive and quickly responsive to environmental stimuli such as stressful or threatening circumstances [2]. Hence, this study was aimed to investigate the hematological effect of post flood reflecting the nutritional, immunological and environmental factors contributing to the health status of the flood victims.

2.0 Methodology

The study area was located in District of Tumpat, Kelantan with 153,976 populations and conducted five months after the flood. Three hundred and nine household from flood area in Tumpat Kelantan were selected based on participation on past project and fulfill the criteria of the sampling frame. Convenience sampling was used for this study as the list of survivors is not available. A series of questionnaire was utilized to categorize household food security. Demographic, socioeconomic, coping strategies and anthropometric information were collected through interviews. Subjects included range between 18 to 87 years of age with no previous medical illness prior to flood including nutritional and immunological diseases or having controlled chronic medical illnesses, diabetes and hypertension.

Blood was collected in EDTA anticoagulant tube and plain tube. After obtaining the full blood count data (FBC), the specimens were processed for flow cytometry. The full blood count data were obtained using Sysmex analyzer XE5000 (Sysmex, Canada). Serum from blood samples were tested for immunoglobulin using on nephlometry test using Siemens BN-Prospect System (Siemens, Erlangen,GE) for Human Immunoglobulins (IgG, IgA and IgM). Sample also tested for RBC folate and Serum feritin. Blood and well water/pipe water were undergo laboratory testing on arsenic, cadmium, plumbum and mercury using Atomic Absorption Spectrophotometer Pin AAcle 900Z (AAS, Waltham, MA) and FIMS 100 (AAS, Waltham, MA)at Pusat Racun Negara, USM Pulau Pinang. Results were analyzed with statistical software, IBM SPSS Statistic version 22 using independent t-test. P-values of less than .05 were considered significant.

3.0 Results and Discussion

Three-hundred and nine subjects were analyzed based on the result from materials and methods. The result showed the prevalence of household food insecurity among flood victim (n=71). Subject that categorized in food secure compromise of 28.4% while the rest were categorise as the food insecure groups (Household insecure (27.1%), Individual insecure (8.4%) and Child hunger (36.0%). In general, the food insecure household was characterized by household living under poverty line and had larger household size, more children, school going children and non-working. One-hundred fifty blood samples were analyzed with the age mean 47.0±15.62 (age range between 18-77yr) for male and 46.6±13.23 (age range between 19-87yr) for female.

Table 1: Differences of hematological biomarkers by food security level

Variables	**Food Secure N=30**	**Food Insecure N=41**	**P value**
HGB	13.29±1.372	12.91±1.279	0.236
MCV	83.11±7.302	84.11±6.597	0.548
MCH	27.92±2.854	27.85±2.636	0.917
WBC	7.74±1.8	7.93±2.31	0.720
RBC	4.8±0.661	4.66±0.505	0.305
PLT	295.73±97.485	283.512±81.605	0.586
FERITIN	145.2±120.09	137.59±166.05	0.830

Table 1 and Table 2 shows the full blood count in post flood victim and non-flood victims. In male, hemoglobin, total white blood cells, red blood cells, and monocytes were significantly different ($p<0.05$) whereas in female only monocytes showed the significant different between the two groups. Results of our study showed that there were differences in the values of Hb, WBC, Neutrophils, lymphocytes, platelets and RBC male and female population. Platelets counts were significantly different in male and female population which can be explained by various factors including iron stores of the subjects [3].

Table 2: Type of anemia among flood victim (n=154)

Gender	**Type of Anemia**				**Total**
	Negative Anemia	Normochromic normocytic anemia TRO chronic disease	Hypochromic microcytic anemia TRO Thalassemia	Hypochromic microcytic anemia TRO Thalassemia concomitance IDA	
Male	60 (38.96)	4 (2.6)	7 (4.55)	1 (0.65)	72 (46.75)
Female	66 (42)	3 (1.95)	11 (7.14)	2 (1.3)	82 (53.25)
Total	126 (81.8)	7 (4.55)	18 (11.69)	3 (1.95)	154

Table 3: Result on lab parameter between Post flood victim and non-flood victim

Variables	Post-flood victim male,(n=68) Female, (n=74) Mean(SD)	Non-flood victim (n=20) Mean (SD)	P-value
Hb (g/dL) Male Female	 14.87 (1.17) 12.85 (1.17)	 15.59 (0.85) 13.20 (0.82)	 0.013 □ 0.200
TWBC (10^9/L) Male Female	7.98 (1.69) 7.90 (2.12)	7.15 (1.00) 7.28 (1.34)	0.008 □ 0.121
RBC (10^{12}/L) Male Female	5.14 (0.67) 4.65 (0.50)	5.50 (0.56) 4.77 (0.54)	0.032 □ 0.368
Monocytes (10^9/L) Male Female	0.65 (0.21) 0.54 (0.17)	0.52 (0.13) 0.45 (0.10)	0.002 □ 0.004 □

As for the lab parameter, significant result shown (Table 3, 4). Comparing the two subject groups, there were significant difference for CD4%, CD8% and CD4:CD8 ratio in male post-flood victim and non-flood victim (Table 3). However, there were no statistically significant differences in absolute numbers of total lymphocytes, $CD3^+$, $CD4^+$,$CD8^+$ T cells, $CD16^+$ NK cells and $CD19^+$ B cells. Comparing the post-flood and non-flood victim, there was no trend towards any difference in total numbers of the CD4 helper T cell or CD8 cytotoxic T cell.In female, IgG and IgM showed a significant different between the two groups. After flood, ecosystem changes could also lead to loss of ecosysytem goods and services that currently support healthy environmental conditions [4]. Flood increase the risk of respiratory and diarrhoeal diseases and cause mental health impact. The variation of lymphocyte subset population may cause by displacing communities and destroying house. Stefanski and Engler [5] suggest that acute and chronic stressful conditions may not necessarily result in similar effects on the immune functioning that should be considered when evaluating the biologic and evolutionary consequences of social stress-induced immune alterations.

Table 4: Lymphocyte subset population and Immunoglobulin between Post flood victim and non-flood victim

Lymphocyte subset population	Post-flood victim male (n=68) Female, (n=74) Mean(SD)	Non-flood victim (n=20) Mean (SD)	P-value
CD4% (cells/µL) Male Female	34.66(7.162) 37.68 (6.264)	30.392±5.090 36.53 (5.56)	0.015 □ 0.458
CD8% (cells/µL) Male Female	24.46 (6.699) 23.30 (6.222)	28.947±8.355 24.67 (5.41)	0.015 □ 0.372
4/8 ratio (cells/µL) Male Female	1.56 (0.634) 1.77 (0.685)	1.17±0.49 1.56 (0.45)	0.012 □ 0.203
Immunoglobulin			
IgG (g/L) Male Female	12.14 (2.821) 12.95 (3.144)	10.89±3.85 9.41 (2.81)	0.149 0.000 □
IgM (g/L) Male Female	0.79 (0.414) 0.99 (0.476)	0.81±0.26 0.67 (0.41)	0.838 0.032 □

□ Type of test-Independent t-test

□ $p<0.05$, significant

4.0 Conclusion

The findings on the effect of flood to post-flood victim are summarized as below.

4.1 Based on the laboratory profiles, immunological status of the post flood victim were affected after the flood. Comparing to normal population, there were significant difference for CD4% (p=0.015), CD8% (0.015) and CD4:CD8 ratio (p=0.012).

4.2 Levels of Immunoglobulin in female was higher as compared to control IgG (g/L), p=0.000 and IgM (g/L), p=0.032. However no significant different shown in male immunoglobulin.

4.3 In post flood victim, TWBC and monocytes were higher among male ($p<0.05$) whereas only monocytes were higher in female ($p<0.05$).

References

Edwards, K.M., et al., *Acute stress exposure prior to influenza vaccination enhances antibody response in women.* Brain, behavior, and immunity, 2006. **20**(2): p. 159-168.

Segerstrom, S.C. and G.E. Miller, *Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry.* Psychological bulletin, 2004. **130**(4): p. 601.

Roshan, T., et al., *Hematological reference values of healthy Malaysian population.* International journal of laboratory hematology, 2009. **31**(5): p. 505-512.

Change, W.C., *Human Health.* Geneva: World Health Organization, 1996.

Stefanski, V. and H. Engler, *Effects of acute and chronic social stress on blood cellular immunity in rats.* Physiology & behavior, 1998. **64**(5): p. 733-741.

3.2: ASSESSING POST-FLOOD ENVIRONMENTAL ASSOCIATED COMMUNICABLE DISEASES AND THE DISTRIBUTIONS THROUGH GEOSPATIAL ANALYSIS

Project Information

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1.0 Introduction

Flood causes serious health consequences especially on environmental-related diseases, particularly water and vector-borne diseases. Receding flood waters and pooling water in poodle provides perfect conditions for mosquito breeding, and increase in potential freshwater breeding sites results in larger numbers of mosquitoes, which would increase the potential for outbreaks of vector-borne diseases such as dengue fever. Contact with contaminated soil and water by animal urine will lead to leptospirosis. These diseases have relationship with the environment and other geographical factors and they could be transmitted not only to the vulnerable groups but also to those who are living near affected area. Therefore, the geospatial analysis is used to determine the relationship between: **i.** Cases of leptospirosis and leptospira isolated from the environment (i.e. water and soil) in Pasir Mas District, Kelantan**. ii.** Cases of dengue fever and distribution of *Aedes* mosquitoes in Kota Bharu and Bachok District, Kelantan.

2.0 Methodology

Geospatial analysis: The coordinates of the cases were obtained from the Health District Offices from their databases. The cases of leptospirosis were from 6 January (epidemiological week 1) to 16 May (epidemiological week 20) of 2015 occurred in Pasir Mas District. For the dengue cases the data obtained were from 1 September 2014 to 30 April 2015 which occurred in Kota Bharu and Bachok Districts. Kota Bharu District represents the urban area while Bachok District represents suburb and rural area. All the data were cleaned and those with correct latitude and longitude coordinates were included. The coordinates were entered and analysed according to their coordinates system either Kertau RSO or WGS. The data were analysed using ArcGIS 10.3 from Esri. The data were analyzed for the proximity and relationship of cases and environmental factor, i.e. the isolation of pathogenic leptospira species from the water and soil for leptospirosis; and the presence of aedes species for dengue fever.

Analysis for leptospirosis**:** Soil and water samples were collected from leptospirosis patients' localities in flood affected areas in Kelantan. Patients with confirmed leptospirosis were selected for environmental sampling. All samples were filtered and cultured on Ellinghausen and McCullough modified by Johnson and Harris media. The cultures were processed according to previously described protocols. Molecular identification of the isolates was performed by partial sequences of 16S rRNA.

Analysis for dengue**:** Mosquito larvae were collected in Kota Bharu (flood affected area) and Bachok (non-flood affected area). Fifty sampling points were selected from each area and eight ovitraps were placed in each sampling points. Mosquito larvae were collected from the ovitraps after a week and kept in a mosquito net cages. Adult *Ae. aegypti* and *Ae. Albopictus* mosquitoes emerged from the larvae were then collected, and kept in separate tubes. The mosquitoes were kept in pools, between 6 to 30 mosquitoes. The mosquitoes were separated between abdominal and head-thorax by using forceps and blade. The abdominal parts were used for NS1 dengue viral antigen detection and heads-thoraxes parts were used for ribonucleic acid (RNA) extraction and reverse transcription polymerase chain reaction (RT-PCR).

3.0 Results and Discussion

The total of the cases of dengue fever was 3202, which 2931 were in Kota Bharu and only the remaining 271 in Bachok. In Kota Bharu and Bachok areas, the number of *A. albopictus* dominant points was more than *A.egypti* dominant points (82 compared to 10 respectively). For the *A. albopictus* dominant points there were total of 132 cases found within 200 meters radius of 27 points (27/82 points) and for *A.egypti* dominant points there were 15 cases within 200 meters radius of 6 points (6/10 points). Analysed using Fischer's Exact test, revealed there was no association between the cases in the buffers and the aedes species points ($p=1.00$).

The distribution of cases of leptospirosis in Pasir Mas district post flood were found to be clustered pattern with NNI = 0.707 (z-score = -6.481, $p < 0.001$ at 99% CI). For the cases of dengue fever in Kota Bharu and Bachok districts, cases also found to be clustered with NNI = 0.373 (z-score = -67.841, $p < 0.001$ at 99% CI). The distribution of environmental samples that pathogenic leptospira being isolated were found to be random with NNI = 1.041 (z-score = 0.269, $p = 0.788$) and environmental samples that intermediate leptospira being isolated were found to be clustered with NNI = 0.350 (z-score = -6.571, $p < 0.001$ at 99% CI). The distribution of A. albopictus were found to be random with NNI = 0.967 (z-score = -0.569, $p = 0.569$) and A. egypti were found to be clustered with NNI = 0.688 (z-score = -1.887, $p = 0.059$ at 90% CI).

Our results also give a preliminary evidence of its usefulness to track and map vector borne diseases and the two are related. The ability to map threats to human and health is important for tracking vector borne disease. Our opinion is that Dengue and Aedes maps enhance the visualization and understanding of the epidemiology of Dengue; and this spatial distribution can provide association between risk factors and dengue for example a climactic phenomenon and dengue fever. Our findings even though are basic but able to support the use of mapping for Dengue by our disease control health-workers because Dengue and Aedes maps provide new insights for public health officials and others making decision about disease surveillance.

For the leptospira, the total number of cases included in this study was 134. Using the spatial analysis, 29 cases were found within 1000 m radius of the 11 positive environmental samples taken (11/12). Using the spatial analysis, 47 cases were found within 1000 m radius of the 21 intermediate leptospira points (21/28). 15 cases were found in the both pathogenic and intermediate leptopsira buffer zones.

4.0 Conclusion

4.1 The small number of isolated pathogenic leptospirosis in found in this study was due to the timing of sampling.

4.2 The sampling of the leptopsira from environmental from the post flood areas with previous cases of leptospira did not revealed a significant association by geospatial analysis.

4.3 The *Aedes aegypti* populations dominated in the urban area (Kota Bharu) while *Ae. albopictus* populations were dominated in rural area (Bachok), which is agreement with several other studies.

4.4 Geospatial analysis between *Aedes aegypti* mosquitos and cases shows significant relationship.

4.5 It is possible that the negative result obtained maybe due to the very low number of RNA present in mosquitoes

References

Subedi D, Taylor-Robinson AW. Epidemiology of dengue in Nepal: History of incidence, current prevalence and strategies for future control. J Vector Borne Dis. 2016;53(1):1-7.

Attaway DF, Jacobsen KH, Falconer A, Manca G, Rosenshein Bennett L, Waters NM. Mosquito habitat and dengue risk potential in Kenya: alternative methods to traditional risk mapping techniques. Geospat Health. 2014;9(1):119-30.

Rogers DJ, Suk JE, Semenza JC. Using global maps to predict the risk of dengue in Europe. Acta Trop. 2014;129:1-14.

3.3: IMPACT ON ENVIRONMENTAL ASSETS: THE INCREASE OF *AEDES* MOSQUITO POPULATIONS AND THE EPIDEMIOLOGICAL IMPLICATION OF DENGUE VIRUSES

Project Information

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1.0 Introduction

The aftermath of the flood catastrophe in December 2014 has set up Kelantan as a potential hotbed for mosquito vector distribution and the diseases associated with it. Standing water and poor hygiene practice after a flood could provide expansion of mosquito breeding ground, especially *Aedes* mosquitoes, thus amplifying arbovirus transmission associated with *Aedes*. Dengue fever cases are on the rise in Kelantan as 8,219 cases with 12 deaths were recorded in 2014 which is considered as the worst record in the state so far. Increase in mosquito density can be further exacerbated with environmental variables such as temperature and humidity, vegetation and land use patterns due to flooding. This will produce mosquitoes with stronger progeny and survivability, which increase the possibility of dengue-carrying mosquitoes in public to transmit disease. As a part of this strategy, virological surveillance of infected mosquitoes remains fundamental for defining the spatial and temporal risk of being diseased with dengue (Gubler et al., 1979). Various types of mosquito tissues are infected in typical dengue infections, and the virus is able to persist in them throughout their life cycle (Rodhain and Rosen, 1997) with the addition of transovarial transmission; hence the virus can be maintained in vector populations through many generations without being reinfected. Thus, by its very nature, the risk caused by the infected vector population is continual. Therefore, virus recovery from field-caught mosquitoes remains ideal compared to virus detection from human-derived samples, which normally has very limited period (4-5 days) of detectable viremia (Beckett *et al*., 2015). Diagnostic techniques using Dengue NS1 antigen kit are are rapid, simple to perform even at field testing, cost-efficient, specific and widely used for detecting DENV NS1 antigen from acute patient serum samples (Ramirez et al., 2009; Shu et al., 2009). It is noteworthy that none of the public health interventions are useful without awareness at the community level. Frequent spraying by public health authorities to monitor vector population is not adequate to control the disease spread (Yasumaro et al., 1988). It is important to assess the knowledge, attitude and practice (KAP) level of the people in the study region, especially after the flood, as part of the dengue control program. The KAP research design is a widely utilized method in diagnosing the current awareness and practices in any diseases and to evaluate the efficiency of any health-related treatments or intervention programs (Kwon and Crizaldo, 2014). Providing health education campaign for the community at risk is essential to ensure the community members understand the vector biology, disease spread mechanisms and key behaviors need to be adopted to prevent transmissions and reduce severe disease.

2.0 Methodology

Aim 1: Mosquito population study in flooded and unflooded regions and detection of dengue virus from field-collected mosquitoes

Study was performed in two selected areas located in Kelantan: (1) Pasir Pekan, Tumpat (flooded area) and (2) Bandar Baru Kubang Kerian, Kubang Kerian (unflooded area). These stations were selected on the basis of dengue hotspots and human population density as provided by the local state government. Data collected for mosquito population density from unflooded area were used as a comparison to the flooded area. An extensive survey and field sampling for mosquitoes were conducted on a monthly basis from April 2015 to October 2015. The mosquito population was estimated by conducting larval surveillance using ovitraps which then were reared to adulthood.

Data obtained was analyzed as: (i) The abundance of *Aedes* mosquitoes collected by species and months, and (ii) Ovitrap index (OI) (%). Percentage of single and mixed infestation of mosquitoes (per month) was calculated using Bivariate Pearson's correlation. Whereas, Pearson correlation coefficient was computed using SPSS 22.0 to study the correlation between mosquito abundance and environmental variables (rainfall, temperature, humidity).

Aim 2: Screening for dengue virus from mosquito samples and serotype identification by using RT-PCR analysis

The captured adult female *Aedes* mosquitoes were prepared for dengue virus detection which then was followed by a serological test. Mosquitoes were grouped into a maximum three pools of 10 mosquitoes each. The dengue detection from field collected mosquito samples was carried out by following the protocols (Tan et al., 2011; Lai et al., 2007). Two techniques were ran to detect the dengue virus in mosquitoes; (i) The supernatant was tested on Dengue NS1 Ag Rapid Test Cassette according to the procedures attached with the kit, and (ii) the dengue virus detection and typing was completed by using a standard RT-PCR assay and gel electrophoresis using protocol by Lai et. al, 2007.

Aim 3: Assessment of knowledge, attitude and practice level

We conducted a descriptive cross-sectional study assessing the knowledge, attitude and practice regarding dengue fever and the prevention in Sekolah Menengah Mahmud Mahyidin, Pasir Pekan, Tumpat. A health education program was carried out by the distribution of dengue awareness booklet during the interphase of the KAP survey. Most of the students attending the school were believed to reside within the sampling area. The same set of questionnaire was re-administered (post-test) to the same group of students after four days and the results were compared with the pre-test.

3.0 Results and Discussion

3.1 Extensive survey of *Aedes* mosquito population upon flooding

Based on the total number of *Aedes* mosquitoes collected throughout the study period, *Aedes* mosquitoes were more abundant in the flooded area compared to the unflooded area. A total of 5,600 *Aedes* mosquitoes was collected from flooded areas and 1,013 *Aedes* mosquitoes from an unflooded area (Figure 1a). The ecological conditions in Pasir Pekan flooded area might be one of the contributing factors to the high number of mosquitoes. The area is a suburban area with residential houses surrounded with various vegetation, trees and shrubs which is not properly managed and maintained. This factor is too contributed to the higher number of *Ae. albopictus* in Pasir Pekan since *Ae. albopictus* breeds in wide variety of natural and artificial containers (Chen et al., 2009). Bandar Baru Kubang Kerian unflooded area is a residential flat area with which recorded relatively lower number of mosquitoes compared to Pasir Pekan. This might be due to less vegetation and disturbance from the residents who discarded the ovitraps. In both locations, *Ae. albopictus* seemed to be dominant compared to *Ae. aegypti* (Figure 1). However, the number of *Ae. aegypti* was found to be more compared to that of Pasir Pekan. This obviously proves the fact that *Ae. aegypti* breeds mostly indoor and near human habitations (Lam, 1994). Overall, mosquito densities in Pasir Pekan showed increasing trend from April to August 2015 but dropped in September and October, 2015. On the other hand, Bandar Baru Kubang Kerian showed fluctuating trend of mosquito densities with a sudden peak in the month of July, 2015 (Figure 1b).

Pasir Pekan showed higher OI in every month compared to Bandar Baru Kubang Kerian. This indicates that Pasir Pekan is at higher risk of dengue transmission. In Pasir Pekan, more single infestations of *Ae. albopictus* were observed, but only one single infestations of *Ae. aegypti* were found in October (Table 1). Bandar Baru Kubang Kerian showed single infestations of *Ae. aegypti* for the month of May, June and August and also showed higher percentage of mixed infestations compared to Pasir Pekan for the month of May, June and July (Table 1). The mixed infestation of *Ae. albopictus* and *Ae. aegypti* indicated that the both species can oviposit in the same containers. The ovitrap index recorded in both localities indicated that the areas are at high risk of dengue transmission (OI > 10%) (Rozilawati et al., 2015). Thus, precautionary steps should be initiated to prevent possible dengue transmission in future.

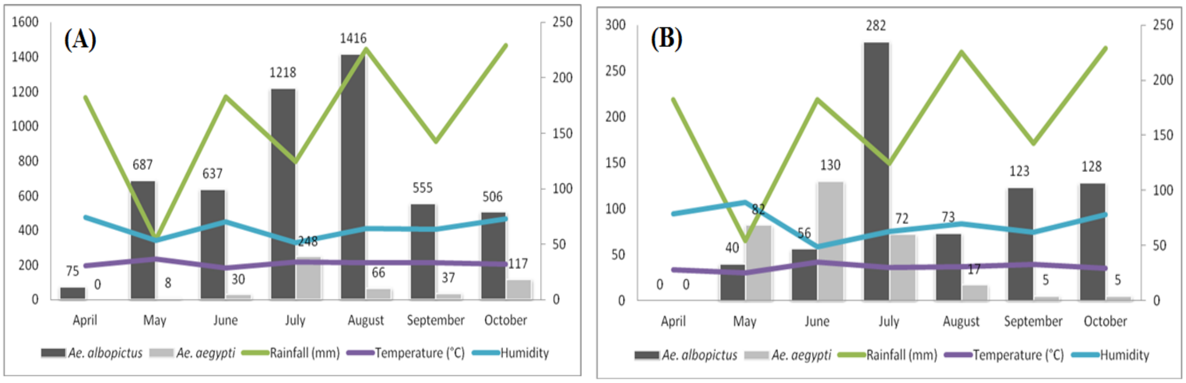

Figure 1. Graph showing the mosquito population trend in association with rainfall, temperature and humidity in flooded (A) and unfolded (B) area.

Bivariate Person's correlation analysis of mosquito abundance with meteorological variables showed that there was no significant correlation exists between the variables and mosquito abundance (P<0.05). We found that no correlation exists between mosquito density and meteorological variables such as rainfall, temperature and humidity. Mosquito distribution and abundance closely related to ecological factors that inherently alter the mosquito's behavior (Monath, 1994). Warmer temperature and relative humidity increase mosquito growth and survival rates (Hopp and Foley, 2001) and also have direct impact on virus propagation (Thu et al., 1998) will result in dengue outbreak.

Table 1: Ovitrap index (OI) and percentage of mosquitoes in flooded and unflooded sites with single and mixed breeding

Month	**Flooded**				**Unflooded**			
	OI (%)	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus + Ae. aegypti*	OI (%)	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus + Ae. aegypti*
April	20.00	100	0	0	0	0	0	0
May	72.41	87.56	0	15.97	48.15	20.49	43.44	36.07
June	92.86	75.86	0	24.14	63.33	11.83	43.01	45.16
July	96.55	61.187	0	38.81	77.78	58.19	0	41.80
August	100	73.21	0	26.79	52.00	81.11	18.89	0
September	86.66	63.68	0	36.32	46.43	87.50	0	12.50
October	79.31	61.16	0.16	38.68	48.15	91.73	0	8.27
	Mean= 78.26 SD= 25.41				**Mean= 47.98 SD= 22.18**			

3.2 Screening for dengue virus from mosquito

Dengue detection in mosquito samples using NS1 Rapid Test and RT-PCR yielded negative results, which means no dengue virus was detected in the mosquito samples collected from both localities (Figure 2). Confirmation test using RT-PCR also yielded in negative results. Early detection of dengue in the mosquito population would enhance the efficiencies of vector control activities. The use NS1 dengue detection kit has been proven by several other studies to detect the presence of dengue viruses in mosquitoes (Tan et al., 2011; Ramirez et al., 2009; Shu et al., 2009). In this case, we can postulate that the occurrence of dengue cases in the study region might be due to human movements from other endemic area. However, it is essential to consider that flooding has reported dengue cases in locations without dengue for a long term. As in United States, flooding is seldom associated with mosquito-borne diseases. But, India and Thailand reported increased mosquito populations and dengue cases after flooding (Chang et al. 2014).

Figure 2. Test cassete A is showing negative result (band appears at control line only) when tested with field-collected mosquito homogenate and test cassette B is showing positive result (band appears at both control and treatment line) when tested with dengue positive patient blood serum.

3.3 Assessment of KAP and dengue awareness education programme

Part 1. Socio-demographic characteristics

A total of 69 individuals participated in the survey with the majority (47.8%) belonged to the age group of 14 years, 43.5% were 13 years and 8.7% were 15 years. A little more than half of the respondents were male (50.7%) and 49.3% were females. The common monthly family income ranged between RM 900-1500 (59%). Most of the respondents are living in Bungalow/Village type of house (75.4%) and 38% of the respondents stated that their house is surrounded by moderate levels of vegetation. There were 7 (10.14%) households had the history of dengue fever in the year of 2015. Most of the respondents' houses (76.8%) were affected by flood in December 2014.

Part 2. Knowledge on dengue fever

Distribution of knowledge on dengue fever among the students in the pre-test showed that 41% of subjects had "high knowledge", 27% had "moderate knowledge" as well as only 1% had "low knowledge". After the post-test, the percentage of students with "high knowledge" increased to 79.1 %. There were none reported with "low knowledge during this session.The mean score for pre- and post-test were 10.65 (SD= 1.21) and 11.05 (SD=1.12), indicated the percentage of subjects answered correctly increased after providing them with a dengue information booklet.

Part 3. Attitude towards dengue prevention.

Survey participants answered 11 questions which gives a total score of 55. At pre-test, 24.6% had a positive attitude, 42% had neutral attitude and 33.4 had a negative attitude. Whereas, in post-test, 16.3% of the subjects had a positive attitude, 72.1% had neutral attitude and 11.6 had a negative attitude. The percentage of subjects with positive attitude dropped slightly about 1.1% during post-test but, the neutral attitude increased by 19.9% in post-test. More interestingly, subjects with negative attitude reduced up to 18.8% during post-test, showing the effectiveness of the dengue awareness booklet. The mean attitude score for all was 39.84 (SD= 4.25) during pre-test and 40.79 (SD= 3.05) during post-test, out of total 55 points. Initially, when assessing the attitude towards dengue prevention, it was found that the participants were more neutral, and negative attitude as the percentage of positive attitude was relatively lower. This shows that they might not be committed to practicing preventive attitude. The possible reason might be that the subjects are school children and they are not directly involved in dengue prevention activities. There are high possibilities for other factors causing such situation as attitude does not depend on knowledge level such as social factors, motivation, belief, etc.

Part 4. Practices regarding dengue fever prevention

In the questionnaire set, there were nine questions related to practices regarding dengue fever prevention. Eight out of nine items showed increasing percentage in the practices to avoid mosquito breeding and bites. However, a slight reduction of 2.3% on using mosquito bed nets to avoid bites was observed in post-test.

Part 5. Practices during flood to avoid dengue infection

In most of the statements in this section showed more than 90% of the subjects agreed that they followed good preventions to avoid mosquito bites by sleeping in mosquito impregnated nets and also spraying aerosol and use mosquito coils. However, 89.9% of the subjects also stated that they did not take any precautions. Overall, the students are practicing good preventive practices to avoid dengue infection and this finding suggests that the students were able to transform their knowledge on prevention and control of dengue into practice. However, the converse relationship between knowledge and practice was observed in several other KAP surveys (Khun and Manderson, 2007; Rajakumari 2015). Additional care of family and public health authorities to avoid dengue infection as post-flood effect could be one of the reasons the students practice good preventive measures.

Part 6. Source of information on dengue fever

In this part, subjects were allowed to select more than one source of information on dengue fever. Most of the subjects received information through TV followed by newspaper and school. The least source of information received by the respondent is from pamphlet/banner and magazines. Similar results were found by Rajakumari (2015) as television emerges as the most important source of information (37.8%). Also, Jain et al. (2014) reported that both television and newsprint as the main source of information about dengue fever among nursing students. Clearly, the knowledge level increased in post-test, after providing the dengue awareness booklet to the subjects. This shows that the booklet was able to increase the subjects' knowledge of dengue, its vectors and other important information provided in the booklet. The study is in agreement with other experimentally controlled health, educational studies that knowledge increased when the student population was supplied with health educational materials (Suwanbamrung et al. 2015; Khun and Manderson, 2007).

4.0 Conclusion

The important finding of our study of the *Aedes* mosquito population in both flooded and unflooded areas in Kelantan are suumarized as below:

4.1 *Aedes* mosquitoes were more abundant in the Pasir Pekan flooded area with 5,600 individuals and showed an increasing trend from April to August 2015 but dropped in September and October, 2015. On the other hand, unflooded area Bandar Baru Kubang Kerian showed fluctuating trend of mosquito densities with a sudden peak in the month of July, 2015 with 1,013 collected *Aedes* mosquitoes.

4.2 Pasir Pekan (flooded) showed higher OI in every month with dominant species of *Aedes albopictus* compared to Bandar Baru Kubang Kerian. (unflooded) and this indicates that Pasir Pekan is at higher risk of dengue transmission.

4.3 The fluctuation of *Aedes* population was not influenced by rainfall, temperature and humidity, but more to ecological conditions and landscape of the study areas such as housing surrounding, vegetation,

4.4 Detection of dengue viruses using NS1 rapid test and RT-PCR yielded of negative results for both places, suggesting that the occurrence of dengue cases in the study region might be due to human movements from other endemic area.

4.5 The dengue awareness health education program using our dengue education kit booklet had successfully improved students' knowledge and attitude towards dengue prevention. The knowledge of dengue after distribution of dengue education booklet increased to "high knowledge" by 79.1%. Whereas, 16.3% of the subjects had a positive attitude and 72.1% had a neutral attitude towards dengue prevention.A total of 90% of the respondent agreed that they followed good preventions to avoid mosquito bites after exposed to our dengue education booklet

References

Beckett CG, Kosasih H, Tan R, Widjaja S, Listianingsih E, Ma'roef C, Wuryadi S, Alisjahbana B, Rudiman I, McArdle JL, Porter KR.(2004) Enhancing knowledge and awareness of dengue during a prospective study of dengue fever. Short report. Southeast Asian J. Trop. Biomed. Pub. Health, 35(3):614-617.

Chang AY, Fuller DO, Carrasquillo O, Beier JC (2014). Social Justice, Climate Change, and Dengue. Health and Human Rights, 16(1): 93-104.

Chen CD, Lee HL, Stella-Wong SP, Lau KW, Sofian-Azirun M (2009). Container survey of mosquito breeding sites in a university campus in Kuala Lumpur, Malaysia. Dengue Bull., 33: 187-193.

Gubler DJ, Suharyono, W, Sumarmo HW, Jahja E, Saroso JS (1979). Virological surveillance for dengue haemorrhagic fever in Indonesia using the mosquito inoculation technique. Bull. WHO, 57(6): 931.

Hopp MJ, Foley JA (2001) Global-scale relationships between climate and the dengue fever vector, *Aedes aegypti.* Climate Change, 48:441–463.

Jain S, Mishra MK, Gupta SK, Agrawal SS, Shukla US (2014) Knowledge, attitude and preventive practices about dengue fever among nursing student of tertiary care hospital. J. Evol. Med. Dental Sci., Vol. 3(6):1481-1488.

Khun S, Manderson, L. (2007). Community and school-based health education for dengue control in rural Cambodia: a process evaluation. PLoS Negl. Trop. Dis., 1(3): e143.

Kwon DH, Crizaldo RL (2014) A Knowledge, Attitudes, and Practices (KAP) Study on Dengue Fever among the Rowenas Community in the Philippines. Mediator 10(1). Asia-Pacific Nazarene Theological Seminary, ISSN 1655-4175.

3.4: ENHANCING COMMUNITY-BASED EDUCATION MODULES OF PREPAREDNESS FOR FLOOD-RELATED COMMUNICABLE DISEASES IN KELANTAN

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1.0 Introduction

Flood disaster happens almost every year in Kelantan especially during monsoon season between November and February. The recent flood in 2014 had resulted in massive damages to the basic infrastructures and daily life of many communities. The trend of communicable diseases in Kelantan such as leptospirosis, respiratory tract infections and acute gastroenteritis were increased after flood, many of which were reported from the flood affected districts (Fauziah et al., 2015). Local community survey among affected households in Tumpat, Kelantan, has shown increased percentages of cases with fever, respiratory symptoms and skin problems, along high numbers of displacements and disrupted use of toilets up to 7 days (Zahiruddin et al., 2015).

There are research gaps in determining people's knowledge and attitude in flood-related health hazards and their preventive practices in reducing the health implications of flood disaster. Limited customized health educations on flood-related communicable diseases in the communities are also a great concern. The aims of this research are to describe the situational analysis on the related issues and also to evaluate the effectiveness of a community-based health education intervention in preventing flood-related communicable diseases among affected communities in Kelantan.

2.0 Methodology

This research project involved two phases. In Phase 1 (between August and October 2015, situational analysis were done in assessing and exploring baseline knowledge, attitude and preventive practices (KAP) of the affected communities with regards to communicable diseases related to flood. Baseline community surveys were conducted using a pre-validated KAP questionnaire through guided interviewed-based technique among 300 villagers. Raw total scores from each section of KAP were converted to percentage scales for analysis while four focus group discussions (FGD) were performed to explore their coping and experiences in the flood disaster.

In Phase 2 (between November 2015 and February 2016), health education materials were developed through series of workshop and then were evaluated through a community intervention. These involved revising existing health education materials, creating new materials tailored to the community and getting feedback from stakeholders. Customized modules that focusing on major flood-related communicable diseases and comprising of printed materials and audio-visual information kits were eventually developed which included 2 series of health education flip charts, 2 series of PowerPoint slides for health talk, 3 series of health education flyers, 10-minute video with captions on flood-health hazards, diseases and prevention messages and other complementary public health information.

A non-randomized community-controlled trial was then conducted to determine effectiveness of the community-based health education modules. The delivery channels of the health modules were conducted at least two weeks before the forecasted flood seasons in that year. Two strategies were applied: targeted small group health education sessions which comprised 20-25 persons each, and mass dissemination of public information health education materials.

3.0 Results and Discussion

Three hundreds repondents were interviewed with a mean age of 45.1 years old (SD=17.34) and mainly those with secondary school education (n=166, 55.3%). Taking mean scores below 80% as unsatisfactory, all knowledge domains, attitude and selected pratices (drinking water and protective habit) need further concern. Between 90.7 to 96.3% agreed that they were more likely to practice preventive measures if given proper information and personal protective tools (e.g soap, hand sanitizer, face mask etc). Between 72.2 - 95.3% agreed that current materials of health education on flood related diseases were useful but interactive small group discussions and demonstrations were also suggested by them.

There were 129 and 101 respondents within the intervention community who were participated in the repeated surveys at 1-week and 1-month post intervention KAP assessments respectively while another 125 in the controlled group. Table 1 shows there were statistically significant improvements in all knowledge components (type of diseases, common symptoms, methods of transmission, susceptible and risk factors, and danger signs) from 9.4% to 52.6% (P<0.001) while there was a 10% increment (P<0.001) in attitude scores toward preventing behaviours on flood-related communicable diseases among the intervention community. There was a slight reduction in most domains at 1-month post intervention; however all mean scores were still higher than at the baseline pre intervention stage.

When compared to the control community at post-1 month, statistically significant difference in mean knowledge scores were shown between 15.4% and 35.4% (P<0.001) on types of diseases, common symptoms and susceptible/ risk factors domains. There were significant improvements on the practice domains at post 1-month in the practice of drinking safe water and protective habits (P<0.001 and P<0.006 respectively) but no changes in the hand-washing and sanitation practice (Table 2).

Table 1: Changes and comparison on mean scores on knowledge and attitude domains in the intervention and controlled communities

Domains on knowledge	Max score	Mean scores (SD)				F-stat (df1, df2)*	*P*-value (within intervention)	*P*-value (vs controlled)
		Pre (n=300)	Post 1-week (n=129)	Post 1-month (n=101)	Post 1-month (controlled) (n = 125)			
Types of disease	7.0	3.8 (2.09)	5.8 (1.52)	4.2 (2.03)	4.5 (1.70)	51.24 (2,330.4)	<0.001[a]	<0.001
Common symptoms	10.0	6.4 (3.1)	8.9 (1.54)	6.8 (2.68)	6.5 (2.71)	48.71 (2,330.2)	<0.001[b]	<0.001
Methods of transmission	14.0	10.9 (4.02)	13.0 (2.26)	12.2 (3.06)	13.1 (2.89)	23.61 (2,397.7)	<0.001[c]	0.733
Susceptible/ risk factors	11.0	7.3 (3.27)	9.0 (1.95)	8.0 (2.58)	7.8 (3.44)	20.44 (2,390.3)	<0.001[d]	0.001
Danger signs & symptoms	6.0	5.3 (1.6)	5.8 (0.55)	5.7(0.89)	5.8 (1.08)	12.39 (2,454.3)	<0.001[e]	0.660
Attitude on prevention	33.0	25 (5.15)	27.4 (5.01)	25.9 (4.92)	26.5 (5.18)	11.31 (2,353.3)	<0.001[f]	0.125

*Brown-Forsythe Modified F test of was applied due to violation of homogeneity of variance assumption. Dunnett's T3 was applied for posthoc multiple comparisons, [a,b,d]Pre-Post 1 and Post 1-Post 2 were significant, [c,e]Pre-Post 1 and Pre-Post 2 were significant, [f]Pre-Post 1 was significant.

Baseline survey has shown the general concerns on inadequacy of local community's knowledge and attitude in flood-related health hazards and their preventive practices in reducing the health implications of flood disaster were shown in this study. Even though after community-based intervention, in term of percentage scores the increments were as low as about 10%, we believe that this project has succeeded in promoting important public health messages at community level. Rose (1992) stated that an intervention that resulted in small population changes is important for public health and the overall health status of that population. In fact, most behavior change specialists believe that a sequence of small or moderate successes is the best way to build morale, self-efficacy and commitment for future goals among the public (Jenkins, 2003).

In this study, there was seemed to be non-improvement in the practice domains on hand-washing and sanitation but this may be due to already satisfactory high scores of these aspects at pre-intervention stage so that to improve further need continuous intensive efforts in modifying these behaviours. Having said that, whether the improvements that were shown among the intervention community can lead to relevant preventive behaviours and reduction in the disease incidences following real flood disaster are not yet proved, as described by studies in Thailand (Piyaphanee et al., 1991) and African country (Haggerty et al., 1994). Thus, we recommend that future data with comparative controls on changes in practices and behaviours, episodes of disease symptoms and incidence rates of related diseases thru surveillances, especially at post-flood.

Barriers and motivation factors should also be studied to improve community preparedness during disaster (Dorasamy et al., 2013). Community preparedness and risk reduction strategies are typically low-cost efforts that can be readily implemented at personal, household and community level, as compared to high-cost disaster relief operations and flood mitigation projects. We hope that the customized health education modules developed from this research project will be able to enhance the knowledge and attitudes regarding flood-related diseases, modify risk-related practices and behaviour of people exposed to these hazards and promote community participation in hazard mitigation.

4.0 Conclusion

The study findings show that:

4.1 the community-based health education has been evaluated to be effective in enhancing existing level of relevant knowledge and attitude as part of their preparedness toward communicable diseases related to flood

4.2 this research furthers contribute by providing customized and comprehensive community-based health education modules in preventing potential communicable disease outbreaks in affected flood-prone communities

4.3 this will further reduce the costs associated with the diseases and reduce the vulnerabilities of communities exposed to floods

References

Dorasamy, M, Raman M, Marimuthu M, Kaliannan M (2013). Disaster preparedness: an investigation on motivation and barriers. J Emerg Manag. 11(6):433-46. doi: 10.5055/jem.2013.0156.

Fauziah, M.N, Hasniza A, Suhaiza S.(2015). 1st National Kelantan Health Conference. Renaissance Hotel, Kota Bharu, Malaysia.

Haggerty P.A, Muladi K, Kirkwood B.R, Ashworth A, Manunebo M. (1994). Community-based hygiene education to reduce diarrhoeal disease in rural Zaire: impact of the intervention on diarrhoeal morbidity. Int J Epidemiol. 23(5):1050-9.

Harris, A.M., Chowdhury, F., Begum, Y.A. (2008): Shifting prevalence of major diarrheal pathogens in patients seeking hospital care during floods in 1998, 2004, and 2007 in Dhaka, Bangladesh. Am. J. Trop. Med. Hyg., 79, 708–714.

Jenkins, C. D. (2003). Principles of Community Health Intervention. Retrieved 10 July 2012. http://www.publications.paho.org/english/Principles_BBH.pdf

Piyaphanee, W.I, Olanwijitwong. J, Kusolsuk. T, Silachamroon U. (2012). Awareness, practices, and health problems of backpackers traveling during flooding in Thailand during 2011. Southeast Asian J Trop Med Public Health. 43(5):1193-200.

Zahiruddin WM. (2015). Community household surveys on experiences and responses towards flood disaster in 2014 in Tumpat, Kelantan (unpublished)

PROJECT 4 : FLOOD & FLOOD DISASTER: HOLISTIC APPROACH IN FLOOD DISASTER MANAGEMENT IN THE PERSPECTIVE OF HEALTH CARE & NON-HEALTH CARE WORKERS BASED ON RECENT FLOOD DISASTER IN KELANTAN (GOVERNANCE, COMMUNICATION, EMERGENCY CARE PROVISION & GEOSPATIAL ANALYSIS)

4.1: GOVERNMENT SERVICE RECOVERY IN FLOOD DISASTER: CASE OF KELANTAN FLOOD PRONE AREA

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1.0 Introduction

The December 2014 flood was considered the worst unexpected natural disaster in Malaysia. Kelantan, Terengganu and Pahang were the three states which were affected the most. Infrastructures and basic facilities including electrical and communication system as well as transportation network were badly affected. Thousands of victims were evacuated and rescued to safer places. This alarming situation had denied the victims from receiving immediate aids of various different forms from several sources. The government through its various agencies, NGOs and others had to struggle in finding appropriate ways to deliver the needed assistance. Numerous claims were made against the government for not providing immediate response and assistance during and immediately after the disaster occurred. A lot of discrepancies were also mentioned in the management and distribution of goods and services to the victims. Service recovery provided by the government is crucial in ensuring the victims to adjust to the displacement, manage physical and mental recovery process as well as maintain normality in everyday life. Service recovery is a cycle of event which covers not only post phase of flood disaster, but also prior and during the period of disaster.

This study embarks on the following objectives; to investigate the government agencies response towards victims of flood disaster, and; to evaluate the existing mechanism of service recovery. The study focuses on Kelantan 2014 flood specifically areas which were heavily impacted by the disaster such as Gua Musang, Kuala Krai, Machang, Tanah Merah and Kota Bharu. Service recovery can be described as actions taken by service providers in response to defects or failure (Gronroos, 1988) in which the actions range from the “do nothing” to “whatever it takes to fix the problems” (Gordon et al., 1999). In marketing, the main objective of service recovery is to move a customer from a state of dissatisfaction to a state of satisfaction (Zemke, 1993). Some literature argues that service recovery is not only recovering the dissatisfied customers to regain their satisfaction and loyalty, but also looking at the prime purpose of service recovery; to improve the service system (Johnson & Michel, 2008; Tax & Brown, 1998). It is two dimensional; outcome and process (Duffy et al., 2006), which integrate “what” the customer actually receives and “how” recovery is achieved. Similarly in governance, service recovery refers to recovering citizens dissatisfaction of services received and returning their grievances to a state of relief. One of the responsibilities of government is to provide services for the people through its various agencies (Dickerson et al., 2010) in resolving political issues (Hague & Harrop, 2013). Decision made is to respond to citizens’ needs and wants and to improve its effectiveness and efficiency. Comprehensive disaster management is based on the following four components (Coppola, 2007): First, *Mitigation* – reducing or eliminating consequences of a hazard; second, *Preparedness* – equipping impacted people to increase their chance of survival and to minimise the losses; third, *Response* – taking action to reduce or eliminate disaster impact to prevent suffering and losses; and fourth, *Recovery* – returning victims lives back to normal. The recovery phase generally begins after the immediate response has ended, and persist for months or years thereafter.

Service recovery is a whole cycle of events which covers not only during and post phase of flood disaster, but also prior or before the disaster occurs. Flood recovery is about rebuilding a sense of home and community as residents adapt to a new and altered set of circumstances. The ultimate aim of service recovery is to correct the current poor situation (Strydom, 2004) and return aggrieved clients to a state of satisfaction with the institution after a service breakdown (Zemke & Bell, 2000).

2.0 Methodology

The unit of analysis consists of government agencies in Kelantan, Kuala Lumpur and Putrajaya which directly involved in dealing with the disaster. It integrates few qualitative methods in data collection including observation, focus group discussion and elite interview. The reviewed literature, along with site observation, is used as foundation to determine the preliminary themes and issues. It also serves to develop the construct of semi structured questions for the pilot study. The questions were refined for the subsequent focus group discussion and elite interview. The sampling population refers to Kelantan Disaster Management and Relief Committee that is co-chaired by the State Government and National Security Council (MKN) with 43 committee members. Each committee member represents government departments and agencies that directly deal with, in this context, flood. Purposive sampling is used in identifying interview samples. Top management personnels from the identified agencies were approached through official letters and telephone calls follow-up. Department of Irrigation and Drainage (Jabatan Pengairan dan Saliran Negeri Kelantan) was first interviewed as pilot study to gather basic flood information. The subsequent 17 interviews with the government agencies were carried out including Kelantan State Government (Kerajaan Negeri Kelantan) and Welfare State Department (Jabatan Kebajikan Masyarakat). The interviews were recorded and later transcribed verbatim. Data analysis was carried out based on the transcription through content analysis method.

3.0 Results and Discussion

The research finding proves the government response towards the flood victims. In the immediate aftermath of the disaster, the government carried out its roles and responsibility through National Security Council by setting up an operation center which main functions are to ensure all government agencies involved to carry out their prescribed tasks. It also continuously received, coordinated and disseminated information about the latest flood situation. The MKN Arahan 20 is utilized as the Standard Operating Procedures for all government agencies involved in managing the flood. The SOP should be the uniform command for all in the disaster. However, the finding indicates that, due to the severity of the flood, the SOP could not be followed entirely, thus contingency plan was applied depending on specific situation at particular time. The finding also suggests that each government agency adopted its own SOP which has led to a chaotic and disorganized situation. The 2014 Kelantan flood also exhibits that the government had insufficient assets in terms of logistic, staff, evacuation and rescue skills and funding to cope with the disaster. Most assets that were used to evacuate and rescue the victims were insufficient and unsuitable for the massive flood. Life boats were not suitable to be used due to very strong water current and unpredictable flooded route. Some of the rescue team members were also flood victims which have led to the existence of role conflict. Lack of preparation was obvious at the relief centres; lost contact with the operation center due to blackout that led to communication problem in carrying out rescue operations, and also insufficient food and water supply. In addition, lack of coordination among agencies and chain of command in managing the disaster has worsened the situation.

The study also reveals that all relief centres were unable to accommodate huge number of victims. The centres were meant for normal flood with number of victims around 500 or less. In some relief centres, the number of victims rocketed to 3000 or more. Most of the gazetted relief centres were also flooded and forced the victims to be transferred to new identified location. The absence of proper population database has apparently distorted the distribution of aids in various forms to the victims during and after the flood. The agencies responsible for the victims' welfare faced difficulties to identify victims and their respective location. More time was needed to compile victims' information for the submission of victims' profile to MKN thus delay the distribution of aids to the victims. Furthermore, political conflict between the state and federal governments disrupted the smoothness of flood operation rescue and recovery. The identification of settlements funded by each government did not reach unanimity. Ready settlements are still not occupied due to ambiguous selection process. There are also a number of victims who refused to occupy new settlements due to the distance from their workplace. In fact, they are still living in improper tents just to be near to their sources of income.

The study also assesses the effectiveness the government agencies role in providing service to victims. The study later develop and recommend a model of effective short, medium and long term service recovery towards disaster.

4.0 Conclusion

- 4.1 Response towards victims of flood disaster was apparent to certain extent due to some limitations and constraints.
- 4.2 The effectiveness of the role of the government agencies in providing service to victims was also apparent to certain extent due to some limitations and constraints.
- 4.3 In the immediate aftermath of the disaster, the government carried out its roles and responsibility through National Security Council by setting up an operation center which main functions are to ensure all government agencies involved to carry out their prescribed tasks. It also continuously received, coordinated and disseminated information about the latest flood situation.
- 4.4 The existing mechanism of service recovery by the government through its various departments and agencies is applicable to only normal flood. In this 2014 flood context, the mechanism was totally insufficient, to certain extent, in terms of response, recovery, mitigation and preparedness.
- 4.5 A model of effective short, medium and long term service recovery towards disaster was finally developed and recommended.

References

Coppola, D.P., (2007). Introduction to international disaster management. Elsevier, Oxford.

Dickerson, M.O., Flanagan, T., O'Neill, B., (2010). An introduction to government and politics (8th Edition), Nelson Education Ltd, Toronto.

Duffy, J.M., Miller, J.M., Bexley, J.B., (2006). Banking customers' varied reactions to service recovery strategies, International Journal of Bank Marketing, 24, 2, 112132.

Gordon, H.G., Terrence, M., Levesques, J., (1999). Waiting for service: The effectiveness of recovery strategies, International Journal of Contemporary Hospitality Management, 11, 1, 6-15.

Gronroos, C., (1988). Service quality: The six criteria of good perceived service. Review of Business, 9, 3, 10-13.

Hague, R., Harrop, M., (2013). Comparative government and politics: An introduction (9th Edition), Palgrave Macmillan, Hampshire.

Johnston, R., Michel, S., (2008). Three outcomes of service recovery. International Journal of Operations & Production Management, 28, 1, 79-99.

Strydom, J., (2004). Introduction to marketing (3rd Edition). Juta and Co Ltd, Cape Town.

Tax, S.S., Brown, S.W., (1998). Recovering and learning from service failure, Sloan Management Review, 40, 1, 75-89.

Zemke, R., (1993), The art of service recovery: fixing broken customers – and keeping them on your side, The Service Quality Handbook, American Management Association, 463-476, New York.

Zemke, R., Bell, C.R., (2000). Knock your socks off: Service recovery. AMACOM, New York.

4.2: APPLICATION OF AN INTEGRATED MEDICAL RESPONSE PROTOCOL TO IMPROVE CLINICAL WORKFLOW FOR HEALTHCARE SERVICE DURING FLOOD DISASTER IN KELANTAN

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1.0 Introduction

Kelantan had experienced the worst flood disaster in December 2014, since the major floods of 1927 and 1967. It was caused by heavy rainfall intensity and duration pummeled by the Northeast monsoon and the man use of river catchment areas [1]. It was considered a `Tsunami-like' disaster displacing almost 202,000 victims over a period of five days. The flood left healthcare facilities badly crippled and patients were not able to receive urgent medical treatment in timely manner because most of the health facilities were located at the major Kelantan river basin. There were two major hospitals in Kota Bharu of which Hospital Raja Perempuan Zainab II (HRPZII) was badly affected leaving Hospital Universiti Sains Malaysia (HUSM) as the only functioning referral hospital in the whole of Kelantan during the flood period. This was compounded by haphazard medical response among medical and non-medical personnel of various agencies during the response phase of the disaster due to existence of many disaster protocols in place that varied widely in terms of definition and workflow. None of these protocols were specific to medical management during flood disaster in Kelantan [1]. We carried out a study to investigate the effect of a proposed integrated medical protocol (IMP) on the knowledge, attitude and practice (KAP) of healthcare providers in Kelantan, Malaysia. IMP is a flood disaster response protocol pertaining to patient management during the response phase of flood disaster in Kelantan. It was written based on various disaster response protocol by various agencies involved in patient management during the disaster as well as findings from focus group discussion (FGD) among healthcare providers (HCP) involved in patient management during response phase of flood disaster in Kelantan [2]. The specific objectives of this study were (1) to investigate real-life issues of patient management during flood disaster in Kelantan (2) to develop and validate a questionnaire measuring KAP of healthcare providers involved in patient management during flood disaster in Kelantan and (3) to investigate the effect of IMP on the knowledge, attitude and practice (KAP) of healthcare providers in Kelantan, Malaysia.

2.0 Methodology

There were 3 phases to the study. In phase 1, a qualitative study was carried out to investigate the issues of patient management during the response phase of flood disaster in Kelantan, Malaysia since little is known or documented on this issues [3]. We conducted a FGD and a subsequent Elite Interviews (EI) among various agencies workers to extract responses to three predetermined categories namely policies, communication and patient transportation. Respondents who involved in patient management during flood disaster in Kelantan were recruited into the FGD session by convenience and snowballing sampling to identify additional potential participants [4]. All responses were audio recorded and translated verbatim. Content analysis included identifying, coding, and categorizing participants' response. Any issues that need further clarifications were followed up in a semi-structured interview for triangulation [3]. Data collection ended once saturation had been achieved in both FGD and EI sessions.

In the next phase, a questionnaire measuring knowledge, attitude and practice of HCP in managing patient during response phase of a flood disaster (FloodDMQ-BM©) was developed and validated. The questionnaire development consisted of generation of questionnaire items, content validation and face validation [5,6]. The psychometric assessment involves Exploratory Factor Analysis

(EFA) and Item Response Theory (IRT) analysis. Expert panels were tasked to develop items based on 4 issue domains (1) communication (2) transportation (3) standard operating procedure (SOP) and (4) alert system. The questionnaire was written in Bahasa Malaysia language. There were 4 sections to the questionnaire (1) demographic data (2) knowledge (3) attitude and (4) practice where each section of the knowledge, attitude and practice contained items reflecting all four issue domains. Construct validation was done to measure underlying hypothetical concepts of the questionnaire [7]. A total of 150 staffs involved in patient management during flood disaster consented to participate in the study. They were asked to answer the questionnaire. Principal axis factoring method was used to extract the factors. The knowledge dichotomous response items were analysed by 2-parameter logistic (2PL) model of IRT.

In the final phase of the study a randomized controlled trial (RCT) was conducted to investigate the effect of IMP on the knowledge, attitude and practice (KAP) of HCP involved in patient management during response phase of flood disaster in Kelantan. All HCP were randomized via simple randomization into control group receiving standard disaster protocol and intervention group receiving IMP. Participants were required to complete FloodDMQ-BM© before and after a flood disaster table top exercise held at a predetermined date. Analysis was performed on intention-to-treat basis. Between-group analysis of variables was conducted using one-way analysis of variance (ANOVA) and reported in terms of means and standard deviations with 95% confidence intervals (CI). A two-way repeated measures ANOVA was conducted to determine whether there was a significant difference between control and intervention group in knowledge, attitude and practice mean scores measured at two time-points as well as the resulting two-factor interaction of group and time.

3.0 Results and Discussion

3.1 Focus Group Discussion results

Thirty eight participants were recruited in to the FGD session. Twelve participants were assigned to the communication group, 12 to the transportation group and the remaining 14 participants to the SOP group. The main themes emerged from the thematic analysis interview transcript of the communication group were unreliability of Government Integrated radio Network (GIRN) during flood disaster and Radio Amateur suggested as an alternative to GIRN. Participants were unfamiliar with air transportation protocol for Madevac cases and suggested patient triaging to be done at landing point (LP). Regarding SOP, participants were unsure of how to utilize existing flood warning system to aid clinical decisions, flood coordination center being relocated quite often, healthcare volunteer were not coordinated and existing SOP lacking specificity to flood disaster in Kelantan.

3.2 FloodDMQ-BM© validation

Out of 150 questionnaires distributed for construct validation of FloodDMQ-BM©, 131 applicants responded to this study yielding an 87% response rate. Based on eigenvalue value of 7.1, observation of scree plot and cumulative percentage of variance of 54.6%, only one factor determined in the attitude section. All the items in the attitude section had factor loading of more than 0.5 and were retained. The internal consistency via Cronbach's alpha coefficient was 0.925. Based on eigenvalue value of 7.063, observation of scree plot and cumulative percentage of variance of 58.85%, only one factor determined for the practice section. All 12 items in practice section had factor loading of more than 0.5 and were retained. The internal consistency via Cronbach's alpha coefficient was 0.935. Based on 2PL model using IRT assessment of the knowledge section, item K5 and item K12 had a negative discrimination estimate of -0.04 and -0.13 respectively while item K8 had an extreme difficulty estimate of 91.48. These items were subsequently removed. The IRT analysis of the remaining items is summarised in Table 1. Item K7 had a high difficulty estimate of 6.88 and low standardized loading value of 0.34 but was retained as it was important to assess knowledge. Two-way marginal fit for the finalized items in knowledge section had residues less than 4 and considered a good fit at 5% significant level [8]. The overall model data fit was adequate with a Root Mean Square Error of Approximation (RMSEA) value of 0.086 and statistically non-significant of S-$X2$ [9,10]. All of the items had good standardized loading ranging from 0.3 to 0.9 and marginal reliability of 0.623. There are finally 9 items retained in the final model of the knowledge section.

Table 1: Item Response Theory parameters estimate of items of the knowledge section of the FloodDMQ-BM

	Item parameters			S- *X2* fit index		
Item after removal	Difficulty (SE)	Discrimination (SE)	Standardized loading	*X*2	df	*P*
K1	0.30 (0.20)	1.24(0.50)	0.78	6.9689	2	0.0307
K2	-0.73(0.21)	1.92(0.78)	0.89	1. 1329	2	0.5675
K3	-0.77(0.20)	2.07(0.78)	0.90	10.7892	2	0.0045
K4	3.30(2.32)	0.46(0.34)	0.42	3.2992	3	0.3477
K6	1.93(0.73)	1.43(0.85)	0.82	6.3548	2	0.1702
K7	6.88(8.10)	0.37(0.45)	0.34	6.7194	3	0.0814
K9	4.03(2.71)	0.73(0.56)	0.59	0.5879	2	0.7453
K10	1.82(0.94)	0.60(0.33)	0.52	2.0620	3	0.5596
K11	0.38(0.26)	0.86(0.34)	0.65	6.3548	3	0.0956

RMSEA = 0.086, M2=52.67, TLI-0.62, CFI=0.72

Abbreviations: S- *X2*=Standardized *X*2, RMSEA =Root Mean Square Error of Approximation, TLI=Tucker-Lewis Index, CFI= Comparative Fit Index

3.3 RCT results of IMP effect on HCPs' KAP

Out of 132 participants, a total of 120 were eligible to participate in third part of the study. Sixty candidates were allocated in each group of control and intervention. However, 13 were lost to follow-up and 5 had missing data and were not included in the analysis. Therefore, only 102 respondents were included in the final analysis giving a response rate of 85%.

Knowledge score

Among control group, the mean knowledge score between pre and post intervention is significantly difference (p<0.001, 95% CI -2.99,-1.54). We observe that the mean (SD) knowledge score after intervention is higher than pre-intervention [3.13 (1.51) vs 5.40 (2.10)]. This shows that the knowledge level has improved even without intervention (72.5 % increment). Among intervention group, the mean knowledge score between pre and post intervention is significantly difference (p<0.001, 95% CI -4.26, -2.90). We observe that the mean (SD) knowledge score after intervention is higher than pre-intervention [2.98 (1.50) vs 6.56 (1.69)]. This shows that the knowledge level has improved after intervention (120 % increment).

Attitude score

Among control group, the mean attitude score between pre and post intervention is not significantly difference (p=0.924, 95% CI -1.96, 2.16). We observe that the mean (SD) attitude score after intervention is not much different than pre-intervention [46.43 (4.55) vs 46.33 (4.82)]. This shows that the attitude score does not show much improvement. Among intervention group, the mean attitude score between pre and post intervention is significantly difference (p=0.001, 95% CI -3.37, -0.91). We observe that the mean (SD) attitude score after intervention is higher than pre-intervention [48.26 (4.28) vs 50.40 (1.28)]. This shows that the attitude level has improved after intervention (4.4 % increment).

Practice score

Among control group, the mean practice score between pre and post intervention is significantly difference (p<0.001, 95% CI -15.87,-11.24). We observe that the mean (SD) practice score after intervention is higher than pre-intervention [31.13 (6.62) vs 44.69(3.91)]. This shows that the practice level has improved even without intervention (43.56 % increment). Among intervention group, the mean practice score between pre and post intervention is significantly difference (p<0.001, 95% CI -16.85, 11.10). We observe that the mean (SD) practice score after intervention is higher than pre-intervention [31.54 (9.93) vs 45.52 (3.12)]. This shows that the practice level has improved after intervention (44.32 % increment).

3.4 Multivariable analysis

Table 2 shows the comparison of knowledge, attitude and practice scores on Integrated Medical Protocol (IMP) between the two groups based on time using Repeated Measure Anova.

Table 2 Comparison of knowledge, attitude and practice scores on Integrated Medical Protocol (IMP) between the two groups based on time using RMA

Variables	Group	Time	Mean score (SD)	95% CI	p-value*
Knowledge	Control	Pre	3.10 (1.50)	(2.68, 3.52)	<0.001
		Post	5.43 (2.12)	(4.84, 6.03)	
	Intervention	Pre	2.98 (1.51)	(2.55, 3.41)	<0.001
		Post	6.56 (1.69)	(6.08, 7.04)	
Attitude	Control	Pre	46.43 (4.55)	(45.15, 47.71)	0.924
		Post	46.33 (4.82)	(44.98, 47.69)	
	Intervention	Pre	48.26 (4.28)	(47.05, 49.48)	0.001
		Post	50.40 (1.28)	(50.04, 50.76)	
Practice	Control	Pre	30.98 (6.59)	(29.13, 32.83)	<0.001
		Post	44.67 (3.94)	(43.56, 45.78)	
	Intervention	Pre	31.54 (9.93)	(28.72, 34.36)	<0.001
		Post	45.52 (3.12)	(44.63, 46.42)	

*Two-way Repeated measures ANOVA (RMA)

There is a significant change of knowledge score over time [F (1, 100 =138.34), p<0.001]. There is significant interaction between group and time [F (1,100= 6.95) p=0.010]. Based on F test, p=0.035 (p<0.05), hence, there is overall mean difference by group (control and intervention) on knowledge score. There is no significant change of attitude scores over time [F (1,99)= 2.90], p=0.092 (p>0.05). There is no significant interaction between group and time [F (1,99)= 3.49], p=0.065 (p>0.05). Based on F test, p<0.001, hence, there is overall mean difference by group (between control and intervention) on attitude score. There is a significant change of practice score over time [F (1,100)= 226.56, p<0.001. There is no significant interaction between group and time [F (1,100)=0.053], p=0.818 (p>0.05). Based on F test, p=0.491 (p>0.05), hence, there is no overall mean difference by group on practice score.

4.0 Conclusion

4.1 Issues of transportation during flood disaster in Kelantan include unclear air transportation protocol, inadequate fuel storage, patient triaging at LP and unknown proper LP coordinate.

4.2 Issues of communication during flood disaster in Kelantan include unreliability of GIRN and radio amateur as a good alternative to GIRN.

4.3 Issues of SOP during flood disaster in Kelantan include inconsistent definitions in various response protocols, protocols not specific to managing patients during response phase of flood disaster in Kelantan and unclear interpretation of alert system parameters into medical decision.

4.4 FloodDMQ-BM© is a reliable and validated tool to measure KAP of HCP managing patients during a flood disaster.

4.5 IMP has significant improvement on HCPs' knowledge, attitude and practice of patient management during flood disaster in Kelantan.

4.6 Based on F test, p<0.001, hence, there is overall mean difference by group (between control and intervention) on attitude and knowledge scores.

References

Baharuddin KA, Abd Wahab S, Nik Ab Rahman, NH, Nik Mohamed NA, Tuan Kamauzaman TH, Md Noh AY. The Record-Setting Flood of 2014 in Kelantan: Challenges and Recommendations from an Emergency Medicine Perspective and Why the Medical Campus Stood Dry. Malays J Med Sci. 2015;22(2):1-7.

TuanHairulnizam TK 2015, Protokol perubatan bersepadu pengurusan pesakit semasa bencana banjir di Kelantan, Pusat Pengajian Sains Perubatan, Kota Bharu.

Liamputtong P. Qualitative research methods. 4th ed. Melbourne: Oxford University Press; 2013.

Polit DF, Beck CT. Essentials of nursing research: Methods, appraisal, and utilization. Philadelphia: Lippincott, Williams, and Wilkins; 2019.

Shuttleworth, M. (2015). *Type of Validity*. Retreived from http://explorable.com/type-of-validity

Harkness, J. A., Van de Vijver, F. J., & Mohler, P. P. (2003). *Cross-cultural survey methods*. Hoboken: Wiley.

4.3: TO DEVELOP EMERGENCY COMMUNICATION SYSTEM PACKAGES USING RADIO WAVE FREQUENCY FOR DISASTER: A STUDY IN KELANTAN, MALAYSIA

Project Information

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1.0 Introduction

The December 2014 flood incidence is identified as the worst unexpected natural calamity ever experienced by the country in decades. The heavy downpours caused severe flooding in several states especially Kelantan, The flood affected thousands of people, with nearly 120,000 people evacuated from their home, over 150,000 people lost their property and livestock while 2000 to 3000 houses destroyed in Kelantan. Floods pose obstacles for disaster response. They can create barriers to evacuation and cause problems to transport various needed supplies. Floods also have the ability to harm infrastructure, utilities and communication. This situation would prevent news and information from being broadcasted and disseminated especially to the victims and the public in general (Penuel & Statler, 2011). Therefore, it is pertinent to identify or develop the most appropriate medium or method of disseminating information in the whole cycle of the flood; pre, during and post disaster. Effective flood warnings and communication are essential to successful flood risk management (Bradford & O'Sullivan, 2013). The main aim is to make sure the information must reach the citizens immediately in order to minimize the intensity of the disaster among the affected people (Shaw & Sharma, 2011). Communication not only requires having the proper radio and other wireless equipment, but being able to integrate, correspond and coordinate (Ohl, 2006). The most local concern issue was upsurge of critical ill patient itself during that peek time without proper communication arrangement.

2.0 Methodology

Part of major methodology obtained were used several stages as below in order to facilitate the flow of research:

1. Propose designated places to build up linkage repeaters.
   Three designated area will be choose among ten districts in Kelantan which are Gua Musang, Kuala Krai and Kota Bharu which are the most venerable with the coverage for the entire Kelantan

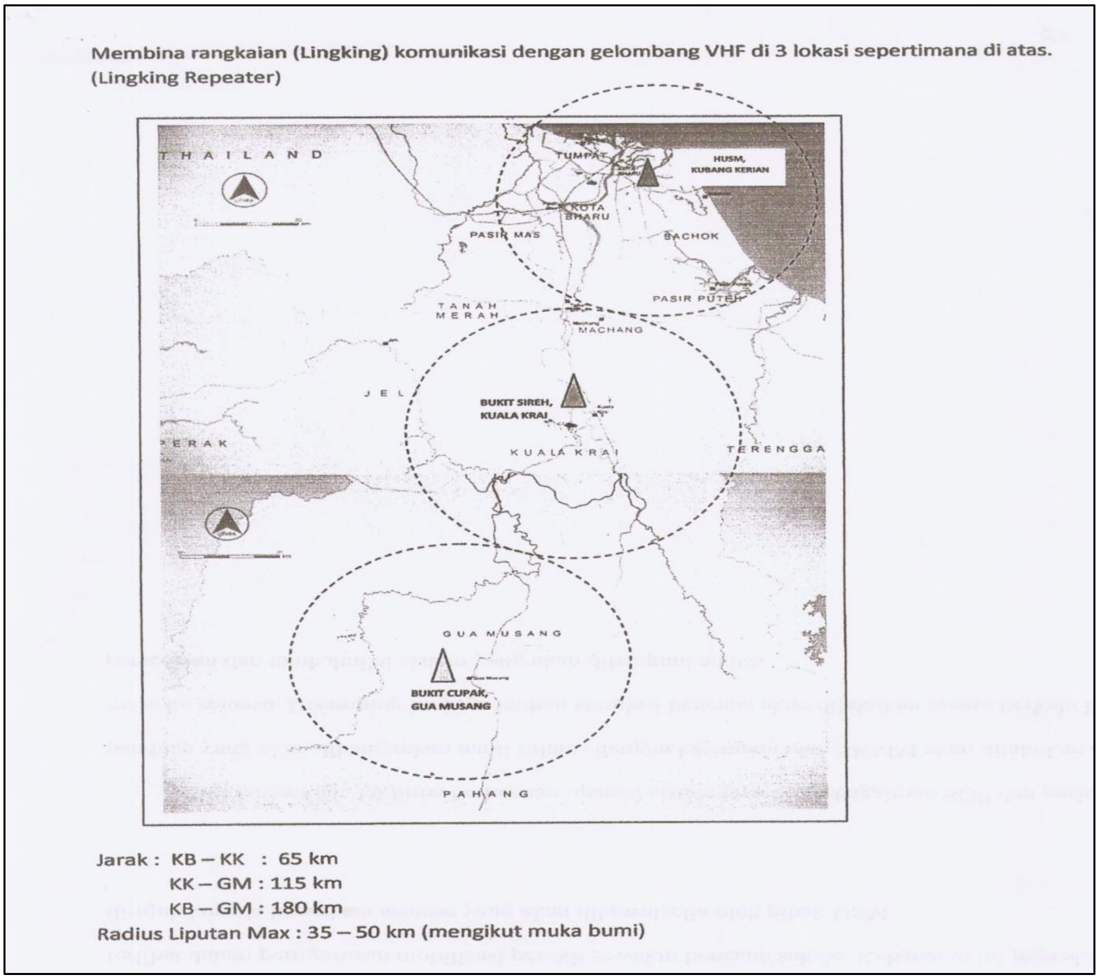
2. Request own frequency and it's license from SKMM
   Waiting the approval and license from SKMM to operate the system and approved with designated frequencies

3. Appoint and training key person
   Training the key person on how to operate the emergency radio networking system operating using own departmental SOP which develop based on standard radio communication SOP

4. Set up the system and schedule drill
   Once everything is put in places, the drill on how the system could be use during flood disaster using simulation scenario will be implement

The overall aim of the project is to address communication issues in the whole cycle of flood disaster; pre, during and post. The project will be use during the disaster only and completely control and supervise by USM health campus in Kubang Kerian, Kelantan. The aim is to improvement the local communication system and back up to integrated communication such as GIRN provide by KKM during disaster

3.0 Results and Discussion



4.0 Conclusion

4.1 To develop communication system networking which are proof and effective between informer and receiver during disaster especially in managing inter-facilities transportation of the patient

4.2 To establish trust with the KKM and private sector prior to a disaster to facilitate above communication system pre, during and post disaster

References

Bradford, R.A. & O'Sullivan, J.J. (2013). Addressing interpretive uncertainty in flood risk management. In Filho, W.L. *Climate change and disaster risk management*, pp. 3 – 1 4. Heidelberg: Springer.

Kundzewicz, Z.W. (2013). Floods: Lessons about early warning system.

Kundzewicz, Z.W. (2014). Adapting flood preparedness tools to changing flood risk conditions: The situation in Poland. *Oceanologia*, 56(2), 385-407.

Ohl, C.A. (2006). Flooding in the US: Responses from government and the medical and public health sectors. In Few, R. 7 Matthies, F. (eds.). *Flood hazards & health: Responding to present and future risks*. London: Earthscan.

Penuel, K.B. & Statler, M. (2011). Encyclopedia of disaster relief (VOL. 2). Los Angeles: Sage

4.4: DISASTER RELIEF AND PREPAREDNESS: INTEGRATED MARKETING COMMUNICATION APPROACH AND DISASTER MANAGEMENT IN KELANTAN FLOOD PRONE AREA

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1.0 Introduction

Flood is one of the most common natural disasters across the globe, jeopardising settlements along the floodplains and being considered a continued hazard for humanity. Malaysia is no exception due to its annual experience with flood during the monsoon season. Looking at the country's geographical location, most flood occurrences are natural resulting from the local tropical wet season that are characterised by heavy regular rainfall approximately during the period of October to March. The most recent incidence of flood disaster was considered the worst unexpected natural disaster in the country. Kelantan, Terengganu and Pahang were the three states which were hit the most, followed by Perak, Johor and Sabah. Worsening flood prompted the government to evacuate the victims to safer places from the middle to the end of December 2014. Infrastructures and facilities including electrical and communication system as well as the transportation network were badly affected by flood (Penuel & Statler, 2011). It can prevent news and information dissemination to the victims specifically and the public in general and also has the ability to create constraints for rescue and evacuation.

The overall research objective is to investigate communication barriers and limitations in dealing with flood disaster. It also attempts to propose an integrated communication approach for the whole cycle of the flood disaster; pre, during and post. This paper specifically aims to address communication issues in the whole cycle of flood disaster from the perspective of government agencies who were directly involved in managing the disaster. The study focuses on the severely affected areas in Kelantan primarily Gua Musang, Kuala Krai, Tanah Merah, Machang and Kota Bharu.

Integrated marketing communication (IMC) is a concept that has become significant to both academics and firms since 1990s (Holm, 2006) as part of vital marketing component. Marketing is the process by which companies create values for customer and build strong customer relationships in order to capture values from customers in return (Kotler et al., 2009). Efforts are basically done with aims to maximise target adopters or social responses (Kotler et al., 2002). The similar purpose can be related to other instances including health related issues such as smoking cessation (Devlin et al., 2007; Vidrine et al., 2007), drug education (Yzer et al., 2004) and disaster information communication (Palttala & VOs, 2012). There are five IMC tools in marketing programs; advertising, sales promotion, direct marketing, public relations, personal selling, event and sponsorship (Kotler & Keller, 2006). The accelerated growth of technology has raised many opportunities for marketing and has improved the spectrum of IMC tools. However, it is pertinent to identify suitable IMC tools for the success of implementing customer relationship management (Ekhlassi et al., 2012) and so for the case of flood disaster.

Looking into such considerations, this study attempts to address marketing communication issues prior, during and post Kelantan 2014 flood disaster based on three-dimensional market orientation constructs namely information acquisition or generation, information dissemination, and information response (Kohli & Jaworski, 1993, 1990). Information generation refers to collection and assessment of both customer needs and the forces (i.e., task and macro environments) that influence the development and refinement of those needs. Information dissemination is the process and extent of market information exchange within a given organisation while information response is action taken in response to information that is generated and disseminated.

2.0 Methodology

The unit of analysis consists of government and non-government agencies in Kelantan, Kuala Lumpur and Putrajaya which directly involved in the information generation, dissemination and response towards the 2014 flood disaster. It employs observation, focus group discussion and elite interview as data collection methods. Observation and extensive literature review act as foundation in identifying communication patterns and issues for the use of developing semi structured questions for the preliminary study. The questions were enhanced for the subsequent focus group discussion and elite interview. Purposive sampling was used to select relevant government agencies and approached for interview including Jabatan Penyiaran Kelantan and Urusetia Penerangan Kerajaan Negeri Kelantan. The samples for non-government agencies include Sinar Harian, Telekom and Radio Amatur Kelantan. Each of the total 20 interviews were recorded, transcribed and analysed.

3.0 Results and Discussion

In regards to information generation, the finding reveals that government agencies such as Department of Irrigation and Drainage – DID (Jabatan Pengairan dan Saliran Negeri Kelantan) and alike that deal directly with issues of flood mitigation, urban drainage, water resource management and hydrology are at the forefront in generating information on flood. DID uses several mechanisms in acquiring such information including measurement of daily rainfall and specified rivers, reading at Tangga Bradley and Tambatan Diraja. Information is subsequently disseminated to all relevant government agencies for disaster preparation, mitigation and response. The Welfare State Department (Jabatan Kebajikan Masyarakat), for instance, responds upon receipt of information by, among other things, setting up and managing relief centres, placing basic supplies in the centres and supply bases and compiling victim database for the purpose of service recovery to lessen the damaging effect of the disaster.

The study illustrates inefficient information dissemination during the massive flood due to immature existing emergency communication tools, black out which resulted in total communication breakdown, lack of access to resources providing accurate weather information and data and failure to distinguish between normal monsoon flood and red flood. There are also constraints in both federal and state governments funding to enhance communication system. The existing early warning information system was unable to provide fast and accurate information and severity of the coming hazard. In fact, incomplete information was revealed to the public to avoid panic situation. Conflicting ways in disseminating information on flood from various sources caused different response from the public and agencies alike. Thus, the public shows lukewarm response due to their interpretation of unseriousness of the warning information by not evacuating their homes.

The finding notes several constraints and limitations in regard to information response during the flood. Insufficient assets, staffs, fundings and lack of rescue skill and expertise resulted in delay in carrying out respective response and rescue operations. During flood disaster, another area of concern is a lack of coordination among agencies involved. Uncoordinated response from various agencies created communication barriers as each agency has its own direction of command. Political barriers have also impeded respective response from government agencies towards victims. The bureaucratic centralization has surfaced the control over the state government.

Communication has been one of the crucial issues in the 2014 flood disaster in Kelantan. Since effective flood warning and communication are essential to successful flood risk management, the identification and development of the most appropriate medium or method of disseminating information in the whole cycle of the disaster is pertinent. Therefore, this study suggests the improvement of the communication system through an integrated communication model. This recommendation used the identified limitations and deficiencies as the principle in proposing the model.

4.0 Conclusion

4.1 Inefficient information dissemination during the massive flood due to immature existing emergency communication tools, black out which resulted in total communication breakdown.

4.2 Lack of access to resources providing accurate weather information and data and failure to distinguish between normal monsoon flood and red flood.

4.3 An improvement of the communication system through an integrated communication model. This recommendation used the identified limitations and deficiencies as the principle in proposing the model.

References

Devlin, E., Eadie, D., Stead, M., Evans, K., (2007). Comparative Study of Young People's Response to Anti-smoking Messages. International Journal of Advertising, 26, 1, 99- 128.

Ekhlassi, A., Mghsoodi, V., Mehrmanesh, S., (2012). Determining the integrated marketing tools for difference stages of customer relationship in digital era, International Journal of Information and Electronics Engineering, 2, 5, 761-765.

Holm, O. (2006). Integrated marketing communication: from tactics to strategy. International Journal of Corporate Communication, 11, 1, 23-33.

Kohli, A. K., Jaworski, B. J., (1990). Market orientation: the construct, research propositions, and managerial implications. Journal of Marketing, 54, April, 1–18.

Kohli, A. K., Jaworski, B.J., Kumar, A., (1993). MARKOR: A Measure of Market Orientation. Journal of Marketing Research, 30, 4, 467-477.

Kotler, P., Armstrong, G., Ang, S.H., Leong, S.M., Tan, C.T., Hon-Ming, O.Y., (2009). Principles of marketing: A global perspective. Pearson Education SouthAsia Pte. Ltd, Singapore.

Kotler, P., Keller, K.L. (2006). Marketing Management (12th edition). Prentice Hall, New Jersey.

Kotler, P., Roberto, N., Lee, N. (2002). Social Marketing. Improving the Quality of Life. Sage Publications, Thousand Oaks, CA.

Palttala, P., Vos, M., (2012). Quality Indicators for Crisis Communication to Support Emergency Management by Public Authorities. Journal of Contingencies and Crisis Management, 20, 1, 39-51.

Penuel, K.B., Statler, M., (2011). Encyclopedia of disaster relief (vol. 2), Sage, Los Angeles.

Vidrine, J. I., Simmons, V. N., Brandon, T. H., (2007). Construction of Smoking-Relevant Risk Perceptions Among College Students: The Influence of Need for Cognition and Message Content. Journal of Applied Social Psychology, 37, 1, 91 -114.

Yzer, M. C., Hennessy, M., Fishbein, M., (2004). The Usefulness of Perceived Difficulty for Health Research. Psychology, Health & Medicine, 9, 2, 149 - 162.

PROJECT 5 : FLOOD AND FLOOD DISASTER: INTEGRATED ASSESSMENT OF EXTREME RAINFALL-RUNOFF ON FLOOD HAZARD, WATER QUALITY AND MICROBIAL VARIABILITY, AND ENHANCEMENT OF STANDARD OPERATING PROCEDURES (SOP) FOR FLOOD DISASTER AWARENESS: CASE STUDY OF SUNGAI PAHANG RIVER BASIN

5.1: BASIN CHARACTERISTICS: RAINFALL DISTRIBUTION IN 5 STATES SINCE 1967 FLOOD UNTIL 2014 FLOOD: DETECTING THE CLIMATE CHANGE EFFECT

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1.0 Introduction

Climate change can severely impact hydrological processes, including increase in precipitation, particularly during extreme events. Generally, in areas with increase in mean total precipitation, heavy and extreme precipitation events also increase with a large percentage (Dore, 2005). Changes in extreme events can effect environment and human activities, threatening to human health and safety. Climate change has already begun to transform the rainfall patterns in Malaysia and extreme floods have become more severe in several states. Recently, extreme rainfall events in Malaysia are becoming more frequent and it revealed that heavy rain events on the east coast of Peninsular Malaysia have increased over 40 years (Mayowa et al. 2015). Various models also projected that rainfall will continue to increase, which will cause an increase of heavy rainfall events in the East Coast of Peninsular Malaysia (NAHRIM 2006).

There are a number of studies in extreme rainfall event over Malaysia but there are still large knowledge gap with regards to extreme events (Tangang et al. 2012). Syafarina et al. 2015 used non-parametric test to analyze rainfall trends and found that hourly extreme rainfall events in Peninsular Malaysia showed an increasing trend with notable increasing trends in short temporal rainfall. Given that these studies focus on the hourly extreme rainfall event, detailed study on short storm duration and long storm duration is needed. It is because of extreme rainfall in short storm durations potentially leads to an increase in the magnitude and frequency of flash floods in urban areas. Furthermore, extreme rainfall events in Malaysia frequently extend over two days due to the influence of monsoon seasons. Therefore, the main objectives of this paper are (a) to investigate changes in the annual maximum rainfall depth of 24 h duration over five major basins, and (b) to investigate the trend of extreme rainfall events in various storm duration by using Mann Kendall test and Sen's Slope Estimator.

2.0 Methodology

The trends of extreme rainfall event in five major basins: Perak, Kelantan, Terengganu, Pahang and Johor river basin are investigated in this study. Rainfall data for a period more than 25 years basins are obtained from Department of Irrigation and Drainage (DID), Malaysia. There are 34 rainfall stations from five major basins were examined in this study.

Mann Kendall (MK) test is a statistical test widely used to assess the trend in hydrological time series. The test statistic of MK test, S, is computed as follows:

$$S = \sum_{k=1}^{n-1}\left[\sum_{j=k+1}^{n} sign\ x_j - x_k\right] \quad (1)$$

$$sign\ x_j - x_k = \begin{cases} 1, & x_j - x_k > 0 \\ 0, & x_j - x_k = 0 \\ -1, & x_j - x_k < 0 \end{cases} \quad (2)$$

Where x_j and x_k are the sequential data values, n is the number of observations. In the MK test, the positive test statistic, S indicates increasing trend, whereas the negative test statistic indicates decreasing trends. The variance for the S statistic is defined by:

$$Var(S)=\frac{n\ \ n-1\ \ \ 2n+5}{18} \quad (3)$$

$$z=\begin{cases}\dfrac{S-1}{Var\ \ s}, S>0\\ 0, S=0\\ \dfrac{S+1}{Var\ \ S}, S<0\end{cases} \quad (4)$$

The test statistic Z is used to measure of significance of the trends. The magnitude of the trend was calculated using the Sen's slope approach. Sen's non-parametric method estimates the magnitude of the trends in the time series data:

$$T_i=\frac{x_j-x_k}{j-k} \quad (5)$$

In this equation, x_j and x_k correspond to data values at time *j* and *k.* Consider

$$Q_i=\begin{cases}T_{\frac{N+1}{2}}\\ \dfrac{1}{2}\ \ T_{N/2}+T_{N+2/2}\end{cases} \quad (6)$$

A positive value represents an increasing trend and a negative value represents a decreasing trend over time. Software used for performing the statistical MK test and homogeneity test is Addinsoft's XLSTAT 2016. The null hypothesis is tested at 95% confidence level.

3.0 Results and Discussion

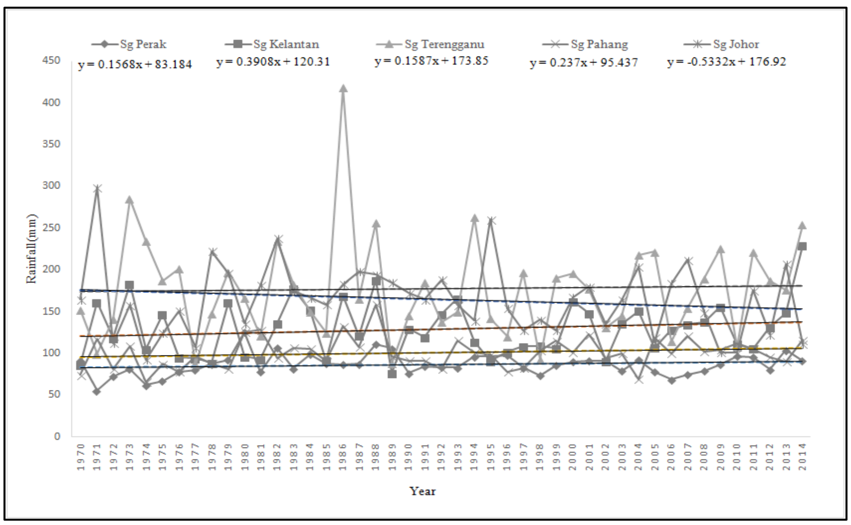
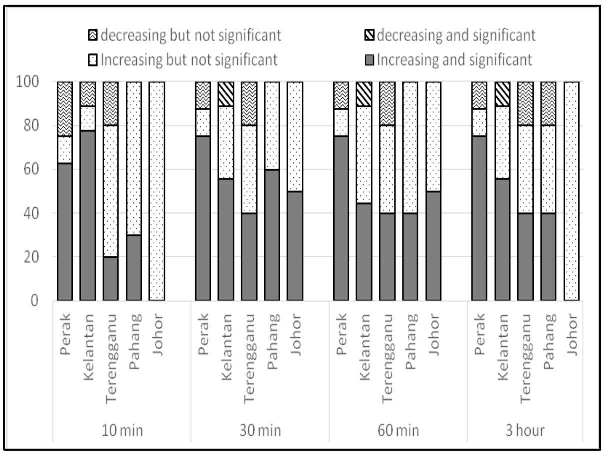
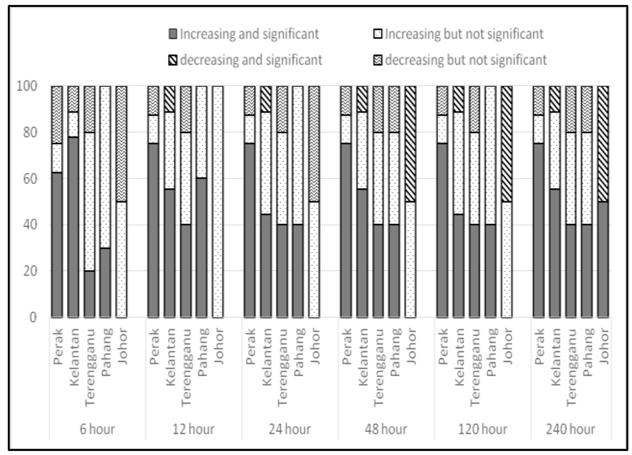


Figure 1. Annual maximum daily rainfall

Based on the graphs in Figure 1, a clear increasing trend in annual maximum daily rainfall was observed for Perak, Kelantan, Terengganu and Pahang river basins and decreasing trends in Johor river basin. Fitting trend lines show positive magnitude in slope for increasing trend and Kelantan River Basin recorded higher magnitude compared to the others. Negative magnitude was detected at Johor river basin showing decreasing trends in annual maximum daily rainfall. It is noteworthy that only two stations were studied in this area. As a result from increase in annual maximum daily rainfall, flood risk will also increase, which in turn can trigger landslide events.

Figure 2 show the percentage of rainfall stations which presented increasing (significant or not) or decreasing (significant or not) with statistical significance of 95% in various storm durations (i.e. 10, 30 and 60 minutes, 3, 6, 12, 24, 48, 120 and 240 hours). Storm durations were classified into two groups: (i) as a short storm duration for duration less than or equal to 3 hours; and (ii) as a long storm duration for a duration equal to or greater than 6 hours. With regards to short storm durations, an increasing trend was identified for all basins which percentage of stations more than 80%. The most marked trend has been detected in 10, 30 and 60 minutes for Pahang and Johor river basin with 100% of the rainfall stations showing increasing trends. Statistically increasing trends more than 40% were notified in short storm duration except for Terengganu, Pahang and Johor (10 mins) and Johor (3 hours). In contrast, there are statistically decreasing trend in 30 mins, 60 mins and 3 hours storm durations for Kelantan river basin but in a very small percentage. The increasing trend also evidenced at long storm duration for all river basins. However, decreasing trends were more noticeable at long storm durations compared with short storm durations especially for the Johor river basin. 50% of rainfall stations in the Johor river basin showing statistically decreasing trend in 48, 120and 240 hours. Given that there are only two stations represent this area, the results can be improved by analyzing more stations.





(a) (b)

Figure 2 Trend of extreme rainfall event in (a) short storm duration and (b) in long storm duration expressed as percentage of rainfall stations of the basins

The results of percentage of stations showing significant and insignificant trend were summarized in Table 1. From the hypothesis test, percentage of stations showing significant increasing trends were more higher in short storm duration for Perak, Pahang and Johor river basin. However, Kelantan and Terengganu river basins show higher percentages in significant increasing trends for long storm durations. As mentioned before, extreme rainfall in short durations potentially leads to flash floods in urban areas. Therefore, particular attention must given to the short storm duration rainfall event in Perak, Pahang and Johor river basin. Increase in the frequency of flash flood occurrence in the western and southern region, particularly because of an increase in a number of very wet and extremely wet of a rainfall station in that area. (Syafarina et al. 2015). Significant increasing trends in long storm duration also give an impact to Kelantan and Terengganu river basin. Given that North East Monsoon brings about heavier rainfall in this area, the probability of getting extreme rainfall in long duration storm is very high in this area. Although the percentage of decreasing trend is small,Kelantan river basin recorded 11% of significant decreasing trend in short storm duration. Whereas, Pahang and Johor river basin recorded significant decreasing trend in long storm duration at 10% and 50% respectively.

Table 1: Results of a percentage of the stations showing trends

Basin	Durations	Increasing		Decreasing	
		Significant	Insignificant	Significant	Insignificant
Perak	Short storm	75	12.5	0	12.5
	Long Storm	62.5	25	0	12.5
Kelantan	Short storm	67	22	11	0
	Long Storm	78	11	0	11
Terengganu	Short storm	40	40	0	20
	Long Storm	60	20	0	20
Pahang	Short storm	50	50	0	0
	Long Storm	30	30	10	30

Johor	Short storm	50	50	0	0
	Long Storm	0	50	50	0

4.0 Conclusion

Important findings of the study are summarized as follows.

4.1 Annual maximum daily rainfall in Perak, Kelantan, Terengganu and Pahang River basin increase throughout 45 years, meanwhile decreasing trend were detected in Johor river basin. Increasing of annual maximum daily rainfall will increase flood risk and indirectly decrease the water quality related to sediment movement. Increasing intensities of rainfall will also lead to increases in soil loss and major landslide events.

4.2 Percentage of stations showing significant increasing trends were more higher in short storm duration for Perak, Pahang and Johor river basin. However, Kelantan and Terengganu river basins show higher percentages in significant increasing trends for long storm durations. It should be noted that the increasing trend in short storm duration rainfall gives an impact on urban drainage and stormwater facilities. Studies dealing with extreme rainfall in urban areas in Malaysia is still rather limited, and detailed studies related to extreme rainfall in short storm durations should be taken into consideration in the future.

References

Dore, Mohammed HI. "Climate change and changes in global precipitation patterns: what do we know?." Environment international 31.8 (2005): 1167-1181.

NAHRIM. Final report: Study of the impact of climate change on the hydrologic regime and water resources of peninsular Malaysia (2006).

Olaniya,O.M., et al "Trends in rainfall and rainfall-related extremes in the east coast of peninsular Malaysia". Journal of Earth System Science, 124.8 (2015):1609-1622.

Syafrina, A. H., M. D. Zalina, and L. Juneng. "Historical trend of hourly extreme rainfall in Peninsular Malaysia." Theoretical and Applied Climatology 120.1-2 (2015): 259-285.

Tangang, Fredolin, et al. "Climate change and variability over Malaysia." Sains Malaysiana 41.11 (2012): 1355-1366.

5.2: INTEGRATED ASSESSMENT OF WATER QUALITY AND MICROBIAL VARIABILITY AT THE HEAVILY FLOOD AFFECTED AREA IN SUNGAI PAHANG BASIN

Project Information

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1.0 Introduction

Flood, due to intense or prolonged rain, or climate change, rising population, and poorly adapted land use, is by far the most critical natural disaster to impact on Malaysia. The worst flood event, 2014, that devastated the East Coast states of Kelantan, Terengganu and Pahang, and the West Coast state of Perak have affected nearly 400,000 of victims, with the infrastructure damages at RM2.9 billion, 24 reported deaths while 8 are still missing ((McMichael *et al*., 2006). The disrupting effects from the contaminated or broken water supply systems have potentially deteriorated on the health status and livelihood of the affected populations. From the conditions of drought and flood and afterwards, there was significant change in water quality of the Pahang River, including from low to high organic loading and with variable high turbidity.

Similarly, seasonal flood provides suitable medium for the transmission of a wide variety of heterotrophic microorganisms. The urban flood water was found to be faecally contaminated, demonstrated by the elevated concentrations of faecal indicator bacteria (Dorsey *et al.,* 2012). These enteric pathogens account for a vast majority of the gastrointestinal illnesses at the global level, and predominantly transmitted via the faecal-oral route (Yuphakhun *et al.,* 2013). To account for the complex interplay between variability of biota and abiotic variables, the establishment of the relationship integrating the water quality and microbial variability with the changing flood events would simulate the understanding of climate vulnerability and hydrological cycle to the severity of disease outbreaks, notably during the heavily flood disaster.

2.0 Methodology

2.1 Site Description

Pahang River, located in the eastern part of Peninsular Malaysia between latitude N 2° 48' 45" and N 3° 40' 24" and between longitude E 101° 16' 31" and E 103° 29' 34", is the longest river in the Peninsular Malaysia. The area has a typical moist tropical climate, with constant temperatures of 25-27°C throughout the year. From the impact of historical global climate change, multiple problems have arisen in the evolution of the meander process at the Pahang River, with the largest flood event being recorded in 1926.

2.2 Sampling Scheme

The sampling was designed to cover a wide range of determinates of key sites, which reasonably represent the physicochemical and biological qualities of the Pahang River basin system. Water samples were collected from accessible areas in industrial and residential areas that were heavily destroyed.

2.3 Physicochemical Measurement

The physicochemical parameters were assessed in according to the laboratory standard procedures (APHA 1998). Hydrological parameters including electrical conductivity (EC), salinity, pH, temperature, dissolved oxygen (DO), temperature, total dissolved solids (TDS), and turbidity were measured using a YSI 556 MPS multi-probe system, a turbidity meter and a pH meter with temperature probe. The analytical determination of biological oxygen demand (BOD_5), chemical oxygen demand (COD), ammonical nitrogen (NH_3-N), total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP), was determined according to the Luminescence measurement, closed reflux colorimetric, Salicylate, Gravimetric, Persulfate Digestion, and Acid Persulfate digestion standard methods, using a spectrophotometer (HACH DR3900). The water quality Standard for Malaysia (INWQS) was given by:

$$WQI = 0.22SIDO + 0.19SIBOD_5 + 0.16SICOD + 0.16SISS + 0.15SIAN + 0.12SIpH \quad (1)$$

Where:
WQI = Water Quality Index
SIDO = Sub-index DO
$SIBOD_5$ = Sub-index BOD_5
SICOD = Sub-index COD
SIAN = Sub-index AN
SISS = Sub-index TSS
SIpH = Sub-index pH

2.4 Metal Analysis

The heavy metals content was analysed according to the United States Environmental Protection Agency standard methods 200.8 and 6020, using an Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

2.5 Bacteriological Detection

Water samples were analysed for the target presumptive bacterial pathogens using internationally accepted techniques and principles (Clesceri and Greenberg, 1998). The collected samples were filtered through a 0.45 µm pore size membrane filter to remove insoluble particulate matter. DNA was extracted from each bacterial suspension after pelleting by centrifugation at 5000 x g for 15 min by using a NucleoSpin® Tissue DNA extraction kit (Macherey-Nagel, Germany) according to manufacturer's protocol. The target genes have been amplified by Polymerase Chain Reaction (PCR) using AmpliTaq polymerase.

3.0 Results and Discussions

The seasonal variations in precipitation, surface runoff, interflow, groundwater flow and pumped in and outflows during the flood events demonstrated a strong effect on river discharge, and subsequently on the concentration of pollutants in the river water. Table 1 shows the variability of turbidity, biological oxygen demand (BOD_5), chemical oxygen demand (COD), ammonical nitrogen, total suspended solids (TSS), dissolved oxygen (DO), temperature, pH and overall water quality index (WQI) for Pahang River before and after the heavily flood events. There was an upward trend for chemical and physical variables changes for turbidity, BOD_5, COD, TSS, and ammonical nitrogen, and a downward trend for pH, DO and WQI.

Table 1: The water quality variations before and after flooding

Water Quality Parameters	**Units**	**Pahang River**	
		Before	**After**
pH	-	7.22-7.62	5.02-5.52
Dissolved Oxygen (DO)	mg/L	6.10-6.93	3.15-4.48
Electrical Conductivity (EC)	µs/cm	-	57.3-104.2
Salinity	ppt	-	0.018-0.027
Total Dissolved Solids (TDS)	ppm	-	31.16-44.14
Turbidity	NTU	0.85-6.65	58.2-191.0
Chemical Oxygen Demand (COD)	mg/L	10.12-13.30	4-125
Biochemical Oxygen Demand (BOD_5)	mg/L	1.13-1.97	1-31
Total Suspended Solids (TSS)	mg/L	0-0.3	3.50-37.75
Total Nitrogen (TN)	mg/L	-	1.8-4.3
Total Phosphorus (TP)	mg/L	-	0.49-0.76
Ammonical, Nitrogen (NH_3-N)	mg/L	0.11-0.19	0.91-2.11
Water Quality Index (WQI)		71.1709	28.299
Class		III	V

These findings illustrated the deterioration of the river water quality in the event of erosion, sedimentation and accumulation of domestic pollutions in the river channels. During the disaster, these organic and inorganic associated sediments were resuspended and transported downstream and dispersed onto the flood plains in the form of vertically accreted overbank alluvium, to imply detrimental impacts on the ecological balance of the recipient environment and a diversity of aquatic organisms (Vinodhini and Narayanan, 2008).

The values of WQI at the river catchments before the flood events was 71.17, while the WQI after the flood events reached to the WQI reading of 28.29. According to the Classification of Water Quality Index given by INWQS, the value of WQI of the river water fall in Class III (51.9-76.5), derived as “slightly polluted” before the flood events, and then it lies in Class V, defined as “highly polluted”, thereafter, respectively. This fact indicated the seasonal fluctuation in the regulation of BOD_5, COD, TSS, pH, DO and ammonical nitrogen, contributing to the overall contamination of river water. Similarly, the heavy metal concentrations at the sampling stations revealed a great amplification where the concentrations increased after the flood seasons (Table 2). The seasonal changes of the heavy metal concentrations in the flood water and sediments could be ascribed to the difference of quantity, quality, intensity, frequency and precipitation of heavy metal load being discharged to the water channels (Nduka and Orisakwe, 2010).

Table 2: Heavy metals variation in Pahang River before and after flooding

Heavy Metals	**Concentration (mg/L)**	
	Before	**After**
Ag	-	0.18
Cu	0.03	0.26
Cd	-	0.22
Cr	-	0.43
Fe	0.59	4.66
Ni	-	0.28
Pb	0.02	0.36
Zn	0.07	0.75

Despite a regulatory framework, microbial quality is often a source of impairment of the compliance of drinking water supply. The main origins of microbial contamination of natural aquatic resources are related to the point sources, such as the discharges of water treatment plants, non-collective sewage systems, or contaminants emissions from hospitals and industries (Othman *et al.,* 2014). The presence of *Escherichia coli*, *Salmonella typhimurium* and *Shigella flexneri* are detected in Sungai Pahang, and clearly expressed by Polymerase Chain Reaction (PCR) method (Figure 1).

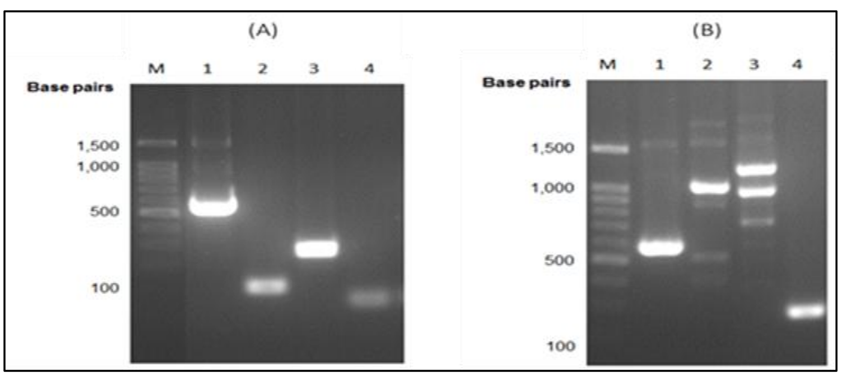

Figure 1: PCR examination of bacterial used for control positive in a 2% agarose gel. Panel A, the PCR products detected using primers *Eco-FR* for *Escherichia coli* (ATCC® 25922) (lane 1), primers *EcoLT-FR* for *Escherichia coli ETEC* (ATCC® 35401) (lane 2), primers *Sal-FR* for *Salmonella typhimurium* (ATCC® 14028) (lane 3) and primers *Shi-ipaH-FR* for *Shigella flexneri* (ATCC® 12022) (lane 4). Panel B, the PCR products detected using primers *Eco-FR* for *Escherichia coli* (ATCC® 25922) (lane 1), primers *EcoLT-FR for Escherichia coli ETEC* (ATCC® 25922) (lane 2), primers *Sal-FR* for *Salmonella typhimurium.* (ATCC® 14028) (lane 3) and *Shi-ipaH-FR* for *Shigella flexneri* (ATCC® 12022) (lane 4). Primers for *Eco-FR*, *Sal-FR* and *Shi-ipaH-FR* were found to effectively cross detection of the presence of *Escherichia coli*, *Salmonella typhimurium* and *Shigella flexneri* at a distinguished manner. Lane M represents 100 bp DNA ladder.

Quantitative evaluation depicted that total coliform before flooding (4.2 x 10^3 cfu/100mL) is lower than post flooding (4.40 x 10^3 cfu/100mL). Likewise, the elevated degree of *Escherichia coli*, *Salmonella typhimurium* and *Shigella flexneri* have been found in the flood water after the flood events, ranging from ≤ 50 cfu/100mL to 96 x 10^3 cfu/100mL (Table 3). These alterations from the flood crisis have placed a pressing pressure on the transmission of water-borne illness, morbidity, mortality, social and economical disruption, and establishment of better health-care facilities.

Table 3: Presence of microbial contamination in flood water in Pahang River.

Microbial contamination	**Range in flood water**
Total Coliform	4.40 x 10^3 cfu/100mL
Escherichia coli	96 x 10^3 cfu/100mL
Salmonella typhimurium	≤ 50 cfu/100mL
Shigella flexneri	12.5 x 10^3 cfu/100mL

4.0 Conclusion

This study established the evaluation of water quality data and distribution of pathogenic bacteria of the Pahang River after the severe 2014 flooding incident.

4.1 The pollutant loadings were significantly disturbed, signifying a tremendously increase in BOD_5, COD, ammonical nitrogen, total nitrogen, total phosphorus, total suspended solids, and heavy metals content after the flood event as compared to the average loadings over the last 30 years.

4.2 During this period, the water supply was unfit for both daily sanitation and consumption, with potentially a health risk.

4.3 This extreme disaster also played a threatening role to the transmission of *Escherichia coli*, *Salmonella typhimurium* and *Shigella flexneri* contaminating the water supply system, insinuating the potential of the widespread of water-borne illnesses.

References

American Public Health Association (APHA), American Water Works Association (AWWA) and Water Pollution Control Facilities (WPCF). (1998). Standard methods for the examination of water and wastewater, 18th ed. American Public Health Association, Washington, United States.

Clesceri AE, Greenberg AD (1998). Eaton. Standard Methods for the Examination of Water and Wastewater (20th ed.), American Public Health Association, Washington, DC.

Dorsey JH, Carmona-Galindo VD, Leary C, Huh J, Valdez J (2013). An assessment of fecal indicator and other bacteria from an urbanized coastal lagoon in the City of Los Angeles, California, USA. Environmental monitoring and assessment 185(3): 2647-2669.

McMichael AJ, Woodruff RE, Hales S (2006). Climate change and human health: present and future risks. The Lancet, 367(9513): 859-869.

Nduka JK, Orisakwe OE (2010). Water-quality issues in the Niger Delta of Nigeria: a look at heavy metal levels and some physicochemical properties. Environmental Science and Pollution Research.

Othman F, Chowdhury MS, Saka N (2014). Assessment of microorganism pollution of Selangor River, Malaysia. International Journal of Advances in Agricultural and Environmental Engineering (IJAAEE): 203-207.

Vinodhini R, Narayanan M (2008). Bioaccumulation of heavy metals in organs of fresh water fish Cyprinus carpio (Common carp). International Journal of Environmental Science & Technology 5: 179-182.

Yuphakhun C, Punnida T, Hajime T, Bon K, Suwimon K (2013). Microbiological evaluation of water during the 2011 flood crisis in Thailand. Science of The Total Environment 463: 959-967.

5.3: GOVERNANCE FOR DISASTER RISK REDUCTION: ENHANCEMENT OF STANDARD OPERATING PROCEDURES (SOP) ON FLOOD DISASTER AWARENESS, PREPAREDNESS, WARNING SYSTEM, EVACUATION PLAN & INSTITUTIONAL ARRANGEMENTS FOR FLOOD RISK MANAGEMENT IN THE SUNGAI PAHANG RIVER BASIN

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1.0 Introduction

The December 2014 flood in Pahang severely taxed flood relief agencies which encountered major obstacles and problems in rescue and relief operations. This study aimed to assess flood victims' evaluation of the Standard Operating Procedures (SOPs) used by government agencies for preparedness, warning, rescue, evacuation, flood relief and recovery. A questionnaire-based cross sectional study was conducted by convenience sampling in Temerloh, Pekan, Raub and Mentakab. Results indicate that majority of flood victims' evaluated the SOPs in terms of preparedness, warning, rescue, transfer/evacuate, flood relief, evacuation centers and recovery as not so effective. During massive flooding disasters, access to many evacuation centers are cut off due to strong currents and bad weather. Rescuers could not reach flood victims as trucks, boats and even helicopters were inoperative. Water levels had rose rapidly resulting in victims being trapped. Many evacuation centers were flooded, rendering SOPs inoperable. Victims confided that little preparedness and awareness education were provided, warning was either not given or came too late, rescue did not come to many and evacuation centers were over-crowded and inadequately staffed. Overall, obsolete SOPs used during big flood disasters are ineffective. Flood managers also suffered as the flood was massive, turning them into flood victims themselves. Overall, it was found that during massive floods, the current SOPs (which are adequate for moderate floods) were rendered inoperable and ineffective.

2.0 Methodology

The methodology is based on: (1) Primary Data - (a) Quantitative Survey of households affected by floods; (b) Qualitative Interviews with Key Stakeholders; and (c) Documentation with camera and video. (2) Secondary Data - Historical Flood Data, theses, government reports, other reports. (3) Observer-Participant method is also used in that researchers would live with flood affected communities over an extended period of time to understand and record in minute details of what goes on before, during and after floods. The methodology relates closely to the Objectives as both Quantitative and Qualitative surveys/interviews document in detail how individuals, families, village networks and society at large employ smart-partnerships and societal linkages/networks to reduce the impacts of flooding and how victims endeavour to recover quickly from the effects of floods. This study therefore adopts a multi-methods approach whereby a combination of complementary research methods are used to support one another. Historical analysis is used for documentation of past floods in terms of frequency, magnitude and severity. Historical flood analysis is used to study how broader physical-socio-political forces have created and perpetuated the flood hazard in the Sg Pahang river basin. As an 'Observer-participant', the author himself is well positioned to as a researcher with rich experience, having worked in the flood management area for more than 30 years. This approach involves asking research questions as an 'observer-participant' and is used in the analysis of key stakeholders (government officials, NGO workers, flood managers and flood victims, and the general public) on their flood losses and their response to the flood hazard. The quantitative questionnaire is employed to study individual perception, understanding, response and evaluation of existing SOPs on flood response. Finally, qualitative indepth interviews are recorded with selected flood victims to highlight the severity of various flood losses incurred. The merits and demerits of each of the above methods are outlined by Chan (1995). The employment of more than one research method to approach a research question, often called 'triangulation', strengthens a study and has become common practice (Fordham, 1992). In terms of research methodology, the triangulation strategy has greater advantage over a single research strategy and is recommended in the literature because of its advantage of possessing the merits of all methods adopted while simultaneously reducing the demerits inherent in them (Frankfort-Nachmias and Nachmias, 1992). According to Chan (1995), triangulation contributes to the overall effectiveness of the study as the many research methods adopted complement each other as different areas/objectives in a study are better tackled by different research methods. In this study, a questionnaire-based cross sectional study was conducted by convenience sampling at locations in Kuala Tembeling, Temerloh, Maran adn Pekan. The questionnaire was divided into four parts: Part A collected the respondents' demographic details; Part B was the perception, characteristics of flood and response/evaluation of SOPs; Part C was on flood losses incurred; and Part D was on flood assistance received. The total number of respondents interviewed was 400. The data was analysed by using SPSS software.

3.0 Results and Discussion

Risk, exposure, vulnerability and flood damage potentials of flooding in many parts of Malaysia have increased substantially in recent decades because of a combination of climate change and rapid developments in floodplains (Chan and Parker, 1996). However, Chan (1995) has demonstrated that the level of annual flood damage suffered both by individuals and public bodies in the country can be substantially reduced by effective flood response SOPs, especially flood warning SOPs. Effective Flood Warning and Evacuation Systems (FWESs) can help reduce flood loss and damage or alternatively increase damage-savings. This is an area where SOPs of the government can involve/engage victims to play a more active role. Effective SOPs, however, rely also on appropriate/correct flood response. As victims have a large degree of freedom and scope for individual choice and action for self-determination, they are expected to take advantage and develop/play active roles in responding to FWESs and heed/follow official advice by responding appropriately to formal FWESs (Chan, 1995).

The December 2014 flood in Pahang exposed the inadequacies of the existing official flood protection measures and the non-existence of a central body to plan, manage and monitor all aspects of flood response in the country (Mohammad Ghazi Hj Ismail et. al., 2015). Furthermore, it showed that rapid development of flood plain regions in the last few decades had substantially increased flood damage potential, particularly in urban floodplains. Despite the fact that flooding is an annual event in many parts of the country and the fact that the annual flood expenditure has increased substantially, flood mitigation has seldom featured highly on government agendas, except perhaps during the aftermath of a major flood like the December 2014 flood in Pahang. Being a rapidly developing country aiming to evolve into a fully industrialised country by the year 2020, Malaysia's pursuit for rapid economic development is relentless. The 2014 flood is evident of the increasing incidence and hazardousnes of flooding and the exposure that FWESs have been hitherto inadequate, ineffective and largely developed with little inputs or engagement of communities. Furthermore, traditional (informal) FWESs have not been adequately integrated into official (formal) FWESs. As a result, it has been noted that official response SOPs to tackle both monsoon and flash floods have largely been based on a reactive approach relying on disaster preparedness, evacuation, and post-disaster rehabilitation (Sim and Chan, 2015).

Results in this study on the 2014 Pahang flood indicate that flood victims receive a lot of flood warnings from all sorts of sources. Surprisingly, most victims (134 respondents or 33.5 %) received flood warnings from TV or radio announcements. This is followed by warnings received from electronic media (81 respondents or 20.25 %). This shows that flood victims are increasingly well connected to ICT and trust the use of ICT such as mobile phones, TV, radio and computers to get warnings and other information on floods. A total of 69 respondents (17.25 %) did not receive any flood warnings. In comparison, all the flood authorities combined (i.e. the Police, Drainage and Irrigation Department and Information Department) provided flood warnings to 33 respondents (only 8.25 %) of all respondents interviewed. Clearly, this shows that flood warnings are not as widely disseminated as believed by the flood authorities. Even social groups such as village heads and other social groups provided more flood warnings than government departments, i.e. to 59 respondents (14.75 %). Hence, the SOPs that designate the government departments as flood warning disseminators are ineffective as only a minority of flood victims actually received warnings from government authorities. In contrast, the majority of flood victims received warnings from other avialble sources which they trust, viz. TV and radio, the elctronic media and social groups.

In terms of evaluation on the effectiveness of flood warnings given out during the December 2014 Flood in Pahang, it was found that more respondents rated the warnings received as effective (267 respondents or 66.75%) as compared to those who rated the warnings received as not effective (103 respondents or 25.75 %). These results indicate that the current SOPs on issuance of flood warnings are accurate or effective. However, this may be due to the fact that the December 2014 flood was an extremely big flood, and people were already well aware of it from the news reports. Hence, people were aware and paid attention and heeded the warnings. Nevertheless, these formal FWES appear to work well during large floods that are considered very extreme. SOPs are considered effective in terms of these flood warnings as people in Pahang are used to such seasonal monsoon floods. People in Pahang have therefore adopted traditional warning mechanism is (as indicated by the significant numbers of people receiving warnings from social groups). As people are already very familiar with official FWESs (especially victims who have been flooded year in and year out over many years), and the SOPs do not ask them to do things that are very different from what they have been doing for years, then they follow the SOPs closely. Respondents also evaluated the effectiveness of flood evacuation SOPs during the December 2014 Flood in Pahang. Of the 400 respondents, 287 (71.75 %) were evacuated while the remaining 113 (28.25 %) were not. Of those evacuate, the majority (89.90 %) were Malays. Only 20 Chinese and 9 Indians were evacuated. In terms of place of evacuation provided to flood victims during the December 2014 Flood in Pahang, 135 respondents (47.04 %) were put up in schools, followed by 97 respondents (33.80 %) in multi-purpose halls. The remaining respondents were put into welfare homes, relative houses, mosques, tents and other evacuation centres. Of those put into evacuation centres, 181 respondents (63.07 %) reported that they faced problems while at the evacuation centres.

4.0 Conclusion

4.1 Overall, the government SOPs in flood disaster response during normal seasonal monsoon floods in Pahang is workable. However, it is during huge floods that the SOPs are rendered inoperable as all the existing SOPs are overtaxed. The December 2014 flood in Pahang is one such massive flood that severely taxed flood relief agencies to the extent that they encountered major obstacles and problems, resulting in poor performance in evacuation, rescue and relief operations.

4.2 In this study, flood victims' evaluation of the SOPs used by government agencies for preparedness, warning, rescue, evacuation, flood relief and recovery, showed that there were a lot of problems and ineffectiveness in the current SOPs. Results indicate that majority of flood victims' evaluated the SOPs in terms of preparedness, warning, rescue, transfer/evacuate, flood relief, evacuation centers and recovery as not so effective. This was because access to many evacuation centers was cut off due to strong currents and bad weather. Rescuers could not reach flood victims as trucks, boats and even helicopters were inoperative. Water levels rapidly resulting in victims being trapped. Many evacuation centers were flooded, rendering SOPs inoperable.

4.3 Victims confided that little preparedness and awareness education were provided, warning was either not given or came too late, rescue did not come to many and evacuation centers were over-crowded and inadequately staffed. Overall, the current SOPs in operation during the big flood disaster in Pahang was ineffective and flood managers also suffered as the flood was massive, turning them into flood victims themselves.

4.4 Results also showed that the current SOPs on evacuation centres are inadequate, especially during big floods. Flood victims who are put in an evacuation centre that is not well equipped stresses the victims and make their lives miserable. It is therefore vital that the flood management authorities,especially in the SOPs, ensure that the places chosen as evacuation centres must be well equipped like evacuation centres. Hence, before the flood season, places amrked as evacuation centres must be fully inspected, repaired, equipped and well stocked with emergency supplies such as food, clothings, blankets, food, medical supplies, furniture, etc.

4.5 If an evacuation centre is a school, the Headmaster should be responsible to ensure all the school's equipment, structures and emergency supplies are in order. For other evacuation centres like multi-purpose halls, mosques, churches, and others, the persons heading these buildings should be responsible. This will make the SOPs a lot more effective than totally relying on the government. Overall, it was found that during massive floods, the current SOPs (which are adequate for moderate floods) were rendered inoperable and ineffective. A comprehensive review of existing SOPs on flood disaster is needed as floods are expected to intensify in the light of climate change.

References

Ahmad Hussaini, "A Comprehensive Urban Stormwater Management Approach in Combating Flood in Malaysia: An Indispensable Link for Safer, Greener and More Livable Urban Environment. " Keynote Paper presented at the 13th international conference on urban drainage, 2014, 7th – 12th September, Borneo Convention Center Kuching, Sarawak, Malaysia. 2014.

Chan, N.W., "A Contextual Analysis of Flood Hazard Management in Peninsular Malaysia." PhD diss., Middlesex University (UK), 1995.

Chan, N.W. (2013) Managing urban flood hazards in Malaysia: emerging issues and challenges. Proceedings IACSC 2012 The 3rd International Academic Consortium For Sustainable Cities Symposium, 8 September 2012 Thailand. Bangkok: Thammasat University, p154-159.

Chan, N.W. (2015) Chapter 12 Impacts of Disasters and Disaster Risk Management inMalaysia: The Case of Floods. In Aldrige, D.P., Oum, S. and Sawada, Y. (Editor) Resilience and Recovery in Asian Disasters, Risks, Governance and Society. Springer (e-Book), 239-265.

Chan, N.W. and Parker, D.J., "Response to Dynamic Flood hazard Factors in Peninsular Malaysia,"*The Geographical Journal* 162 (3), November, 1996: 313-325.

Chan, N.W., Narimah Samat, Lai Kuan Lee and Aminuddin Ab Ghani, „Role of Citizen Science in Responding to Flood Disasters: A Case Study from Malaysia." In Proceedings of the International Conference on "Towards Urban water Security in Southeast Asia: Managing the Risks of Extreme Events", Phnom Penh, Asian Institute of Technology, 227-238. 2015.

Fordham, M.," Choice and constraint in flood hazard mitigation: the environmental attitudes of floodplain residents and engineers." PhD diss., Midddlesex Polytechnic (UK). 1992.

5.4: LAND-USE AND LAND-COVER: DEVELOPMENT OF A TWO-DIMENSIONAL NUMERICAL MODEL FOR MUDFLOW WITH APPLICATION ON FLOOD ROUTING WITH THE INCORPORATION OF MUD FLOW

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1.0 Introduction

The recent December 2014 unprecedented Malaysia East Coast flood has brought the attention to the lack of river basin management in our country. The effects of land-clearing and uncontrolled agricultural activities on steep slope have resulted failure of the river to accommodate the rapid increase of flow discharge and sediment load. Other events related to the exposure of soil at steep slope are the mudflow and debris flow which are often triggered during high intensity and long duration storm or monsoon rain. This study aims to develop an in-house numerical code to simulate the phenomena of mudflow and to use the model to simulate flood routing with the incorporation of mudflow. Based on several proposed constitutive relations for mudflow and debris flow, a two-dimensional code will be developed. The investigation of suitable constitutive relation for local mudflow will be carried out and incorporated into the numerical model. The model will be later used to investigate the potential damage of a typical mudflow. The effectiveness of mudflow and debris barrier will also be investigated using the model. The study starts with the collection of soil samples followed by the development and application of numerical model and finally potential damage assessment and hazard map development. The ability of numerical model to simulate mudflow provides an efficient way for engineers, planners, policy makers, investor and even inventors to make quick yet wise decisions when managing land use. Numerical model comes in handy when physical experiment is time-consuming and expensive in providing reliable information for better land-use management.

2.0 Methodology

The study begins with the validation of the numerical model by simulating the “dam-break flow” benchmark problem using several candidates for mudflow constitutive relations. This is carried out using a one-dimensional depth averaged model and a two-dimensional depth averaged model. The results are compared with theoretical and experimental data from literature studies. By using the two-dimensional depth averaged model, the numerical model is then used to assess the damage potential of mudflow. The flood routing simulation which incorporate mudflow will be carried out using the numerical model, with several flood mitigation scenarios.

3.0 Results and Discussion

The results of the studies can be divided into three parts, based on the type of numerical model used to study the mudflow:

3.1 Two-dimensional model

The two-dimensional continuity and momentum equations are solved in this model based on the finite volume method with VSIAM3 technique (VSIAM3=Volume Surface Integrated Averaged Multi-moment Method). The VOF method is used for surface tracking where the F function is solved using the THINC method (THINC=Tangent of Hyperbola for Interface Capturing) which is a conservative, oscillationless and smearing-less scheme. Two constitutive models are used for the mudflow: a modified Herschel-Buckley model and Papanastasiou model. It was found out that the modified Herschel-Buckley model performed better than the Papanastasiou model. However, the disadvantage of adopting the modified Herschel-Buckley model is in achieving convergence in the initial stage when viscosity is high. The findings in this part was submitted in the following paper:

Puay, H. T., Abdullah, M. Z., Zakaria, N. A., Chan, N. W., Ahamad, M. S. S. and Lau, T. L., Evaluation of rheological model for numerical simulation of mudflow on steep slope triggerd by heavy rainfall., Jurnal Teknologi, 2015.

3.2 One-dimensional depth averaged model

The St. Venent equation was solved in this model by finite difference method. Harten's TVD scheme (TVD=Total Variation Diminishing) scheme was adopted in the numerical model to improve shock wave capturing and suppress oscillations. The numerical model was initially validated against Ritter's solution for a simple dam-break problem. For the simulation of mudflow, it was assumed that the mudflow is made up of hyper-concentrated fine suspension, and the constitutive relation is based on Herschel-Buckley model and expressed in the form of bedshear stress, which was obtained empirically. The model was then used to simulate the release of mudflow from a reservoir onto an inclined channel. The performance of the model was validated with experimental data from literature for the time variations of flow depth at three locations along the channel. It was found that the empirical model based on Herschel-Buckley model is suitable for the simulation of mudflow if it comprised of hyper-concentrated fine suspension. The findings in this part was submitted and accepted for following conference paper:

Puay, H. T., Zakaria, N. A. and Hosoda, T., Numerical simulation of mudflow on steep slope triggered by heavy rainfall., 20th Congress of the Asia Pacific Division of the International Association for Hydro Environment Engineering & Research, IAHR APD Sri Lanka, 2016.

3.3 Two-dimensional depth averaged model

A two-dimensional depth averaged model was solved by discretizing the governing equaitons using finite volume method. A high accuracy in space was achieved by adopting van Leer's MUSCL scheme (MUSCL= Monotone Upstream-Centered Scheme for Conservation Law) with midmod slope limiter to ensure TVD property. Meanwhile, a second order accuracy in time was achived by using the second order Adams-Bashforth method. The verification of the model was carried out by simulating the partial dam-break problem and validated with numerical data from literature studies. The model was then used to simulate the release of mud suspension from reservoir onto an inclined plane. The flow profile, peak discharge and run-out distance were compared with experimental data from literature studies. Finally, the model is used to simulate mudflow event with obstacles representing buildings at the downstream.

The findings in this part was submitted for the following conference paper:

Puay, H. T., Zakaria, N. A., Numerical simulation of mudflow event with a two-dimensional depth-averaged flow model, Persidangan Kajian Bencana Banjir 2014, 2016.

4.0 Conclusion

Important findings of the study are summarized as follows:

4.1 Selection of suitable constitutive model for the numerical simulation of mudflow is critical. If the mudflow is mostly comprised of fine suspension, the Herschel Buckley model is suitable.

4.2 For simulation of mudflow event, a two-dimensional depth-averaged model with empirical formula based on Herchel Buckley model is suitable. However, this is only applicable for mudflow which is mostly comprised of hyper-concentrated fine suspension.

4.3 For more accurate simulation, the mudflow sample has to be obtained from site immediately or during the mudflow event. However obtaining such sample is very dangerous and access to the site is usually cut-off during such events.

References

Puay, H. T., Zakaria, N. A., Numerical simulation of mudflow event with a two-dimensional depth-averaged flow model, Persidangan Kajian Bencana Banjir 2014, 2016.

Puay, H. T., Zakaria, N. A. and Hosoda, T., Numerical simulation of mudflow on steep slope triggered by heavy rainfall., 20th Congress of the Asia Pacific Division of the International Association for Hydro Environment Engineering & Research, IAHR APD Sri Lanka, 2016.

Puay, H. T., Abdullah, M. Z., Zakaria, N. A., Chan, N. W., Ahamad, M. S. S. and Lau, T. L., Evaluation of rheological model for numerical simulation of mudflow on steep slope triggerd by heavy rainfall., Jurnal Teknologi, 2015.

5.5: FLOOD AND FLOOD DISASTER: MODEL-BASED MORPHOLOGICAL PREDICTION FOR LARGE SCALE RIVER BASIN IN RAISING FLOOD PROTECTION LEVELS FOR SUNGAI PAHANG

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1.0 Introduction

The Sungai Pahang river basin is located in the eastern part of Peninsular Malaysia and drains an area of 29,300 km^2 of which 27,000 km^2 lies within Pahang (about 75% of the State) and 2,300 km^2 is located in Negeri Sembilan. Sungai Pahang is the longest river in the Peninsular Malaysia at about 435 km. Sungai Pahang originates from Kuala Tembeling at the confluence of two equally large and long rivers, about 304 km from the river mouth in the central north, the Sungai Jelai emerges from the Titiwangsa Range at the northwestern tip of the Sungai Pahang Basin, while the Sungai Tembeling originates from the Timur Range at the northeastern edge of the basin.

Several major floods occurred in the last few decades in Sungai Pahang river catchment, causing extensive damage and inconvenience to the community. According to records of past floods, 1926 flood was the worst flood affecting most of Peninsular Malaysia. However, official records are too insufficient to describe the condition of that flood in detail. The scale of January 1971 flood is over the 100-year ARI based on the hydrological probability analysis using the mean 8-day rainfall records (DID, 1974) followed by November 1988, December 1993, December 2007 and the most recent one December 2014.

2.0 Methodology

River surveys, flow measurement and field data collection have been carried out during May, August, and November 2015 to obtain the basic physical information such as sediment characteristics, and flow discharge; which is needed for the planning and design of river engineering. In addition to the data needed for sediment transport studies, use of a sediment transport model also requires field data such as channel configuration before and after the flood, a flow record and sediment characteristics, which are generally used for simulation of a model. The bed material samplings were carried out by grab sampling from the boat using a Van Veen grab sampler along the selected cross sections at Sungai Pahang river catchment. The data for bed materials were obtained at nine grab sampling sites along Sungai Pahang from CH 29700 (upstream - Kuala Tembeling) to CH 9000 (downstream – Pekan). Ten (10) samples were collected at the evenly spaced sampling points in the cross section of Sungai Pahang, whilst the spacing between measuring points differs for one cross section to the other and depends on the river width. Besides that, the profiling of bed elevation, water surface and thalweg elevations, the deepest bed elevation for a cross section, were also carried out at the selected cross sections using an acoustic doppler current profiler (ADCP). Recent analyses have shown that ADCP streamflow measurements can be made with similar or greater accuracy, efficiency, and resolution than measurements made using conventional current-meter methods (Oberg and Mueller, 2007).

The sediment transport model, InfoWorks RS is a rainfall-runoff simulation developed by the Wallingford Software for steady and unsteady flows, and applicable to model open channel and overbank flows in any network of channels. InfoWorks RS provides good analytical tools for flood stage and sediment transport analysis. The software is designed for big river system covering hundreds of kilometres in length. The combination of both analysis (flood and sediment transport) should give better results for design of flood mitigation systems. Since the average sediment size for Sungai Pahang is made up of medium sand to very coarse sand and gravel, the Engelund-Hansen (1967) equation is selected to be used in the sediment transport modeling. The sediment transport function predicts the equilibrium sediment concentrations at each cross section. These methods are based on the assumption that sediment concentration in transport has adjusted to the local hydraulic conditions.

3.0 Results and Discussion

The mean sediment sizes in terms of d_{50} for the tributaries and downstream of Sungai Pahang show fining occurred during the December 2014 flood (Table 1). The ranges of average sediment size between 0.28 mm and 1.90 mm show that upstream of Sungai Pahang is made up of medium to coarse sand, whist the average bed material size (d_{50}) are varies from 3.00 mm to 1.30 mm between CH 22500 and CH 9000 for approximately 200km reach, show that the main river of Sungai Pahang is made up of very coarse sand and gravel.

Table 1 Mean sediment size of bed materials

River Name	Location	Mean Sediment size d_{50} (mm)
Sungai Jelai	Sungai Jelai 1	1.20
	Sungai Jelai 2	0.90
Sungai Tembeling	Sungai Tembeling 1	1.90
	Sungai Tembeling 2	0.28
Sungai Pahang	Kuala Tembeling (CH 295000)	0.60
	Kuala Krau (CH 225000)	3.00
	Temerloh 1 (CH 189000)	0.33
	Temerloh 2 (CH 177000)	3.40
	Chenor (CH 129000)	1.50
	Lubuk Paku (CH 105000)	1.40
	Kampung Serengkam (CH 93000)	1.50
	Paloh Hinai (CH 54000)	1.80
	Pekan (CH 9000)	1.30

From this study, the results with sediment transport modelling show the significant changes on water level and cross sections aggradation and degradation. Peak water surface and changes of the channel geometry due to scour and fill were depicted by the simulated changes in channel bed profile based on the surveyed cross section was provided by DID (JICA, 2011). From the simulation results, water level for Sungai Pahang are almost similar during low flow, but flood level was predicted much higher during peak hydrograph at most cross sections using sediment transport model. Commonly, the pattern indicated that erosion and sedimentation occurred along Sungai Pahang at most cross sections at Sungai Pahang after the flood event. Figure 1 shows the simulated longitudinal profile of Sungai Pahang with the sediment transport modeling using Engelund-Hansen total load equation.

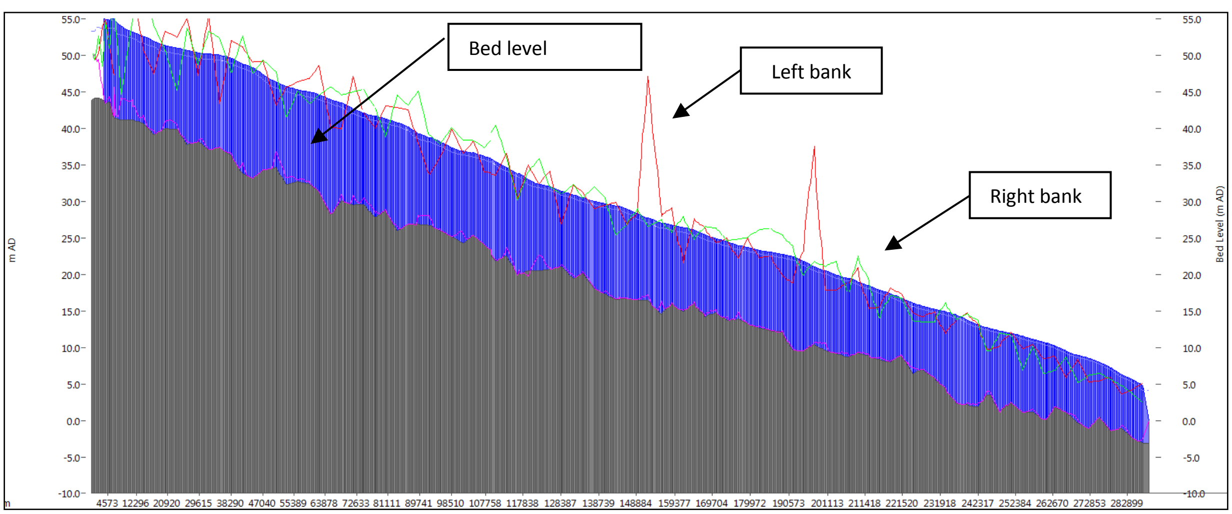

Figure 1. Longitudinal profile of Sungai Pahang with the sediment transport modeling using Engelund-Hansen total load equation

In general, the simulation results indicate that the maximum flood level with and without sediment transport modelling has a difference of at least 0.30m (Table 2). This implied that a freeboard of at least one meter should be provided if the modelling was carried without sediment transport. Table 3 shows the bed level change along Sungai Pahang after 2014 flood event. The results show that Sungai Pahang is self-regulating to adjust their characteristics in response to any change in the flood discharge with the pattern indicating that erosion and sedimentation occurred along the river.

Table 2: Comparison of simulated maximum flood level during 2014 flood event

Location	Maximum Water Level (2014 Flood Event)		Difference (m)
	Without sediment transport modeling	With sediment transport modeling	
CH 252000	46.730m	47.401m	0.671
CH 222000	41.134m	41.721m	0.587
CH 192000	35.723m	36.203m	0.480
CH 174000	31.569m	32.030m	0.461
CH 153000	28.285m	28.885m	0.600
CH 141000	25.909m	26.596m	0.687
CH 108000	22.011m	22.461m	0.450
CH 75000	15.438m	15.891m	0.453
CH 42000	10.791m	11.113m	0.322

Table 3: Comparison of bed level changes after 2014 Flood Event

	Thalweg elevation		Remarks
	Without sediment transport modelling (original survey level)	With sediment transport modelling (end of flood event)	
CH 252000	33.099m	33.003m	Scour (0.096m)
CH 222000	27.755m	28.449m	Sedimentation (0.694m)
CH 192000	24.122m	23.865m	Scour (0.257m)
CH 174000	20.710m	20.997m	Sedimentation (0.287m)
CH 153000	16.738m	16.661m	Scour (0.077m)
CH 141000	16.062m	15.252m	Scour (0.810m)
CH 108000	9.692m	10.011m	Sedimentation (0.319)
CH 75000	6.381m	7.126m	Sedimentation (0.745m)
CH 42000	1.152m	1.525m	Sedimentation (0.373m)

Figure 2 show the flood map with and without sediment transport modeling. In summary, the inundated area without sediment transport modelling are approximately 1130 km^2 compare to 1134.1 km^2 inundated area using sediment transport modelling. The difference of the flood inundation area are 4.1 km^2 (410 ha).

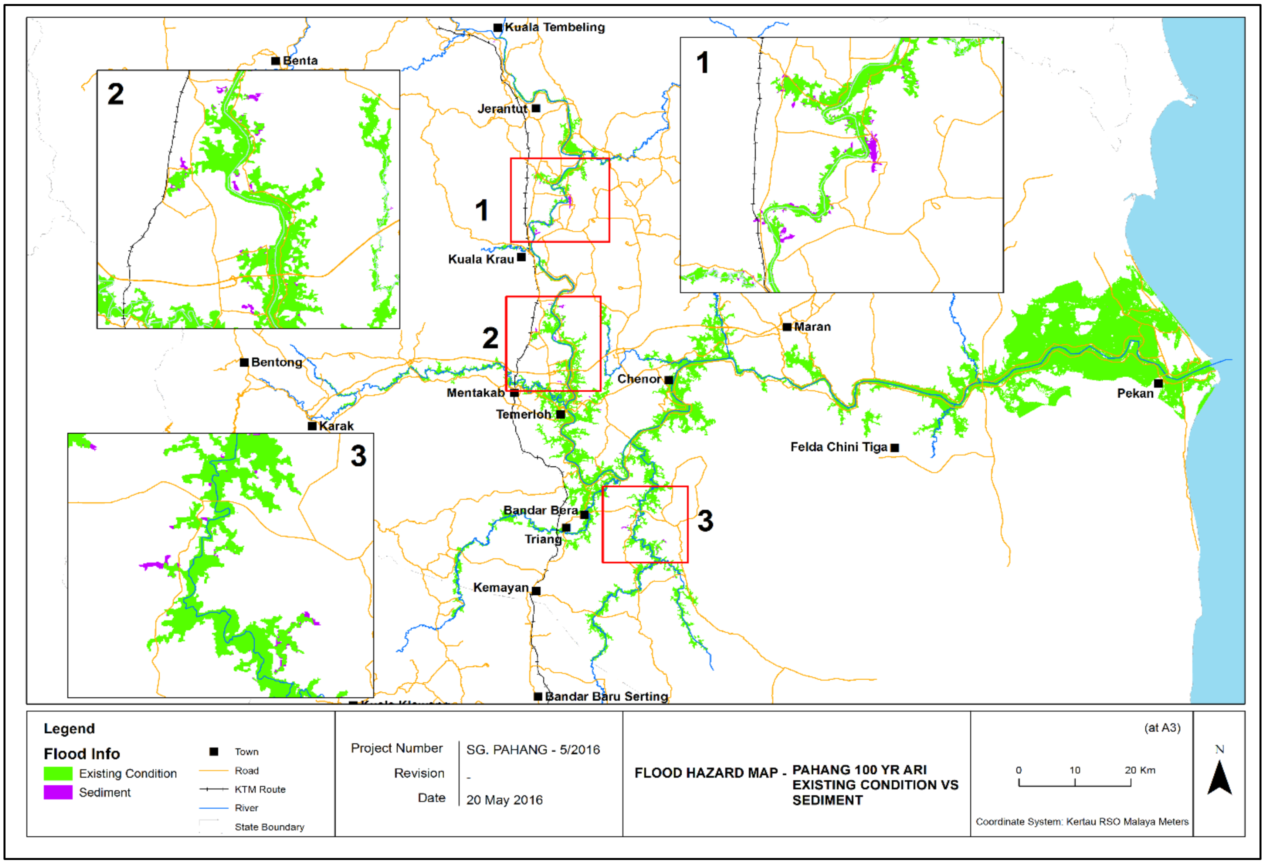

Figure 2 Flood map with and without sediment transport modelling for Sungai Pahang Catchment

4.0 Conclusion

Important findings of the study are summarized as follows.

4.1 Generally excessive soil erosion in the basin and consequent generation of sediment load in the river system causes deposition in the river channels and river mouth, which leads to increased tendency to flooding due to the decrease of the flow capacity of the channels. The current study attempted to give an overview of the sediment transport phenomena which affected the river stability and caused variation in sediment distribution along Sungai Pahang.

4.2 The December 2014 flood was expected to carry further downstream sediment load from the upstream of the Sungai Pahang river catchment as indicated from the bed material samplings. The flooding in Sungai Pahang is found to affect not only maximum flood level but also changes in channel geometry.

4.3 The present study provides an estimate of sediment transport in large scale of river and serves as a reference for sediment transport modeling of sandy streams in Malaysia and overseas.

References

Department of Irrigation and Drainage or DID. “Pahang River Basin Study, Vol. 3: Basin Hydrology and River Behaviour”. Malaysia, Kuala Lumpur. 1974.

Engelund, F. and Hansen, E. “A monograph on sediment transport in alluvial streams”. Teknisk. 1967.

Japan International Cooperation Agency or JICA. “The preparatory survey for integrated river basin management incorporating integrated flood management with adaptation of climate change”. Final Report: Volume 3 – Pahang River Basin. Tokyo: JICA, No. GED CR (11-031). 2011.

Oberg, K.A. and Mueller, D.S., “Validation of streamflow measurements made with Acoustic Doppler Current Profilers”. Journal of Hydraulic Engineering, 133-12 (2007): 1421–1432.

PROJECT 6 : INTEGRATED WATER RESOURCES MANAGEMENT APPROACH FOR SUPPORTING INTEGRATED FLOOD DISASTER MANAGEMENT DECISIONS

6.1: DISASTER RESILIENT STRUCTURAL DESIGN FOR URBAN AND RURAL CULTURAL LANDSCAPES OF PAHANG RIVER BASIN

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1.0 Introduction

The anthropogenic development activities transform more natural Pahang River Basin into a rapidly changing anthropogenic cultural landscape. With the increasing of more anthropogenic development activities and infrastructural settlements, peoples' vulnerabilities also increasing regardless their socio-economic and cultural condition. In reality, avoiding risk is generally not an option for people with little financial and material resources. Therefore, design and technological solutions sponsored by the community offer the most viable risk reduction mechanism available to the majority of people. A community could be both disaster-resistant and disaster-resilient. Resilient communities are flexible and resourceful. They have many ways to recover from a disaster (Kalema, 2013; Designboom, 2013).

The local communities within peninsular Malaysia including Pekan have very little skills to exploit the vast benefits of bamboos which are now known to be useful in flood mitigation and adaptation. Other than shelters, bamboo has many other economic benefits as it can be utilised as raw material for joss sticks, poles, flooring, baskets, handicrafts, food, forage, bio char (Poh et al, in press), a good substitute for timber (Azmy et al, 2009; Drunkelberg 1992) and even for energy (Langford, 2014). There is also a lack of understanding about the usefulness of bamboo among government bodies and local voluntary organisations for disaster preparedness and prevention. Therefore bamboo has not been incorporated in regulations and policies pertaining to flood disaster management.

2.0 Methodology

1) Identification of risk zones: GPS will be used to get point data of these settlements, Remote Sensing and GIS technology will be applied.
2) Delineating potential area for infrastructural designing and planning. Expert judgment, rehabilitation and shelter centre, identifying risk zones for development, key environmentally sensitive areas etc. (Remote sensing and GIS).
3) Designing integrated shelter centre and a plan for proper distribution (Structural design, expert judgments, capacity building through consultation and training).
4) Designing integrated shelter centre and delineating potential area (structural software programme, GIS, RS, etc.)
5) A social survey will be conducted to assess the readiness of stakeholders for the adoption of bamboo cultivation as a way to increase the resilience of flood affected communities.
6) Evaluation of the training and workshops to be conducted through a structured survey.
7) Workshops on awareness of the importance of innovative structures and cultivation (i.e., bamboo cultivation, terrace structures) in flood affected areas, strategies and policy recommendations.

3.0 Results and Discussion

The 2014 and 2015 flood affected population and their houses have been visualized in the map and showed a considerable proportion of the residents living in the flood disaster risk zones of this river basin area. The households located within the flood risk zones according to the degree of risk are delineated and mapped. In addition, the position of shelter centers are demarcated. It revealed that the proportion of the shelter centers versus the affected populations are not adequate.

Evacuation centers are the main shelters during flood events. Proper selection of sites can guarantee citizens' safety rights, prevent life and property loss and maintain trusting relationship between citizens and the government (Yang et al, 2012). Typology consideration includes, capacity, available facilities, and sustainability of maintenance, proximity to flood affected areas, elevation and management. Table 1 are examples of typical evacuation centers studied with various typology and location.

Schools are prioritized to be used as evacuation centers due to several good reasons. However, the themes and objectives of the Sendai Framework for Disaster Risk Reduction must be put into action especially the concept of "Build Back Better". Schools and other buildings that have been identified as suitable evacuation centers should be designed to be adaptable and multifunctional. During the December 2014 floods, several of the gazetted evacuation centers could not be used as they themselves were inundated by the floods and were either damaged or could not be accessed. An integrated approach which utilises GIS technology should be used to understand the affected sites and the best locations for evacuation sites (Yang, 2012). While the use of LIDAR technology for mapping structures and landscapes may be expensive at this point in time, the high geospatial accuracy exhibited by such maps should be given consideration for investment to give accurate guidance for land use planning for disaster risk reduction (Serafica, 2013).

Table 1. Suitability evaluation of evacuation centers according to Sphere Project guidelines: some examples

Typology	Name of School		
	S.K Temerloh Jaya	S.K.Khee Chee	S.K Teluk Ira
Capacity	2400 people	500 people	250 people
Site planning - elevation	Flat	On high ground	Flat
- building elevation	3-storey academic block, single storey canteen	4-storey academic block and 3-storey multi-purpose block on high ground, canteen on a level below	4-storey block with several single storey blocks for classrooms, hall, canteen, toilets
- landscaping	Well managed landscape around the campus	Large trees and small vegetation	Surrounded by oil pal plantation
- parking area	Available (large space)	Available (limited)	Available
- open space	Tarmac ground	Full size open field on the lower ground with amphitheater	Tarmac ground, small gardens and mediem sized field
Materiality	Brick and concrete, noticeable cracks	Brick and concrete well maintained	Brick and concrete, noticeable cracks, timber
Functionality - toilet	Sufficient – provides washroom at each floor of each block	Good number of washrooms found each floor of each block and separately to service the hall	Sufficient. Each floor has toilets (in the 4-storey block) and another separate blocks for toilets
- hall	N.A	Very spacious, good facilities, well maintained	N.A
- Canteen	Single-storey, located away from academic block. May be out of reach for those with mobility difficulties	Single-storey, located at a level below the multipurpose hall. May be out of reach for those with mobility difficulties.	Separate block for the canteen, adequate for school, might be too small for evacuees
- Others	-	Additional water storage tank on ground level	Few blocks including canteen were affected during 2014 flood up to 2-3 inches water level
Flexibility-buildings/ spatial layout	Buildings are in close proximity to each other but far away from the entrance	The essential spaces are interconnected	A few courtyard spaces (as assembly spaces) in between building blocks
- others	-	Shaded basketball court can be assembly place as well; a multipurpose hall provided with toilets	Partition instead of brick walls in classrooms, better flexibility
Other consideration	Adjacent to SMK Temerloh Jaya	-	-

4.0 Conclusion

In summary, the important findings of the study are:

4.1 Flood risk zones have been delineated and mapped. This map has potential sue for the flood disaster risk management along the Pahang and Kuantan River Basin.

4.2 The distribution of shelter centers and approximates areas of severity of risk to flood disaster for Pekan, Temerloh and Kuantan has been delineated and mapped. This risk map can be used to design more shelter centers required to safeguard people's life from the future flood disasters.

4.3 Need to consider designing of post disaster temporary houses based on sustainable and renewable material such as bamboo and to support livelihood options for the community that applies to enhance the level of structural and community resilience in the Pahang River basin.

4.4 Several approach and ideas have been designed based on bamboo for the development of ecotourism in the Pahang River Basin area. It has been identified that the alternative approach for ecotourism and livelihood development is important to build up resilience and thus helpful for long-term flood mitigation.

4.5 Workshops on awareness of the importance of innovative structures and cultivation (i.e., bamboo cultivation, terrace structures) in flood affected areas motivated local leaders and community for a bottom up approach and built up resilience among the affected community.

References

Azmy HM, Wan Rashidah WAK, Rasminah H, NurMastura HA (2009). Early performance trial of four Malaysian commercial bamboos in southern Peninsular Malaysia. Borneo Sci 25: 81-86.

Bishwakarma MC, Pokharel S, Gautam S (2010). Bamboo and bioengineering interventions for mitigation of river bank erosion: a case study. Kailali disaster risk reduction. Mercy Corps Nepal, Ulla Dons.

Designboom (2013). Low cost bamboo housing in Vietnam by H & P Architects. Designboom 8 Apr 2013. http://www.designboom.com/architecture/low-cost-house-for-middle-vietnam/

Dunkelberg K (1992). Bamboo as a building material, In: IL31 Bambus, Karl Krämer Verlag Stuttgart

Goodier R (ed.) (2015). Engineering for change.11 Nov 2015. Emergency shelter for the people: Four questions with Tom Newby. Retrieved 7 Nov 2015, https://www.engineeringforchange.org/emergency-shelter-for-the-people-four-questions-wi om-newby/th-t

Kalema AN (2013). Controlling Floods with Bamboo. Agri pro-focus 17 May 2013.

Langford K (2014). Could bamboo be the bioenergy of the future? Agro-forestry World Blog, 10 Oct 2014. http://blog.worldagroforestry.org/index.php/2014/10/10/could-bamboo-be-the-bioenergy-of-the-future/

Poh LV, Mohd Shahwahid HO, Judi S (2016). Kajian Industri Buluh di Semenanjung Malaysia. Ibu Pejabat Perhutanan Semenanjung Malaysia, Kuala Lumpur.

Serafica R (2013). LiDAR flood maps completed for disaster risk reduction. Retrieved 7 November 2015, http://www.rappler.com/move-ph/41611-lidar-flood-hazard-maps-completed

Yang J, Joo Y, Jun C (2012). Determining site suitability of evacuation shelters using GIS. Geospatial World Weekly. Accessed October 8, 2015, http://geospatialworld.net/Paper/Application/ArticleView.aspx?aid=30331

6.2: SOCIOECONOMIC, WELLBEING AND HEALTH IMPACTS OF FLOOD DISASTER IN THE PAHANG RIVER BASIN: IMPLICATIONS FOR LIVABILITY, SUSTAINABILITY AND QUALITY OF LIFE

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1.0 Introduction

Floods are mostly associated with climate variability. The most immediate and serious consequence of heavy rain is the flooding of river basin through both inundation and recession. Flooding creates many risks, including impacts on health and well-being, damage the ecosystems and disruption of people's lives. The severity of flood impacts may further increase in the future due to the climate change. The most devastation natural disaster experienced in Malaysia is flood. Pahang river Basin experienced flood almost every year, but 2014 flood was one of the worst flood disaster ever occurred. River flood exposes the population to multiple hazards from the physical, mental, health risks and its related negativities. The aim of the study was to assess the socio-economic, health and well-being status and impacts of 2014 flood on communities along the Sungai Pahang River and their households. This study analyses the socioeconomic and health impacts of 2014 floods in the Pahang River Basin and explores the ways in which residents in Pekan, Kuantan and Temerloh districts dealt with the extreme floods. Adaptation and mitigation strategies to deal with the climate change and climate variability will be identified and recommended.

2.0 Methodology

Data was collected using of a structured socio-economic and health questionnaire containing both open and close ended items. The questionnaire administration was cross-sectional in nature. It was designed, tested and administrated at the household level. They were conducted by trained enumerators from the local people to ensure that the questionnaire can be understood and accepted by the respondents. The study employed mainly primary data sources from respondents in Temerloh, Pekan and Kuantan districts. The survey was conducted within sixth month after the floods, which was in June 2015. Face to face interviews with 602 respondents were conducted, representing the number of households chosen by stratified random sampling technique. Data was analysed using Statistical Package for Social Science (SPSS) for Windows version 21. Descriptive statistics such as frequency distribution, observation scale; range and percentage value are widely used to quantitatively discuss and justify the arguments.

3.0 Results and Discussion

The study shows that more than 50 percent of respondents earn RM1500 and below per month. This indicates that households affected by the flood are mostly in the low income category. The floods result in the increase in hard- core poor group by 23% overall, and by 1.5%, 0.5% and 6.5% for Pekan, Kuantan and Temerloh, respectively which is higher than Pahang state hard-core poverty level (0.3%) for the year 2009 (Economic Planning Unit, 2009). In comparison, overall the poor category decreased by 9.72%, while the non-poor decreases by 3.2%. For the bottom 40 percent group remained unchanged for Pekan, while in Kuantan and Temerloh there was a reduction for 0.5% and 3.0%, respectively.

Results of the study show that the flood has reduced average income of farmers by 40%, 33.5% and 31.2%, respectively in Pekan, Kuantan and Temerloh, due to destruction of crops and small business activities. The flood also results in the increase in the hard-core poor by 1.5%, 0.5% and 6.5% in Pekan, Kuantan and Temerloh respectively. Vulnerabilities of communities are related to not receiving flood warning, landlessness, unstable housing and food insecurity, in addition to female headed households with financial burden.

The study shows the top four prevalent conditions were found to suffer hypertension (11.0%), diabetes (7.3%), arthritis (4.0%) and heart disease (3.2%). The main symptoms experienced among respondents during flood and immediately 2 weeks post flood were questioned among the respondents (R) and their household members (HM). The top five symptoms were cough (R=47.2%, HM=43.7%), flu (R=42.7%, HM=40.4%), fever (R=39.5%, HM=39.5%), sore throat (R=29.9%, HM=28.1%), and headache (R=23.6%, HM=15.0%). Besides the physical stress, respondents were also affected with emotional stress. Post-traumatic stress disorder (PTSD) may occur among individuals who experience disaster situation or a life threatening incident. Individuals would indicate reactions such as palpitations, constantly relieving the images and sleep difficulties. Upon screening of PTSD and depression among respondents, 5.5% and 17.3% were suspected to suffer from PTSD and high depression respectively. Mostly, affected respondents were coming from highly urbanised districts which are Kuantan, followed by Pekan and Temerloh.

Knowledge, skills and training for facing disaster is required to deal with disaster occurrence. The awareness and empowerment indicators clearly indicate that most of the respondent have no training and skill to avoid disaster in the three districts, couple with no training programme at community level to deal with it. In Temerloh and Kuantan, most of the training programme was handled by community leaders, while in Pekan it was from the voluntaries. On readiness to receive the training programme on avoiding disaster, majority of respondents in Kuantan (83%) and Temerloh (78%) agree to participate. Television/radio is the most important information medium, where respondents receive disaster preparedness information. However, the community empowerment approach for disaster management helps create a more proactive stance and attitude among the people. It contributes towards deciding on the goal and strategies for disaster risk management, pool and organise resources and monitor their performance.

4.0 Conclusion

In summary, the important findings of the study are:.

4.1 The households affected by the flood are mostly in the low income category. The floods result in the increase in hard-core poor group by 23% overall, and by 1.5%, 0.5% and 6.5% for Pekan, Kuantan and Temerloh, Average income of farmers was reduced in Pekan, Kuantan and Temerloh, due to destruction of crops and small business activities.

4.2 In terms of health impacts, the top five symptoms of health impacts were cough, flu, fever; sore throat and headache. In addition, 33 respondents suffered PTSD (Post-traumatic Stress Disorder). Upon screening of PTSD and depression among respondents, 5.5% and 17.3% were suspected to suffer from PTSD and high depression respectively. Mostly, affected respondents were coming from highly urbanised districts which are Kuantan, followed by Pekan and Temerloh.

4.3 In terms of recommendations, upgrading of communication system, diversification of income and strengthening of social institution networks are most appropriately recommended for flood adaptation and mitigation strategies. Although flooding is an annual event, disasters can be addressed to reduce the risk of damage and losses caused by the flood.

References

Chan, N. W. (2012). *Impacts of Disasters & Disasters Risk Management In Malaysia: The case of floods.* (pp. 503–551). Retrieved from http://www.eria.org/Chapter_14.pdf

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, *18*(4), 598–606. doi:10.1016/j.gloenvcha.2008.07.013

Economic Planning Unit of Malaysia. (2009). hardcore poverty malaysia.pdf. *Department of Prime Minister, Malaysia*. Retrieved March 16, 2016, from http://www.epu.gov.my/en/arkib-pendapatan-kemiskinan-isi-rumah

6.3: INTEGRATED RIVER BASIN MANAGEMENT (IRBM) APPROACH TO SUPPORT FLOOD DISASTER STRATEGY FOR PAHANG RIVER BASIN

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1.0 Introduction

Pahang was severely affected by the 2014 flood which was occurred at the end of December 2014 and early January of 2015. Heavy rainfall was expected as the main cause of the flood event. However, specifically in context of study as human activities were identified as the issues contributed to the worse phenomena and higher flood magnitude that has changed the natural ecosystem functions. Generally, this study aims to introduce the IRBM approach for Pahang River basin in order to overcome flood problem or at least to reduce its magnitude in the future. Several specific objectives have been identified. Firstly, to understand the basin characteristics of Pahang River basin and identified the source of flood disaster. Secondly, to estimate pre and post environmental impact of flood disaster and lastly, to develop an integrated institutional framework which involve all stakeholders of the basin.

Floods of Pahang river basin have become an annual natural disaster event where all the stakeholders have their own responsibilities to take care. Pahang is rich in water resources and receive high total rainfall during northeast monsoon period with almost 40% of total rainfall annually (JMM 2010). With the growing awareness and concern over environmental issues, it is imperative that water resources development must be undertaken in an environmentally sustainable manner. Environmental considerations included in the early stages of these projects contribute to ensuring the sustainability of the water resources projects (DID 2000). Integrated River Basin Management (IRBM) is an introduced concept of planning, development, management and use of land, water and related natural resources within hydrologic boundaries. The general concept in IRBM involved the ecological sustainability and the partnership of institutions which involved the government and non-government parties. IRBM is an approach of managing the basin in considering these aspects. The principles of IRBM introduce a management that give focus on all natural resources; air, water, flora and fauna nearby the basin, balancing the needs of human beings, plants and animals, conservation of natural resources of the basin, respecting the needs of ecosystem and biodiversity and ensuring that adequate quantity of water are in the river (DID 2005).

2.0 Methodology

This study involved primary data collection which include questionnaire, interview with community and consultation workshops with stakeholders while the secondary data collection include raw data and information from several government agencies, flood reports from affected districts in Pahang River Basin, as well as previous studies on Pahang River Basin from books, reports and papers. The methodologies used in this study involved the primary and secondary data collection especially from Department of Irrigation and Drainage (DID), site visits and stakeholder consultation workshop. These methods were conducted at three different districts which are Jerantut, Temerloh and Pekan. The stakeholders of Pahang river basin were interviewed to gather information and verify the issues, causes, impacts and related factors for pre and post flood events. A stakeholder consultation workshop was conducted and all parties took part in this workshop.

3.0 Result and Discussion

Results showed several issues related to flood in Pahang River Basin that need to be solved with strategic and integrated approach i.e reduction of wetland area, massive land clearing for agriculture, shallow river, sedimentation and basin management. An institutional framework that consist of all river basin stakeholders from government, non-government organizations and individual is suggested in this study based on the issues arised which cover the scope for planner, implementer, user and preserver of the basin especially the land and water bodies. Integrated management approach is essential as it controls human activities in the basin that might affect the natural ecosystem functions and natural flood defence. The general basin characteristics were described in Table 3.1 and the issues, proposed strategies and agencies are shown in Diagram 3.1 while proposed coordination body for IRBM Pahang i.e. LUAP is shown in Diagram 3.3.

Table 3.1. General basin characteristics

General Basin characteristics	**Description**
Location	N 2° 48' 45" - N 3° 40' 24", E 101° 16' 31" - E 103° 29' 34"
Length	435 km
River bed slope	Sungai Pahang: 0.016% (1/6200) Sungai Jelai: 0.034% (1/2900) Sungai Tembeling: 0.024% (1/4100)
Catchment area	29,300 km^2 (27,000 km^2in Negeri Sembilan, 2300 km^2 in Negeri Sembilan)
Main geological features	Shale, Mudstone, Limestone & Rock
Ecosystem	-Lowland tropical rainforest • Lowland Dipterocarp forest: usually dense, with many thousands of species of trees as well as shrubs, herbs and woody climbers • Hill Dipterocarp forest: similar to lowland Dipterocarp forest • Upper Dipterocarp forest: characterized by *Shorea platyclados* -Lower and upper montane forest: *Fagaceae* and *Lauraceae, Preris ovalifolia, Rhododendron spp. and Vaccinium spp.* -Peat swamp forest and mangrove forest: along the coast -Forest plantation*: Pinus caribaea, Araucaria spp, Acacia mangium,Gmelina arborea* and *Paraserianthes falcatari*
Climate	-Daily minimum and maximum temperatures are around 23℃ and 32℃ (except in the highland) -Annual rainfall varies from 1700-2800 mm within the basin (mean annual rainfall obtained from 10 year)
Land used	Jungle, rubber, paddy, oil palm, other agricultural crops and urban
Geographical Regions	-Tributaries: Tembeling, Jelai, Lipis, Tekman, Kerau, Semantan, Triang, Bera, Jengka, Jempul, Luit, Mentiga, Lepar and Serting -Main lake: Lake Bera and Lake Chini

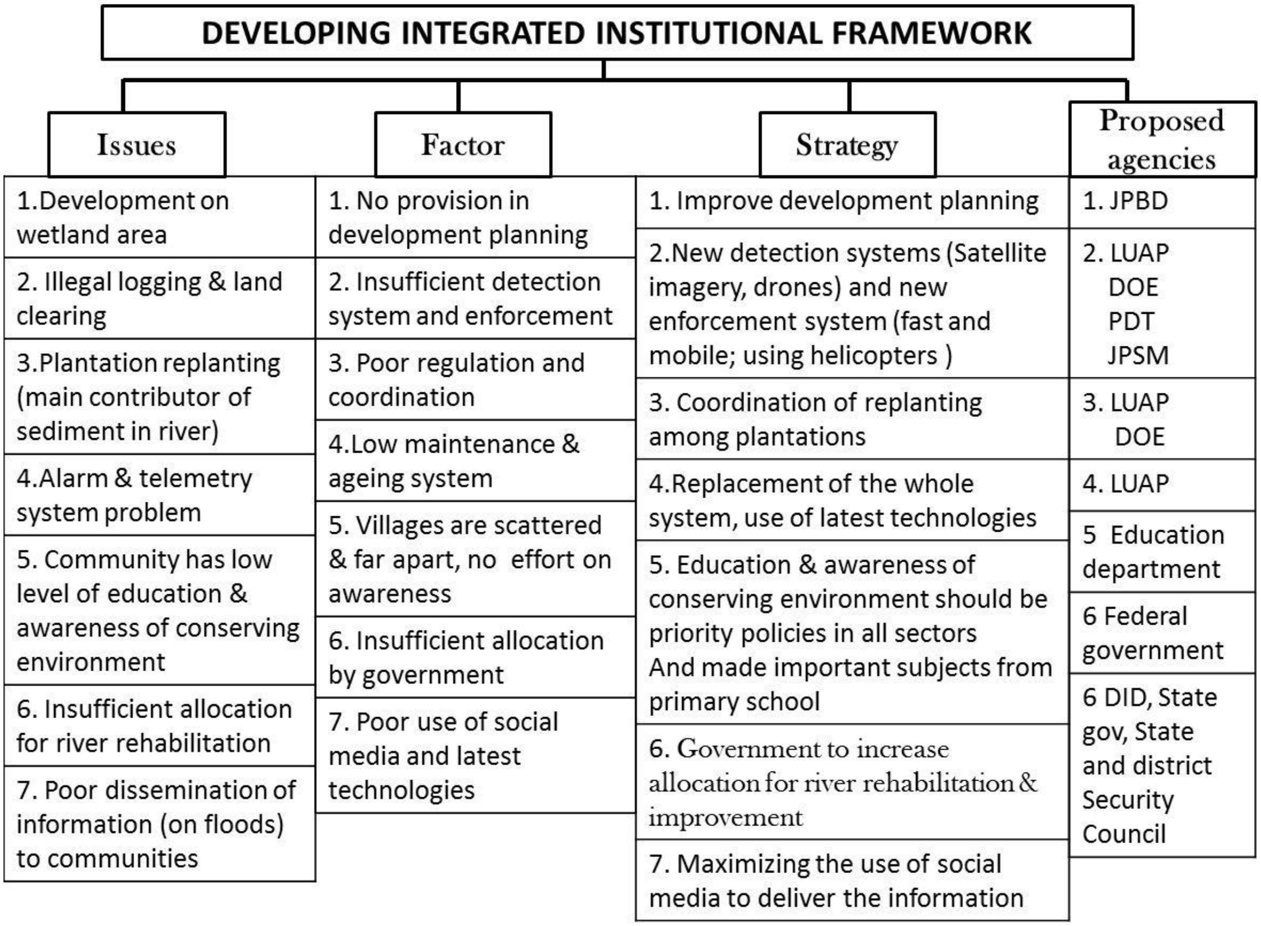

Diagram 3.1. Issues, proposed strategies and agencies

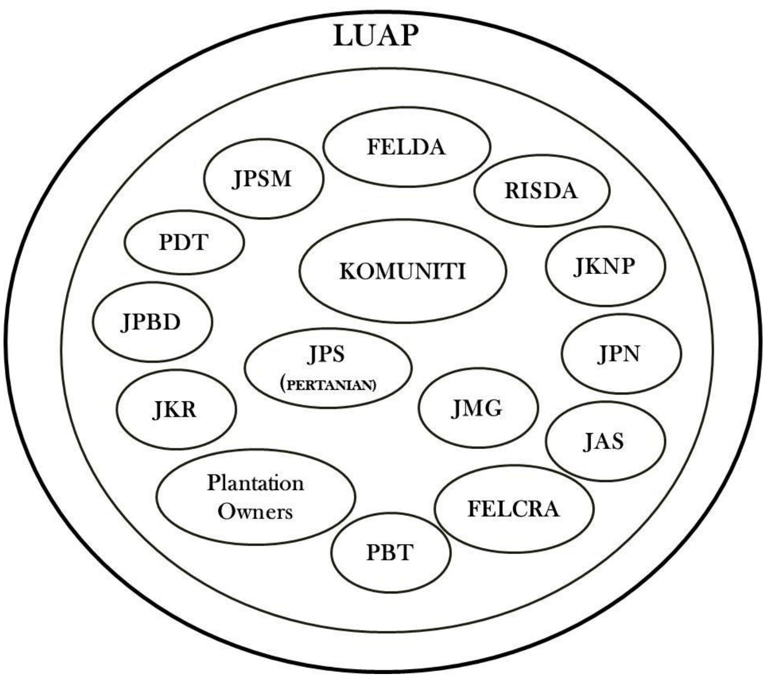

Diagram 3.2. Ordination body, Lembaga Urus Air Pahang, LUAP

4.0 Conclusion

Although the rainfall is the main natural factor that given impact to the changes of Pahang River, anthropogenic factor are always considered as the cruel factor that causes and worsen the whole natural scenario into more complicated way (Pan Ia Lun 2011). The findings of the study were summarised as follows:

4.1 The numerical data such as rainfall, water quality, water level and water discharged are the technical components to identify the sources of flood.

4.2 The heavy rainfall and high water level resulted as the sources of flood events. This is due to river water overflow from low absorption of rainfall from forest which caused by developments, deforestation, loggings and contributes in high sedimentation.

4.3 The size of the irrigation system is insufficient to bear the water flow rate and the tributary network is unable to withstand the large runoff. Increased reclaim of wetland area for development causes irrigation system to be narrowed and obstructed for the water to flow in to the tributaries.

4.4 Prevalent forest clearing and logging activity increased the water non-absorbent area, ground cutting for development purpose decreased the rain water absorption into the ground and increased surface water runoff, thus causes the watershed area decrease in its ability to hold water. Shallow estuary caused by high sedimentation from various activities leads to slow water conduction flowing from flood area to the sea. Most residential area are located at lowland and flood plain region coupled with bad irrigation system especially in big residential area also became the sources of flood and increase the flood risks.

4.5 The management and operating systems before, during and after flood event are also reviewed to be the important aspect in reducing flood impact. The cooperations between the stakeholders to take care of the basin area are the key to reduce the flood impact.

4.6 The result of this study also has revealed the roles and responsibilities of the stakeholders to take part in preserving the river basin. The surveys were purposely carried out to determine the level of awareness of agencies on IRBM, to determine the level of knowledge of agencies on IRBM, determine the preparedness of agencies on encountering flood with the application of IRBM concept and to know the action of agencies on encountering flood with the application of IRBM concept. The agencies involved are from the three districts. The results show the level of knowledge and awareness of agencies on IRBM is still poor and there is no policy which support IRBM, willingness to implement IRBM principles is still at low levels. Agencies are not conversant enough with IRBM concepts and IRBM concepts being inadvertently applied.

4.7 The main issues highlighted as the result of this study include the development on wetland area, deforestation and land clearing for agriculture, problem of alarm and telemetry system the low level of education and awareness of environmental conservation of the community, insufficient allocation for river rehabilitation, poor dissemination of information (on floods) to communities and increased number of rural poor subjected to basin flooding.

4.8 An institutional framework that consists of all basin stakeholders from government, non-governmental organizations and individual is suggested in this study This institutional framework suggested is known as Lembaga Urus Air Pahang (LUAP).

4.9 LUAP is meant to be introduced as purposely to coordinate the stakeholders and agencies while preserving the basin. All agencies should give high cooperation in playing their roles in order to preserve and maintain the river while considering all factors involved.

4.10 IRBM is a concept comprise all factors which include the environmental resources, socio-economic and the institutional frameworks. Implementation of IRBM may be the only way forward for the preservation of Pahang River Basin.

References

Pan Ia Lun, Muhd. Barzani Gasim, Mohd. Ekhwan Toriman, Sahibin Abd. Rahim & Khairul Amri Kamaruddin. 2011. Hydrological Pattern of Pahang River Basin and Their Relation to Flood Historical Event Volume 6, Number 1, 29-37, 2011. ISSN: 1823-884x

Department of Irrigation and Drainage (DID). 2000. Annual Flooding Report of Pahang State 2000. Department of Irrigation and Drainage Malaysia (DID Malaysia).

Department of Irrigation and Drainage (DID). 2005. Annual Flooding Report of Pahang State 2005. Department of Irrigation and Drainage Malaysia (DID Malaysia).

Jabatan Meteorologi Malaysia (JMM). 2010. Monsun. Portal Rasmi Jabatan Meteorologi Malaysia.http://www.met.gov.my/index.php?option=%20com_content&task=view&id=69&Itemid=160&limit=1&limitstart=0. Jabatan Meteorologi Malaysia.

Japan International Cooperation Agency (JICA). 2011. The Pre-paratory Survey For Integrated River Basin Management Incorporating Integrated Flood Management With Adaptation Of Climate Cahange. *Final Report : Volume 3 – Pahang River Basin. Tokyo : JICA, No. GED CR (11-031)*

6.4: INTEGRATED APPROACH FOR AIDING DECISION MAKING PROCESS FOR BETTER FLOOD DISASTER RISK MANAGEMENT

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1.0 Introduction

Floods affect many people by destroying their houses, properties and livelihoods. Resilience to flooding conditions within communities have over the years deteriorated. The anthropogenic development activities transform more natural Pahang River Basin into a rapidly changing anthropogenic cultural landscape. This ongoing rapid transformation make this river basin prone to disasters and people living in this river basin and flood plains become more vulnerable. With the increasing of more anthropogenic development activities and infrastructural settlements, peoples' vulnerabilities also increasing regardless their socio-economic and cultural condition.

In reality, avoiding risk is generally not an option for people with little financial and material resources. Therefore, design and technological solutions sponsored by the community offer the most viable risk reduction mechanism available to the majority of people. That is why it is important to involve designers in this process of risk assessment and risk reduction planning. Disaster-resistance and disaster-resilience are two concepts in disaster management that have different focuses. Disaster-resistance focuses on preventing disasters from happening, while disaster-resilience focuses on recovering from damages caused by disasters. These two concepts are not mutually exclusive. A community could be both disaster-resistant and disaster-resilient. Resilient communities are flexible and resourceful. They have many ways to recover from a disaster (Kalema, 2013; Designboom, 2013). A resilient community has these characteristics: knowledge, health of its members, and wealth. The kind of knowledge that matters most immediately after a disaster is knowledge about how to survive in the conditions that prevail in the aftermath of the disaster, how to obtain the necessities of life such as food, water, shelter, safety and security. Only after these basics are obtained could people turn their attention to the task of reconstructing the community.

In fact, the rural and urban settings and infrastructures varies at a great deal and so on their types of vulnerabilities. Therefore, the traditional disaster mitigation measures mostly found ineffective and failed to serve for the long run. It is therefore important to design for innovative structures or planning to mitigate disasters like floods for long lasting period. In the case of rural area, the culture of farming and slope protection management by planting indigenous crops and plants which is a part of flood resilience have since eroded. The local communities within peninsular Malaysia including Pekan have very little skills to exploit the vast benefits of bamboos which are now known to be useful in flood mitigation and adaptation. Other than shelters, bamboo has many other economic benefits as it can be utilised as raw material for joss sticks, poles, flooring, baskets, handicrafts, food, forage, bio char (Wong, 1989; Belcher et al 1995: Poh et al, in press), a good substitute for timber in producing high value added products (Azmy et al, 2009; Drunkelberg 1992) and even for energy (Langford, 2014). There is also a lack of understanding about the usefulness of bamboo among government bodies and local voluntary organisations for disaster preparedness and prevention. Therefore bamboo has not been incorporated in regulations and policies pertaining to flood disaster management.

2.0 Methodology

1) Identification of risk zones: Unsuitable infrastructures that influence flood and flash flood will be identified. GPS will be used to get point data of these settlements, Remote Sensing and GIS technology will be applied.

2) Delineating potential area for infrastructural designing and planning. Expert judgment will be taken through field visit, focus group discussion and inviting experts from international and national institutions. Rehabilitation and shelter centre, identifying risk zones for development, key environmentally sensitive areas etc. (Remote sensing and GIS).
3) Designing integrated shelter centre and a plan for proper distribution (Structural design, expert judgments, capacity building through consultation and training).
4) Designing integrated shelter centre and delineating potential area (structural software programme, GIS, RS, etc.)
5) A social survey will be conducted to assess the readiness of stakeholders for the adoption of bamboo cultivation as a way to increase the resilience of flood affected communities.
6) Training on proper bamboo cultivation and utilization for the purpose of flood prevention and adaptation to be conducted for participants from selected from flood affected areas.
7) Evaluation of the training and workshops to be conducted through a structured survey.
8) Workshops on awareness of the importance of innovative structures and cultivation (i.e., bamboo cultivation, terrace structures) in
9) Workshops on awareness of the importance of innovative structures and cultivation (i.e., bamboo cultivation, terrace structures) in flood affected areas, strategies and policy recommendations.

3.0 Results and Discussion

3.1 Flood risk zones and structures

Using Landsat satellite images and GIS technology based on ENVI software, an approximation of a flood risk map was produced (Figure 1). The 2014 and 2015 flood affected population and their houses have been visualized in this map and showed a considerable proportion of the residents living in the flood disaster risk zones of this river basin area. Figure 2 shows the households located within the flood risk zones according to the degree of risk. In addition, the position of shelter centers are demarcated as green circles. From the analyses of these maps, it is revealed that the proportion of the shelter centers versus the affected populations are not adequate. These maps, therefore, revealed clearly that the areas need more shelter centers to support disaster affected population. The appropriate authority should take action in a priority basis to designate and design more shelter centers in the High Risk Zone areas in order to save the population from the potential threats in the coming monsoonal period.

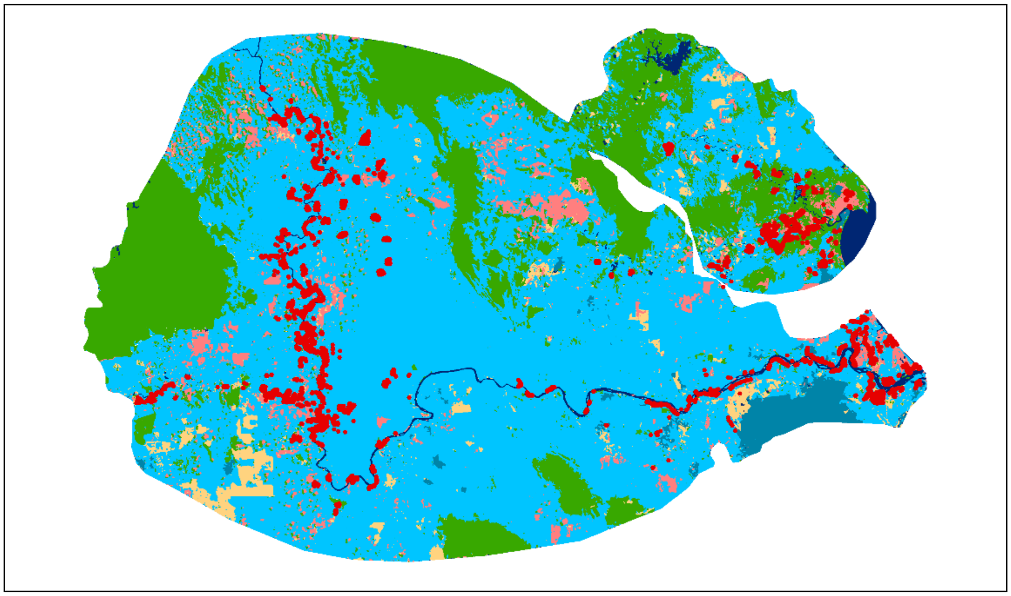

Figure 1. Distribution of population residing in the flood disaster risk zones along the Pahang River Basin. Red colour denotes areas with houses located within the flood disaster risk zones which have been experiencing long duration of inundation during the 2014 and 2015 flood.

Evacuation centers are the main shelters during flood events. Proper selection of sites can guarantee citizens' safety rights, prevent life and property loss and maintain trusting relationship between citizens and the government (Yang et al, 2012). The present study revealed that the selection and gazetting of evacuation centers were conducted through a hierarchy of appropriate typologies as well as location. Typology consideration includes, capacity, available facilities, and sustainability of maintenance, proximity to flood affected areas, elevation and management. Table 1 are examples of typical evacuation centers studied with various typology and location.

Schools are prioritized to be used as evacuation centers due to several good reasons. However, the themes and objectives of the Sendai Framework for Disaster Risk Reduction must be put into action especially the concept of "Build Back Better". Schools and other buildings that have been identified as suitable evacuation centers should be designed to be adaptable and multifunctional. The Sphere Project emphasises on safe public design and construction. Temporary and permanent public buildings such as schools should be constructed or repaired to be disaster-resilient. Accessibility for those with mobility, visual or communication problems must also be considered. It should also be considered whether it is necessary to build permanent evacuation centers instead of relying on public buildings. If not, more public buildings and public spaces should also be designed to serve as evacuation centers to eliminate the sole dependency on schools.

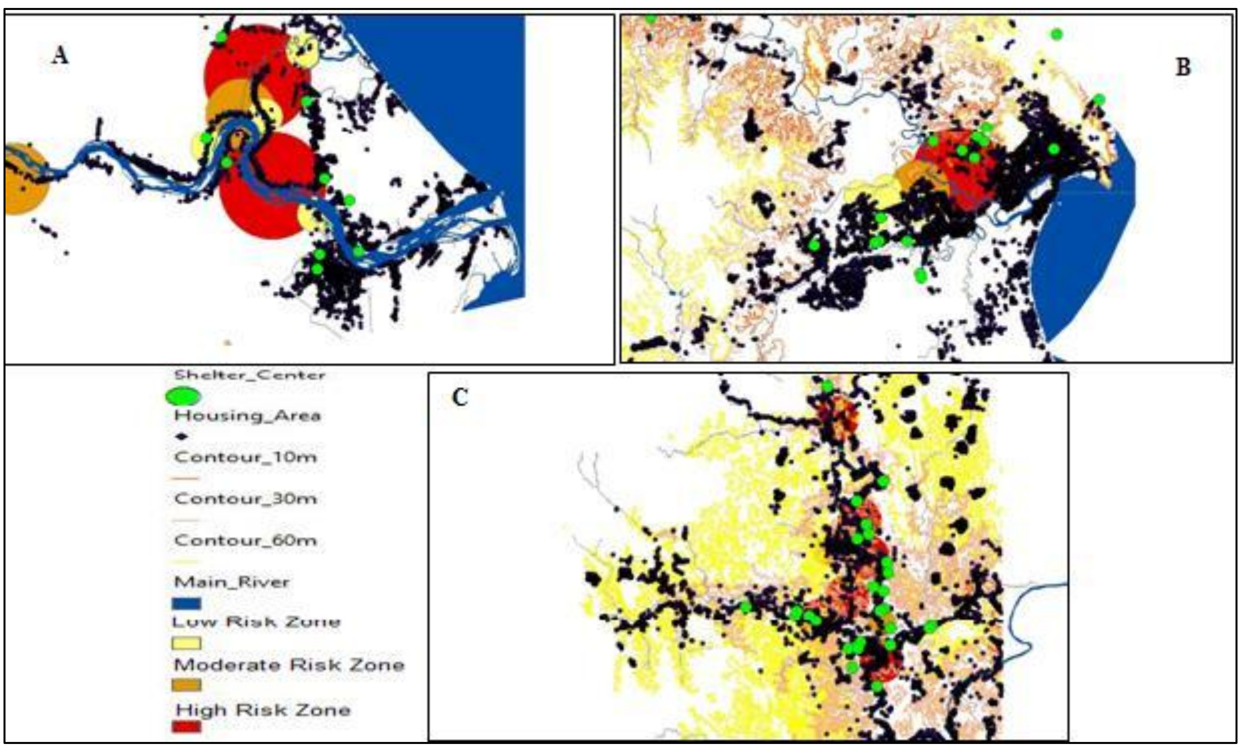

Figure 2. Map showing flood disaster population and shelter centers in (A) Pekan; (B) Kuantan and (C) Temerloh.

On the issue of evacuation center location, it was found that during the December 2014 floods, several of the gazetted evacuation centers could not be used as they themselves were inundated by the floods and were either damaged or could not be accessed. Having assessed the evacuation centers in the vicinity of Temerloh based on the Sphere Project guidelines, the study concluded that not much development is needed in terms of structural strength but rather on the design, management strategies and logistics that are involved in using evacuation centers. Recommendations for further improvement in flood resilience of evacuation centers in the area include input from and action by all parties including the local community, city council, academicians and the private sector; an up-to-date data collection and information be made available in order to comprehensively understand the geographical and socio economic changes; in terms of land use and landform and local people's needs. An integrated approach which utilises GIS technology should be used to understand the affected sites and the best locations for evacuation sites (Yang, 2012). While the use of LIDAR technology for mapping structures and landscapes may be expensive at this point in time, the high geospatial accuracy exhibited by such maps should be given consideration for investment to give accurate guidance for land use planning for disaster risk reduction (Serafica, 2013).

Table 1. Suitability evaluation of evacuation centers according to Sphere Project guidelines: some examples

Typology	Name of School		
	S.K Temerloh Jaya	S.K.Khee Chee	S.K Teluk Ira
Capacity	2400 people	500 people	250 people
Site planning - elevation	Flat	On high ground	Flat
- building elevation	3-storey academic block, single storey canteen	4-storey academic block and 3-storey multi-purpose block on high ground, canteen on a level below	4-storey block with several single storey blocks for classrooms, hall, canteen, toilets
- landscaping	Well managed landscape around the campus	Large trees and small vegetation	Surrounded by oil pal plantation
- parking area	Available (large space)	Available (limited)	Available
- open space	Tarmac ground	Full size open field on the lower ground with amphitheater	Tarmac ground, small gardens and mediem sized field
Materiality	Brick and concrete, noticeable cracks	Brick and concrete well maintained	Brick and concrete, noticeable cracks, timber
Functionality - toilet	Sufficient – provides washroom at each floor of each block	Good number of washrooms found each floor of each block and separately to service the hall	Sufficient. Each floor has toilets (in the 4-storey block) and another separate blocks for toilets
- hall	N.A	Very spacious, good facilities, well maintained	N.A
- Canteen	Single-storey, located away from academic block. May be out of reach for those with mobility difficulties	Single-storey, located at a level below the multipurpose hall. May be out of reach for those with mobility difficulties.	Separate block for the canteen, adequate for school, might be too small for evacuees
- Others	-	Additional water storage tank on ground level	Few blocks including canteen were affected during 2014 flood up to 2-3 inches water level
Flexibility- buildings/ spatial layout	Buildings are in close proximity to each other but far away from the entrance	The essential spaces are interconnected	A few courtyard spaces (as assembly spaces) in between building blocks
- others	-	Shaded basketball court can be assembly place as well; a multipurpose hall provided with toilets	Partition instead of brick walls in classrooms, better flexibility
Other consideration	Adjacent to SMK Temerloh Jaya	-	-

For post-disaster reconstruction, many shelter home designs fail to be practical as the designs were not made in consultation with the community and their livelihoods in mind (Goodier, 2015). Priority 4 of the Sendai Framework which stipulates that flood risk management has to take into account how post-flood structural design can be used and improved effectively by involved communities. Resilient structures are designed in such a way as to cut down the cost and time required to rebuild and reuse should it be flooded. Alternatively, finishes can be designed to be removable or sacrificial and easily replaced in the zone affected by flooding. The design should be culturally appropriate, and preferably involving participation of local community members at the construction stage. Robust materials and finishes should be used. The materials used should take into consideration costs, availability, and ease of transport. In a life cycle assessment study comparing local and global materials for construction of shelters, Escamilla and Harbert (2015) found that although global materials such as steel and concrete are generally more superior in terms of providing efficient structures that can resist natural hazards, these materials incur a much higher embedded energy than local materials such as bamboo and wood. Local materials have the added advantage of having higher potential for low environmental impacts and cost. Design consideration is of the utmost importance in using local materials in providing structures that resist natural hazards. Among all the materials studied, bamboo based shelters incur the lowest impact and cost pre functional unit. Locally, in Malaysia, wood has become an unsustainable material and costly as there are now high restrictions for logging. Bamboo has traditionally been used for construction of temporary shelters. In recent years, rural communities in many countries emphasizes on sustainable construction material such as bamboo to mitigate floods. For instant, Bishwakarma et al. (2010) Mercy Corps have successfully implemented bamboo crib walls to mitigate river bank erosion during floods in Nepal. However, the local Malaysian populace has, in effect, lost the skills in bamboo construction due to the overdependence on global materials in the nation's development. Although bamboo can be found all over the country, the accessibility for the utilisation of bamboo as construction material is limited. It is apparent that with proper planning for skills building in bamboo construction and a concerted effort to plant bamboo species for construction, bamboo can be the sustainable material of choice for disaster reconstruction for the country in the foreseeable future.

3.2 Ecotourism for livelihood and resilience

Structural measures for disaster risk reduction often times can only be effective when the design and construction of the structures was conducted in consultation and involvement of the community that is well informed of flood disaster risks and whose livelihoods may be enhanced or not be threatened by these measures. These measures, therefore, need to be culturally acceptable to the community in its design and location. Flood plains with its attendant natural beauty and natural resources can be exploited for ecotourism and thereby enhancing the community's income and economy. Table 1 lists the livelihood assets related to ecotourism potential for the area of Kg. Mengkarak, which is a small village on the bank of Pahang River. Figure 3 illustrates several design ideas based on bamboo for the development of ecotourism in the Pahang River area.

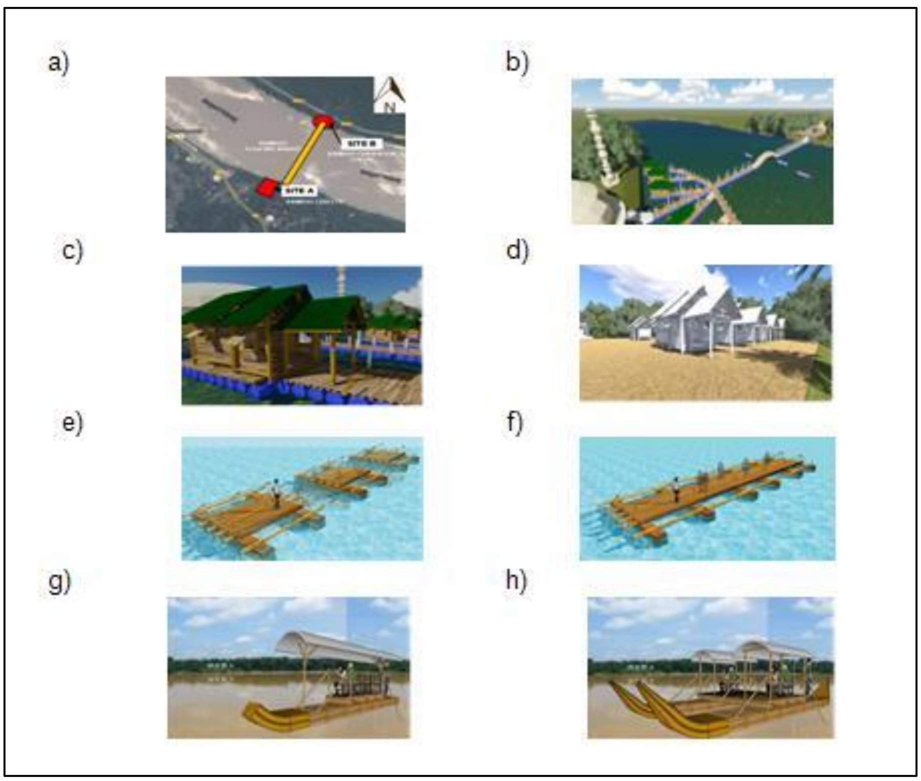

Figure 3. Bamboo value creation for ecotourism in Mengkarak Bera Waterfront, Pahang a) Site of activity b) Mengkarak bamboo based design proposal for floating bridge and floating houses c) bamboo floating houses d) bamboo shelter homes which can be converted to homestays e) modular bamboo bridges f) joined modular bamboo bridges g) single bamboo catamaran f) double bamboo catamaran

4.0 Conclusion

Following are the major findings of this project. It can be assumed that these may able to contribute significantly for the structural resilience and community resilience for long term flood risk management in the Pahang River Basin area.

4.1 Flood risk zones have been delineated and mapped. This map has potential sue for the flood disaster risk management along the Pahang and Kuantan River Basin.

4.2 The distribution of shelter centers and approximates areas of severity of risk to flood disaster for Pekan, Temerloh and Kuantan has been delineated and mapped. This risk map can be used to design more shelter centers required to safeguard people’s life from the future flood disasters.

4.3 Some policy recommendations include addressing potential improvements in critical facilities (refer to SPHERE Project), to consider designing of post disaster temporary houses based on sustainable and renewable material such as bamboo and to support livelihood options for the community that does not threaten flood protecting infrastructure and sustainable at the same time with the intention for stakeholders to apply in order to enhance the level of structural and community resilience in the Pahang River basin. Moderate correlations were found between peak flow and flood volume as well as flood.

4.4 Several approach and ideas have been designed based on bamboo for the development of ecotourism in the Pahang River Basin area. It has been identified that the alternative approach for ecotourism and livelihood development is important to build up resilience and change the attitude of the community towards eco-centric and thus helpful for long-term flood mitigation.

4.5 Workshops on awareness of the importance of innovative structures and cultivation (i.e., bamboo cultivation, terrace structures) in flood affected areas have conducted and it recognized local leaders and community are interested for the approach which is a good sign to build up resilience among the affected community.

References

Azmy, H. M., Wan Rashidah, W.A.K., Rasminah, H., and NurMastura H.A. 2009. Early performance trial of four Malaysian commercial bamboos in southern Peninsular Malaysia. Borneo Science 25:81-86.

Belcher, B., Karki, M. and Williams, T. (eds.) 1996. Bamboo, People and the Environment: Socio-economics and Culture. Prov. 5th I’nal Bamboo Workshop and the 4th I’nal Bamboo Congress, Bali, Thomson Press, New Delhi.

Bishwakarma, M.C., Pokharel, S. and Gautam, S. 2010. Bamboo and bioengineering interventions for mitigation of river bank erosion: a case study. Kailali disaster risk reduction. Mercy Corps Nepal, Ulla Dons.

Designboom, 2013. Low cost bamboo housing in Vietnam by H & P Architects. Designboom 8 Apr 2013. http://www.designboom.com/architecture/low-cost-house-for-middle-vietnam/

Dunkelberg, K. 1992. Bamboo as a building material, in: IL31 Bambus, Karl Krämer Verlag Stuttgart

Escamilla, E.Z. & Habert, G. 2015. Global or local construction materials for post-disaster reconstruction? Sustainability assessment of twenty post-disaster shelter designs. Building and Environment 92 (2015) 692e702. Retrieved 7 Nov 2015.

Goodier, R. (ed.) 2015. Engineering for change.11 Nov 2015. Emergency shelter for the people: Four questions with Tom Newby. Retrieved 7 Nov 2015, https://www.engineeringforchange.org/emergency-shelter-for-the-people-four-questions-wi om-newby/th-t

Kalema, A.N. 2013. Controlling Floods with Bamboo. Agri pro-focus 17 May 2013.

Langford, K. 2014. Could bamboo be the bioenergy of the future? Agro-forestry World Blog, 10 Oct 2014. http://blog.worldagroforestry.org/index.php/2014/10/10/could-bamboo-be-the-bioenergy-of-the-future/

Poh, L.V., Mohd Shahwahid H.O and Judi, S. 2016. Kajian Industri Buluh di Semenanjung Malaysia. Ibu Pejabat Perhutanan Semenanjung Malaysia, Kuala Lumpur.

Serafica, R. 2013. LiDar flood maps completed for disaster risk reduction. Retrieved 7 November 2015, http://www.rappler.com/move-ph/41611-lidar-flood-hazard-maps-completed

Wong, K.M. 1989. Current and potential uses of bamboo in Peninsular Malaysia. J. Amer. Bamboo Soc. 7(1 & 2): 1-16.

PROJECT 7 : REGENERATING FARMERS' INCOME POST-FLOOD THROUGH SUSTAINABLE AGRICULTURAL PROJECTS

7.1: POSSIBILITIES OF REJUVENATING POST-FLOOD RUBBER TREES USING AERATION AND ANTI-HYPOXIC COMPOUNDS, AND INTER CROPPING TREE ROWS WITH MISAI KUCING, AND HEMPEDU BUMI FOR REGENERATION OF FARMERS' INCOME

Project Information

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1.0 Introduction

Recent prolonged flooding in Kelantan caused severe stress to rubber trees that led to loss income for farmers because their rubber trees were severely affected. Oxygen limitation to the plants especially to the roots is a common occurrence in crop plants after prolonged flooding. Rejuvenation of the plants is possible through application of oxygen rich compounds to rhizosphere which will enhance new root growth. Flooding can adversely affect seed germination, seedling establishment, impair growth and development of plants leading to serious reduction in crop productivity and even crop losses (Araki *et al*., 2012; Boonlertnirun *et al*., 2013). Severity of these effects however depends on crop species and the length of their exposure to hypoxia. However, most crop plants including rubber trees are typically sensitive to hypoxia (Wandman-van Schravendijk and Van Andel, 1985). Moreover, roots are especially sensitive to oxygen deficiency which can accrue rapidly in waterlogged soils as diffusion of air in saturated soils is relatively low.

Prolonged flooding in Kelantan on December 2014 caused waterlogged soil (low air diffusion in soil) and plant hypoxia (oxygen limitation especially to the roots). These factors affected rubber plant growth, latex productivity and subsequently, farmers' income. Main objective of this study was to regenerate farmers' income post-flood through plant rejuvenation and inter cropping. Study conducted based on two sub-objectives:

1) to compare the effectiveness of oxygen-rich peroxides with aeration in alleviating the adverse effects of hypoxia on the growth and development of rubber trees, and
2) evaluate the suitability of misai kucing and hempedu bumi for inter cropping with rubber trees and the economics of the cropping system.

2.0 Methodology

Research locations had been identified near Kelantan River Basin which were affected by December 2014/January 2015 big flood. Two rubber planted areas have been identified, Kampung Sungai Nal,Kuala Krai (KN) and Kampung Berchang Bukit Panau, Tanah Merah (BP). Rubber trees in both locations were partially submerged and latex production decreased post flood as communicated verbally by the owners of the land. Samples for preliminary analysis have been collected from selected sites and subjected to physicochemical properties and soil texture analysis. This information were gathered as part of pre-treatment data collection. Soil and leaf samples were taken in June 2015 from identified locations. The samples were air-dried, ground in a mortar (for soil sample) or grinder (for leaf sample) to obtain 2 mm size. Samples were extracted by Mehlich III method (Mehlich, 1984) and Ca, K, Mg and P analysis were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), Optima 8300, Perkin Elmer. Total C,N and S were analyzed by CNS TruMac Determinator (Leco, USA). Mechanical analysis for the determination of soil texture were conducted accordingly to Sung and Talib (2006) method.

To achieve first objective, which is to rejuvenate the silted land, different treatments were conducted on August 2015 (T_1: control, T_2: fertilizer only, T_3: fertilizer + Zappa™ 1%, T_4: fertilizer + Zappa™ 2%, T_5: fertilizer + hydrogen peroxide 1%, T_6: fertilizer + hydrogen peroxide 2% and T_7: fertilizer + BioAdd®). Rubber yield expressed in gtt (gram per tapping per tree) for both locations (KN- latex and BP-cup lump) were recorded for five cumulative months (August,2015 to January,2016). As for second objective, to evaluate the suitability of misai kucing and hempedu bumi for intercropping under rubber ecosystem, one month herbs seedlings were transplanted in selected rubber planted areas, Kuala Nal (Misai Kucing) and Bukit Panau (Hempedu Bumi). About 2,000 seedlings were transplanted per location with planting distance of 0.5m x 0.4m (20,833 plant/ha). Effects of intercropping on rubber productivity was also evaluated based on rubber yield (gtt). Herbs were harvested five months after transplanting and growth as well as yield of herbs were determined based on plant height, fresh and dry biomass. All experiments were conducted using Randomized Complete Block Design (RCBD). Data collection of soil samples and rubber yield were subjected to the analysis of variance and means were compared using the Least Significant Difference (LSD) test at the 0.05 probability level. Tissue samples data were analyzed using a Student's t-test. All statistical analyses were performed using SAS software, Version 9.3.

3.0 Results and Discussion

3.1 Soil Physicochemical Characteristics

Soil and leaf samples for pre-treatment analysis have been collected from both locations and subjected to pH and physico-chemical properties analysis. The pH of soil samples in both location were acidic which ranged from pH 3.30 – 4.16 with values decreasing with the depth of soil. Soil texture analysis determined showed that the soil texture as clayey for both sites (Kuala Nal and Bukit Panau) indicated the slow drainage rate. Soil chemicals analysis post-flood conducted indicated that soil pH, total nitrogen content, available P, potassium and magnesium which are crucial for plant development and productivity were very low compared to the recommended values. Based on soil textural triangle, soil samples from both locations and soil depths were identified as clay textured type which is known for its poor water penetration (infiltration) characteristic due to highly dense and saturated soils (Figure 1).

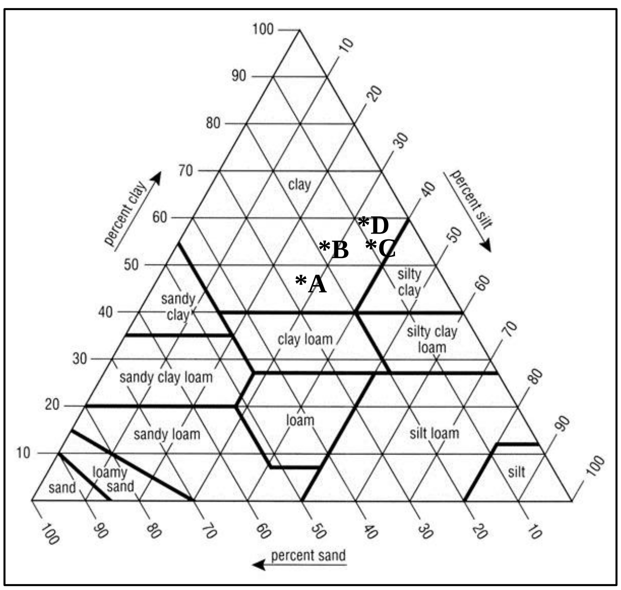

Figure 1 Soil texture for different soil samples and depth based on soil textural triangle represented by *. A: KN (0-15cm), B: KN (15-45cm), C: BP (0-15cm) and D: BP (15-45cm). All soil samples were categorized as clay textured type

Physicochemical and fertility of soils improved through liming, fertilization and treatments. Liming activities conducted in late November, 2015 to overcome the soil acidity problem managed to increase soil pH ($p>0.05$) compared to values before treatment. Percent increment were 12-25% (K. Nal) and 25-47% (B. Panau). According to Zalidis et al. (2002) acidification causes the depletion of the soil's buffering capacity and decline of soil fertility. Therefore, treatment to overcome the soil fertility issue should become a priority to evade serious reduction in crop productivity. Based on Total C results, most sediment from treatments contained 2.6-3.5% (total C x 1.724) organic matter which was considered as sufficient for normal crop growth.

3.2 Land Productivity Response to Soil Treatment

Fertilizer+BioAdd® treatment recorded the highest land productivity ($p>0.05$), 443 kg/ha with the highest percentage of increment (43%) compared to untreated plot in Kuala Nal (Figure 2a). In Bukit Panau, all treatments produced higher land productivity (kg/ha) compared to control (Figure 2b).

Figure 2.Land Productivity during 6 Months Tapping, from August 2015 to January 2016,
a) Kampung Sungai Nal,Kuala Krai and b) Kampung Berchang Bukit Panau, Tanah Merah.
Data values are means of triplicate plots. Means by the same letter within a column are not significantly different (LSD $\alpha = 0.05$)

Experiment demonstrated the importance of soil treatment to enhance the soil quality as well as to minimize the adverse effect of flood to rubber productivity. Minimal treatment to reduce the flood effect is by applications of lime and fertilizer. Subsidies or incentive grants should be provided for the rubber tappers post-flood to enhance their livelihood. Nutrient availability to plant is related to soil pH and soil amelioration that could be done through liming. Low pH leads to aluminium toxicity which eventually affected plant growth as well as land productivity.

3.3 Misai Kucing and Hempedu Bumi Intercropping Under Rubber Ecosystem

Rubber yield was not affected by misai kucing and hempedu bumi intercroppings based on non-significant yield values ($p>0.05$) after six months transplanting for both locations (Figure 3). Plot with intercropping program recorded higher value of land production compared to the control plot. This trial proved that intercropping did not affect the main crop i.e. rubber yield even though land preparation might have tendency to damage and disturb root system of the rubber trees. This could probably be due to tillage during soil preparation for intercrop increased root proliferation and improved the soil texture Ji et al. (2013).

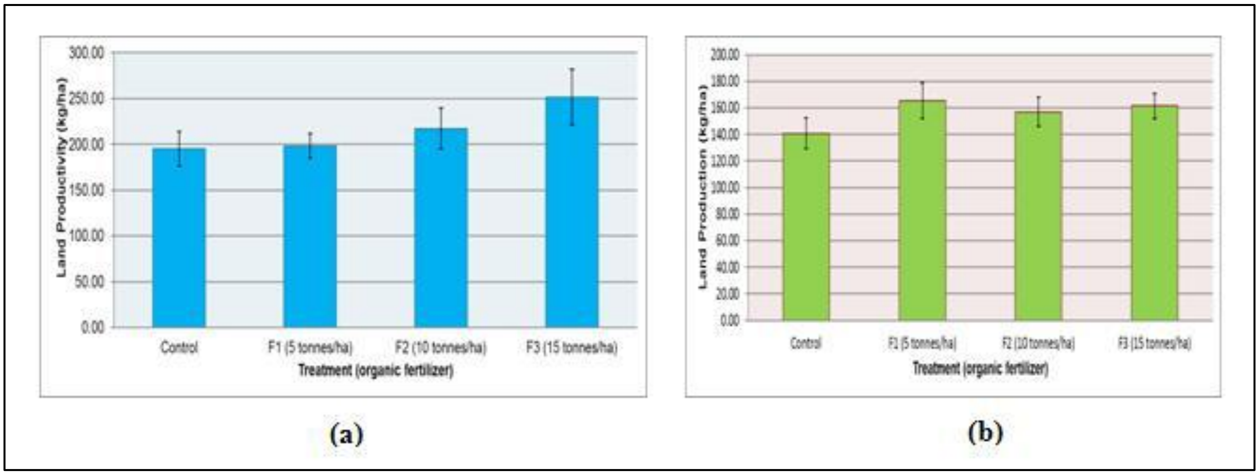

Figure 3. Effect of herbs intercropping on rubber productivity. a) Misai kucing in Kuala Nal and b) Hempedu bumi in Bukit Panau. Data values are means of triplicate plots. * No significant difference within treatment based on analysis of variance (ANOVA)

In this case, compact and dense soil due to flood was indirectly aerated and thus, hypoxia (waterlogged or low air diffusion in soil) effect can be reduced.

3.4 Growth and Yield of Misai Kucing under Rubber Ecosystem

Table 1 Effect of different rates of fertilizer on growth parameters and yield of Misai Kucing. Data values are means of triplicate samples. Means by the same letter within a column are not significantly different (LSD α = 0.05)

Treatment	Plant Height (cm) *	Branch No. *	Fresh Biomass (g)	Dry Biomass (g)	Plant Production (kg/ha)
F_1 (5tonnes/ha)*	88.25	9	84.83^{b}	15.54^{b}	1738.30^{b}
F_2 (10tonnes/ha)*	84.83	10	116.83^{ab}	19.00^{b}	2394.00a^{b}
F_3 (15tonnes/ha)*	75.58	12	151.83^{a}	26.91^{a}	3111.20^{a}

*No significant difference

Table 1 showed that the highest (p>0.05) Misai Kucing biomass and plant production (kg/ha) was recorded in F_3 treatment (15 tonnes/ha). Highest plant production demonstrated in F_3 treatment, 3111kg/ha compared to F_1 treatment (5 tonnes/ha), 1738kg/ha. Low value of all elements in Misai Kucing leaf tissues indicated low plant uptake due to several factor such as treatments only utilized organic fertilizer which itself low in nutrients and heavy rainfall and heavy water flow resulted in surface runoff that washed the nutrients away. Research constraints which affected the herbs yield were animal intruding and temporary flood occurrence due to heavy water flow (heavy rain) which led to deterioration of herb plant quality. However, this experiment proved that land use efficiency of rubber land is possible to be increase if intercropping is implemented to generate farmers' extra income.

Figure 5. Misai kucing intercropping under rubber ecosystem

4.0 Conclusion

As a conclusion, it can be are summarized as follows:

4.1 Due to prolonged flood, soil become acidic indicated by low pH which affected the growth and productivity of rubber.

4.2 Lime treatment is important to alleviate the effect of soil acidity. In terms of cost, fertilizer treatment or BioAdd ® is able to increase the yield and improve soil fertility.

4.3 Intercropping does not affect rubber yield. In fact, rubber yield increased from intercropping plots. Ploughing, land preparation and intercropping activities increased the aeration, stimulate new growth of root hairs and improve soil structures.

4.4 Market availability aspect should be taken into consideration to ensure the herbs is demanded and therefore marketable.

4.5 However, extensive research should be conducted with adequate period of time. This is important when working with perennials like rubber where responses can fully be seen only after 6-12 months of treatments.

References

Araki, H., Hossain, M.A. and Takahashi T. (2012) Waterlogging and Hypoxia Have Permanent Effects on Wheat Growth and Respiration. *Journal of Agronomy and Crop Science*, 198, 264-275. http://dx.doi.org/10.1111/j.1439-037X.2012.00510.x

Armstrong, W., 1980. Aeration in higher plants. Adv Bot Res. 7:225-232.

Boonlertnirun, S., Suvannasara, R. and Boonlertnirum, K. (2013) Effects of Hypoxic Duration at Different Growth Stages on Yield Potential of Waxy Corn (*Zea mays* L.). *International Journal Biological*, *Veterinary*, *Agricultural and Food Engineering*, 7.

Attoe, E.E. and U.C. Amalu. 2005. Evaluation of phosphorus status of some soils under estate rubber (*Hevea brasiliensis* Muel. Argo.[sic]) trees in Southern Cross River State. *Global J. Agric. Sci.* 4(1): 55–61.

de Carvalho, A., Lira,J.M.S., de Oliveira, L.E.M., de Cavalho, J.N., Domiciano, D., Cardema, H., Vegetal, F, 2012. Nitrate addition improves photosynthesis and flooding tolerance of rubber tree plants. *Australian Journal of Crop Science AJCS*, 9(7), 684-689.

Drew MC (1997) Oxygen deficiency and root metabolism: injury and acclimation under hypoxia and anoxia. *Ann Rev of Plant Physiol Plant Mol Biol*. 48:223-250.

Ji, B., Zhao, Y., Mu, X., Liu, K. and Li, C. (2013) Effects of tillage on soil physical properties and root growth of maize in loam and clay in central China. *Plant Soil Environ*. 59(7): 295-302.

Mehlich, A., 1984. Mehlich No. 3 soil test extractant: a modification of Mehlich No. 2. *Commun. Soil Sci. Plant Anal*., 15, 1409–1416.

Oku, E. Iwara, A, Ekukinam, E, 2012. Plantation on pH, Organic Carbon, Organic Matter, Nitrogen and Micronutrient Status of Ultisols in the Humid Forest Zone of Nigeria. *Kasetsart J. (Nat. Sci*), 46, 684-693 (2012)

Rodrigo, V.H.L., Stirling, C.M., Silva, T.U.K, Pathirana, P.D. 2005. The growth and yield of rubber at maturity is improved by intercropping with banana during the early stage of rubber cultivation. *Field Crops Research*. 91(1): 23-33

Rodrigo, V.H.L., Stirling, C.M., Naranpanawa, R.M.A.K.B., Herath, P.H.M.U. 2001. Intercropping of immature rubber in Sri Lanka: present status and financial analysis of intercrops planted at three densities of banana. *Agroforestry Systems*. 51 (1), pp35-48

Shin, R., Berg, H. and Schachtman, P. (2005) Reactive Oxygen Species and Root Hairs in Arabidopsis Root Response to Nitrogen, Phosphorus and Potassium Deficiency. *Plant Cell Physiol*. 46(8): 1350-1357.

Sung, C.,T.,B. And Talib, J., 2006. Soil physics analysis. Universiti Putra Malaysia Press, 1-6, Serdang, Malaysia.

Wadman-van Schravendijk, H., and O.M. van Andel. 1985. Interdependence of growth, water relations, and abscisic acid level in *Phaseolus vulgaris* during waterlogging. *Physiol. Plant*, 63, 215-220.

7.2: THE IMPACT STUDY OF FLOOD AGRICULTURE AND INTERVENTION PROGRAM TO REGENERATE INCOME OF FARMERS

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1.0 Introduction

A flood is defined as "an abnormal progressive rise in the water level of a stream that may result in the overflowing by the water of the normal confines of the stream with the subsequent inundation of areas which are not normally submerged". Some empirical works on the impacts of natural disasters on agriculture have also been conducted. Loayza, *et al*. (2009) found that, in contrast to the weak effects on overall GDP growth, droughts and storms have negative impacts on agriculture while floods have a positive effect. Sivakumar (2005) explained that the predominant impacts of natural disasters on agriculture are negative. Long (1978) argued that the negative effects are a powerful partial explanation of the lack of agricultural self-sufficiency in a large number of low income countries and consequently go some way towards explaining the occurrence of hunger and poverty in these countries. The impacts of natural disasters on natural resources and the environment have also been investigated in the literature. Sivakumar (2005) explained that natural disasters cause environmental degradation which in turn contributes to the disaster vulnerability of agriculture, forestry and rangelands. Extension program and activities can help the farmers to redevelop their live again after the flood. The intervention through program or agriculture project need to be done to make sure the farmers community will have their income from farm production in the short time after post flood. The suitable project must be plan base on the situation analysis and needs of community. As we know, Kelantan, Terengganu, Perak and Pahang were hit by flood end of 2014. Kelantan is among hardest hit by this natural disaster. The natural disaster have negative socio, economic, physiological and enviromental impacts on people and the affected areas. Furthermore, the agriculture and natural resources sectors are highly vulnerable because they are continuously exposed to natural disaster and their welcome consequences.

The main objective of this study is to quantitatively and qualitatively analyse, to the extent possible with available data and information, the impacts of floods on agriculture and food security. The specific objectives are to:

a) Present an overview of agriculture, disaster management, and the occurrences of floods in the country;
b) Evaluate the impacts of floods on agriculture at both the national and provincial level;
c) Assess the impacts of this disasters on food security; and
d) Implement the agriculture extension training and education to farmers through the agriculture projects to regenerate their income after post flood.

Result from this studies which are the impacts of foods on agriculture in Kelantan will assist goverment to identify the needs, mechanism and stages to recover the effect of natural disaster. The data and information aas well as overall knowledge gained from this study may prove useful in developing strategies to address the effect of natural disaster. Moreover, the result and findings may help other reserchers to identify futher studies which have relation to natural disasters particularly in Malaysia.

2.0 Methodology

This study had been conducted by selecting 371 respondents among farmers in Kelantan that experienced flood disaster in 2014. The study location was alongside of Sungai Kelantan that heavily involved of flood disaster. The questions were done according to the subsector of agriculture namely aquaculture, animal livestock, food crop and plantation crop. The survey was conducted by face to face approach with questionnaire guidance. The questionnaire was derived in six (6) parts: respondents' profile; farm profile; perception toward impacts of flood to agriculture, socioeconomic, environment and psychology; food security; social adaptation toward flood; and others. Data collected were subjected to statistical analysis using descriptive statistics. Simple percentages, frequency distribution, means and level of each perception by using Statistical Package for Social Sciences (SPSS Version 21). For extension program, the regeneration farmers income after flood programs were selected among potentially village that willing to learn and implemented extension program. Five (5) villages were selected for the program.

3.0 Results and Discussion

3.1 Socio Demographic Profiles

From the Table 1 shows socio-demographic profile data that highlights the socio-economic status of respondents. The socio-economic status based on the age, gender, race, education qualification, main occupation, side occupation, years of involvement and income.

Table 1: Profile Data of Respondents

Variables	Description	Frequency (n=371)	Percentage (%)
Gender	Male	315	84.9
	Female	56	15.1
Race	Malay	344	92.7
	Chinese	8	2.2
	Others	19	5.1
Age	≤ 30	22	5.9
	31-40	43	11.6
	41-50	83	22.4
	51-60	118	31.8
	61-70	87	23.5
	≥70	18	4.9
Education level	Never been to school	43	11.6
	Religious school	15	4.0
	Primary	138	37.2
	Lower Secondary	56	15.1
	Upper Secondary	97	26.1
	Certificate/Diploma	16	4.3
	Degree	6	1.6
Main Occupation	Farmer	278	74.9
	Government/Private	35	9.4
	Self-Working	53	14.3
	Pensioner	5	1.3
Side Occupation	Farmer	99	26.7
	Government/Private	31	8.4
	Self-Working	86	23.2
	No Side Job	155	41.8
Income Level	Below RM1000	253	68.2
	RM1001-RM2000	76	20.5
	RM2001-RM3000	14	3.8
	RM3001-RM4000	1	0.3
	RM4001-RM5000	5	1.3
	RM5001 and above	22	5.9
Years of Involvement	1-5 years	84	22.6
	6-10 years	71	19.1
	11-15 years	36	9.7
	16 years and above	180	48.5

Respondents represented 84.9% of them were male gender and 15.1% were female gender. 92.7% of respondents were Malay respondent followed by 'Others' races which is Siamese at 5.1% and 2.2% were Chinese respondents. For education level, the finding shows that majority of respondents were educated at primary school as 37.2% due to reason that most of them in their youth days were not able to further their study because of family financial constraint, secondary schools nearby their place was too far and lack of education awareness. However, 26.1% of respondents were educated at upper secondary school. Most of respondents that have secondary upper education level were located nearby cities that have enough facilities for education. Only 1.6% and 4.2% of degree and certificate or diploma education level were collected as respondents. Based on the age variable, dominant age of respondents which they are actively being a farmer in age group of 51–60 years old at 31.8% and followed by group older than that which is 61–70 years old at 23.5%. The youth which is younger than 30 years old represents 5.9% only as second lowest after 70 years old and above. From this statistic, it shows that the youths are not interesting to involve in agriculture sectors. While, many of respondents were among 51 to 60 years old because they do not have any options unless to utilize their land by agriculture activities and some of them were involved in agriculture during the retirement ages.

3.2 Damages and Impacts of Flood

Table 2 shows perception level of damages and impact of flood in Kelantan. 4 levels were classified to understand respondents perception level (not affected, low, moderate and high). There were two factors that show high level of damages and impacts of flood that is emotion and psychology and livestock/crop. Emotion and Psychology: this variable shows high level as the most frequent level at 32.3%. It means that flood affects their emotion because it was a big flood in 2014 that had damage their house and destroy their properties.

Table 2: Perception Level of Respondents toward Damages and Impact of Flood

Damages and Impacts	Not Affected	Low	Moderate	High
Emotion and Psychology	75 (20.2%)	88 (23.7%)	88 (23.7%)	**120 (32.3%)**
Farm Infrastructure	**186 (50.1%)**	62 (16.7%)	40 (10.8%)	83 (22.4%)
Farm Tools and Utility	**189 (50.9%)**	58 (15.6%)	48 (12.9%)	76 (20.5%)
Fertilizer stock	**211 (56.9%)**	51 (13.7%)	35 (9.4%)	74 (19.9%)
Farm Store	**246 (66.3%)**	46 (12.4%)	27 (7.3%)	52 (14%)
Irrigation and Drainage	**250 (67.4%)**	47 (12.7%)	23 (6.2%)	51 (13.7%)
Livestock/crop	101 (27.2%)	58 (15.6%)	76 (20.5%)	**136 (36.7%)**
Farm Machineries	**250 (67.4%)**	45 (12.1%)	29 (7.8%)	47 (12.7%)
Labour	**280 (75.5%)**	36 (9.7%)	20 (5.4%)	35 (9.4%)

However, more than 50% of respondents were selected farm infrastructure, farm tools and utility, fertilizer stock, farm storage, irrigation and drainage, farm machineries and labour as not affected because of most of the farmers were smallholders in Kelantan. Most of smallholders do not pactice a proper management and operation system for their farming activities. For them, as long as there is livestock or crop so they will continue farming.

3.3 Time Recovery from the Damage after Flood

Table 3 indicates the time recovery for the damage and effects of respondents that went through after flood to restart their farming activities. The big flood had paralyzed many activities in the area that affected. Especially for emotion and psychology, most of respondents (23.4%) were taken 2-5 months to be recover. The respondents need time to stabilise their house and properties after flood, before they restart their farming activities. Other than that, factor such as livestock and crop were also required two to five months for them to stable. This is because the land condition after flood was muddy. This caused respondents unavailable to restart their farm immediately.

Table 3: Time Recovery needed from Impacts and Damages of Flood

Impacts and Damages	Not Affected	<1 Months	2-5 Months	6-9 Months	>10 Months
Emotion and Psychology	84 (22.6%)	92 (24.8%)	**124 (23.4%)**	36 (9.7%)	35 (9.4%)
Farm Infrastructure	**202 (54.4%)**	40 (10.8%)	72 (19.4%)	30 (8.1%)	27 (7.3%)
Farm Tools and Utility	**202 (54.4%)**	53 (14.3%)	69 (18.6%)	20 (5.4%)	27 (7.3%)
Fertilizer Stock	**214 (57.7%)**	44 (11.9%)	66 (17.8%)	24 (6.5%)	23 (6.2%)
Farm Store	**258 (69.5%)**	29 (7.8%)	48 (12.9%)	20 (5.4%)	16 (4.3%)
Irrigation and Drainage	**249 (67.1%)**	32 (8.6%)	57 (15.4%)	17 (4.6%)	16 (4.3%)
Livestock/Crop	114 (30.7%)	58 (15.6%)	**124 (33.4%)**	35 (9.4%)	40 (10.8%)
Farm Machineries	**261 (70.4%)**	28 (7.5%)	48 (12.9%)	18 (4.9%)	16 (4.3%)
Labour	**281 (75.7%)**	20 (5.4%)	41 (11.1%)	19 (5.1%)	8 (2.2%)

3.4 Cost of Damages and Losses after Flood

Table 4 shows cost of damage and losses after flood was calculated from farm utility cost, farm machineries costs, fertilizer cost, crop, livestock, irrigation and drainage, and farm infrastructure that were affected by flood. The table shows that majority of respondents were classified at the highest range (42.9%) of cost losses at RM4001 and above. This is because many crops and livestock were dead cause of flood. However, from the table itself revealed that 32.1% of respondents were renge less than RM1000 of damage cost. This is might because of respondents that planting crop such as rubber or oil palm do not affects too much of damage cost because do not much plant were dead by flood. The least that they need to buy is small cup for latex that do not cost too much.

Table 4: Cost of Damages and Losses after Flood

Cost of Damages and Losses	Frequency	Percentage
No loss	8	2.2%
Less than RM1000	119	32.1%
RM1001-2000	41	11.1%
RM2001-3000	31	8.4%
RM3001-4000	13	3.5%
RM4001 and above	159	**42.9%**

3.5 Perception Level toward Food Security

Table 5 indicates perception level of respondents toward local food security after flood in affected area. Food availability factor shows that the total average mean is moderate because some areas were not get any food after flood. They need to be in hunger within less than 2 days. However, some places with a good pathway to access their places had reached for rescued immediately. Factor of food utility shows that there is no problem of daily food cooking process, sufficient of basic equipment and providance of electricity and gas after flood. Flood agencies and NGOs were reached to their place immediately with aid of gas tank and cooking utensils was given.

Table 5: Perception Level of Respondents toward Local Food Security after Flood

No.	Local Food Security	Mean	S.D.
1.	Food Availability	2.369	1.193
2.	Food Accessibility	2.336	1.143
3	Food Utility	2.530	1.686
	Total Average Mean	**2.412**	**1.341**

Table 6 shows three factors of local food security indicates moderate level. This is because some place do not faced any shortages of food supply after flood because a lot of NGOs reached to their places early after flood. However, there were some place that were very difficult to be reached and abandoned by the NGOs and National Security Council. It is difficult to differentiate all these factors without understand of topography problem and inadequate resources.

Table 6: Overall Perception Level of Respondents toward Local Food Security after Flood

Perception Level	Low	1-2.33
	Moderate	**2.34-3.66**
	High	3.67-5

3.6 Intervention Program for Regeneration Farmers Income

There are four (4) programs was conducted in several area of Kelantan. The details are explain in the Table 7.

Table 7: Intervention Programs

No.	Program Name	Total Participants	Date	Place	Content
1.	Discussion about Needing, Solution, and Crop problem among Rubber Smallholders	50	8/11/2015	Kampung Kuala Tol, Gua Musang, Kelantan	Issues, Crop Problem, and Solving Method • Market • Seed • Scrub Price • Intercropping • Knowledge, Attitude and Prices among Farmers
2.	Agricultural Method Demonstration	50	5/12/2015	Kampung Kuala Tol, Gua Musang, Kelantan	Method Demonstration • Compost Process • Durian Belanda Crop • Biological Pest Control • Sprayer Practices
3.	Technical Vegetable Crop Seminar	50	20/11/2015	Taman Kekal Pengeluaran Makanan Batang Merbau, Tanah Merah, Kelantan	• Crop Physiology • Crop System • Crop Pest and Diseases • Crop Yield Market
4.	Paddy Crop Seminar	50	19/11/2015	Pertubuhan Peladang Kawasan Wakaf Bharu, Tumpat, Kelantan	• Land Fertility • Implementation of Organic Fertilizer in Paddy Crop

4.0 Conclusion

The impact on farm activities, socioeconomic, environment and psychology perception level are moderate. Among these factors, we can say that impact is more on farm activities rather than emotions and psychology, Socio economic and environment factors because of the respondents could not generate income without a proper operation and management system if farm activities were interfered. Food availability, accessibility and utility perception level in local area are moderate. To conclude that most of the respondents were faced food problem after flood. However, this is because of food supplying methods were weak and not in a good way of management. Perception level of national food security policy among respondents in Kelantan revealed low level. Most of respondents do not know about any planning or strategies from government. Lacking of government agencies to meet respondents and no enlightenment from agencies to respondents.

References

Loayza, Norman V. & Olaberría, Eduardo & Rigolini, Jamele & Christiaensen, Luc, 2012. "Natural Disasters and Growth: Going beyond the Averages," World Development, Elsevier, vol. 40(7), pages 1317-1336.

Long, F. (1978). 'The Impacts of Natural Disasters on Third World Agriculture: An Exploratory Survey of the Need for Some New Dimensions in Development Planning', American Journal of Economics and Sociology, Volume 36 Number 2 (April 1978).

Sivakumar, M. V. K. (2005), 'Impacts of Natural Disasters in Agriculture, Rangeland and Forestry: An Overview', in M. V. K. Sivakumar, R. P. Motha and H. P. Das (Eds.) Natural Disasters and Extreme Events in Agriculture. Springer Hiderberg Berlin, New York, pp. 1-22

7.3: ESTABLISHING CROP PRODUCTION ON LAND AFFECTED BY FLOOD IN THE KELANTAN PLAINS

Project Information

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1.0 Introduction

Occurrence of a big flood is disastrous not only to human lives and their properties, but also to agricultural land in its vicinity. Kelantan suffered huge economic losses during the flood of 2014. Houses, lands and crops located along the running water pathways were destroyed beyond imagination. It occurred due to extraordinary rain falling within a short duration. The productivity of the soils in the lower reaches of Kelantan River were significantly affected by this great flood. A study was conducted in the Kelantan Plains to: 1) Ameliorate the infertility of the soils affected by the flood; 2) Enhance crop production on the soils; and 3) Identify pests found in the study area, resulting from the flood.

2.0 Methodology

To achieve the objectives of the project, four studies were conducted in the vicinity of Tumpat district in the Kelantan Plains, located in the lower reaches of the Kelantan River. The studies carried out were:

1. Preliminary study. This study was to survey the areas in the Kelantan Plains affected by the flood. Soil samples were collected in these areas so as to determine the physico-chemical properties of the silted sediments, either in the rice fields or vegetable plots;
2. The second study was on acid sulfate soils cropped to rice in Tumpat district affected by the flood. The field was treated with ground magnesium limestone (GML) in combination with bio-fertilizer fortified with effective microorganisms. Rice was grown for 2 seasons;
3. The third study was growing cash crops (sweet corn, dwarfed long bean and cucumber) on the affected land in the vicinity of Kg Pasir Pekan Hilir, Tumpat. The exact location was not far from Kota Bharu - on the other side of the Kelantan River; and
4. The last of the study was to determine the incidence of pests in the vicinity of the flood affected areas in the Kelantan Plains.

3.0 Results and Discussion

Results from study 1 showed that the reddish/yellowish materials deposited on the Kelantan Plains were mostly loamy in texture, containing high silt contents, indicating that they were materials mostly coming from the subsoil of the upper reaches of the Kelantan River, which were clearly evidenced from this study (Shamshuddin et al., 2016). The sediments were characterized by low pH (pH <4), having high amount of Al and/or Fe, which were eventually hydrolyzed that further lowered soil pH that reduced soil productivity (Figure 1). Amelioration of the soils mixed with the infertile sediments required application of GML in combination with bio-fertilizer fortified with microbes. Hopefully, the disturbed agricultural land can be utilized for sustainable crop production after the process of amelioration was done and over with.

Figure 1. Flood sediments found at Kg Pasir Pekan Hilir, Kelantan

For the rice study in Tumpat, 2 tons of GML plus 2 tons of bio-fertilizer were applied in season 1. For the control treatment, water pH increased from 3.8 to 5.5 fifteen days after flooding; however, for the treated soil, water pH had gone up to above 7. The ameliorative effects had increased rice yield to a level higher than the national average of 4 t/ha/season (Figure 2); for the treated soil, the yield was about 7 tons. Unfortunately, the rice was attacked by rice blast in season 2, decreasing the yield significantly. The increase in pH had eliminated Al, thereby its toxicity was no longer becoming a threat to the rice. Thus, the agronomic practice so introduced is good enough to be adopted by the farmers growing rice on the acidic soil affected by the great flood of 2014. Cash crops grown at Kg Pasir Pekan Hilir were sweet corn, dwarfed long bean and their combination. The soils fertilized with NPK fertilizers in combination with bio-fertilizer were alleviated such that it was good enough to grow sweet corn intercropped with dwarfed long bean (Plate 3). Likewise, cucumber grown at the same site was positively affected by the treatment.

Figure 2. Harvesting rice in the field

Figure 3. Sweet corn intercropped with dwarfed long bean

Insects in the study areas were captured by various means during the study. It was found that the common pests identified were Diptera, Hymeptera and Coleoptera, which could affect crop production without proper pest control practices (Figure 4). Without any data taken before the flood, it is difficult to conclude whether this insect population was greatly affected by the flood.

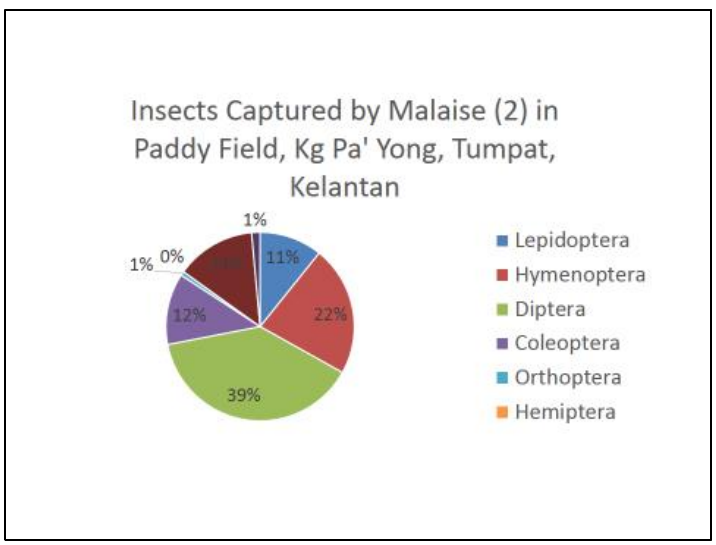

Figure 4 Common insects found in the vicinity of Tumpat, Kelantan

4.0 Conclusion

The conclusions are summarized as follows:

4.1 There was strong evidence to suggest that the silted sediments in the Kelantan Plains were derived from the subsoil of the upper reaches of Kelantan River. These sediments had low pH with high amounts of exchangeable Al and extractable Fe, indicating that they were not suitable for crop production unless properly ameliorated using GML and/or organic fertilizer;

4.2 Treating acid sulfate soils in the flood affected area of Tumpat using GML in combination with bio-fertilizer had alleviated their infertility. Water pH in the treated rice field had increased to a level above 7, eliminating Al toxicity. This resulted in the significant increase of the rice yield to a level above the national average of 4 t/ha/season;

4.3 It was found that NPK fertilizers in combination with bio-fertilizer to grow sweet corn intercropped with dwarfed long bean or cucumber was a viable agronomic practice. This would have increased farmer's income in the long run; and

4.4 The common pests identified in the Kelantan Plains after the great flood were Diptera, Hymeptera and Coleoptera. These insects can affect crop production in the area without proper pest control practices.

References

Shamshuddin J, Panhwar QA, Radziah O, Roslan I, Hamdan J and Melissa AY (2016). Effects of December 2014 great flood on physico-chemical properties of the soils in the Kelantan Plains, Malaysia. Journal of Water Resource and Protection. 8: 263-276.

PROJECT 8 : IMPACT OF SPATIO-TEMPORAL RATES AND PATTERNS OF LAND USE LAND COVER CHANGES TO FLOOD PREVENTION AND MITIGATION

8.1: ASSESSING AND MONITORING THE IMPACT OF LAND USE CHANGES ON EXTREME FLOODS

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1.0 Introduction

Land Cover changes triggered by population increase and economic growth in recent decades is considered as the dominant cause of increased flood occurrence (Boyle et al. 1997; Weng 2001). Malaysia was affected by uncontrolled deforestation in the last decades. The massive deforestation raised the runoff coefficients and reduced the infiltration and retention, so a higher volume of rainfall becomes runoff, which concentrates as flash floods. A research note on the estimated of flood event showed that 9% of Malaysia's land area, which amounts to 29000 km^2, is under flood disaster. The Kelantan river basin at the east coast of the peninsular Malaysia is one of flood prone area, which is affected with the north-east monsoon season during November and December. Meteorological factors (e.g., climate change), rapid changes in land use, urbanization, and weaknesses in development planning and monitoring are affected on the increasing of flood events at Kelantan river basin in recent decades.

The land cover changes lead to higher peak flow and large volumes of runoff flow. Therefore, this study tried to quantify the effects of land cover/ land use (LULC) changes (e.g., urbanization, deforestation) on increased rate of flood at the Kelantan river basin. In this regards, a hydrological regional modeling of rainfall induced runoff event was developed and employed to compute rate of loss/ infiltration, and subsequently changes in the discharge volume and peak discharge in the study area. The effects of land use changes on peak discharge and flood volume are investigated using a storm rainfall events during December 2014. Attention was given to differences in peak flood and discharge volume resulting from the land cover changes during 30 decades.

2.0 Methodology

To minimize losses incurred by flood events, a hydrological and geotechnical grid-based regional modeling (Integrated model) was performed and developed using Microsoft Excel® and GIS framework system to compute the rate of infiltration and the additional assessment the impact of land cover changes in the Kelantan river basin focused on the runoff contributions from different land cover classes and the potential impact of land cover changes on runoff generation (Saadatkhah et al. 2015; Saadatkhah et al. 2016). Figure 3.1 shows the overall research flow of this study. The Integrated model was applied based on three major components; rainfall interception loss model, rainfall infiltration analysis model, and the runoff analysis model.

The Richards equation has been employed in the integrated model to define unsaturated vertical flow in reaction to infiltration/ loss water at the ground surface with the precipitation distribution data and rainfall interception loss approach based on experimental equation (Lawrence and Chase 2007). In the process of assessing the impact of land cover changes on the extreme flood events, knowledge of canopy characteristics and geotechnical properties of the study area are imperative steps. The first part of the research methodology focused on the preparing raster data to simulate runoff event at the Kelantan river basin. Having an information assigned to each cell, the input data was converted into a grid-based framework (e.g. terrain data, slope geometry data, soil hydrological and mechanical properties, rainfall information, interception loss water data, drainage basin areas, and plant cover maps).

The second part of research methodology is dedicated to analyse the impact of land cover changes on the flood volume and peak discharge based on catchment areas and land cover maps. In this regard, the assessment of the effect of land cover changes as a main factor in the rate of infiltration/ loss water, consequently the runoff volume is conducted based on an integrated model in this study. The last part of the current study is dedicated to creating flood protection system based on flood management in three case studies; one upstream, one midstream and one in the downstream part of the catchment. The process safety management is conducted and continued to find a suitable solution on the area of study.

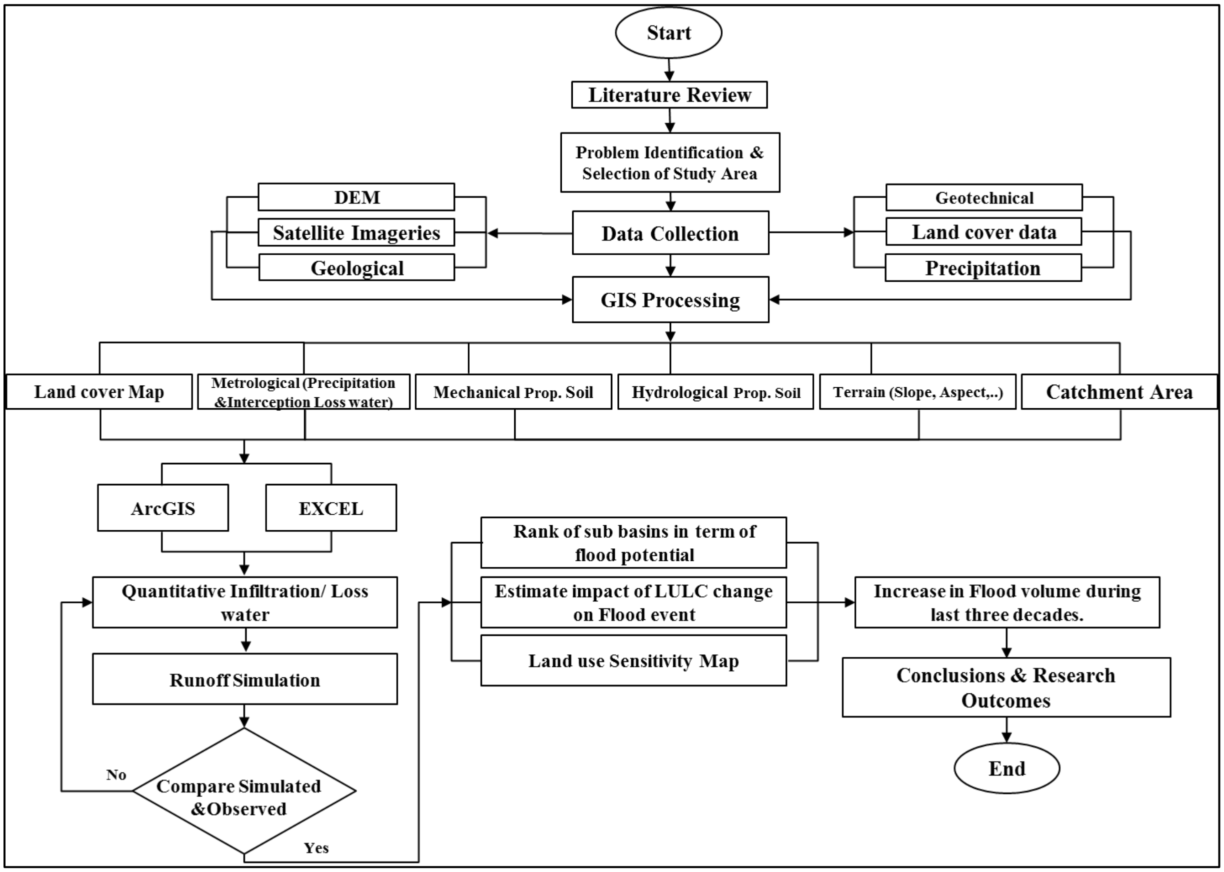

Figure 1 The general framework of this study

3.0 Results and Discussion

3.1 Land Use Sensitivity Map

The covered area of Kelantan land has been defined by forest reserves, which is 956,139.9 ha (63.66% of Kelantan's total land area). It is mainly located in the upstream of Kelantan river basin and is followed by agriculture, which covers an area of 395,156.8 ha (26.32%), i.e. rubber and oil palm cover 349,365.4 ha (23.27%), while urban area and development area covers only 14,616.5 ha (0.92%). The remaining area is covered by scrub, grassland, pasture, secondary forest and other crops. Due to an urban development, the way, the land is used has been changed. Whereas, the conversion of forests into agricultural areas has been changing progressively with a higher pace during 1984 to 2002, which became slower in 2002 until 2013.

The land cover distribution for this study area was classified based thirty two types of land covers, i.e. lake/ pond, highway/ main road, railway, power lines, recreational area, mine and ex-mining area, urban/ residential etc., quarry and ex-quarry, cemetery, agriculture station, floriculture, mixed horticulture (village), vegetables, herbs and spices, cocoa, coconut, rubber, oil palm, orchard, banana, paddy, tobacco, other crops, aquaculture, poultry and others, pasture/ ruminant, idle grassland/ lallang, scrub, forest, secondary forest, swamp forest/ mangrove swamp, marshland, beach sand/ river sand, cleared land, eroded area, a limestone hill and reclaimed areas.

The initial run of the models are made for the end of December 2014 with land use/ land cover values obtained from site. The land use parameter was chosen to further evaluate rainfall runoff models sensitivity at Kelantan river basin. Land use changes in any catchment areas affect many processes like interception loss, resistance to surface runoff, and evapotranspiration. The input values were initially set based on the best fit of outputs and expected ranges. Figure 2 showed the total amounts of precipitation along with the total infiltration losses that resulted in the presented with the extreme rainfall intensities of more than 44 mm/hour in the most intense 1 hour of the 10 day storm. The absolute loss of a certain event is only a function of the land cover, soil characteristics, and the absolute rainfall depth regardless of the intensity distribution. According to apply integrated model, after the beginning of the rainfall event, no runoff begins until the accumulated precipitation P equals the initial hydraulic conductivity of soil K. After the accumulated rainfall exceeds the initial K, runoff is calculated by subtracting R (water retained in the watershed) from the accumulated rainfall.

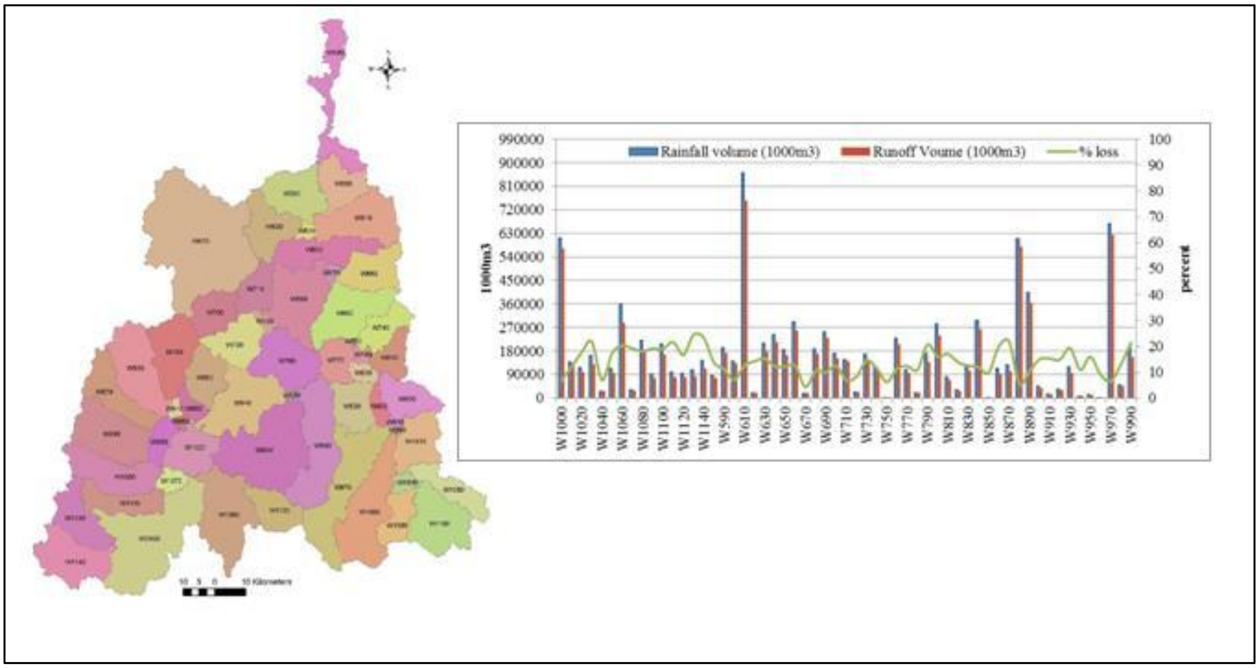

Figure 2 The total amounts of precipitation along with the total flow volume at catchment areas of Kelantan river basin

According to using the integrated model, the resulting land use changes effects on the flood flows as the land use sensitivity evaluations are illustrated in the study area (Fig. 3). The critical runoff events were mainly scattered on the cleared areas and the areas under development (i.e., urban areas). Forest conversion to the less canopy coverage (i.e., oil palm, rubber, and mixed horticulture areas) is responsible for a very high to high level of runoff events in the study area (Fig. 3a, b, and c). In this regards, the fatal debris flows and runoff were caused by a combination of extreme rainfall, destruction of natural forest cover (human-caused), and conversion to agricultural plantations in thin, granitic soils.

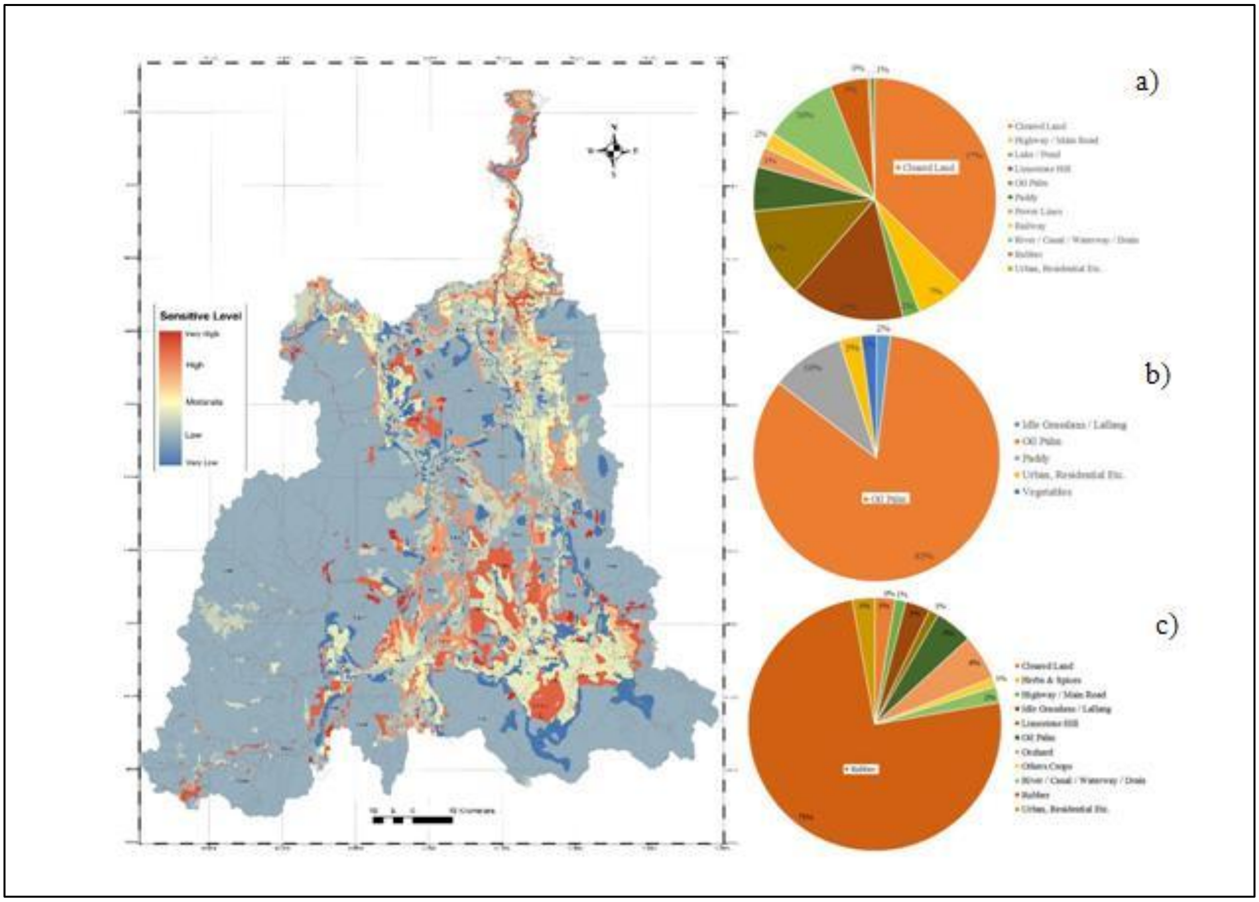

Figure 3 Land use sensitivity map, a) Critical; b) very high; and c) high Land use sensitive level based on sensitivity map

3.2 Flood Protection and Flood Control System

Flood management upstream: Land management (Reforestation and combining farming and catchment scale planning)

In Nature, there is no flood damage. Floods only lead to damage when uses by human beings are detrimentally affected. The more intensively and the less suitably the flood basin is used, the greater the potential for damage and then the actual damage when the flood occurs. The overall approach of the flood protection system in upstream is to implement catchment scale planning and land management to help manage river flows in an ecologically sustainable way (Fig. 4). Sustainable land management means that the solutions contribute to protecting the forest areas, reforestation, and planning to keep future ecological value of the river and that they are self-managing and do not require costly ongoing investments or long-term maintenance.

Once the catchment will be modelled and in theory will be shown where and what type of land management changes can be most effective, the task of implementing these changes comes. Land in the river catchment will be composed of farms and estates in private property who have to be shown and convinced that there are benefits for them for adapting their land management to reduce flood risk downstream. Successful delivery of flood protection system depends on involving the local farming community.

Flood management mid-stream: combining forestry and flood storage reservoirs

The storage effect of vegetation, soil, ground and wetlands has an important mitigating effect particularly in minor or medium-scale floods. Each of these storage media is capable of retaining certain quantities of water for a certain length of time. A large natural storage capacity provides slow rises in water levels and comparatively minor floods. Retaining water on the natural media should have priority over swift water runoff. In some cases, in the event of heavy and lasting rainfall, natural storage impact is less relevant as regards the reduction in flow, but is still extremely beneficial when it comes to reducing sediment yield.

Two thirds of the mid-stream of Kelantan river basin is covered with forest and secondary forest which at the moment is safe from floods. To minimize the damage of a potential flood event on nature and forestry the concept of ecological floods can be designed. For using forest area as retention area, forest conversion of predominant terrestrial communities includes substitution of flood sensitive species with flood tolerant species. Hard wood trees do not tolerate long lasting flood events or high water levels. Therefore the sensitive trees will be converted to trees are able to withstand floods for up to three months. These species can help to guarantee a sustainable and cost efficient forestry for the future within an emergency polder. Improvement of forest areas according to the location depending on the local altitude of the area tree species suitable for the future dynamics in water level will be replanted. This helps to guarantee profitable forestry in the long term (Fig. 4).

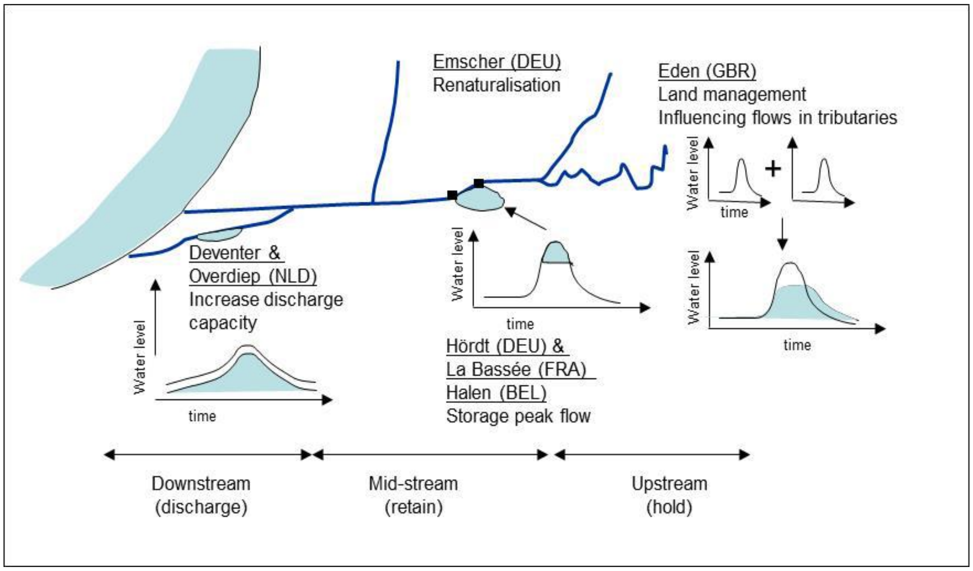

Figure 4 Flood risk management in the upper, middle and lower part of the catchment

Flood management down-stream: combining farming and flood discharge

According to last Kelantan river flood events, the water levels were extremely high and the dikes just managed to hold some of water volume. As a result a major program should be initiated called Room for the River. This river room can be done by widening the river where necessary, creating by-pass channels, lowering the floodplain, taking away obstacles like bridges, lowering groins etc. The room of River program can be increase the discharge capacity of the large and main rivers. Two measures from Room for the River are relevant as examples of water friendly land management; the Overdiepse polder and the river widening.

Overdiepse polder is involving the floodplain area that it possibilities to combine ecological farming and the maintenance of the ecologically valuable floodplain. The combination of maintaining an organic dairy farm in the floodplain seems feasible. The organic character of the business (closed circle energy and food) blends in well with the proximity to the river and the task of maintaining the floodplain free of heavy vegetation. However an evaluation over a long term (e.g. 10 years, including seasons with good harvests, ad harvests ad floods) is needed to assess and gain experience on how and under what conditions the water friendly farm can run as a profitable business (Fig. 4).

4.0 Conclusion

This project provides the assessment of land cover impact on the runoff processing using hydrological and geotechnical grid-based regional modeling (Integrated model) under rain stream events during last three decades at Kelantan river basin and mitigation plan. The following conclusions and key findings can be summarized:

4. 1 The usage of the integrated model showed that land cover changes caused significant differences in hydrological response to surface water. The increasing of runoff volume at Kelantan river basin is as a function of deforestation and urbanization, especially conversion the forest area to agricultural land (i.e. rubber and mixed- agriculture).

4. 2 Deforestation and conversion to agricultural area caused increases in peak of discharge and flood volume due to lower interception loss, evapotranspiration capacity. In contrast, urban development area lead to a greater impervious ground surface and excess to runoff volume when less infiltration occurred.

4. 3 The main findings of this paper demonstrated that forest area plays an important role in controlling water flow and subsequently minimizing the runoff volume in the study area. If jungle area were replaced by different land cover types such as development area and agricultural land, less loss/ infiltration would be incurred and hence a higher flood magnitude would be predicted.

4. 4 After the calibration and verification process for the integrated model, it is clearly demonstration by the evaluation results that the model is capable of generating reliable water level forecasting at Kelantan river basin.

4. 5 The mitigation plan entails a three-step approach for flood management in the study area. First hold water where rainfall occurs. If this is not possible, store water temporarily. The third and final option is to discharge water downstream as quickly as possible

References

Boyle, C.A., Lavkulich, L., Schreier, H. and Kiss, E., 1997, Changing in land cover and subsequent effects on lower Fraser basin ecosystems from 1827 to 1990, Environmental Management, 21(2), 185-196.

Weng, Q., 2001, Modeling urban growth effects on surface runoff with integration of remote sensing and GIS, Environmental Management, 28(6), 737-748.

DID. Drainage and Irrigation Department. 2004. Annual flood report of DID for Peninsular Malaysia. Unpublished report. Kuala Lumpur: DID.

Lawrence, P. J. and Chase, T. N. (2007). Representing a new MODIS consistent land surface in the Community Land Model (CLM3.0). J. Geophys. Res. 112. doi: 10.1029/2006JG000168.

Saadatkhah N, Kassim A, Lee ML (2015) Spatiotemporal Regional Modeling of Rainfall-Induced Slope Failure in Hulu Kelang, Malaysia. Environmental Earth Sciences. 73 (12): 8425-8441.

Saadatkhah, N., Shattri, M., Kassim, A. and Lee, M. L. (2016). Regional Modeling of Rainfall-Induced Landslides using TRIGRS Model by Incorporating Plant Cover Effects: Case Study in Hulu Kelang, Malaysia. Environmental Earth Sciences, DOI: 10.1007/s12665-016-5326-x

8.2: USE OF GEOSPATIAL APPROACHES FOR QUANTIFYING FOREST BIOMASS AND ANALYSIS OF FLOOD OCCURRENCE IN KELANTAN

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1.0 Introduction

A heavy monsoons rainfall was occurred from 15 December 2014 to 3 January 2015, triggered flood along Malaysia's east coast. The worst flood occurred along the east coast of peninsular Malaysia in the states of Kelantan, Terengganu and Pahang. Thousands of damages and losses were occurred. Flood disaster is one of the disasters that mostly happen and cause serious impacts. The increasing risk of this hazard is mostly due to anthropogenic activities such as river regulation measures, intensified land use and forestry and also anthropogenic climate change.

Land use and climate change have complex and interacting effects of naturally dynamic forest landscapes (Mohd Hasmadi et al., 2015). Depending on scale, the removal of large areas of trees can increase the flow of surface water, as well as loss of soil and increased sediments in bodies of water. It can also reduce groundwater recharge and the amount of water transpired into the air that contributes to rain. This increases the risk of drought, and temperature variations. Forests are vital to the water cycle. They slow down water flow and filter the water that enters our rivers, lakes, streams and groundwater. They also transpire water into the atmosphere, contributing to the formation of clouds and rain. The effect of land use on rainfall run-off process is studied to understand the relationship between land use and flood disaster. In the flood generation process, the effect of land use pattern and intensity on run-off generation and concentration are the foundations to study the change of flood caused by the human activities (Nirupama and Simonovic, 2002).

The forest biomass quantification and method to analyze flood occurrence were develop in this study, by fine tuning of methods involving satellite images that very helpful in reducing the time frame for disaster study and monitoring. The aim of this study is to quantify forest biomass and analyze the flood occurrence in Kelantan by using geospatial information technology. The objectives are as follows: (i) to quantify a forest biomass of water catchment in Kelantan river; (ii) to establish relationship between forest biomass and climatic condition on catchment scale and (iii) to analyze the effect of biomass and climatic condition on flood occurrence.

2.0 Methodology

Remote sensing imageries were mostly used in this study. The excellence of remote sensing that sensitive in capturing earth surface features was one of the obvious reasons behind it. Six scenes from both Landsat 5 TM and Landsat 8 OLI-TIRS were employed simultaneously during image interpretation and digital image processing. The standard level-one images have been corrected in both radiometric and geometric. The unsupervised classification technique with ISODATA algorithm is adapted due to the limited source of information regarding land-use/land-cover of the surrounding area at that time. Some images from Google Earth were also utilized to validate the classification result. Nine classes have been generated and later verified with the land-use/land-cover map from Department of Agriculture, Malaysia, including agriculture, barren-land, development area, forest, grassland, mangrove/swamp, oil palm, rubber and water body. For the purpose of this study, the classes have been simplified into primary forest, secondary forest, and non-forested area.

There are two types of microclimate information being used in this study, i.e. temperature and rainfall. Temperature data were generated from the satellite images. Thermal infrared band of Landsat image was specifically used to develop Land Surface Temperature (LST). The temperature data were available in Celcius unit. Rainfall data were obtained from eight meteorological stations in state of Kelantan. Rainfall maps were generated using interpolation technique in GIS software. The interpolation process was solely based on average annual rainfall from meteorological station in Kelantan. The stations were firstly plotted on the map based on their geographic location and interpolation processes were further applied, based on the value of average annual rainfall. Both cloud and cloud shadow were masked out of the whole images.

Flood simulation generated using HEC-RAS model. This model is basically generated from several variables, such as Digital Elevation Model (DEM), river network and rainfall. DEM is used to separate between floodplain (the area that usually flooded by overflow) and hilly area (the area unreachable by water). River network is divided into two parts, i.e. main and banks (both left and right banks) by digitizing technique. River cross-sections were also created during this process. Lastly, discharge data based on ten days rainfall were added into the model. After the simulation is completed, flood area can be converted to vector data and being overlaid with other supporting data.

A total of 18 trees were observed as samples. During the field campaign, a number of stand parameters such as diameter at breast height (DBH) and total tree height were collected from the selected trees. A rectangular 30 m x 30 m plot was used and being divided into four quarter. The above-ground biomass (AGB) was measured using allometric equation, which has become one of the common and cost effective methods to be used in biomass quantification (Ravindranath and Ostwald, 2008). This study used allometric equation developed by Kato et al. (1978), which allows to estimate AGB, especially for lowland dipterocarp forest (Hamdan, 2015). The formulas are as follow:

$$1/H = 1/(2*D) + (1/61) \qquad (4)$$

$$M_s = 0.0313*(D^2 H) \qquad (5)$$

$$M_b = 0.136*M_s^{1.07} \qquad (6)$$

$$1/M_1 = 1/(0.124 M_s^{0.794}) + (1/125) \qquad (7)$$

where H is tree height (meter), D is diameter at breast height (cm), M_s, M_b and M_1 are dry mass of stems,branches and leaves.

Once it is completed, a map of biomass for study area can be developed, by correlating the biomass value with spectral bands and vegetation index from remote sensing images. For the purpose of this study, the Normalize Difference Vegetation Index (NDVI) has been developed during digital image processing. NDVI has been applied in many biomass and carbon studies (Liu et al., 2004; Zhu and Liu, 2015). Relationships between microclimate and biomass were measured by applying correlation and regression analysis. The analysis uses AGB, LST and rainfall values extracted from previous processes as inputs. The AGB is treated as predictor, while LST and rainfall were added as response variable. The regression analysis is performed to know how significant the relationship between AGB and LST or rainfall is.

3.0 Results and Discussion

Based on image classification, the forest area was slightly reduced for about 0.63 % during 1989 until 2014. It is significantly different when compared to land-use map from Department of Agriculture, Malaysia which shows 21.47 % of forest changes in the same period. However, the number is slightly close if compared with Jabatan Perhutanan Semenanjung Malaysia (JPSM) data, which shows 3.42 % of forest changes between 2004 and 2014. Changes were mostly occurred on the Gua Musang District, southern part of Kelantan, where forests are dominantly being converted to oil palm or rubber. There were more than 125,000 Ha area of forest that is being converted from 1984 to 2014, which is about 15 % of the total forest in Gua Musang District. Based on the calculation, approximately 10.6 % of forest areas were converted to oil palm, while about 3 % were changed to rubber, the rests were changed to agriculture and development area (Table 1).

Table 1: Forest area changes from 1989 until 2014 in Gua Musang District

Land-use change	Area (Ha)	Percentage (%)
Forest to Oil Palm	79569.64	10.58
Forest to Rubber	21821.72	2.90
Forest to Agriculture	6163.81	0.82
Forest to Development Area	2287.75	0.30

The trend from 30-years of annual rainfall data basically shows an increasing number of rainfall from 1984 until 2014. The highest rainfall was recorded on 2014 in Pusat Pertanian Haiwan Tanah Merah Station, which signifies an increase of five percent (5 %) from previous 30-years. The lowest amount was recorded on 2002 in Kuala Krai Station (Table 2). This data proves that high intensity of rainfall might trigger the 2014 flood events in Kelantan. A similar figure also showed by LST data. The trend from 1989 until 2014 was showed an increasing surface temperature. The maximum LST in 1989 is 30.18^{o} C. It was raised for about 8.81 % and reached 32.84^{o} C in 2014. (Figure 10

Biomass map is built based on the relationship between ground data of AGB with spectral value and NDVI from remote sensing image. A number of models are tested, from relating spectral value of single band to values of multiple bands plus the NDVI. The combination between NDVI and all bands of Landsat 8 was selected as model since it is able to explain about 98 % of the variables (Table 3). Map of AGB distribution showed by Figure 2.

Table 2: Average annual rainfall

STATIONS	**1984 (mm)**	**2002 (mm)**	**2004 (mm)**	**2013 (mm)**	**2014 (mm)**
Mardi Jeram Pasu	279.61	251.08	267.39	281.83	318.84
Mardi Kubang Kerani	171.84	198.49	199.90	184.35	218.98
Pusat Pertanian Haiwan Tanah	354.66	230.45	257.78	299.23	375.38
Pusat Pertanian Lundang	203.00	185.81	175.40	203.83	215.48
Pusat Pertanian Pasir Mas	239.16	148.77	165.98	208.19	301.23
Pusat Pertanian Melur	243.68	219.10	215.47	240.93	284.82
Kota Bharu	190.99	185.91	160.72	186.23	249.91
Kuala Krai	No data	128.57	229.34	261.17	259.82

Table 3: Linear regression between AGB with spectral bands and NDVI

Variable	R	R Square	Adjusted R Square	Std. Error
Band 1, Band 2, Band 3, Band 4, Band 5, Band 6, Band 7, Band 9, NDVI	0.991	0.983	0.964	30.7011639 2

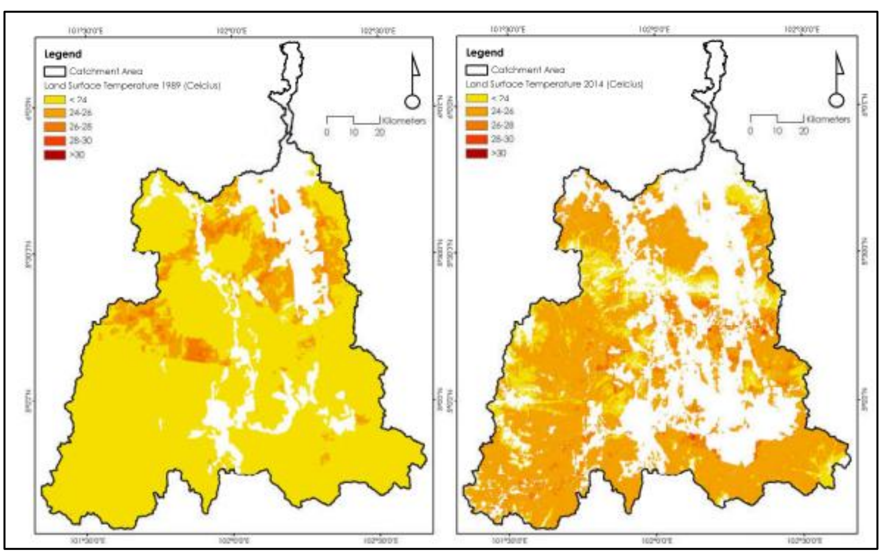

Figure 1. Annual average temperature between 1984 until 2014

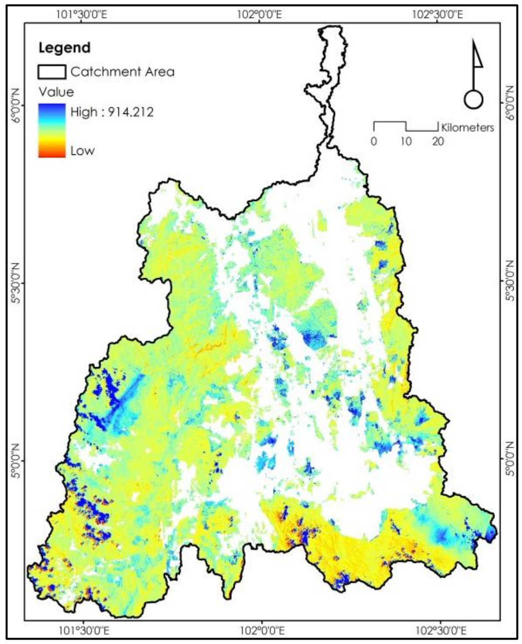

Figure 2: Distribution of AGB based on model

Since the data distribution is not normal, this study used Spearman's rho to correlate LST and rainfall with biomass. At confidence level of 95 %, the correlation analysis shows no significant correlation between LST and rainfall with biomass. Nevertheless, there is a slightly strong correlation between LST and rainfall (coefficient correlation = 0.485). The non-significant correlations also proved by the scatterplots between those variables. The points were too randomly distributed on the plot, which may be caused by the insufficient of samples or extreme values.

4.0 Conclusion

Important findings of the study are summarized as follows:

4.1 There are approximately 0.5 to 3.0 % forest losses for the last 30 years in Kelantan. In Gua Musang forest area was reduced for about 15 %. The losses are mostly due to conversion of forest area to oil palm and rubber.

4.2 Single remote sensing band is not able to explain the AGB distribution. However, combination of all bands and NDVI are successfully mapped the distribution of AGB in study area. The result from regression analysis shows a significant relationship between AGB and combination of Landsat bands and NDVI.

4.3 Generally, results from correlation analysis explain no significant relationship between biomass on LST and rainfall. Nevertheless, results showed that rainfall had the strongest effect on AGB (0.08). Although temperature via LST analysis is a surrogate of energy available to forest, it relatively or positively associated with availability of biomass (0.067). These results indicating that there is a trade-off effect between LST and rainfall on biomass. Thus the findings fortify that rainfall is a major factor influencing biomass for forestland ecosystem.

4.4 As prevention and mitigation of flood disaster, implementation of replanting program on degraded forestland is needed. It is also important to control the conversion of forest area, especially for the purpose of agricultural expansion.

References

Hamdan, O., Hasmadi, I. M., Aziz, H. K., Norizah, K., & Zulhaidi, H. (2015). L-band saturation level for aboveground biomass of dipterocarp forests in Peninsular Malaysia.*Journal of Tropical Forest Science*,*27*(3), 388-399.

Kato, R., Tadaki, Y., & Ogawa, H. (1978). Plant biomass and growth increment studies in Pasoh Forest.*Malayan Nature Journal*.

Liu, G. R., Liang, C. K., Kuo, T. H., Lin, T. H., & Huang, S. J. (2004). Comparison of the NDVI, ARVI and AFRI Vegetation Index, Along with Their Relations with the AOD Using SPOT 4 Vegetation Dat.*Terrestrial Atmospheric and Oceanic Sciences*,*15*(1), 15-32.

Mohd Hasmadi Ismail, Shattri Mansor, Farrah Melissa Muharam, Zailani Khuzaimah, Helmi Zulhaidi Mohd Safri, Hamdan Omar and Iqbal Putut Ash Shidiq. (2015). Initial Result of the Precipitation Trends for Flood Studies in Kelantan. Paper presented at the Workshop 1: Flood Studies 2014, 14-15 September 2015, Everly Hotel, Putrajaya, Malaysia.3p.

Nirupama, N., & Simonovic, S. (2002). A spatial fuzzy compromise approach for flood disaster management. *The Institute of Catastrophic Loss Reduction, London, Ontario, Canada*.

Ravindranath, N. H., & Ostwald, M. (2007).*Carbon inventory methods: Handbook for greenhouse gas inventory, carbon mitigation and roundwood production projects*(Vol. 29). Springer Science & Business media.

Zhu, X., & Liu, D. (2015). Improving forest aboveground biomass estimation using seasonal Landsat NDVI time-series. *ISPRS Journal of Photogrammetry and Remote Sensing*, *102*, 222-231.

8.3: INTERACTION EFFECTS BETWEEN AGRICULTURAL LAND USE CHANGES AND FLOOD EVENT

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1.0 Introduction

Agriculture in Kelantan played important role as economic resources. Plantation crops such as rice, oil palm, rubber and orchards contribute to 23.5% of its gross domestic product (GDP). Approximately 30% of lands in Kelantan dedicated for agriculture. Agriculture in Kelantan mostly located in low lying regions which have fertile soils, however, susceptible to extreme flooding leaving to crops destruction (Su et al., 2000). In December 2014, Kelantan faced extreme floods in 40 years which causing USD 26 million of agricultural losses. While the flood even directly impacted the agricultural production, it was reported that the main cause of this extreme flood was likely contributed by forest-to-agriculture land use changes especially for rubber and oil palm estates (Syed Hussain et al., 2014).

Apparently, changes of land use have affected directly to surface runoff and also consequently flood occurrences. In assessing relationship between land use changes and surface runoff or flood occurrences, geospatial techniques were utilized. Dynamic simulation of land use changes and analysis of the impact of land use changes can be a complex process. Common approaches used for these simulation is Markov and combination of cellular automata processing. Markov can be defined as a process of random selecting system for the prediction which not only explain the quantification of conversion but also can reveal transfer rate among different land use types. CA-Markov is a process with combination of Markov, cellular automata and multi-criteria decision method to predict future land use.

The understanding of the impact of land use changes especially agricultural driven activities on surface runoff characteristics will further provide relevant assistance for agriculture development in flood affected area. Thus, the objectives of this study are to predict future agricultural land use changes in Kelantan river basin and quantify the effect of land use changes to flood occurrences and vice versa.

2.0 Methodology

Located in the East Coast of Peninsular Malaysia, Kelantan with total area approximately 15,000 km^2 received annual temperature and relative humidity about 27.5 C and 81%, respectively. Kelantan River basin with its four tributaries namely Galas, Nenggiri, Lebir and Pergau received annual rainfall of 2500 mm during northeast monsoon. Kelantan River flows through several populated cities such as Kuala Krai, Tanah Merah, Pasir Mas and Kota Bharu before discharges to South China Sea.

Due to limitation on frequency of land use map, this study focused on agricultural land use changes from 2002 to 2013 and simulation of 2024 which is 11 years gap. Land use of 2002 and 2013 underwent Markov process that created transition area and transition probability of each agricultural land use types to change in future. Factors such as proximity to road and river, population, slope, soil permeability and porosity, crop price, yield and production underwent Analytical Hierarchy Process to create transition suitability. Therefore, CA-Markov applied transition area, probability and suitability combined with land use 2013 were used to simulate 2024 agricultural land use.

The improved TRIGRS model was used in this study to calculate surface runoff increment and sensitivity map from two period times which were 2013 and 2024. The first part of this method was preparation of data such as terrain map, slope, soil properties, rainfall information, interception loss data, and land cover where they were converted into a same size grid. The second part of was dedicated to analyze the impact of land cover changes on the flood volume in terms of sensitivity. In this regard, the assessment on the effect of land cover changes was made by considering the rate of infiltration/ loss water as the main factor, while for calculation of runoff volume was conducted based on modified TRIGRS model (Saadatkhah et al., 2015).

HEC-GeoRAS was finally utilized to generate flood simulation in Kelantan Basin. By using DEM as the modelling basis, data for flood simulation such as river, river banks, floodplain and river cross section was digitized in ArcGIS software. This model simulated flood area based on water overflowed from river to floodplain area. After simulation of flood area was completed, flood area was converted into vector data and overlaid with the simulated 2024 land use simulation map in order to analyze the affected agriculture areas.

3.0 Result and Discussion

Figure 1 illustrates the changes of land use type in 2013 and 2014. Based on the result, changes of agricultural area in Kelantan from 2013 to 2024 was anticipated to increase for most agricultural crops with exceptions for forest, coconut, paddy and rubber.

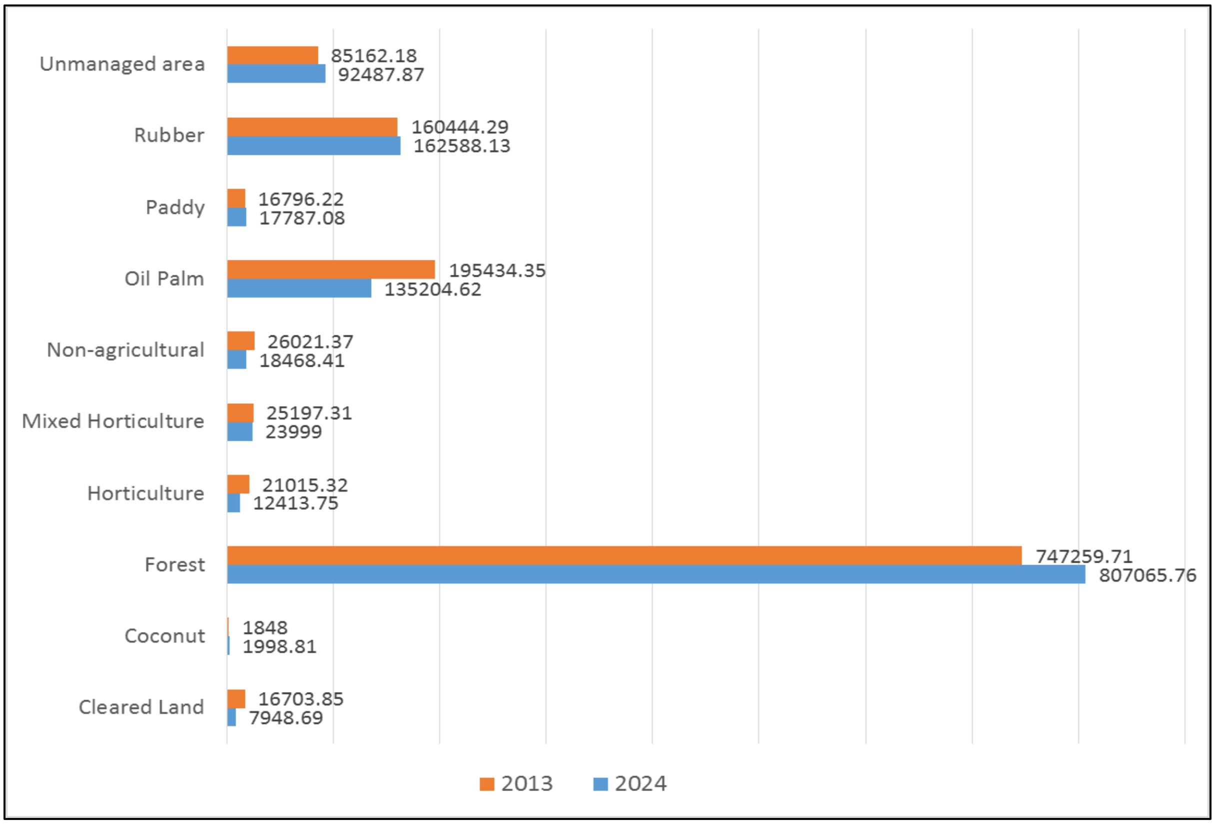

Figure 1. Land use (in ha) according to agricultural classes in 2013 and 2024

Horticulture was expected to increase about 69.29% from 2013 to 2024. Although the percentage was the highest, the increment in terms of hectare was 8601.67 ha only. Oil palm cultivation area in 2024 was estimated to expand to 44.55% or 60229.73 ha. Previous literature finds that expansion of oil palm production area occurred primarily over the logged-over forest and former rubber and coconut plantations (Abdullah and Nakagoshi, 2007). With increasing world demand for palm oil from the food, oleochemical and energy industries combined with high palm oil prices has resulted in large profits from the production of palm oil and thus a motivation for producers to expand their operations. Therefore, rising palm oil production is likely to cause land use changes in the study area. Although this study could not quantify the exact role that palm oil production, it has played a role in past land use change in Kelantan (Wicke et al., 2011). Additionally, it was predicted that non-agricultural area will likely to increase in area for about 40.9%, perhaps due to urbanization. As of importance, forest area will likely to face decrement for about 7.41%, caused by the opening of new agricultural areas such as oil palm and logging industry.

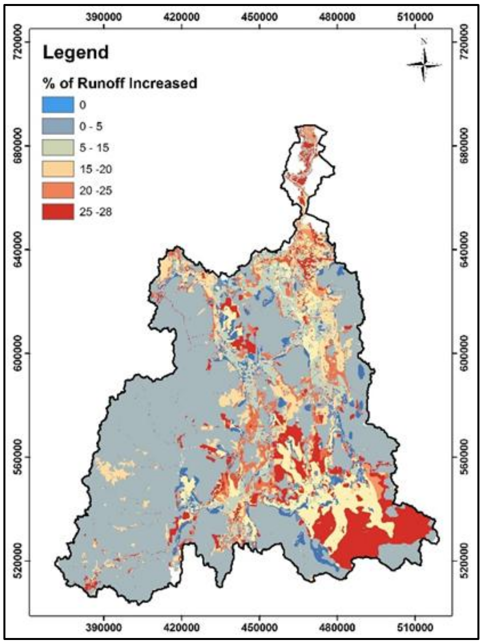

Figure 2. Increased in percentage runoff from 2013 to 2024

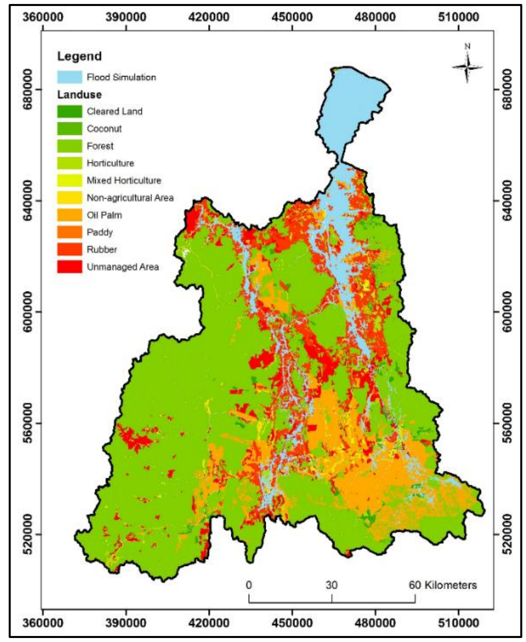

Figure 3. 2024 flood simulation

Figure 2 shows that the increasing runoff volume will be a consequence of deforestation and urbanization for the study area. The agricultural land use changes from 2013 to 2024 revealed a moderate percentage of total forest conversion to an agricultural area and an increase in non-agricultural area. The red area mostly in the southeast part of Kelantan basin was predicted to have an increment of 28% runoff. Such increments in flood volume will occur probably due to deforestation and conversion to agricultural land such as oil palm, rubber and mixed horticulture.

The critical runoff events were mainly scattered on the agricultural regions and the areas under development. Forest conversion to the less canopy coverage, i.e., urban and agricultural areas is responsible for higher level of runoff events in the study area. In this regards, the fatal debris flows and runoff will be caused by a combination of extreme rainfall, destruction of natural forest cover (human-caused), and conversion to agricultural plantations in thin, granitic soils.

Figure 3 shows the simulated flood affected area in Kelantan River basin. The highest agriculture area that will be affected based on this flood simulation is rubber, with 39115.21 hectare or 31.98 % of total flooded area. Rubber is planted at lowland area, therefore, rubber is prone to affected by flood. Flood simulation also will affect oil palm and paddy about 19153.26 and 15634.24 hectares, respectively.

The Stream of Kelantan River can be divided into three sections which are upper stream, middle stream and downstream. Upper stream is the section where the runoff occurs while middle stream acts as the water holding are. Downstream is where all the runoff is discharged. From Figure 3, it shows that the occurrence of flood did not occur at the upper and middle stream, but rather at the downstream part, where this area is concentrated with urban area. For the downstream area, the only available agriculture area is coconut crop that is located closed to the beach.

4.0 Conclusion

This study integrated various geospatial data, land use modeler and hydrological model to predict agricultural land use change and explored its potential on crop changes and flood events in Kelantan. Results in this study showed that Markov and CA-Markov were able to predict land use cover for 2024 in Kelantan. From the predicted land use map of 2024, the forest will be likely to change to oil palm area especially in the southeast part of Kelantan. The Improved-TRIGRS model illustrated that these forest-to-agricultural area conversions will likely to play an important role in runoff occurrence in the Kelantan Basin. Changes from thick canopy areas to fewer canopy areas accuse as the main cause in 28% increment of runoff level. From the simulation of 2024 flood, most affected agriculture area in Kelantan is rubber and also, the whole Kota Bharu will be submerged too.

References

Abdullah, S.A., Nakagoshi, N., (2007). Forest fragmentation and its correlation to human land use change in the state of Selangor, Peninsular Malaysia, Forest Ecology and Management, 241, 39-48

Tuan Pah Rokiah Syed Hussain, (2010). Pengaruh aspek fizikal dan gangguan manusia terhadap kejadian banjir di Lembangan Saliran Kelantan. (Doctoral Thesis dissertation). Fakulti Sains Sosial dan Kemanusiaan, Universiti Kebangsaan Malaysia. (Unpublished)

Wicke, B., Sikkema, R., Dornburg, V., Faaij, A., (2011). Exploring land use changes and the role of palm oil production in Indonesia and Malaysia, Land Use Policy, 28, 193-200

Saadatkhah N, Kassim A, Lee ML (2015) Spatiotemporal Regional Modeling of Rainfall-Induced Slope Failure in Hulu Kelang, Malaysia. Environmental Earth Sciences. 73 (12): 8425-8441

Saadatkhah N, Kassim A, Lee ML (2014) Hulu Kelang, Malaysia regional mapping of rainfall-induced landslides using TRIGRS model. Arabian Journal of Geoscience. 8 (5):3183-3194

Su, W., Zhang, X., Wang, Z., Su, X., Huang, J., Yang, S., Liu, S. (2000). Analyzing disaster-forming environments and the spatial distribution of flood disasters and snow disasters that occurred in China from 1949 to 2000.

PROJECT 9 : FLOOD MONITORING USING MULTI-TEMPORAL SAR REMOTE SENSING IMAGERY IN KELANTAN RIVER BASIN

9.1: DETECTING, MAPPING AND CHARACTERIZATION OF LANDSLIDES AND LANDSLIDE ASSESSMENT IN KELANTAN RIVER BASIN DURING DECEMBER 2014 FLOODING USING SATELLITE SAR DATA

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1.0 Introduction

In the GIS-based statistical models, it is very useful for generation of landslide susceptibility mapping and remote-sensing data, namely SAR for Kelantan River Basin area. Ten factors including slope, aspect, soil, lithology, NDVI, land cover, distance to drainage, precipitation, distance to fault, and distance to road were extracted from SAR data, and other available high resolution satellite-optical data, namely SPOT 5 and WorldView-1 images. The relationships between the detected landslide locations and these ten related factors were identified by using GIS-based statistical models including analytical hierarchy process (AHP) and weighted linear combination (WLC) models (refs, Shahabi et al, 2013, Shahabi et al 2015). The landslide inventory map which has a total of number of landslide locations will be created based on numerous resources such as digital aerial photographs, AIRSAR data, WorldView-1 images, and field surveys. The assessment of results will be assessed based on Relative landslide density index (R-index) and Receiver operating characteristic (ROC), where 80% of the landslide inventory will be used for training the statistical models and the remaining 20% was used for validation purpose. Previous recent similar studies have shown expected accuracy of AHP and WLC models for landslide susceptibility is in the range of 90~95% at 95% confident level, hence adequate for mapping, planning and monitoring of landslide occurrences (Kouli et al., 2014).

There two main expected outputs are: landslide inventory occurrences map during Dec 2014 flooding episode, and the generation of landslide susceptibility map for entire Kelantan River Basin. These main output landslide occurrence and susceptibility maps would be useful for hazard mitigation purpose and regional planning of sustainable landscape development. Despite all previous work had done by Malaysian researchers, all this have been fragmented elsewhere. This project will concentrate on flood Dec 2014 in Kelantan.

2.0 Methodology

2.1 Materials

Satellite data : COSMOS SAR data, fine resolution optical data,
Data processing : ENVI 4.8 Image processing system, e-cognition, Arc GIS system

2.2 Methods

This section reports on two types of landslides that occurred during severe flooding episode in Kelantan 2014. Both types of landslides consist of: (i) a landslide size exceeds 900 m^2 and, (ii) a landslide sizes (less than 900 m^2) occurring along the roads and areas that can be visited during fieldwork observations of the disaster area. Mapping landslides over 900 m^2 in size conducted with remote sensing technology in which data of Landsat 8 Operational Land Imager (OLI) was used. In this study, a landslide caused by heavy flooding episodes the Kelantan in December 2014 was reported in two parts: i) mapping of landslide inventory of large-scale (>900 m^2) of satellite remote sensing data; and ii) field work to collect, measure and determine the location of all elements of landslides on a small scale (<900 m^2) on selected major roads in Kelantan.

$$NDVI_{OLI}=(Band5_{OLI} – Band4_{OLI}) / (Band5_{OLI} + Band4_{OLI})$$

where Band 5_{OLI} is reflectance unit of NIR band Landsat 8 OLI; and Band 4_{OLI} is reflectance unit of red band Landsat 8 OLI.

Using AHP, comparisons between the parameters or element involved including slope, land-use type, distance to fault line and precipitation intensity are demanded. A scale of numbers is crucial to indicate how many times more important or dominant one element is over another element with respect to the criterion or property with respect to which they are compared. Ten factors including slope, aspect, soil, lithology, NDVI, land-cover, distance to drainage, precipitation, distance to fault, and distance to road were extracted from ScanSAR data and Landsat 8 images. The relationships between the detected landslide locations and these ten related factors were identified by using GIS-based statistical models including AHP. The distance between detailed fault line derived from ALOS PALSAR-2 data and all landslides point was computed in ArcMap software using Euclidean distance.

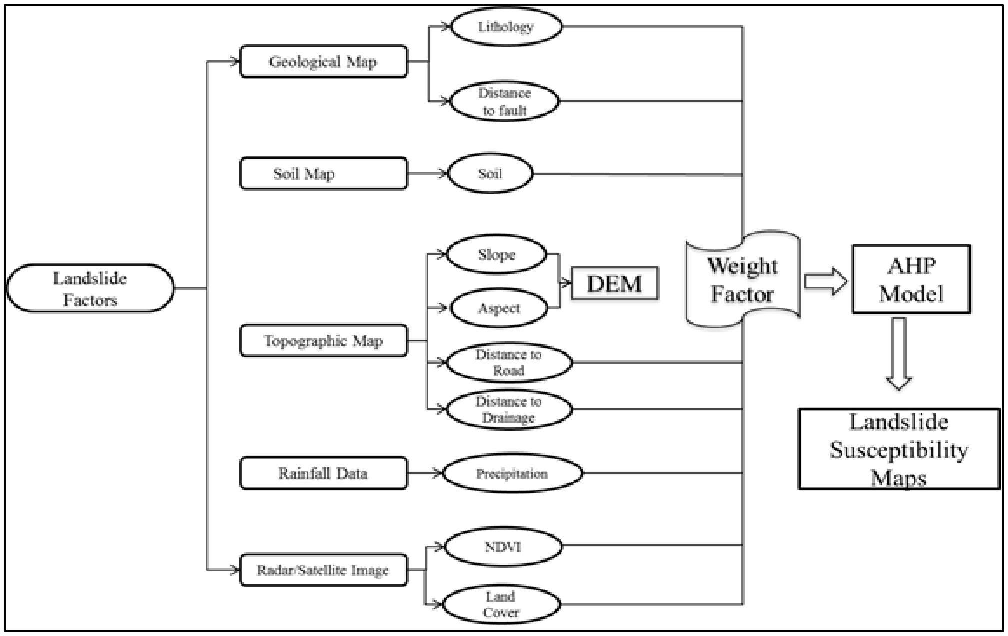

Figure 1. Procedure of AHP to produce risk map of flood in Kelantan.

3.0 Results and Discussion

Table 1. Summarize large size of landslides after flood episode of Kelantan 2014

Landuse type	Number of landslide	Area (ha)	Area (%)	Watershed			
				Sg Kelantan	Sg Golok	Sg Semerak	Sg. Kemasin
Forest	26	9.1	66.1	25	1	0	0
Rubber	7	3.5	25.5	6	0	1	0
Bushes	2	1.0	7.2	2	0	0	0
Mixed-vegetation	1	0.2	1.3	1	0	0	0
Total	36	13.8	100	34 (94%)	1 (3%)	1 (3%)	0 (0%)

Table 2. Summarize of small and medium size of landslides after flood episode of Kelantan 2014

Landuse type	Number of landslide	Area (ha)	Area (%)	Watershed			
				Sg Kelantan	Sg Golok	Sg Semerak	Sg. Kemasin
Forest	129	23.49	91.1	110	19	0	0
Rubber	159	2.084	8.1	113	46	0	0

Bushes	10	0.010	0.04	8	2	0	0
Mixed-vegetation	61	0.101	0.39	48	13	0	0
Oil palm	28	0.060	0.23	28	0	0	0
Open area	23	0.026	0.10	17	6	0	0
Built-up area	6	0.003	0.01	6	0	0	0
Total	416	25.78	100	330 (79%)	86 (21%)	0 (0%)	0 (0%)

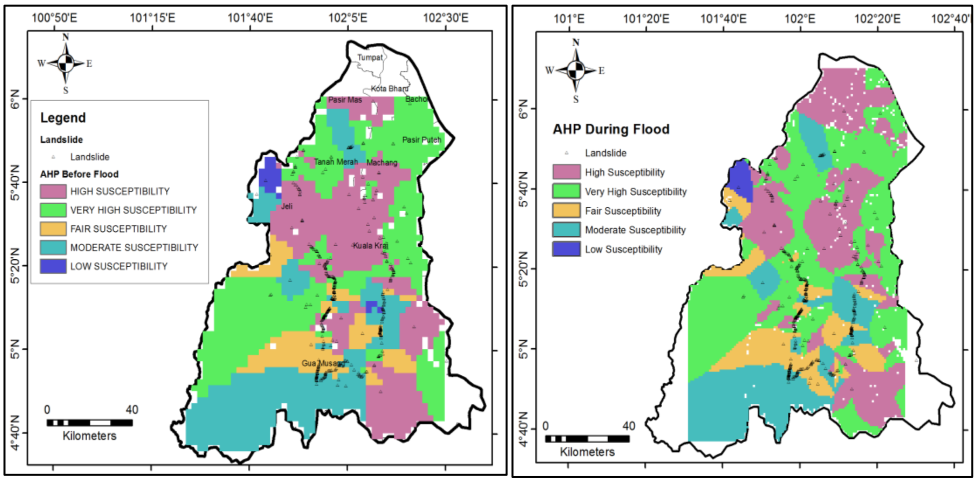

Figure 2. Risk map of flood in Kelantan before and during flood episode flood event in December 2014.

4.0 Conclusion

Successful findings have been produced with combination of all sources of data remote sensing and build up an AHP model to produce flood risk map using the 10 related-factors listed.

4.1 36 large landslides have been identified from remote sensing satellite, Landsat 8 OLI, while 416 small landslides points has been recorded by field visit.

4.2 The road which having high risk on facing the small magnitude of landslide have been highlight in this study.

4.3 From AHP, precipitation is the prime factor causing slope failure in Kelantan, followed by slope and distance to river factor, referred to weighting factor given by AHP with 0.5745 consistency ratio (CR).

4.4 Based on the rainfall anomaly assessment, the 300mm precipitation in three days would trigger >15 landslides to occur.

References

Shahabi, S Khezri, BB Ahmad, M Hashim (2013) Landslide susceptibility mapping at central Zab basin, Iran: A comparison between analytical hierarchy process, frequency ratio and logistic regression models, Catena 115: 55-70.

Shahabi, H. and Mazlan Hashim (2015) Landslide susceptibility mapping using GIS-based statistical models and Remote sensing data in tropical environment, Scientific Reports, 5.

Kouli, M., Loupasakis, C., Soupios, P., Rozos, D., Vallianatos, F. 2013. Comparing multi-criteria methods for landslide susceptibility mapping in Chania Prefecture, Crete Island, Greece. Natural Hazard and Earth System Sciences, 12: 73–109.

9.2: IMPACT OF CLIMATE AND LAND-USE CHANGES ON HYDROLOGICAL COMPONENTS OF THE KELANTAN RIVER BASIN, MALAYSIA

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1.0 Introduction

Understanding of Earth's water resource situation is very crucial for robust socio-political and economic strategies development to promote sustainable water use (Fukunaga et al., 2015). The known relationship between water, land-use and climate system must all be identified in the quest of sustainability. Integrated land-use planning and management is an effective way to enhance the long-term sustainability of water resources. In recent years, hydrological models have been extensively used to evaluate impacts of various management strategies in the areas of water resource allocation, flood control, land-use planning and water quality assessment (Bourdin et al., 2012). Besides that, these models can be used to design policies to mitigate water and soil quality degradation by determining suitable conservation programs for a particular basin.

The Soil and Water Assessment Tool (SWAT) has been successfully applied for basin-scale water resources management around the world with different environmental conditions. Besides that, various advantages of SWAT, such as its free availability, user-friendly interface, efficiency in data handling and ability to simulate different land-use and climate scenarios, are among the reasons to choose this model. In Malaysia, several studies have been applied SWAT model for hydrological modelling (Hasan et al., 2012; Memarian et al., 2014, Tan et al., 2014, 2015), and these studies showed SWAT performed well. However, application of SWAT model in other basins is still needs to be evaluated.

The Kelantan River is the main river of Kelantan state that located in north-eastern Peninsular Malaysia. The major economic activities of the Kelantan state are agriculture-based such as paddy rice, oil palm and rubber. These human activities have caused deforestation and lead to water pollution and flood event, which is affecting the Kelantan's population. Besides that, Kelantan is subject to one of the most severe monsoon flooding in Malaysia that brought by the northeast monsoon. Therefore, effective basin management and land-use planning are important to promote environmental sustainability in this region. The major objective of this study is to evaluate the performance of the SWAT model to simulate streamflow in the Kelantan River Basin (KRB). Careful calibration and validation of SWAT model is essential to successfully apply the model in practical water resource investigations. The calibrated model can be used to further analyze the impacts of land-use and climate changes on hydrological cycle in the KRB.

2.0 Methodology

2.1 SWAT Model

The Soil and Water Assessment Tool (SWAT) model is developed by the United States Department of Agriculture (USDA) to predict the impact of agriculture or land management on water, sediment, and agriculture chemical yields in ungauged basins (Arnold, 1998). It is a continuous and semi-distributed hydrological model that runs on daily, monthly and annual time steps. The model is semi-physically based and allows the simulation of a high spatial detail. In SWAT, a basin is divided into various sub-basins, which are then further divided into hydrologic response units (HRUs) where the water balance is estimated. These HRUs are defined as homogeneous spatial units characterized by similar geomorphologic and hydrological properties. They are composed of a unique combination of homogeneous soil properties, land use, and slope. For climate, SWAT uses the climate data from the station nearest to the centroid of each sub-basin. More information about SWAT theory can be found in Neitsch (2011).

The SWAT simulates the hydrology based on the water balance equation as below:

$$SW_t = SW_o + \sum_{i=1}^{t}\left(R_{day} - Q_{surf} - E_a - w_{seep} - Q_{gw}\right)$$

Where SWt is the final soil water content (mm H2O), SWo is the initial soil water content on day i (mm H2O), t is the time (days), Rday is the amount of precipitation on day i (mm H2O), Qsurf is the amount of surface runoff on day i (mm H2O), Ea is the amount of evapotranspiration on day i (mm H2O), wseep is the amount of water entering the vadose zone from the soil profile on day i (mm H2O) and Qgw is the amount of return flow on day i (mm H2O).

2.2 Input Data

The main input data for SWAT modelling include a Digital Elevation Model (DEM), land use map, soil map and hydro-climatic data are listed in Table 1. Climate and streamflow data were collected from Department of Irrigation and Drainage Malaysia (DID). Besides that, the daily rainfall, minimum and maximum temperature data sets collected at the Kuala Krai station were obtained from the Meteorological Malaysia Department (MMD). The DEM was obtained from Shuttle Radar Topography Mission (SRTM) and had a 90m resolution (Figure 2). The land use and soil maps obtained from the Ministry of Agriculture and Agro-based Industry Malaysia were used as spatial input for SWAT. An additional vector layer of the stream network was derived from topographical map that prepared by Department of Survey and Mapping Malaysia (JUPEM). The SWAT model is simulated from 1985 to 2012, and one year is set as a warm-up period.

2.3 SWAT Calibration and Validation

The SWAT model was calibrated and validated using observed monthly streamflow at the Jam Guillemard station that located at outlet of the KRB (Figure 1). The observed data were divided into calibration (1986-2000) and validation (2001-2012) periods. The SWAT-CUP tool, a free program that was developed for sensitivity analysis, calibration and validation of SWAT model is used. The Sequential Uncertainty Fitting algorithm (SUFI-2) within the SWAT-CUP was selected to calibrate and validate the SWAT model in this study. The SUFI-2 was selected because of its capability of handling and analyzing many parameters in the smallest number of model runs (Abbaspour et al., 1997; Yang et al., 2008; Ghaffari et al., 2010). Besides that, the global sensitivity analysis technique was used to perform sensitivity analysis of eight parameters. The accuracy of precipitation products and SWAT model was evaluated using statistical analysis to compare simulated and observed data. In this study, the statistical analysis methods are the Nash-Sutcliffe (NSE) and coefficient of determination (R2).

3.0 Results and Discussion

A sensitivity analysis was applied to identify sensitive of eight parameters for model calibration. The global sensitivity analysis showed the most sensitive parameter for this study was CH_K2 (effective hydraulic conductivity in main channel alluvium), followed by GW_REVAP (groundwater ‘revap’ coefficient), GWQMN (threshold water depth in the shallow aquifer for return flow to occur), CH_N2 (manning’s “n” value for the main channel), REVAPMN (threshold depth of water in the shallow aquifer for “revap” to occur), CN2 (initial SCS CN II value), ESCO (soil evaporation compensation factor), and SOL_AWC (available water capacity of the soil layer) (Table 1)

Table 1: Calibrated parameters for the SWAT model (1: most sensitive)

No	Parameter	Name	Min	Max	Fitted Value
1	CH_K2	Effective hydraulic conductivity in main channel alluvium	0	500	135.5
2	GW_REVAP	Groundwater ‘revap’ coefficient	0	0.8	0.684
3	GWQMN	Threshold water depth in the shallow aquifer for return flow to occur	0	1000	599
4	CH_N2	Manning’s “n” value for the main channel	0	0.3	0.0183
5	REVAPMN	Threshold depth of water in the shallow aquifer for “revap” to occur	0	500	423.5
6	CN2	Initial SCS CN II value	-0.5	0.5	0.367
7	ESCO	Soil evaporation compensation factor	0	1	0.521

8	SOL_AWC	Available water capacity of the soil layer	-0.5	0.5	-0.309

The R2 values for calibration and validation periods are 0.85 and 0.75, respectively. This indicated that the observed and simulated streamflow are correlated well for both calibration and validation periods. Similar results were reported by Hassan (2012), where the SWAT model showed good streamflow simulation performance in the Bukit Reservoir Catchment, Malaysia, with the R2 values of 0.87 and 0.69 for calibration and validation periods, respectively. Besides that, Tan (2014) also showed SWAT model performed well in the Johor River Basin that located in southern Peninsular Malaysia, with a R2 of 0.67 for calibration period and 0.68 for validation period.

Figure 1 presents observed and simulated monthly streamflow hydrograph at the Jam Guillemard station during the calibration and validation periods. For NSE method, the SWAT model results both of 0.79 for calibration period and 0.6 for validation period. Based on Moriasi (2007), the SWAT model performance was considered "very good" in the calibration period and "satisfactory" for the validation period. The performance of SWAT model for the calibration period is better than validation period, is mainly due to occurrence of extreme flood events in early 2008 and 2010 where the SWAT model poorly matched the peak flow. Besides that, validation period hydrograph shows an overestimation of simulated streamflow during dry season, which was also the case of other studies (Levesque, 2008; Zhang et al, 2015). This might be due to temporal variations in SWAT model parameters have not been effectively accounted.

Overall, the SWAT model has the potential to be used a useful tool for water resources management, especially when applied to land-use and water related policy development. In many countries, policy makers and water resources managers are usually unable to sustainably manage their water resources due to lack of accurate and comprehensive water resources information. Hence, the calibrated SWAT model can be used to guide better decision-making on water-resources program, especially on land-use planning, flood mitigation and control management.

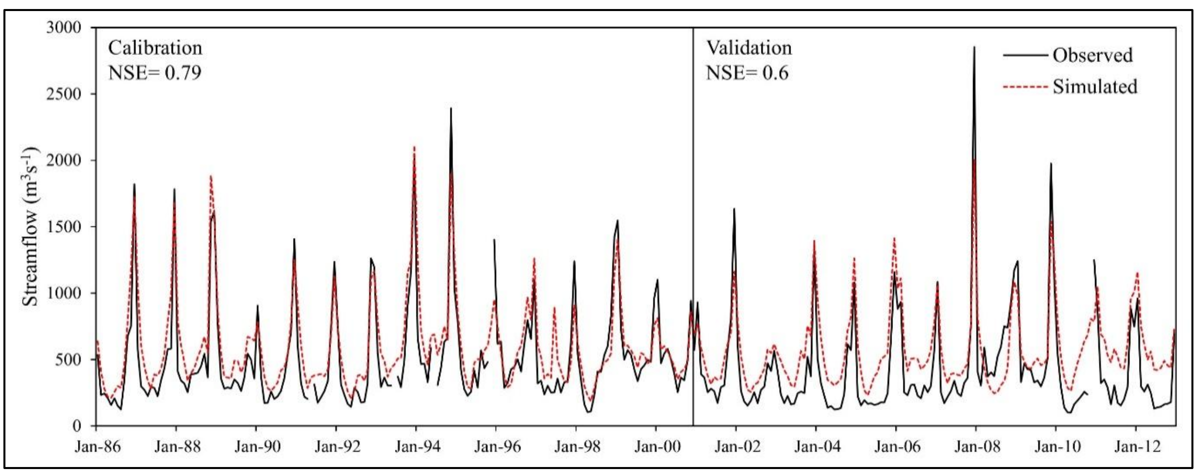

Figure 1: Observed and simulated monthly streamflow hydrograph at the Jam Guillemard station during the calibration (1986-2000) and validation (2001-2012) periods.

4.0 Conclusion

In this study, parameters sensitivity analysis showed the CH_K2 (effective hydraulic conductivity in main channel alluvium) and GW_REVAP (groundwater 'revap' coefficient) are the most sensitive parameters for the SWAT calibration in the Kelantan River Basin (KRB), Malaysia. Besides that, this study showed that the SWAT model can performs well in hydrological cycle simulation in the KRB for the period from 1985 to 2012. The calibrated model will be used to investigate the potential impacts of land-use and climate change on the hydrological components, with emphasis on streamflow in the KRB.

References

Abbaspour, K.C., van Genuchten, M.T., Schulin, R. and Schläppi, E. 1997. A sequential uncertainty domain inverse procedure for estimating subsurface flow and transport parameters. Water Resour. Res. 33(8): 1879-1892.

Adnan, N.A. and Atkinson, P.M. 2011. Exploring the impact of climate and land use changes on streamflow trends in a monsoon catchment. Int. J. Climatol. 31(6): 815-831.

Arnold, J.G., Srinivasan, R., Muttiah, R.S. and Williams, J.R. 1998. Large area hydrologic modeling and assessment - Part 1: Model development. J. Am. Water Resour. As. 34(1): 73-89.

Bourdin, D.R., Fleming, S.W. and Stull, R.B. 2012. Streamflow Modelling: A Primer on Applications, Approaches and Challenges. Atmos.-Ocean. 50(4): 507-536.

Fukunaga, D.C., Cecílio, R.A., Zanetti, S.S., Oliveira, L.T. and Caiado, M.A.C. 2015. Application of the SWAT hydrologic model to a tropical watershed at Brazil. CATENA. 125: 206-213.

Ghaffari, G., Keesstra, S., Ghodousi, J. and Ahmadi, H. 2010. SWAT-simulated hydrological impact of land-use change in the Zanjanrood Basin, Northwest Iran. Hydrol. Process. 24(7): 892-903.

Hasan, Z.A., Hamidon, N., Yusof, M.S. and Ab Ghani, A. 2012. Flow and sediment yield simulations for Bukit Merah Reservoir catchment, Malaysia: a case study. Water Sci. Technol.66(10): 2170-2176.

Levesque, E., Anctil, F., van Griensven, A. and Beauchamp, N. 2008. Evaluation of streamflow simulation by SWAT model for two small watersheds under snowmelt and rainfall. Hydrol. Sci. J. 53(5): 961-976.

PROJECT 10 : IMPACT ASSESSMENT OF FLOOD DISASTER ON ENVIRONMENTAL SERVICES AND RIVER DEGRADATION ON UPPER SG KELANTAN BASIN

10.1: AFTERMATH OF FLOOD DISASTER: SEDIMENT FINGERPRINTING STUDY IN UPPER SG. KELANTAN RIVER BASIN

Project Information

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1.0 Introduction

Biggest flood event hit the state of Kelantan in 2014, the worst flood event ever to be recorded in the history of Malaysia. The National Security Council (NSC) reported that the water level exceeded the danger level of 25m (at 34.17m) higher than major past event in 2004, which was at 29.7m. Which highlighted the need to identify the source of sediment as soon as possible to enable mitigation actions. The role of suspended sediment in non-point pollution from landuse activities and in the transport of nutrients and contaminants has highlighted the need for sediment monitoring programs to provide information on sediment sources as well as concentrations and loads. The sediment fingerprinting technique offers an alternative approach in sediment source ascription. This approach in discriminant of catchment sediment sources using a combination of chemical and statistical approach has been proven to be applicable in tropical region at a large catchment scale (Walsh *et al*., 2011; Annammala *et al.,* 2013; Blake *et al*., 2014).

2.0 Methodology

Selection of major tributaries of the Kelantan River catchment, the number and location of sites had to be determined before creating the Standard Operating Procedure (SOP) for both field and lab sampling and analysis. Minimum 5 were collected at each/some tributary to ensure the collected samples were representative of the selected tributary. Total 20 sampling locations were selected(Table 2.1). Samples were air dried, sieved and analyzed in the laboratory. After the XRF analysis of the samples, the geochemical elements significant to each tributaries were selected for further statistical analysis to act as tracers.

Table 2.1: Sampling points along the Kelantan River basin and summary of main land-use/ land-uses within the tributaries of the Kelantan River Basin.

No	River	LATITUDE	LONGITUDE	Main Land-uses
1	Kuala Krai (Sink Area)	N 5°31'44.6"	E 102°11'35.5"	Urban
2	Sg. Lebir-(Sink)	5°23'15.83"N	102°14'14.07"E	Oil Palm, rubber, Forest, Quarry, logging
3	Sg. Galas (sink)	5°22'55.16"N	102° 1'26.00"E	Urban, Rubber, Oil Palm, Open area, Logging
4	Sg. Pergau (Hilir)	5°23.694N	102°00.640 E	Oil Palm, Rubber, Forest
5	Sg. Setong	5°20'36.03"N	101°58'57.19"E	Oil Palm
6	Sg. Nenggiri	5° 8'50.23"N	102° 2'39.91"E	Forest,Oil Palm, Rubber, cleared land
7	Sg. Balahok	4°39'36.89"N	101°29'1.77"E	Vegetable, forest
8	Hulu Sg. Galas	4°45'23.61"N	101°45'3.91"E	Vegetable, forest
9	Sg. Betis	4°53'31.40"N	101°45'39.6"E	Oil Palm, Rubber, Forest
10	Sg.Perias	5° 2'8.40"N	101°44'44.60"E	Forest
11	Sg.Jenera	5°13'57.50"N	101°46'9.00"E	Forest

12	Sg.Depak (kg Linggi)	5° 12'32.0"N	102°18'28.30"E	Rubber
13	Sg.Chalil	5° 6'41.70"N	102°17'2.40"E	Forest, Oil Palm
14	Sg. Relai	5° 2'26.38"N	102°23'2.04"E	Oil palm, Rubber
15	Sg. Aring	5° 0'30.52"N	102°23'1.95"E	Oil Palm
16	Hulu Sg. Lebir	4°52.173'N	102°26.393"E	Oil Palm, Rubber, Forest
17	Anak Sg. Galas	5° 4'51.29"N	102° 4'15.77"E	Oil Palm, Rubber, cleared land
18	Sg. Chiku	5° 02'24.90"N	102° 08'49.60"E	Oil Palm, Rubber, cleared land
19	Lata Rek	5°18'43.25"N	102°17'50.99"E	Rubber, Logging upstream
20	Sg.Pergau (Hulu)	5°29'08.5"N	101° 54'20.5"E	Oil Palm, Rubber

Apart from field sampling (Figure 2.1), some informal interviews with the locals were conducted to gather more insight information about the flood event, the frequency of flood and the water quality of the selected area as secondary data apart from formal information gathered (i.e: from Department of Drainage and Irrigations, Malaysia).

3.0 Results and Discussion

The sampling locations and points and were mapped against land-use (Figure 2). In 1978, Kelantan was predominantly under forest cover with minimal logging and conversion to agriculture. The completion of north south highway acted as a catalyst for the development in Kelantan. During the 1980's timber extraction accelerated and much of the lowland forested area were logged and then converted to agricultural plantation mainly oil palm and rubber plantations (Kumari 1995).

Figure 1: Example of sampling strategy for sediment samples along riverbanks for sediment fingerprinting analysis.

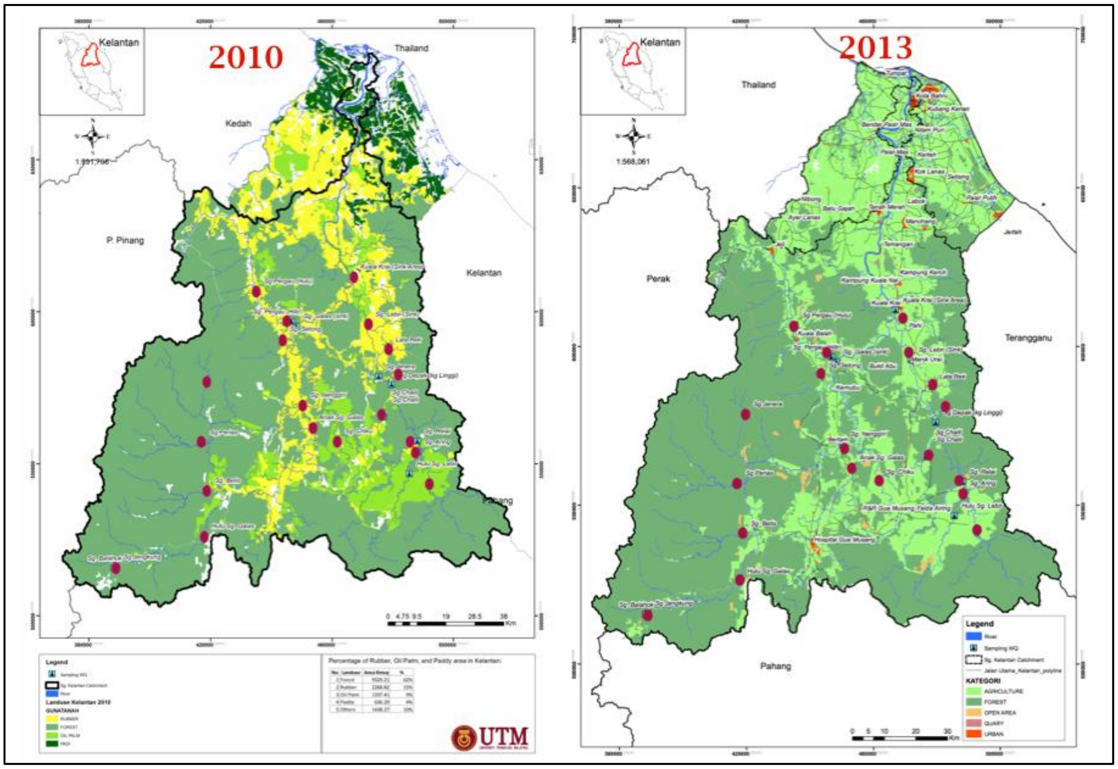

Figure 2: Sampling locations along the Kelantan River basin against the land-use (2010 Vs 2013)

In the 1990's land conversions to vegetable farming, coffee plantations and oil palm and rubber plantations continued to incline rapidly (Hussain & Ismail 2013). Current main land-uses in Kelantan includes Oil Palm plantation, Rubber and Paddy plantation, a summary of major land-uses within the study area is as presented earlier.

3.1 Predicted Sediment contributions from the main sources

A single diagnostic property would not be capable of clearly discriminating contributions from a number of potential sources. Attention focused on identification and use of several properties, which together would provide a composite fingerprint capable of discriminating unequivocally between several potential sources (Walling, 2005). From the 83-measured elements 50 trace elements have been shortlisted to be considers as tracers. These elements includes Mg, Al, Si, Cl, K, Mn, Fe, Co, Ni, Cu, Ga, Se, Br, Y, Sn, Sb, Te, Ba, La, Ce, Hf, Ta, Ir, Pt, Au, Ti, Bi, Th, U, Na, Zr, Re, Os, Ra, Pa, Eu, Dy, Er and Tm.

Although alkaline and alkaline earth elements are all considered mobile elements during weathering the latter are more susceptible to retention by sorption. Among alkali and alkaline earth metals in leachable and weather-able minerals: Na, Ca and Sr are most rapidly and strongly removed during weathering of fresh parent rock (Figure 3). In the following figures, the graphs are presented in two shades; Green indication of all tributaries of the Galas River and Blue from the Lebir River.

From the results it was observed that there were no obvious concentration trend to be picked up for Na, mostly in the same range of 20k ppm except for Sg. Chiku. To be precise, concentration values varied from 9800 ppm (in Sg. Chiku) to 203200 ppm in Sg. Nenggiri. While for Ca, higher peaks were observed in two tributaries of the Galas River namely Sg. Pergau (5068 ppm) and Sg. Nenggiri (5640 ppm). High Ca concentrations were also observed in three river catchments within the Lebir river tributaries. Those rivers are; Sg, Relai (5100 ppm) , Sg. Depak (5732 ppm) and upstream river (5410 ppm). As for Sr, highest concentrations were observed from Galas tributaries (Sg. Pergau with 224 ppm and Sg.Setong with 202 ppm). Whereas Rb, Ba, K and Mg are generally retained in weathering profiles by cation exchange and adsorption reactions on secondary clay minerals (Agbenin, 2001) (Figure 4).

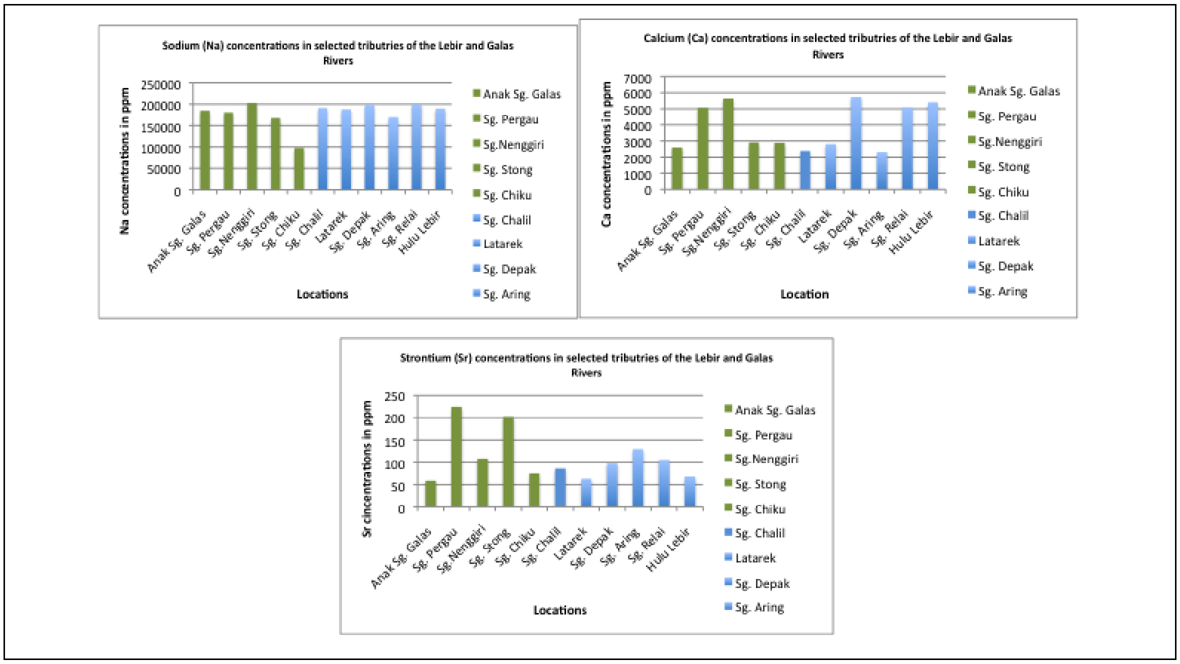

Figure 3: Concentrations of Sodium (Na), Calcium (Ca) and Strontium (Sr) from Lebir and Galas river catchments

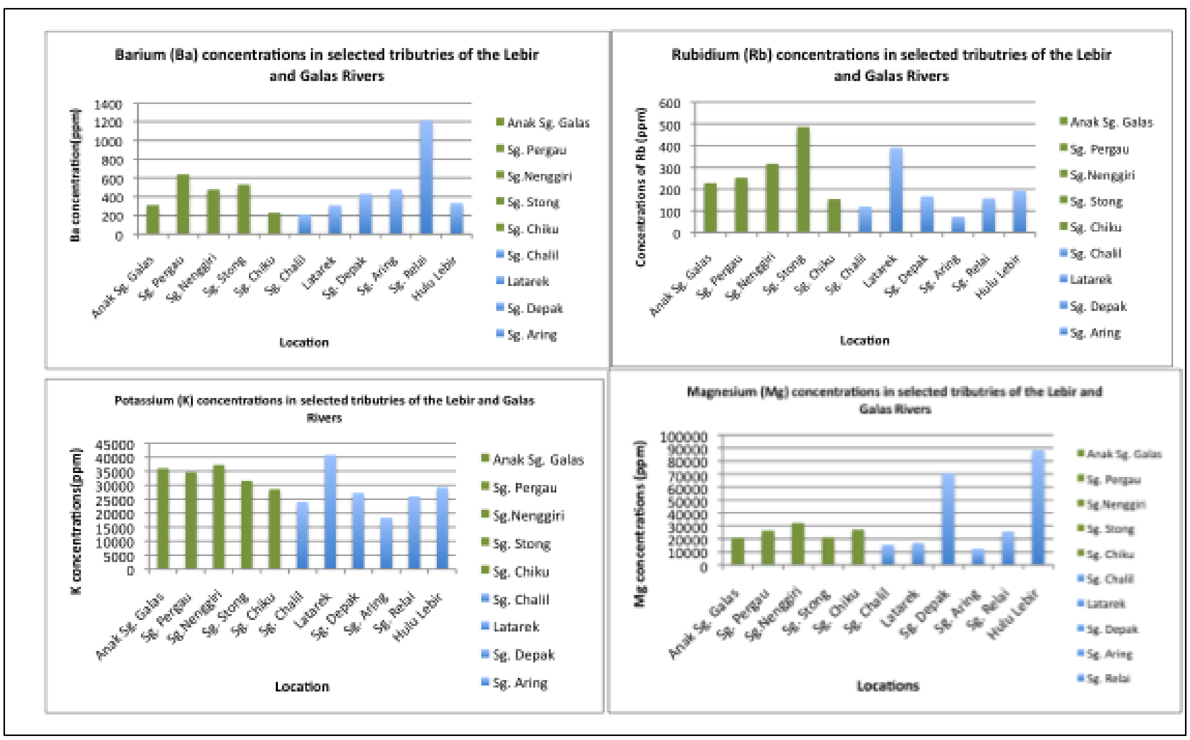

Figure 4: Concentrations of Barium (Ba), Rubidium (Rb), Potassium (K) and Magnesium (Mg) from Lebir and Galas river catchments

Fe was the highest in Sg. Aring (145k ppm) followed by Sg. Relai (82.6k ppm), Similar trend observed with Mn (highest in Sg. Aring and Sg. Relai rivers) with concentrations of 64.7k and 14.6k ppm respectively both located in upper Lebir catchment with concentrations. Both these elements are often related to originate from heavily weathered materials (Tardy 1997) (Figure 5). The high reading of manganese supports the reason for the mining operations at the particular area.

4.0 Conclusion

Overall results indicated that during the recent flood sedimentation input to the Kelantan River system was more contributed by Lebir River (56%) with catchment size of approximately 3,326.9 km^2 compared to the Galas River (44%) with catchment area of proximity 7,834.6 km^2

4.1 Floodplain at Kuala Krai was dominated by sediments contributed surprisingly by a relatively small tributary namely Sg. Rek in Lata rek. A place well known for the beautiful waterfalls (28%). This area has been reported to be badly effected to flood. Lata Rek's major Geology is slightly distinctive compared to the rest of the middle and lower catchment of the Lebir River with mixture of acid intrusive and Permian compared to Triassic and cretaceous towards the middle and upper catchment. This suggests that the source of sediment delivered to the bench deposit may have varied both in horizontal space (i.e. the proportions coming from different sub-catchments) and vertical space (i.e. the proportions coming from surface *versus* subsurface material linked to different erosion processes).

4.2 Another major sediment contributor from the Galas catchment is from Anak Sg. Galas (20%). While the former might have an influence on geochemical composition given heterogeneity in geology within the upstream catchment, the effects of weathering can be hypothesized to be ubiquitous within this catchment.

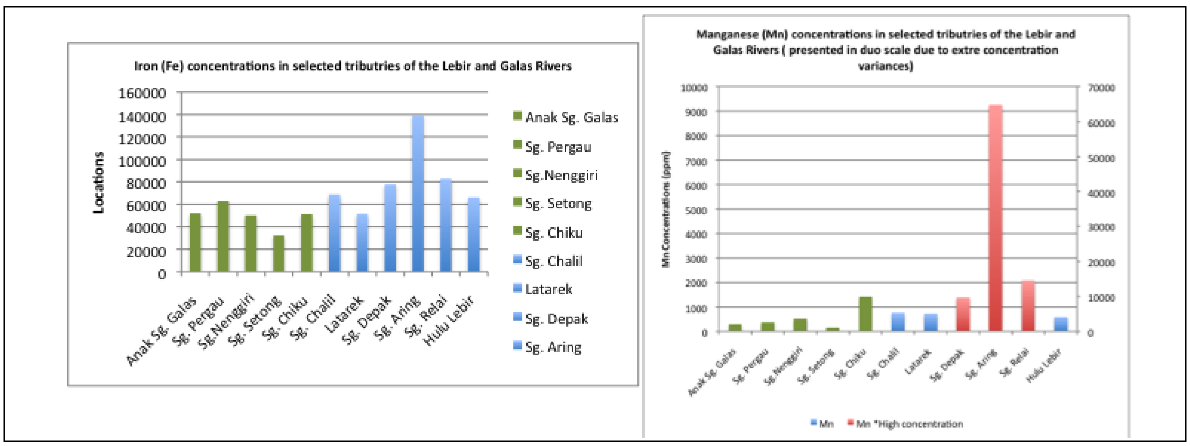

Figure 5: Concentrations of Iron (Fe) and Manganese (Mn) from Lebir and Galas river catchments

4.3 River Nenggiri is one of the largest catchment feeding to the Galas River. Within this river system, further 4 rivers feed towards this catchment namely Jenera, Perias, Betis and Belahok rivers. Within this closed system, Sg. Jenera (34 %) have been noted to be a major sediment contributor to the Nenggiri river, followed by Sg. Perias (32 %) and Sg. Betis 29 %.

This explains the complexity of sediment fingerprinting when working at a large catchment scale. When decision making mitigation actions are to be planned; accurate location is vital. As large catchment sediment contribution is narrowed down/ zoomed in to the finer details within the river systems, more complicated routes are discovered. But this will enable one to produce a precise source identification to make achievable-targeted mitigation plans with positive results.

References

Agbenin JO (2001). The status and fluxes of alkali and alkaline-earth metals in a savanna Alfisol under long-term cultivation. Catena 45, 313–33

Annammala KV, Walsh RPD, Bidin K, Nainar A (2012). Higher Erosion Rate and Enhanced Sedimentation from disturbed landforms in Eastern Sabah, Borneo. 2nd International conferences on Water Resources in Conjunction with 20th UNESCO-IHP regional Steering Commitee Meeting for Southeast Asia and the Pacific Proceedings. 5-9th November, 2012. Langkawi Malaysia.

Blake WH, Walsh RPD, Bidin K, Annammala KV (2015).Contextualising impacts of logging on tropical rainforest catchment sediment dynamics using the stratigraphic record of in-channel bench deposits. Earth Surface Processess and Landforms (In Press)

Hussain TPR and Ismail H (2013). Flood frequency Analysis of Kelantan River Basin, Malaysia. World Applied Sciences Journel 28 (12); 1989-1995.

Kumari K (1995). An Environmental and Economic Assessment of Forest Management Options: A Case study in Malaysia. Environment Department Papers 026. Washington, D.C: The World Bank.

Tardy Y (1997). Petrology of laterites and Tropical soils. A.A Balkema**.** Netherlands.

Walling DE (2005). Tracing suspended sediment sources in catchments and river systems. Science of the Total Environment. 344: 159-184.

Walsh RPD, Bidin K, Blake WH, Chappell NA, Clarke MA, Douglas I, Ghazali R, Sayer AM, Suhaimi J, Tych W, and Annammala KV (2011). Long-term responses of rainforest erosional systems at different spatial scales to selective logging and climatic change. Philosophical Transections of the Royal Society. 366: 3340-3353.

10.2: EVALUATION OF FLOOD DISASTER IMPACTED ON WATER QUALITY AND AQUATIC HABITAT IN WATER ENVIRONMENT

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1.0 Introduction

Flood hazard, risk, and disaster are the products of an interaction between environmental and social process (Parker, 2000). They are characterised by five critical components: the magnitude of discharge, the velocity of the discharge, the duration of the flood, timing or seasonality of the event and the frequency of the disturbances. Flood often take place around rivers and plains, which indicates a higher risk in this area. High intensity of rainfall fill the stream and river once the soil are saturated, the shallower the river the faster the river get filled. Large flood flows maintain ecosystem productivity and diversity through processes such as transport and cycling of nutrients, sediments and organisms between river channels and floodplains (Poff *et al*., 1997; Baldwin & Mitchell, 2000), and habitat creation and maintenance of channel structure through scouring fine sediments and washing organic matter out onto floodplain (Poff *et al*., 1997). The organisms of flood prone systems are adapted to this disturbance, with many species of fish and maroinvertebrates requiring flood events to complete their life cycle (Junk *et al*., 1989). It is expected that river water overflowing onto the floodplain will increase the availability of shelter and allocthonous food sources and enrich the water with nutrients carried down from slopes or nutrients present in flooded organic or inorganic materials (Agostinho *et al*., 2004). However, large input of organic matters to aquatic floodplain habitats may reduce dissolved oxygen and result in the emigration or death of a great number of fishes (Winemiller, 1990). On the other hand, large-scale disturbance caused by floods often reduces the abundance of benthic invertebrates (Hildrew & Giller, 1994), although the communities usually recover within weeks to months (Lake, 2000; Mackay, 1992; Matthaei *et al*., 1997; Robinson *et al.,* 2005).

2.0 Methodology

The Kelantan River is the largest river in the Kelantan state and second largest river in Peninsular Malaysia. The catchment area of Kelantan River is approximately 11900 km^2, drains northward passing through several districts such as Gua Musang, Pasir Putih, Kuala Krai and Kota Bahru and creates a large floodplain area. A study was conducted three times in June, August and September 2015. Field samplings were carried out from three major rivers namely Kelantan, Galas and Lebir rivers including its tributaries. A number of 13 sampling stations were established for water quality and biological sampling, respectively. Coordinates for each sampling station is shown in Table 1.

Table 1: The geographical coordinate of sampling station

Station	Location	Longitude	Latitude
1	Sg. Betis	N 4°52'52.8"	E 101°44'40.8"
2	Sg. Nenggiri_Gua Cha	N 5°00'33.9"	E 101°45'36.4"
3	Sg. Nenggiri	N 4°58'12.9"	E 101°46'19.0"
4	Sg. Lebir_1	N 5°00'12.3"	E 102°19'38.9"
5	Sg. Lebir_2	N 5°00'29.6"	E 102°17'40.7"

6	Manek Urai_1	N 5°20'23.2"	E 102°13'35.9"
7	Manek Urai_2	N 5°22'15.8"	E 102°13'52.4"
8	Sg. Durian	N 5°33'54.7"	E 102°12'05.4"
9	Sg. Geh	N 5°37'31.5"	E 102°12'09.4"
10	Sg. Jelawang	N 5°20'37.9"	E 101°59'00.5"
11	Sg. Kenerong	N 5°17'28.6"	E 101°59'04.0"
12	Kg. Bertam Baru	N 5°09'30.2"	E 102°02'23.0"
13	Sg. Lah	N 5°09'08.4"	E 101°58'28.1"

A multihabitat sampling procedure was opted to sample macroinvertebrates using a rectangular dip net with a catching area 0.15 m^2, attached with a mesh bag (mesh size 500 μ nytex screen). A dip net was placed resting on the shallow running water substrate against the water flow. Thereafter, the substrate was disturbed, and boulders were rubbed gently until the current dislodged the organisms into the net. Samples collected were rinsed using a 300 μm sieve to remove the sediments, leaving behind any sediment-dwelling invertebrates and kept in a vial filled with 70% ethanol for temporary preservation. Identification of macroinvertebrates was performed using a stereo microscope. References used to assist the identification process are from Pennack (1978), Throp & Covich (1991) and Yule & Yong (2004).

On the other hand, fish collection was carried out along each river using a battery-powered backpack electro-fisher, while gill nets was located at the downstream of the study reach and in river with deep water where electro-fishing cannot be conducted at the area. Electro-fishing is conducted in a slow zig-zag pattern, against the water flow. The fishes captured were then counted, measured their body length, weight and identified to the lowest possible taxon using standard taxonomic keys of Kottelat *et al*. (1993), Rainboth (1996) and Ambak *et al.* (2010).

In-situ measurement of water quality have been made for parameters of dissolved oxygen (DO), pH, temperature and conductivity using a YSI ProPlus meter, whereas other parameters such as total suspended solid (TSS), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD) and ammoniacal-nitrogen (NH_3N) were determined by APHA standard method procedures (APHA, 2000). Determination of water quality index (WQI) according to the equation from Malaysian Department of Environment (DOE) was calculated based on (1).

$$WQI = 0.22(SIDO) + 0.19(SIBOD_5) + 0.16(SICOD) + 0.15(SIAN) + 0.16(SITSS) + 0.12(SIpH) \quad (1)$$

where SI indicates the sub-index for each parameter.

3.0 Results and Discussion

In general, physical and chemical parameters measured are varies from Class I to IV of water quality index (WQI). Some parameters are found to have a constant reading, while some are less consistent. Comparison of mean values of physicochemical parameters are given in Table 2. Among those who showed significant differences are BOD_5, TSS and NH_3N. High concentration of TSS was observed at station 1 (Sg. Betis) with an average value is 152.00±143.36, while high content of NH_3N was recorded at station 3 (Sg. Nenggiri) with an average value is 1.68±1.40. Both readings are in class IV according to the Malaysian DOE-WQI Classes (DOE, 2002). In all stations, DO readings are uniform and showed high values, put the study area in a Class I according to the National Water Quality Standards (NWQS). Conversely, temperature values in all stations are above the normal level of 25 °C in the tropics (Ahmad Ismail & Asmida, 2008). According to Connell (1981), aquatic organisms are very sensitive to changes in pH and can live well in the range of 6.0 to 8.5. However, the average pH values observed are below the normal level and are acidic. High concentration of certain parameters was believed to occur due to the river receiving high runoff during the monsoon season. Runoff will not only lead to soil erosion but also increase the acidity of the receiving water body as soil particles typically carry nutrients that can cause water acidity. Similarly, TSS will generally give a higher reading during the rainy season because of runoff during rainfall has high erosion and resulted in a strong rate of soil erosion. Thus, this contributes to the increase of suspended solids in the flat lands which are particularly vulnerable due to the land-based activities (Zaiha *et al*., 2015). Beside suspended solid, soil erosion tends to increase biochemical oxygen demand, which both of these elements contributed to the degradation of water quality, all of which can affect downstream users of drinking water (Sève 1999). Many studies have proven that the anthropogenic impact on natural habitat has led to major changes in physical and chemical properties of water body. Deforestation for instance, always been associated with changes in pH, DO, and temperature of the water, as well as habitat degradation and stream communities (Douglas *et al*., 1992; Iwata *et al.,* 2003a,b; Wantzen, 2006; Lorion & Kennedy, 2009; Aweng *et al*., 2011; Narangarvuu *et al*., 2014).

Table 2: Comparison of mean values of water quality parameters

St.	Water quality parameters						
	Temp. (°C)	pH	DO (mg/L)	BOD_5 (mg/L)	COD (mg/L)	TSS (mg/L)	NH_3N (mg/L)
1	27.83±1.63	6.76±0.05	8.83±1.19	5.00±3.12	8.17±3.82	152.00±143.36	0.73±0.10
2	26.07±2.30	6.75±0.06	8.72±1.62	3.67±0.76	5.67±1.26	25.67±15.04	0.18±0.12
3	26.00±1.19	6.75±0.06	9.17±0.94	6.33±1.89	8.83±1.89	107.00±83.80	1.68±1.40
4	29.32±1.23	6.79±0.04	8.42±0.97	4.50±2.78	7.17±4.86	35.33±26.00	0.71±0.39
5	28.27±1.42	6.79±0.02	8.24±0.65	7.33±6.60	13.17±11.09	97.67±94.16	1.10±0.61
6	30.70±2.79	6.78±0.06	8.45±1.04	5.33±2.25	8.33±3.79	56.83±31.03	0.59±0.22
7	30.28±2.48	6.78±0.04	8.42±1.18	4.83±1.53	8.33±1.76	37.00±27.18	0.33±0.07
8	27.37±1.05	6.75±0.05	8.75±1.30	8.67±4.04	13.17±5.80	14.5.± 13.03	0.36±0.22
9	29.40±1.73	6.85±0.08	8.15±1.31	9.67±3.06	15.00±3.28	9.67±5.80	0.30±0.15
10	25.37±1.59	6.77±0.04	8.85±1.56	5.50±0.00	8.17±0.58	7.33±0.58	0.13±0.02
11	23.35±2.75	6.86±0.19	8.90±1.30	4.17±0.76	7.17±0.58	6.00±0.00	0.07±0.08
12	26.93±0.38	6.75±0.02	9.10±1.12	3.50±0.87	5.67±1.44	30.17±36.66	0.36±0.46
13	30.27±0.70	6.78±0.01	8.57±1.05	6.83±0.29	10.67±0.76	30.17±27.04	0.51±0.13

The use of water quality index (WQI) is a conventional method for monitoring and assessment of river status in Malaysia. Calculation of WQI for 13 sampling stations at Kelantan river systems has been done. As a result, the WQI ranged from 69.00 to 83.84 and classify the study area into Class II to Class III (Table 3). Class II of WQI indicate good water quality and suitable for multiple uses such as recreational with body contact and requires conventional treatment for drinking water supply. Meanwhile, Class III is considered as moderate water quality and requires extensive treatment for drinking water supply. This kind of water quality can accommodate certain tolerant species of fish that are more common and low in economic value.

Table 3: Water Quality Index (WQI) score and interpretation

Station	Location	WQI Score	WQI Class	Category
1	Sg. Betis	71.57	III	Slightly Polluted
2	Sg. Nenggiri_Gua Cha	80.75	II	Clean
3	Sg. Nenggiri	69.00	III	Slightly Polluted
4	Sg. Lebir_1	76.02	III	Slightly Polluted
5	Sg. Lebir_2	70.81	III	Slightly Polluted
6	Manek Urai_1	74.22	III	Slightly Polluted
7	Manek Urai_2	78.01	II	Slightly Polluted
8	Sg. Durian	75.39	III	Slightly Polluted
9	Sg. Geh	75.18	III	Slightly Polluted
10	Sg. Jelawang	81.40	II	Clean
11	Sg. Kenerong	83.84	II	Clean
12	Kg. Bertam Baru	80.44	II	Clean

13	Sg. Lah	74.91	III	Slightly Polluted

Overall, there were a total of 944 individuals comprising 10 orders and 25 families had successfully sampled, as shown in Figure 2. Insecta occurred in every sampling event with high taxa richness and abundance, widely distributed and dominating in various types of aquatic habitats. Decapoda represent the second highest taxa with an abundance of 116 individuals. Meanwhile, Bivalves and Gastropods were also present but only available on the very low composition. Some order of the class Insecta found to be present with a highly composition. The moderately tolerant taxa, Odonata has been found widely distributed with high abundance and dominated in every sampling session. Four most prominent family and consistently appeared from Odonates order were Corduliidae (196 individuals), Gomphidae (178 individuals), Coenagrionidae (74 individuals) and Libellulidae (72 individuals). This group of macroinvertebrates was fairly adapted to tolerate a broad range of environmental conditions to cope with decline in the water quality (Kay *et al*., 2001; Al-Shami *et al*., 2010). Ephemeroptera, Plecoptera and Tricoptera (EPT) are often considered as good indicators of water quality (Rosenberg & Resh, 1993; Ahmad *et al*., 2013) and can only survive in clean and oxygen-rich waters. The EPT fauna were also recorded in this study even in low composition and restricted to certain location. The mayflies are categorised as a primitive winged insect. Their larval can adapt from tranquil river to fast-flowing water (Che Salmah *et al*., 2001). Family Heptageniidae and Leptophlebiidae are more dominant in station 11 (Sg. Kenerong), probably due to the morphological characteristics of this group which correspond to the habitat with rocky substrate and a fast-flowing water. Plecoptera represented by two dominant families namely Leuctridae dan Perlidae.

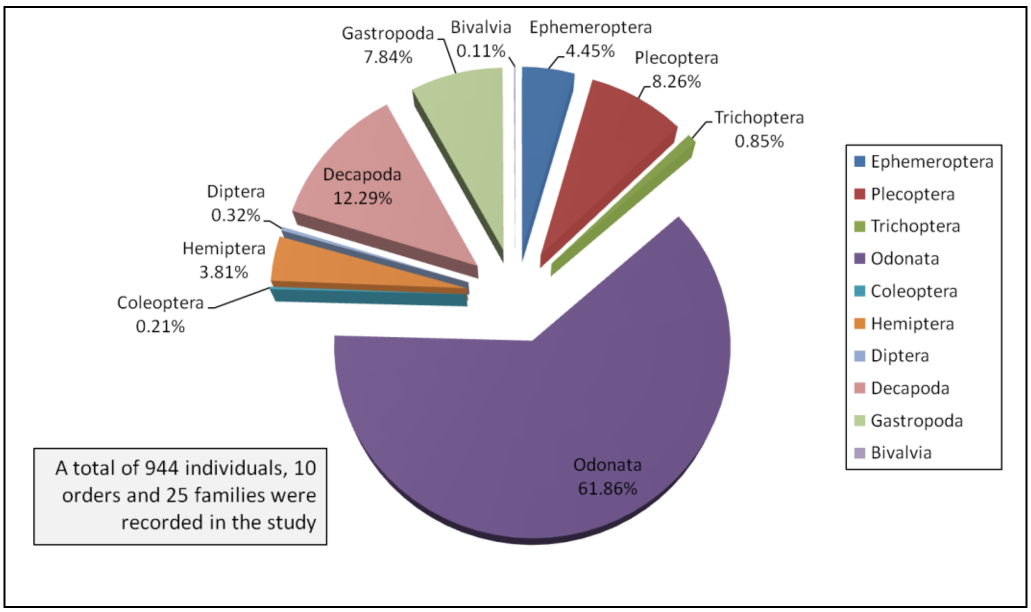

Figure 1: The composition of benthic macroinvertebrate

According to Che Salmah *et al.* (2001), this type of insect fond of various sizes of rocks, debris and leaf packs as their habitat. High density of vegetative habitat provides leaf debris (allocthonous) as a food source for Stonefly insects (Bispo *et al*., 2006). The nymph stage of Plecoptera stays in the water from two weeks to several years (Yule & Yong, 2004). They usually live in the area of pristine water and this organism has a specific niche in a high water quality (Spellman & Drinan, 2001). Caddisfly is one of the largest group of aquatic insects (Morse *et al*., 1994) inhabiting aquatic ecosystem from moderately poor to good water quality. Their larval stage can be found in rivers and lakes, and are highly specialized in food acquisition (Rosenberg & Resh, 1993; Morse *et al*., 1994). The presence of Trichoptera at certain sampling stations implying a good water quality (Chakona *et al*., 2009).

With regards to Biological Water Quality Index, in A Guide to Freshwater Invertebrates of Ponds and Streams in Malaysia, all stations were classified as very clean water (Class A) to rather clean-clean water (Class B) as shown in Table 4. The highest BWQI mean value was observed in station 11 (Sg.

Kenerong) (8.42). Other stations were classified into class B (range score 5.1 - 7.5). Two lowest score were observed at station 8 (5.2) and station 9 (5.1), respectively. The composition and diversity of the macroinvertebrate communities were evaluated to calculate Shannon diversity index (*H'*), Pielou evenness Index (*J*) and Margalef richness index (*D*). The macroinvertebrate community was most diverse in station 12 with *H'* values of 2.02. Station 4 had the lowest diversity score (*H'*=0.53). Station 5 was the least evenly distributed as indicated by the lowest value of evenness index (*J*=0.65).

Table 4: The diversity and abundance of benthic macroinvertebrates in the sampling area and total number of individuals caught from all stations (N)

Station	Index			
	BWQI	Shannon (*H'*)	Pielou (*J*)	Margalef (*D*)
1	5.53±0.40	1.12±0.09	0.87±0.05	1.06±0.41
2	6.63±0.55	1.48±0.61	0.90±0.08	1.99±0.95
3	6.17±0.40	1.48±0.30	0.90±0.08	1.59±0.40
4	6.00±0.00	0.53±0.23	0.76±0.34	0.57±0.30
5	6.17±0.29	0.66±0.48	0.65±0.19	0.60±0.32
6	6.80±0.40	1.31±0.06	0.81±0.03	1.15±0.07
7	6.40±0.10	1.06±0.32	0.77±0.15	0.87±0.15
8	5.20±0.69	1.32±0.19	0.79±0.08	1.29±0.10
9	5.10±0.26	1.31±0.58	0.82±0.08	1.26±0.97
10	5.90±0.17	0.93±0.47	0.71±0.25	0.88±0.47
11	8.42±0.25	1.27±0.43	0.86±0.10	1.26±0.72
12	6.67±0.32	2.02±0.13	0.92±0.02	2.30±0.34
13	6.17±0.90	1.80±0.12	0.91±0.05	0.91±0.05

A total of 623 individuals from 14 families and 27species were caught from all the 13 stations. In terms of the percentage of four dominant families based on the number of individual caught, 83.47% was represented by the family Cyprinidae, 2.87% by Mastacembelidae, 2.57% by Belonidae, and 2.25% by Channidae (Figure 2). The rest of the 10 families make up about 8.84% of the total number of individuals caught. In terms of the percentage of six dominant species based on the number of individuals caught, 70.14% was represented by the *Mystacoleucus marginatus*, 4.82% by *Osteocheilus vittatus*, 4.65% by *Rasbora sildii*, 2.89% by *Mastacembelus mastacembelus*, 2.57% by *Tylosurus crocodilus* and 2.09% by *Eleutheronema tetradactylum*. The rest of the 21 species make up about 12.84% of the total number of individuals caught. Cyprinids appeared to be the dominant family at all sampling stations and their dominance is shown throughout the Asian and Southeast Asian regions (Rainboth, 1996; McConnell & Lowe-McConnell, 1987). To date, at least 1600 species have been identified in the Southeast Asian region (Shannon & Weaver, 1949). It was reported that 30% of all species of freshwater fish in Malaysia are cyprinids (Salam & Gopinath, 2006). Other studies successfully recorded 79.7% cyprinids from the Jempol and Serting River's (Jeffrine *et al*., 2005); 52% cyprinids from the Krau Wildlife Reserve (Samat *et al*., 2005); 37% cyprinids from small streams around Gunung Jerai, Kedah (Shah *et al*., 2009) and cyprinids from Taman Negara Pahang (Yahya & Singh, 2012). In general, the fish community in all stations recorded low diversity and richness, *H'* ranged from 0.44 to 1.47 and *D* ranged from 0.79 to 2.11.

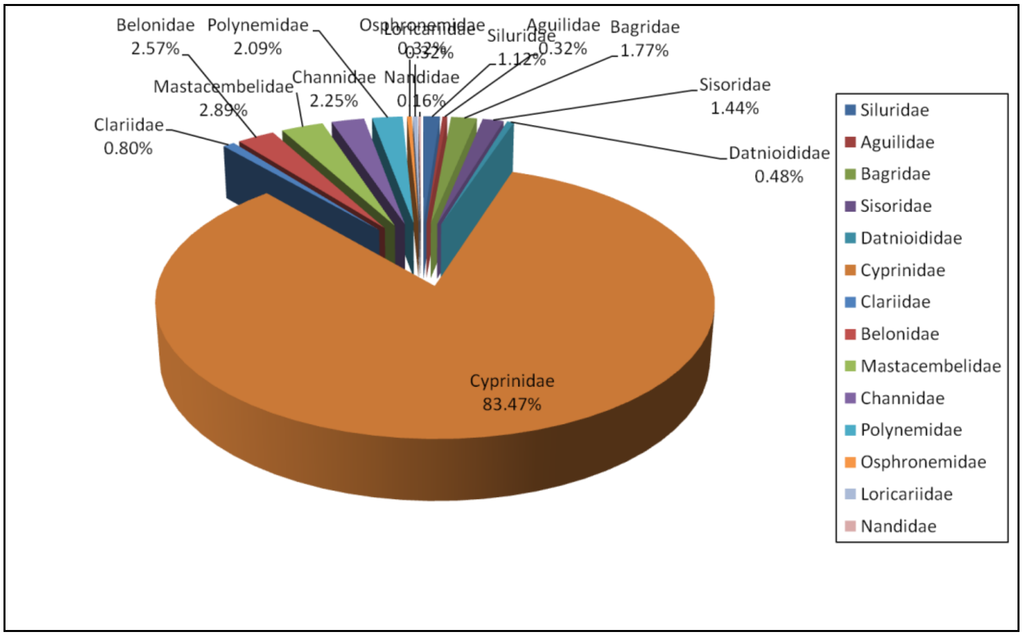

Figure 2: The composition of fish family

4.0 Conclusion

The conclusions that could be drawn from this study are as follows:

4.1 Compared to the status of water quality in the previous years (2013-2014), floods in Kelantan witnessed a decline in water quality level based on the calculation of water quality index (WQI).

4.2 Kelantan river system support low diversity of organisms as shown by Shannon diversity index (*H'*) values for macroinvertebrate and fish composition – averagely below 1.5, indicating that there are pollution and degradation of habitat structure.

4.3 Various approaches including both structural and non-structural flood mitigation measures have been implemented by related agencies with a view to control and reduce the negative impacts of future flood events on society and the environment. The structural measures - improving river channel sections, building of flood protection bunds, perimeter bunds, by-pass flood ways, use of former mining ponds for flood attenuation and construction of flood retention dams to regulate flood flows and minimize flood occurrence. Meanwhile, non-structural measures involves planning, programming, setting policies, co-ordination, facilitating, rising awareness, assisting and strengthening the society to face the threats and impacts of floods. It also covers educating, training, regulating, reporting, forecasting, warning and informing those at risks.

References

Abdul Salam, M. N., & Gopinath, N. (2006). Riverine fish and fisheries in Malaysia: An ignored resource. *Aquatic Ecosystem Health & Management*, *9*(2), 159-164.

Ahmad Ismail & Asmida Ismail (2008). *Ekologi Air Tawar*. Ed. ke-2. Kuala Lumpur: Dewan Bahasa dan Pustaka.

Ahmad, A. K., Abd Aziz, Z., Fun, H. Y., Ling, T. M. & Shuhaimi Othman, M. (2013). Makroinvertebrat bentik sebagai penunjuk biologi di Sungai Kongkoi, Negeri Sembilan, Malaysia. *Sains Malaysiana* 42(5): 605-614

Al-Shami, S. A., Rawi, C. S. M., Hassan Ahmad, A., Nor, S. A. M., (2010). Distribution of Chironomidae (Insecta: Diptera) in polluted rivers of the Juru River Basin, Penang, Malaysia. *J. Environ. Sci-China* 22, 1718–1727

Ambak, M. A., Isa, M. M., Zakaria, M. Z. Ghaffar, M. A., (2010). *Fishes of Malaysia*. Penerbit Universiti Malaysia Terengganu. 334 pp.

Ambak, M. A., Isa, M. M., Zakaria, M. Z. Ghaffar, M. A., (2010). *Fishes of Malaysia*. Penerbit Universiti Malaysia Terengganu. 334 pp.

10.3: EVALUATION OF RISK AND ABATEMENT MEASURES IN FLOOD DISASTER IMPACTED AREA FOR SUSTAINABLE WASTE MANAGEMENT

Project Information

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1.0 Introduction

The unprecedented flood disasters in December 2014 left thousands of people homeless, heaps of waste and housing debris and total loss of several thousand million Ringgit. These were further aggravated by human activities and improper post-flood management as manifested in the form of environmental degradation due to huge heap of waste; blockage of water ways and lack of physical and financial resources to cope with flood disasters. The poor disposal of waste results in blockages of drainage and watercourses, which reduces their conveyance leading to flooding (Muñoz-Cadena et al., 2009, Bras et al., 2009). Wastes and debris carried by floodwaters can cause increased damage to property and lead to higher flood losses (Nicholas et al., 2002, Chen et al., 2007). After a flood the deposition of waste can block access and be a source of toxins and breeding ground for disease (Lamond et al., 2012). Floods can also have an impact on waste management systems leading to leaching of toxins into groundwater (Pilapitiya et al., 2006).

However, the consequences of flooding to the environment is extremely complex and hard to evaluate since they exist in large spatial extent, with multiple sources, sinks and types of pollutants, which have potential effects on most of the environmental component (Tilotta et al.,2003). Hence, this study focused on alleviating flood disaster impacted areas to manage waste in the informal areas by developing tools for better understanding and responding to these complex natural, technological and social factors. The findings of the study revealed that poor waste management strategies as one of the factors that resulted in many environmental and social issues. This was further aggravated by unavailability of enforceable legislation, non-availability of institutional framework, lack of coordination and communication, non-availability of district and divisional contingency plans, less political will and inadequate resources including finance, equipments and labor.

2.0 Methodology

In this study, data collections were carried out using both qualitative and quantitative data for interpretation. Self-completions Questionnaires (SCQ) have been used to collect quantitative data and the semi structured interviews are conducted also to gather and determine basic data. Secondary data are compiled via government reports, municipal council reports and many other documents from different organizations and academic papers. Self-completions Questionnaires (SCQ) were distributed among the local people and agencies in two impacted areas; Gua Musang and Kuala Kerai, followed by semi-structured interviews. The questionnaires only disseminate to SWCorp agencies as one of responsible agencies for waste management. The semi-structured interviews were done to 28 respondents from the impacted areas in Gua Musang and Kuala Kerai. 25 respondents were villagers and 3 respondents from SWCorp agencies. All of the data collection above is then analyzed with the assistance of the Qualitative Social Research (QSR) software package NVivo.

Qualitative research is a term applied to a wide range of methods for handling materials that are relatively unstructured and not appropriately reduced to numbers. Working with transcripts of interviews, focus groups, or audio/video files or with field notes or other documents, researchers seek new understanding of a situation, experience or process.

Analysis process using NVivo are as follows:

- Transcripts data to text form (from interviews, observational notes, memos, audio, video, etc).

- Reading the data and segregate data (data reduction: coding process). Typically, the researcher records interviews digitally to capture all the details revealed by the interviewee.
- Development of categories/ working with nodes. The function of nodes is to store a place in NVivo for references to code text. That means the two types of nodes; tree and free, contain the all known information about a particular concept or category as in Figure 1.
- Validating or confirming findings. In this stage, the researcher can go forward to analyze the data. The researcher should focus on the techniques for utilizing the available tools productively and analytically.

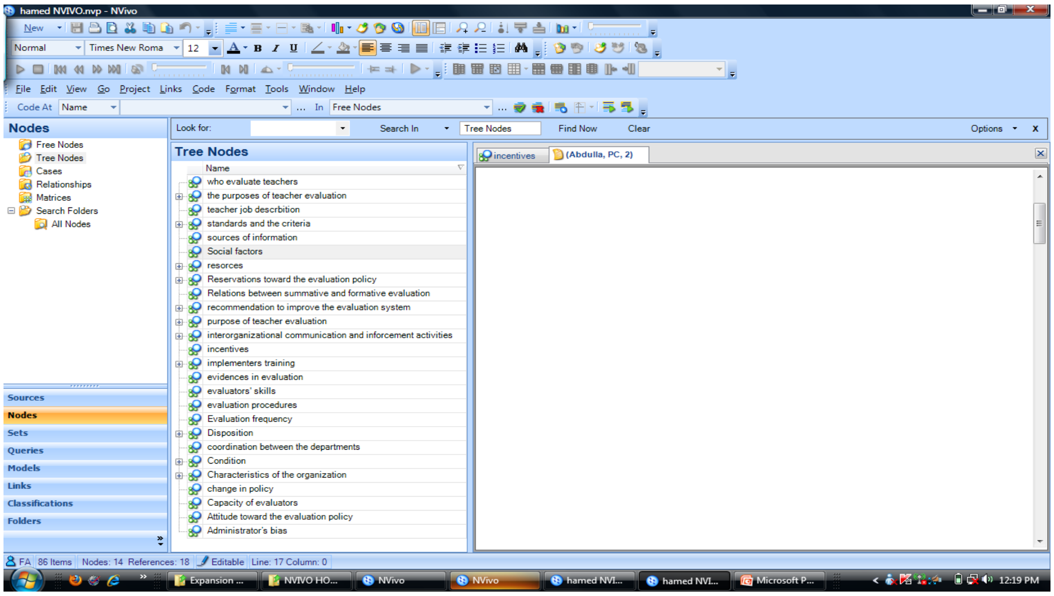

Figure 1. NVivo sample of tree coding process

- Visualizing the data/ create a model from the analysis process. Models are a way of illustrating and clarifying the ideas and allowing reflecting on different ways of seeing the data.
- Reports.

3.0 Results and Discussion

The intensity and duration of flood occurred were different in each area and immediately after the flood have receded the municipalities, The highly varied flood waste was collected without any waste separation consideration and directly disposed to the nearest landfill; some of them were disposed into the temporary landfill before moved into the permanent one. This study recorded that during the flood event in Gua Musang and Kuala Krai (Figure 2), the highest waste type generated were plastics (15.9%), glass (11.65) and textile/ fabrics (10.9%).

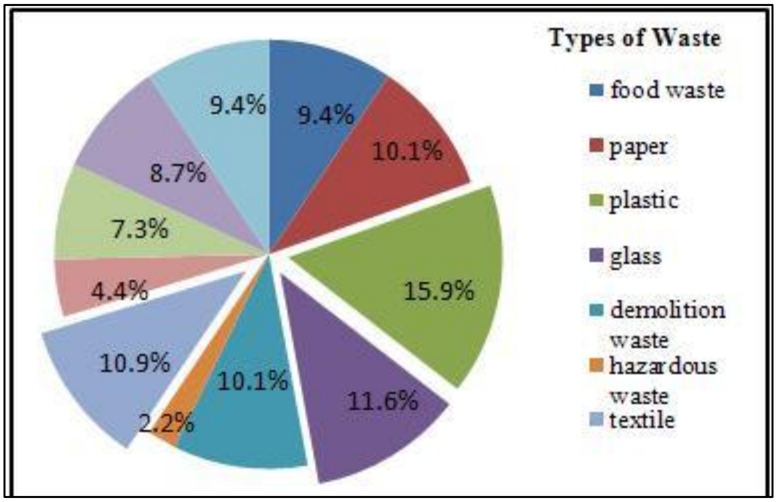

Figure 2. Types of waste generated based on questionnaires results in two impacted areas; Gua Musang and Kuala Krai

Among the impacted districts in Kelantan, the results shows that Gua Musang recorded the highest amount of waste during the flood event which was 538 tonnes/ day (SWcorp, 2015). The total waste generated in impacted areas are shown in Figure 3.

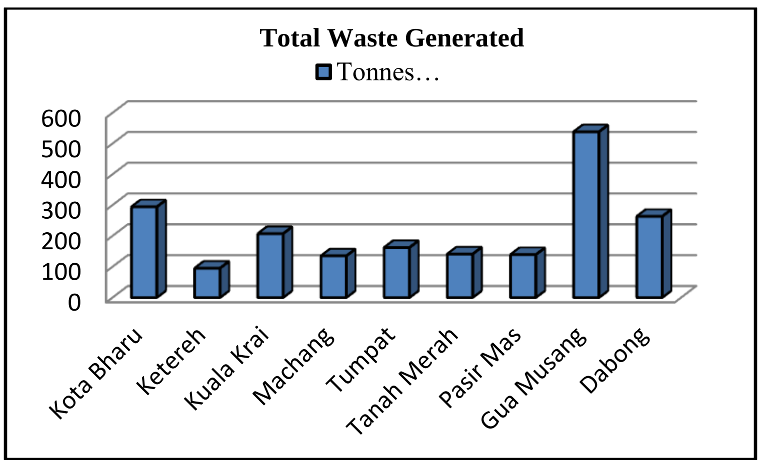

Figure 3. Total waste generated during the flood event in impacted areas

The main challenges for waste management during the flood event is how to dispose, the technical factors such as management traffic to collect the waste, time scheduling, places to dispose, etc. The ineffective and inefficient waste collection process encourages the villager's to use other methods to disposal of their waste such as dumping on the streets, drains, unauthorized places, rivers, stockpiling in the ground and burning. In fact, this situation brings serious problems to the environments, sanitary and health. From the survey, the results indicated the disposal of the waste based on the types of waste after the flood receded. 59.6% respondents said that they dump the waste to the open area near their home and wait for the municipalities, NGO and others agencies to collect it, 16.1% said that they burn by themselves, 7.5% said that they do selection first to the things that can be recycle, 6.7% said they piled up all the waste on the ground, 5.9% they said they do selection to the things that can be reuse and 4.3% respondents said they only do open dumping.

Villagers also pointed out that there is no point in separating waste since everyone wants to do the cleaning quickly to prevent the spread of diseases. If they do so, the waste collectors again mix them together when transporting it to the place of disposal. Therefore, the majority of households leave their mixed wastes at one place or in plastic bags. Figure 4 shows the awareness of villagers for the separation of waste for recycling purposes (but this will not apply in emergencies flood). The result indicates that the large proportion of the villagers actually just need a little bit reinforcement and they are ready to separate waste and participate in the recycling program with a proper waste management process. This is in line with Zurbrugg (2002) research findings where the public willingness to cooperate and participate in waste management relies on awareness, attitude and enforcement from authority.

From a survey conducted several months after the floods disaster, it also found that waste management still has not worked well. From self-observation results can be seen as in the Figure 5 where unauthorized waste disposal was observed. Figure 6 shows the roadsides and riverbanks dumping of waste by the villagers. The villagers pointed out due to the insufficient bins for the daily disposal and lack of daily waste collection process encourage the people to improper waste dumping practices.

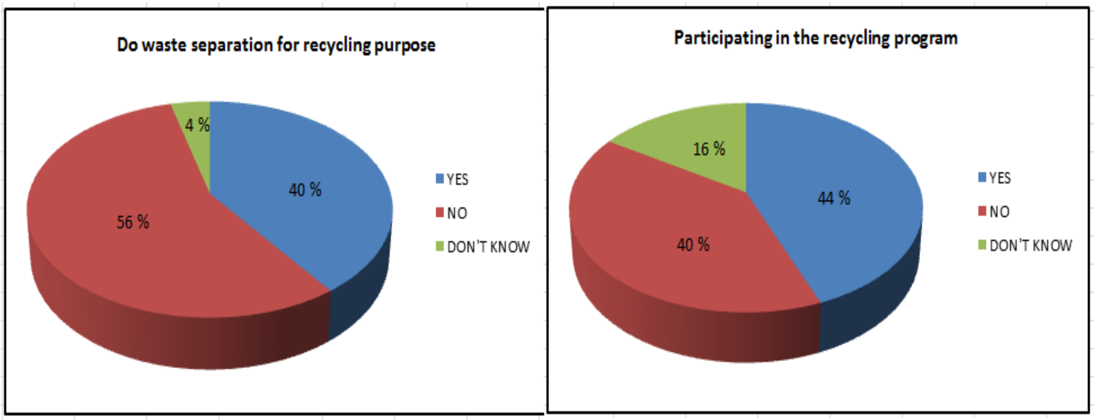

Figure 4. The villager's awareness for the separation of waste for recycling purposes

Figure 5. Unauthorized waste dumping by villagers

Figure 6. Unauthorized waste disposal by the roadside and riverbank

During and after a few days of the flood occurred, there is no landfill site can be identified as sanitary landfill for final disposal of solid waste. All of the solid wastes were throw out into the temporary landfill and the municipalities, NGO and other agencies use the open dumping strategy. On that moment, there are no resources and facilities or either funds to maintain the landfill and did separation or recyclable waste. Open dumps create a public nuisance, create a dangerous such as open burning by scavenger, littering, increase of diseases, etc. (See Figure 7).

Figure 7. Open burning of waste disposed at a temporary dumping area

Interviews with the local authorities from Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam (SWCorp), Municipal agencies and also from the community, revealed that poor coordination among the authorities causes the various issues after the floods recede such as the collection of the waste cannot relocate to the landfill quickly due to the traffic, lack of the equipment, transportation management and also lack of resources and workers. In short, the interviews revealed that the main constrains and issues during the disaster are;

- Lack of a framework or statutory guidelines that could be enforced during a disaster,
- Lack of technical knowhow on C&D waste management,
- Lack of funds, resources, and equipment, and
- Coordination issues.

Based on these observations; there is a need for a waste management in disaster management guidelines in Malaysia to reduce this problem. Hence, referring to the quantitative, qualitative result and the previous practices, the proposed disaster prevention and mitigation for future flood disaster are divided into three phases. The coding purposes for the three phases for creating the waste management guideline or model by using NVivo are shown in Figure 8 and the proposed lay out model shown in Fig 9.

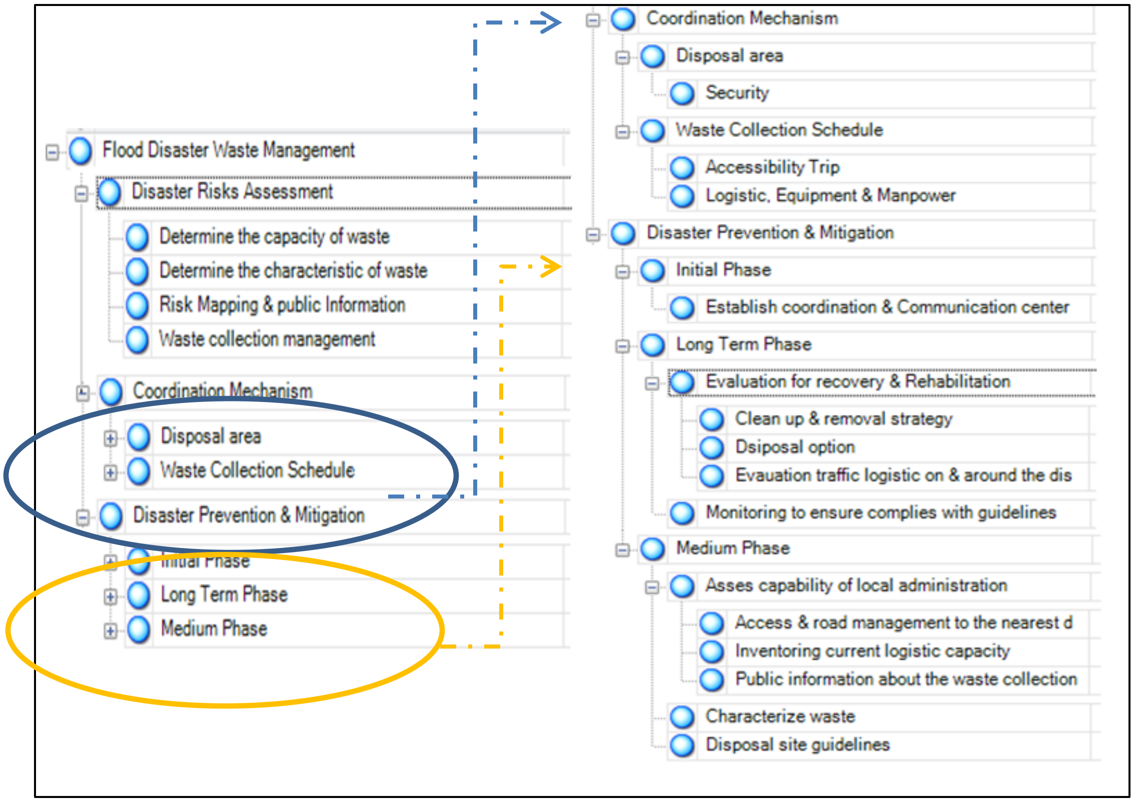

Figure 8. Coding Structure for the Proposed Model

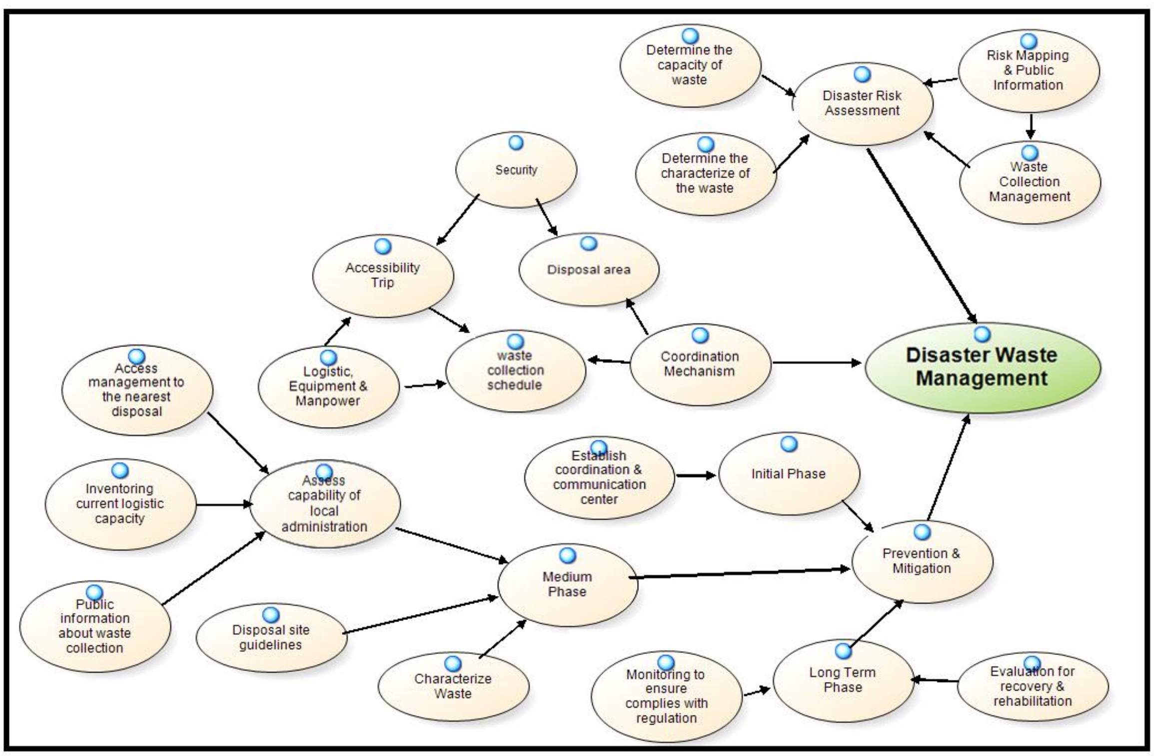

Figure 9. Lay out proposed guidelines/ model

4.0 Conclusion

Flood disaster is not a new thing that happens around the world today with distressing impacts towards communities and the environment. Findings are revealed that;

4.1 Poor waste management strategies during and after flood disaster to be creating many environmental and social issues. Unavailability of enforceable legislation, non-availability of institutional framework, lack of coordination and communication, non-availability of district and divisional contingency plans, and inadequate resources including finance, equipment and labour further aggravated the impact.

4.2 There is a gap in terms of what has been planned and implementation actions in particular disaster waste management during the flood disaster. The need of solid flood waste management guideline for agencies that are responsible to manage solid waste properly, rapidly, efficiently and can reduce the quantity of solid waste which the locals will dispose of during flooding cannot be avoided.

4.3 The implementation of corrective solid waste management guidelines will help the agencies responsible for solid waste management to prevent and manage flood waste effectively,

4.4 Well enforcement of solid waste management for pre-flooding, during flooding, post-flooding and rehabilitation after flooding, can help to effectively and rapidly decrease the risk to the population's health and relieve the impact on the environment during the disaster time,

4.5 The implementation of solid waste management plans in flood situations, each local administration should provide a proper manual to suit their own area for the most effective operation.

References

Ang Kean Hua. "*Monsoon Flood Disaster in Kota Bharu, Kelantan Case Study: A Comprehensive Review*". International Journal of Scientific Engineering and Research (IJSER) www.ijser.in, ISSN (Online): 2347-3878, Volume 3 Issue 9, September, 2015.

Begum, R. A., *et al*., *Attitude and Behavioral Factors in Waste Management in the Construction Industry of Malaysia*. Resources, Conservation and Recycling. 53: 321-328, 2009.

Boo Su-Lyn. "Kelantan floods like Japan's 2011 Tsunami, says NSC Malaysia". (MY): The Malay Mail Online; 2015. Accessed March 15, 2016. http://www.themalaymailonline. com/malaysia/article/kelantan-floods-like-japans-2011-tsunami-says-nsc .

E. M. A. Zawawi, et.al., *Important Criteria for Managing Disaster Waste in Malaysia*. Jurnal Teknologi. 75:9, 89–93, 2015

Grodzinska-Jurczak, M., M. Tarabula, and A.D. Read. "*Increasing Participation in Rational Municipal Waste Management-A Case Study Analysis in Jaslo City (Poland)*". Resources, Conservation and Recycling. 38: 67–88, 2003.

Jayawardane AKW. "*Recent Tsunami Disaster Stricken to Sri Lanka and Recovery*". International Seminar on Risk Management for Roads Organized by PIARC and Ministry of Transport , 26-28April, 2006.

Meen-Chee, H. and S. Narayanan. "Restoring the Shine to a Pearl: Recycling Behavior in Penang, Malaysia". Development and Change, 37: 1117-1136, 2006.

Mohd Khairuddin AR. "Bah Kuning: Jangan tuding jari salahkan Kelantan Malaysia". (MY): Harakah Daily; 2015. Accessed March 15, 2016. http://www.harakahdaily.net/index.php/berita-utama/33177-bah-kuning-jangan-tuding-jarisalahkan-kelantan.

Mohamad Sukeri Bin Khalid and Shazwani Binti Shafiai. "*Flood Disaster Management in Malaysia: An Evaluation of the Effectiveness Flood Delivery System*". International Journal of Social Science and Humanity, Vol. 5, No. 4, April 2015.

Petersen M. "*Restoring waste management following disasters*" International conference on post disaster reconstruction, 22-23 April, UK Coventry: IF Research group, 2014.

Purcell, M and W.I. Magette. "*Attitudes and Behavior Toward Waste Management in the Dublin, Ireland Region*". Waste Management Journal, 30: 1997-2006, 2010.

Tilotta D.C., Kozliak, E., Pyle, SJ. " *Environmental Contamination as a Result of Flooding: A Case Study of Heating Oil Pollution in the Red River Valley*". Final report Research Grants/Fellowships/SBIR, University of North Dakota, 2003.

10.4: ASSESSMENT OF THE FLOOD AFTERMATH OF WATER AND WASTEWATER UTILITY ASSETS TOWARDS DEVELOPING FLOOD RESILIENCE SYSTEM

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1.0 Introduction

Flood is a hazard which threatened some parts of Peninsular Malaysia annually. In Kelantan, it normally occurs during the month of December to February, during the Northeast monsoon. In December 2014, the state of Kelantan was severly hit by flood, which had never being experienced before in the country's history. Between 20 – 25th December 2014, the rain intensity recorded at Gg. Gagau rain gauging station was about 1500 mm, which is equivalent to more than half-a-year average annual rainfall (AKSB, 2015).

During flood, many public utlitities including those of water supply and wastewater systems were affected. Not only that the public were devoid of basic facilities of electricity, water and sanitation, significant loss of money due to the destructions (and repair work) of these facilities were incurred by the government and responsible parties. As for Kelantan, the public was devoid of water supply for several days and the repair work of the water assets was mounting to RM 36 million (AKSB, 2015).

Due to global warming phenomena, the climate is expected to change in the future. Dry period is expected to become longer and rain is anticipated to be more intense. With the rise of sea level, flood will be an ongoing challenge for water and wastewater utilities. The resilience of the utilities in minimizing damage and rapidly recovering from distruptions need to be taken into serious consideration. This can be enhanced by implementing minigating measures, which include emergency response plan, barriers around key assets, and elevated chemical storage and electrical equipment.

A study was conducted to assess the vulnerability of the water and wastewater treatment assets to flood in the area of upper basin of Sg. Kelantan, which covers the area of Kuala Krai and Gua Musang. Additionally, the mitigating measures to reduce the effect was identfied and proposed. A Georaphical Information System (GIS) database system of water supply and wastewater system assets (excluding water supply network) was developed and used as the tool in the study.

2.0 Methodology

The study covers the area of upper basin of Sg. Kelantan, which includes Gua Musang and Kuala Krai. Secondary data, which comprised of location, size (in terms of production rate and treatment capacity), types of system and 2014 flood condition were collected from Air Kelantan Sdn. Bhd. (AKSB) and Majaari Services Sdn. Bhd. (MSSB).

Site visits were then conducted to determine the exact coordinate and elevation of the treatment plants. Additionally, the elevation and height of each unit process within the plants were measured. The coordinates and the elevations were determined using Receiver Topcon HiPer II (Position Partners) and laser measuring tool (Leica DISTO D-2). These data were incorporated into a GIS database system (ArcGIS version 10.1), which was developed for the study.

Based on the elevation of the unit processes, the vulnerability of the assets to flood was evaluated. The mitigating measures at different levels of difficulty and effectiveness were suggested based on the literatures.

3.0 Results and Discussion

3.1 Water and Sewage Treatment Plant

There are 10 water treatment plants (WTP) located in the study area. The plants are operated by AKSB, with capacity ranging from 0.6 to 21.3 MLD. The water source are mainly surface water with water intake point located at the river bank. The elevation of the WTPs ranges from about 42 to 124 m (from MSL). All the treatment plants employed conventional processes, which comprised of coagulation, flocculation, sedimentation, filtration and chlorination. Assests at the WTP include pump, chemical storage, electrical facility, instrumentation and control panel. As for the sewage treatment plant (STP), there are 11 mechanical STPs (in the form of Extended Aeration and Hi-Kleen) in the study area, while the rests are either communal septic tank (CST), Imhoff tank (IT) or individual septic tank (IST). The STPs are either operated by contractor or by the owner of the premises; Majaari Services Sdn. Bhd. does not operate any of the STPs in the study area. The elevation of the mechanical STPs ranges from 30 to 129 m (from MSL). As sewage is normally conveyed to the STP using gravity flow, the STPs are mainly located at the lowest point in the area. The numbers of CST, IT and IST are too many and were not recorded. They are of standard fabricated concrete, pre-fabricated tank or a tank, simply made of culvert. Assests at the mechanical STPs include pump, air blower, electrical facility, instrumentation and control panel.

The distribution of the CST, IT, and IST is according to the distribution of the township and rural area. Out of 10 WTPs located in the study area, three were completely flooded, five were affected due to the destruction of the water intake structure, while two were not affected by the flood but were closed down due to power shut down by the Tenaga National Berhad (TNB). The flooded treatment plants were Tualang WTP and Dabong WTP, located in Kuala Krai, and Aring WTP, located in Gua Musang. During the flood, three mechanical STPs were flooded; three are located in Kuala Krai and one is located in Gua Musang. Many CST, IT and IST located in the flooded area were also affected. However, their locations were not recorded as they are high in number.

3.2 Vulnerability Assessment

The vulnerability assessment of the treatment plants followed the guideline and approach used by the USEPA (2014). It is based on the elevation of the assets within the treatment plant, which include pump, chemical storage, air compressor, electrical facility, instrumentation and control panel. The elevation of the asset indicates the level at which the asset will become vulnerable to flood.

For Dabong WTP, except for aerator, filtration tank and clarifier, the rests of the assests were flooded in 2014 flood event. The elevation of flood threat within the WTP (except for water intake) ranges from 42 to 48 m (from MSL). As for Sg. Durian Police Quaters STP, all the assets were flooded. The elevation of flood threat ranges from 30 to 32 m (from MSL). As water intake is normally located at the river bank, it is the most vulnerable assest at the WTP. This is followed by the chemical room, office and also pumping stations. Aeration tank is the least vulnerable to flood as it is normally located at the highest level due to gravity flow mode of the treatment plant design. For STP, inlet chamber is typically the most vulnerable due to its lowest position.

3.3 Proposed Mitigating Measures

Mitigating measures to reduce flood risk were evaluated based on three criteria namely effectiveness, practicality and estimated cost. In general, the low-cost mitigating measure is less efficient as compared to high-cost measure. However, they may be an effective temporary measures under specific circumstances.

It is important to note that the mitigating measures need to be carefully studied and planned. The plan should include prioritization, scheduling, and funding. The low-cost measures can be carried out as the initial stage, while the mitigating measures that involve major capital and infrastructure investments can be integrated into the long-term upgrading planning of the plant. Examples of mitigating measures for water and wastewater treatment plants are given in Table 1. A more detail lists is available in USEPA (2014).

Table 1: Example of mitigating measures to reduce flood risks

Asset/ Operation	Possible Mitigation Measures	Effectiveness	Practicality	Estimated Cost	Recommended (Yes/No)
Blower (STP)	Constructing a static barrier/flood wall around blowers	High	High	Low	Yes
	Relocation of blowers before flood event	High	Med	Low	Yes
Control panel (WTP/STP)	Elevate individual instrumentation/controls, or relocate to remote locations outside of the flood zone.	High	Med	Med	Yes
	Constructing a static barrier/flood wall around	High	High	Low	Yes

	blowers				
Water intake (WTP)	Relocate or elevate pump house and distribution system appurtenances that are in the flood zone	High	High	High	No (high cost)
	Protect and reinforces intake structures from floating debris and erosion	High	High	Med	Yes
Grit chamber (STP)	Vertically extend the tank walls above flood stage	High	High	Med	Yes
	Construct flood-proof/seal structures to prevent seepage of flood water into the chamber	Med	High	Med	Yes

4.0 Conclusion

The important findings of the project are as follows:

4.1 In 2014 flood, out of 10 WTPs in the area, three were completely flooded, five were affected due to water intake structure failure, while two were shut down due to power failure. As for the mechanical STPs, four of the 12 STPs were flooded including many CST, IST, and IT.

4.2 Water intake is the most vulnerable assest at the WTP, followed by the chemical room, office and also pumping stations. Aeration tank is the least vulnerable to flood. For STP, inlet chamber is typically the most vulnerable due to its lowest position.

4.3 The mitigating measures to reduce the flood risk varies according to effectiveness, practicality and cost. Simple measures such as sand bag or relocation of equipment or chemicals can be effective to reduce the risk.

4.4 With the availability of flood map of different return period, simple flood assessment can be of sigificant value to reduce the damage caused by the flood.

References

Air Kelantan Sdn. Bhd., Mohd Safrurazi Bin Salleh, Personal Communication, 2014.

Majaari Services Sdn. Bhd., Suhaimi Bin Mohamad Nazori, Personal Communication, 2014.

US EPA. “Flood Resilience: A Basic Guide for Water and Wastewater Utilities.” EPA 817-B-14-006, 2014.

PROJECT 11 : MANAGING FUTURE FLOODS AFFECTED BY CLIMATE CHANGE: FOCUSING ON KELANTAN RIVER BASIN

11.1: CHARACTERIZATION OF MALAYSIA'S EAST-COAST EXTREME RAINFALL AND FORMULATION OF RAINFALL DISTRIBUTION PATTERN

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1.0 Introduction

Every year Malaysia has suffered from the northeast monsoonal floods within November to March. The severe monsoonal flood can cause deaths and property loss up to billions Ringgit Malaysia. In December 2014, Kelantan had experienced the most severe flood in history. Several thousand people were evacuated from their homeland and the flood severely affected the food supplies, electricity, clean water, sewerage, health care and other emergency services and caused an unprecedented public outcry. Consequently, it has drawn government attention to take necessary measures for reduction of flood risk.

Flood frequently related to the heavy rainfall in short period. Therefore, the objectives of this study were: (1) to conduct statistical analysis on extreme rainfall in the east-coast of Peninsular Malaysia, (2) to produce return periods at sub-basin levels for extended rainfall durations, (3) to examine the return periods developed from the December 2014 rainfall events, and (4) to develop the best design rainfall temporal distribution pattern at specific sites according to extreme rainfall values identified.

2.0 Methodology

Rainfall records for the time period 1970-2013 and 16-26 December 2014 were collected from Department of Drainage and Irrigation (DID). Hundreds of selected stations were used for the analysis. The selection of rain gauge stations was based on the following criteria: (1) stations within river basins; (2) stations having more than 25 years of record, considering that at least a sample size of 25 requires for annual maximum precipitation (AMP) modeling; (3) stations having rainfall data during 16-26 December 2014; and (4) stations having minimum missing rainfall values during 1970-2013. However, due to the severe missing data in some stations, a quadrant method was used to infill the missing values. The rainfall in Kelantan, Pahang, and Terengganu river basins were accumulated for various days such as 1-, 2-, 3-, 5- and 7-day.

This study used a Thiessen polygon method to estimate the areal rainfall or mean areal precipitation (MAP). The observed AMP series are fitted with generalized extreme value (GEV) distribution function and the corresponding cumulative distribution function is used to determine the return periods of the flood while the quantile function is used to estimate the extreme rainfall for *T*-year return level. The procedure of the proposed new design temporal rainfall pattern was as summarized in Figure 1. It can fractionate extreme rainfall into smaller time scale. In other words, the designed temporal rainfall pattern can predict each hour rainfall from a total rainfall amount.

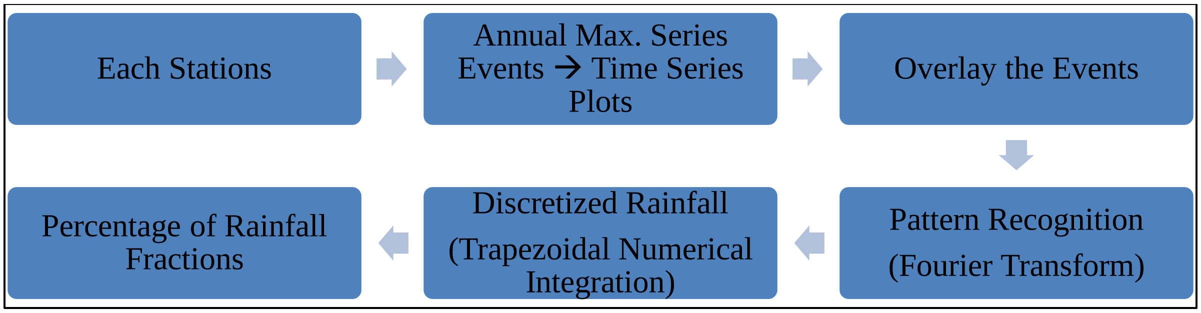
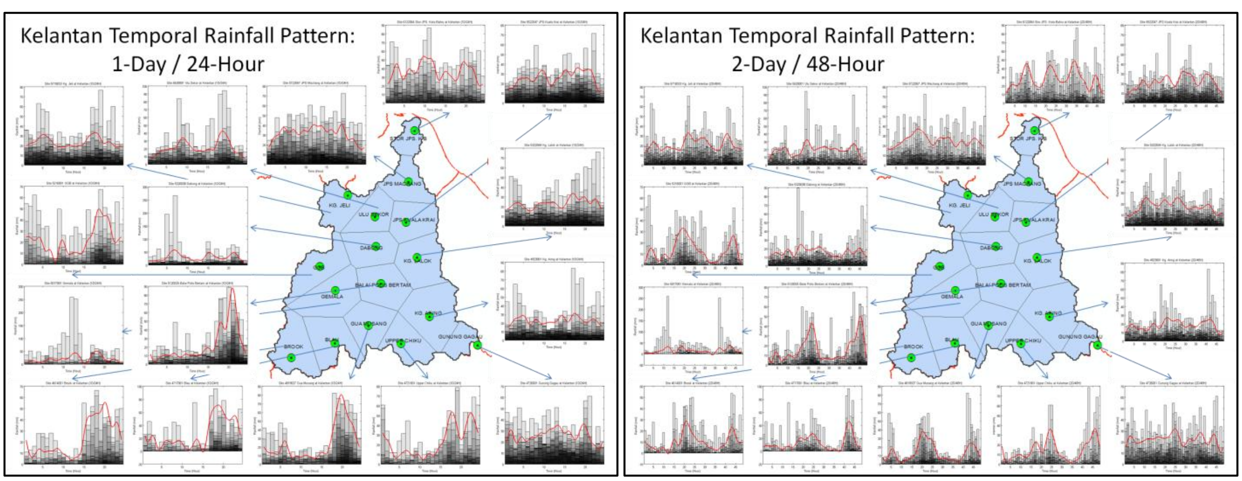


Figure 1 New Designs of the Temporal Distribution Rainfall Pattern

3.0 Results and Discussion

The rainfall analyses were subjected to both calendar year and water year. The date cycle for calendar year is 1 January to 31 December while the date cycle for water year in Malaysia is defined from 1 July to 30 June. Being a state of the east-coast Malaysia, Kelantan 2014 rainfall has produced extremely high return periods (>200 years) for all accumulated areal rainfalls. This condition was contradicted with the areal rainfall in Pahang and Terengganu of smaller return periods. For the point rainfall, most of the rain gauge stations in Pahang have the return periods less than 100 years while almost all rain gauge stations in Terengganu have the return periods less than 50 years. In this circumstance, the return periods of the rain gauge stations in Kelantan were comparatively high with manu stations exceeding a 200 year rainfall events. Areas receiving extreme amount of rainfall are Brook, Upper Chiku, Gunung Gagau, Gua Musang and JPS Machang.

Comparison on the cumulated rainfall depth shows differently. The cumulated rainfall depths up to the 7th and 11th day of heavy rainfall shows Kelantan and Terengganu having comparable rainfall depths (around 2000 mm). However, the rainfall events in Kelantan has extreme return periods values as compared to Terengganu were the stations experienced less than 50 years rainfall events. This can signify that the heavy rainfall in Terengganu has been experienced many of times however such rainfall amounts are very rare in Kelantan.Temporal patterns based on a collection of rainfall records were developed. Figure 2 show some preliminary results of the proposed temporal distribution patterns for Kelantan only. The proposed temporal distribution patterns still requires further verification, however the overall construction process has been proposed. This temporal patterns are beneficial to be used to discretized design rainfall for long-period.



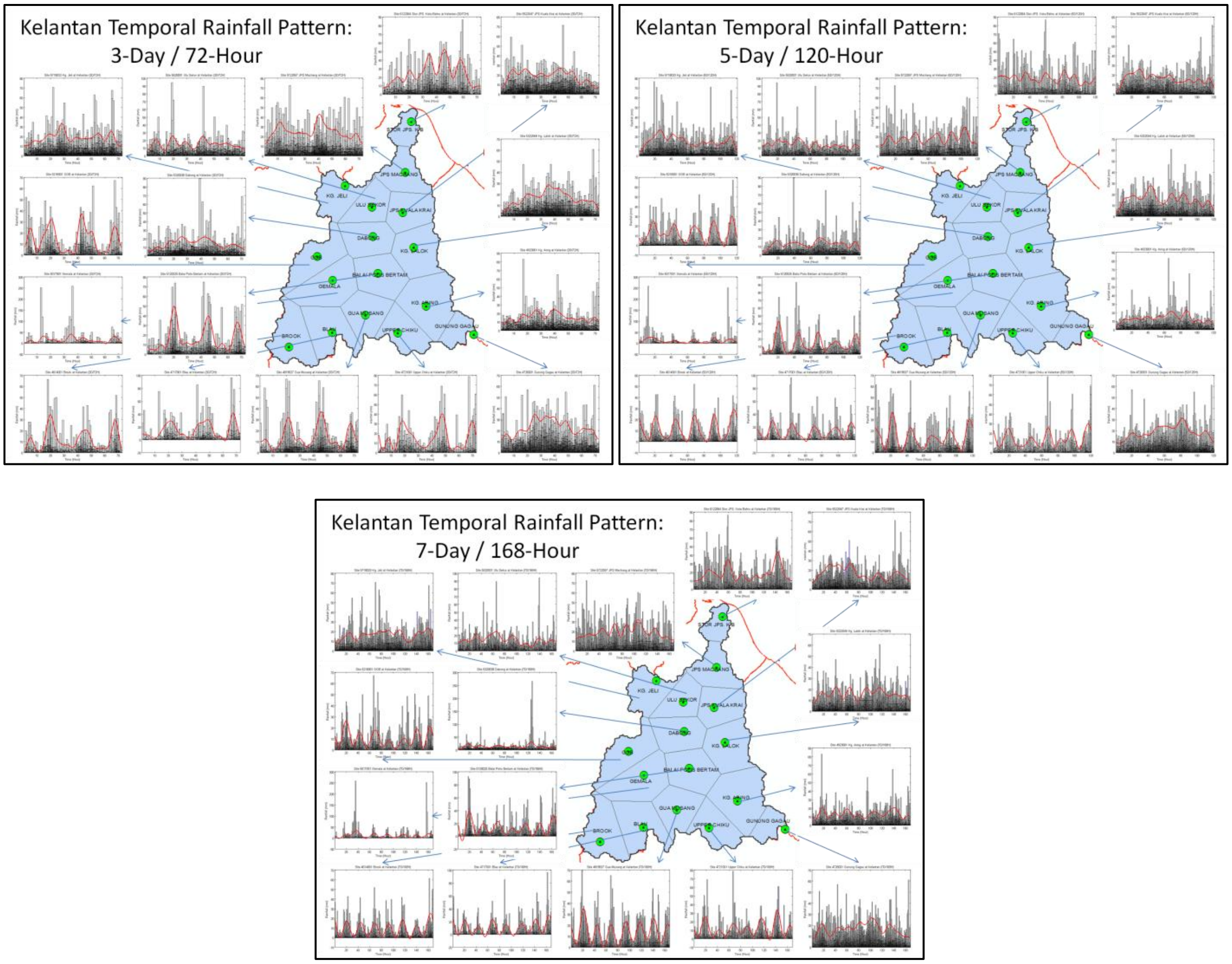


Figure 2 Temporal Rainfall Distribution Pattern

4.0 Conclusion

4.1 Kelantan has the highest recorded rainfall which exceeded historical values and experienced over 200 year rainfall events. Areas receiving extreme amount of rainfall are Brook, Upper Chiku, Gunung Gagau, Gua Musang and JPS Machang.

4.2 In Pahang, only station Kuala Tahan experiences an extreme rainfall event (> 200 Year rainfall)

4.3 Stations in Terengganu did not recorded any extreme rainfall event (no events with >200 rainfall) however the cumulated rainfall is still high which is comparable to Kelantan. This signifies that Terengganu was exposed to high amount of rainfall before; however such rainfall amount were rare for Kelantan.

4.4 Cumulated rainfall in Kelantan was recorded to be around 2000 mm on the 11th day in Gunung Gagau station (16 to 26 December 2014). Similar event were observed in Terengganu, however, Terengganu was saved from disastrous flood such as in Kelantan due to the existence of Kenyir Dam.

4.5 Proposed temporal pattern for multiple areas in Kelantan, Terengganu and Pahang were developed using a new method. Further developments of the rainfall patterns are needed.

11.2: DETECTING TREND AND DEVELOPING INTENSITY-DURATION-FREQUENCY(IDF) CURVES OF FUTURE RAINFALL DATA

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1.0 Introduction

Recently(2014) Kelantan received exceptionally heavy rainfall that had caused flooding in most parts of the state. The events were supposed to be the usual event due to the influence of the Northeast monsoon. However, the unusually and unexpectedly high amount of rainfall had caused the existing preventive and mitigation measures and the existing design storm infrastructure to be inadequate and insufficient to withstand such magnitude of floods. Hence, the loss of properties and lives were significantly high. Therefore, a study on the future extreme events was conducted to prepare for such disaster in the future. The generated future rainfall amount from year 2010 to year 2100 from various GCM (General Circulation Models) are readily available and were used in analysing the future extreme events. In determining the flood risk, future extreme values for 25,50 and 100 years return periods were calculated. Return periods at various scales were measured in analysing the future changes in the flood risk. The future IDF (Intensity Duration Frequency) curve were constructed to provide information on the likelihood of heavy rainfall events of various amounts and duration. The values are critical to determine the appropriate design standards and management for rainwater infrastructure in the future. In general, this study provides useful information to policymakers and practitioners to understand the climate change impact and to design appropriate infrastructure and flood mitigation works in the future.

2.0 Methodology

The research started with the finding of the Annual Maximum Series (AMS) for durations durations of 1-hour, 2-hour, 6-hour, 12-hour, and 24-hour. Then, for each AMS, the trend analysis using Mann Kendall Trend Test were measured to determine the behavior of series at each duration. GEV distribution was then fitted to the AMS and the parameters estimated were then used in evaluating the return periods. Finally, the IDF curves were constructed. When these procedures were applied to the historical hourly data, the historical IDF curves were able to be constructed. The future IDF curves were constructed using the future generated data , generated by Global Circulation Model (GCM). climate change factor was needed to be determined. The climate change "load" factor (CCF) for each return period was generated and used in constructing the future IDF curves. The CCF was used to reduce uncertainty of the projected rainfall data. The comparison between the historical IDF and future IDF were made by determining the percentage of change between them at all stations.

3.0 Results and Discussion

Intensity duration frequency (IDF) curves characterize the relationship between the intensity of rainfall occurring over a specified period of time and its frequency of occurrence. IDF relationships of extreme precipitation are widely used for flood design estimation. They describe the relationship between mean precipitation intensity and frequency of occurrence (the inverse of a given return period) for different time intervals of a given duration.

Extreme rainfalls are essential inputs to develop intensity-duration-frequency curves, which are used to derive design rainfalls for infrastructure project designs and flood mitigation work (Resenberg et al. 2010). One way to be prepared for possible changes, and to decrease the vulnerability of hydraulic infrastructures to climate change, is to predict potential effects as manifested by the IDF curves (Prodanovic and Simonovic 2007). A recent study by Mirhosseni et al. (2013) developed IDF curves for Alabama using high-resolution projections of three-hour precipitation events (2038-2070) derived from dynamical downscaling of GCM by regional climate models (RCMs). A stochastic model was used in that study to disaggregate 3-h precipitation into 15-min precipitation. Since rainfall characteristics are often used to design water structures, reviewing and updating rainfall characteristics for future climate scenarios are necessary (Mirhosseni et al., 2013). The estimation and use of IDF rely on the hypothesis of rainfall series stationarity, namely intensities and frequencies of extreme hydrological events remain unchanged over time. De Paola et al.,(2014) used IDF curves to frame the rainfall evolution of the three case studies used in their work by initially considering only historical data, then taking into account the climate projections, in order to verify the changes in rainfall patterns. Since IDF values are critical in determining the appropriate design standards and management for rainwater infrastructure, this method will also be applied to future data.

The results of the trend of the annual maximum series at different time scales (1-hour, 2-hour, 6-hour, 12-hour, and 24-hour) are given in Table 2. The results show that ten stations (Brook, Blau, Upper Chiku, GuaMusang, Kg Aring, Balai Polis Bertam, Gob, Kg Lalok, JPS Kuala Krai and Kg Jeli) show increasing trends , while six stations (Gunung Gagau, Gemala, Dabong, UluSekor, JPS Machang and Stor JPS Kota Bharu) show decreasing trends on all the different time scales. The results clearly show that the majority of the rainfall stations especially stations situated at the southern part of Kelantan experienced increasing extreme events trends.

It is found that the CCF for all the station varies according to stations and return periods. The lowest and highest CCF value are 0.62 at station Upper Chiku for 2-year return period and 2.82 at station Brook for 200-year return period respectively. The future return period values show an increase of more than 100% but the decrement is less than 50%. Only station at JPS Machang had decrement for every return period. This show the rainfall intensity was predicted to be reduced in the future. By contradiction, there have some station had increment for all return period which are Brook, GunungGagau, Kg. Aring, Gemala, Balai Polis Bertam, Gob, Dabong, UluSekor, Sek. Men. Teknik Kuala Krai and Stor JPS Kota Bharu. The increment is between 3% and 282%. Simulated data show the rainfall intensity around the station will be increase in time. In the table also included the value of CCF for whole Kelantan (Areal). The value for every time period show an increment from 3% to 102%.

Based on the Mann-Kendall trend test and the IDF curves, the results shown that most of the stations at the Kelantan River Basin having the increasing trends in the intensity of future rainfall data. The annual maximum rainfall for varies time scales exhibit ten of the stations (Brook, Blau, Upper Chiku, GuaMusang, Kg Aring, Balai Polis Bertam, Gob, Kg Lalok, JPS Kuala Krai and Kg Jeli) are increasing trend, while five stations (GunungGagau, Gemala, Dabong, UluSekor, JPS Machang and Stor JPS Kota Bharu) are the decreasing trend.

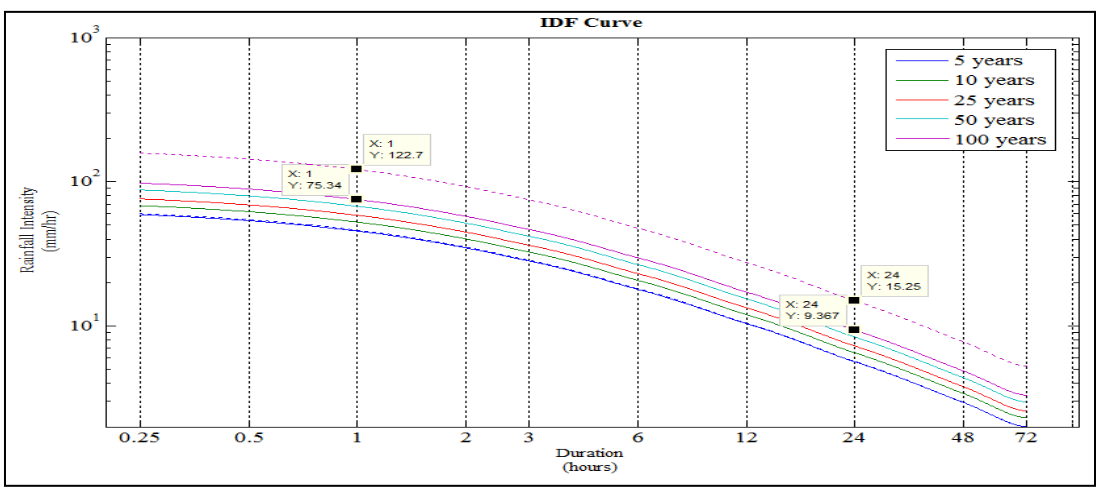

Fig 1: IDF for Areal Rainfall

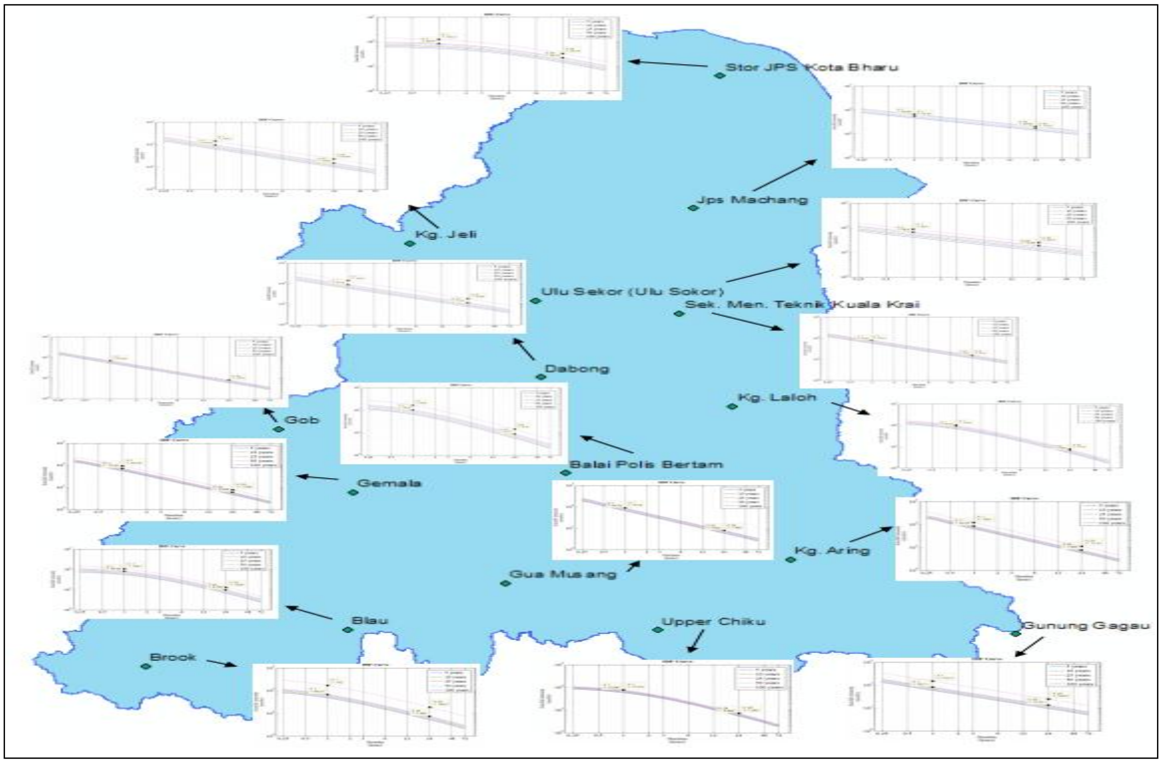

Fig 2: IDF for all stations in Kelantan

According to the IDF curves, four stations (Brook, GunungGagau, Dabong and Kg. Jeli) show a significant increase in the rainfall intensity for the future rainfall for all the return period (2, 5, 10, 25, 50, 100 and 200) and all the hour (1, 2, 6, 12 and 24); 7 stations (Blau, Kg. Aring, Balai Polis Bertam, Gob, UluSekor, JPS Kuala Krai and StorJPS Kota Bharu) show the increasing trend at most of the return period and hours; and 5 stations (Upper Chiku, GuaMusang, Gemala, Kg. Laloh and JPS Machang) show the decreasing trend at most of the return period and hours. Table 1 shows the percentage increase between historical and future IDF curves for Station Brook and Blau. Both shows significant increase in IDF curves in the future.

Table 1: The percentage of the change between the historical IDF and the future predicted IDF.

a. Station Brook (4614001)

	Change (%)						
	Return Period (Years)						
Hour	**2**	**5**	**10**	**25**	**50**	**100**	**200**
1	55.5	57.9	69.7	94.2	119.6	151.6	191.6
2	48.1	53.9	67.5	94.6	122.2	156.9	200.3
6	72.6	72.4	80.8	98.9	117.6	140.7	169.1
12	90.0	80.9	83.7	93.9	105.6	120.6	139.0
24	82.7	80.9	92.1	117.0	143.4	177.1	219.1

b. Station Blau (4717001)

	Change (%)						
	Return Period (Years)						
Hour	**2**	**5**	**10**	**25**	**50**	**100**	**200**
1	4.7	-0.9	2.8	12.7	23.3	36.4	52.2

2	19.8	7.0	7.4	13.6	21.3	31.4	43.8
6	52.0	29.0	22.7	19.9	20.3	22.2	25.5
12	64.8	45.1	36.2	27.4	22.0	17.2	13.0
24	65.5	53.2	45.1	34.2	25.7	17.1	8.5

4.0 Conclusion

In this study, the results have shown that there were Increase in historical trends observed in majority of the stations. The study also show there were upward increments observed in majority of the IDF curves with some stations showing more than 100% increments (Brook and Gunung Gagau). Therefore, this study recommends new updated IDF curves to be constructed which can provide useful information to policy makers and practitioners to consider the possibilities of designing a new and an appropriate infrastructure and flood mitigation works in the future.

References

Mirhosseini,G., Srivastava, P., and Stefanova, L., (2013). "The impact of climate change on rainfall intensity-duration-frequency (IDF) curves in Alabama". Reg. Environ. Change. 13(1), 25-33.

Pradanovic, P., and Simonovic, S.P. (2007). "Development of rainfall intensity duration-frequency (IDF) curves for the City of London under the changing climate". Water Resources Research Rep. No. 058, Univ of Western Ontario, London, ON, Canada.

De Paola, Francesco, Giugi, Maurizio, Topa, Maria Elena and Bucchignani, Edoardo. (2014). "Intensity- duration-frequency (IDF) curves for data series and climate projection in African cities". 3:133 1-18.

Al-Shaikh, A.A. Rainfall frequency studies for Saudi Arabia, M.S. Thesis, Civil Engineering Department, King Saud University, Riaydh (K.S.A), 1985.

Al-Dokhayel, A.A. 1986. Regional rainfall frequency analysis for Qasim, B.S. Project, Civil Engineering Department, King Saud University, Riaydh (K.S.A), April, 1986

11.3: DEVELOPING VULNERABILITY INDICES TO FLOODING FOR THE KELANTAN RIVER BASIN

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1.0 Introduction

The efficiency of flood management system is essentially important because it influences two vital components; losses of human lives and damages to property (Khan, 2012). One of the most important sections of flood management is assessing flood vulnerability. Flood vulnerability is the key element in flood risk assessment and damage evaluation. There is a need to enhance our understanding of the vulnerability because nowadays it is understood that vulnerability is the root cause of disasters (NRE, 2007). For achieving this goal, developing vulnerability indices is the main approach that can determine which areas are most vulnerable.

The flood in Kelantan was mainly due to the continuous heavy rainfall from 21-23 December 2014 which was equivalent to more than 60 days of rainfall, whereby the water level in the river exceeded those of recorded floods of 1967 and 2004. From 1961 to 2006, the Kelantan River basin has experienced flooding for a total 275 times at early warning level, 92 times at warning level and 23 times at dangerous level (Hussain et al., 2014). This scenario illustrates higher flood risk tendency if relevant parties do not take prudent mitigation measures including flood management system especially for the three stages before, during and after flood occurrence.

The identifying flood-prone areas within a river basin and application of the remediation measures in the flood-prone areas can significantly reduce flood damages. In this study, the proposed river basin approach to minimize flood damages is by identifying the flood-prone areas in the Kelantan River basin. A GIS-based analysis of the Kelantan river sub-basins with the main objective of developing flood vulnerability indices is proposed. The vulnerability of river basin is proposed to be computed by measuring different indices, soil erosion risk, potential of soil for agriculture, population vulnerability, road infrastructure vulnerability, market infrastructure vulnerability and flood depth-inundation area vulnerability were assessed with respect to flooding risk. These developed indices framework will be helpful to the river basin managers and policy makers to develop a systematic plan in the river basin so the losses of human lives and property would be minimized during future massive floods.

2.0 Methodology

A GIS-based tool was used to identify Kelantan's most vulnerable sub-basins that reflect the spatial distribution of risk and the locations of flood events likely to occur. When assessing an area for flood risk, many variables need to be taken into account (Hassan et al., 2006; Smith and Hersey, 2008; Alaghmand et al., 2010). In this study, we used population, soil to erosion, soil potential, transportation network, shopping market locations, and flood depth-inundation area for developing flood vulnerability index in the Kelantan River basin. Depending on the weight applied to these variables (i.e., is it more important to protect roads from flood rather than voluble soil), decision makers can use the proposed tool to know where to build flood control devices in the flood affected areas. The methodology adopted in this study can be divided into the following steps;

Step-1[Sub-basins]: Determine the boundaries and the drainage area for the "priority" river basins by creating sub-basins (e.g. SB_1, SB_2, SB_3,…SB_{22}).

Step-2 [Erosion Risk Index]: Use the Intersect command in ArcGIS to intersect SBi (Sub-basin) & ER (Erosion Risk) = SBER. Determine the drainage area fraction by category, where;

$SBER_i = ER_{W1} \times ER_{value}$; and, $SBER_1 = {}_{i=1}^{n=22} ER_{Wi} \times ER_{i\ value}$, (1)

Calculate [$\sum SBER_i = SBER_1 + SBER_2 + \ldots\ldots + SBER_{22}$] then, normalized the scores and produced ranking of the Sub-basin Erosion Risk,

Step-3 [Soil Potential Index]: Intersect Sub-basin (SBi) & Potential Soil (PS) = SBPS (Sub-basin Potential Soil). This index is the inverse of erosion risk index. We then multiply the drainage area fraction by index category, where

$SBPS_i = PS_{W1} \times PS_{value}$ and, $SBPS1 = {}^{n=22}_{i=1} PS_{Wi} \times PS_{i\ value}$ (2)

We then sum the categories to compute a "sub-basin soil potential" score.

$[\sum SBPS_i = SBPS_1 + SBPS_2 + \ldots\ldots\ldots\ldots\ldots.. + SBPS_{22}]$.

Step-4 [Population Vulnerability Index]: Use the Intersect command to intersect SBi & FPA (Flood Prone Area) = $SBFPA_i$. Then,

[$SBFPA_i$ x PD (Population Density) = FPAPDi] (3)

Later, we determine the population density in the flood plain area and ranked the highest to the lowest vulnerable population.

Step-5 [Road Vulnerability Index]: Intersect $SBFPA_i$ & RN (Road Network). Determine road categories and assign weights as proxy of "road replacement value" *(5=national highway. 4=arterial road, 3=local road, 1=service road).* Then, multiplying (road weights X road distance per weight X flood plain category) where,

$SBRN_i = [\sum RN_w \times RN_d \times FP_{category}]$ and, $SBRN_1 = {}^{n=22}_{i=1} RN_{wi} \times RN_{di} \times FP_{i\ category}$ (4)

Then sum the weight values, $[\sum SBRN_i = SBRN_1 + SBRN_2 + \ldots\ldots.\ldots + SBRN_{22}]$ and compute the "road vulnerability" for each sub-basin by intersecting with SBFMi (Sub-basin Flood Map).

Step-6 [Market Vulnerability Index]: Intersect SBFPAi and Market Locations (M). Determine market category and assign weight as (*urban=3, regional=3 and rural=1)*. We then multiplying (number of markets X market per category X Flood plain category) where,

$SBM_i = [\sum M_n \times M_c \times FP_{category}]$ and, $SBM_1 = {}^{n=22}_{i=1} M_{ni} \times M_{ci} \times FP_{i\ category}$ (5)

Then, calculate "sub-basin market values" by summing the category values and produce ranking of $[\sum SBMi = SBM_1 + SBM_2 + \ldots\ldots\ldots\ldots\ldots.. = SBM_{22}]$

Step-7 [Flood Depth Vunerability Index]: Intersect SBFAi with flood inundation area (FIA) and flood depth (FD) and = SBFID. We assigned weights to flood depth (0.7) and inundation area (0.3) variables. Where,

$SBFID_i = \sum (FD \times 0.7) \times (FI \times 0.3)$ and, $SBFID_1 = {}^{n=22}_{i=1}(FD_i \times 0.7)\ X\ (FI_i \times 0.3)$ (6)

3.0 Results and Discussion

This section presents the spatial database elements and variable analysis, as factors in the development of GIS-based decision making. The choice of variables used in the vulnerability analysis and their classification into risk classes and intensity of importance (Nasiri and Shahram, 2013). Hence, the criteria considered in this study were chosen due to their significance in causing flood in the study area.

3.1 Erosion Risk Index

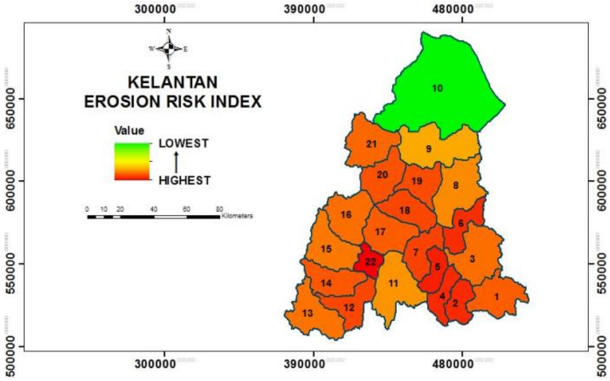

Figure 3: Erosion risk map of Kelantan

Fig. 1 shows the result for deriving an erosion risk index. It combines four factors: slope, soil erodibility, climate erositivity and land use cover. The highest ranked of river basins for erosion risk located roughly in the upstream. This is due to the primarily steep terrain and high elevations (around 100-500m), whereas the lowest ranked of river basin occur at the downstream are generally characterized by low mountains and large alluvial plains (0-50m). The significance of this analysis shows that the sub-basin's heightened erosion risk were highly vulnerable due to high mountain ranges.

3.2 Soil Potential Index

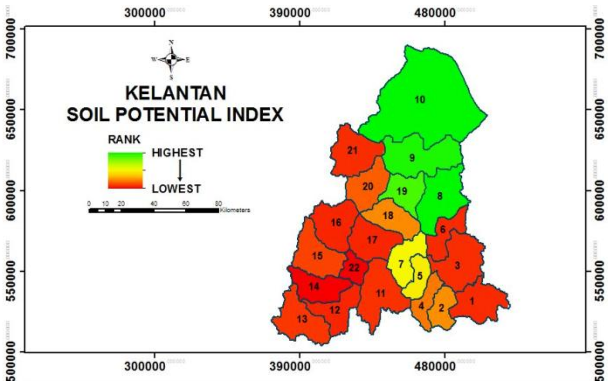

Figure 4: Soil potential map of Kelantan

Soil potential index is basically the inverse of the erosion risk index ranking. Figure 2 shows the highest index is at sub-basin 10 that is covered by the flat/alluvial surface, and the lowest ranked of sub-basin occur along the high ridges which are located at the mountainous area (red colour). Sub-basin 10 mostly covered by the quaternary soils, which is good in terms of soil stability and infiltration that possibly allows the water to infiltrate into the ground as well as the growth for plants and crops.

3.3 Population Vulnerability Index

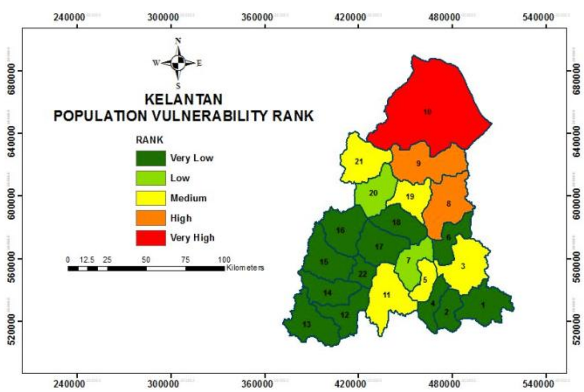

Figure 5: Population vulnerability map of Kelantan

Figure 3 shows the intersection of the population density map with the flood prone area map for estimating the population exposed to floods. Sub-basin 10 representing the major urban areas of Kelantan state (Kota Bharu region) generated the highest index of population vulnerability where the high population densities residing at low coastal plain. At the other extreme, the lowest indices of sub basins (green color) were characterized by relatively low population densities residing in areas with elevated plains.

3.4 Road Vulnerability Index

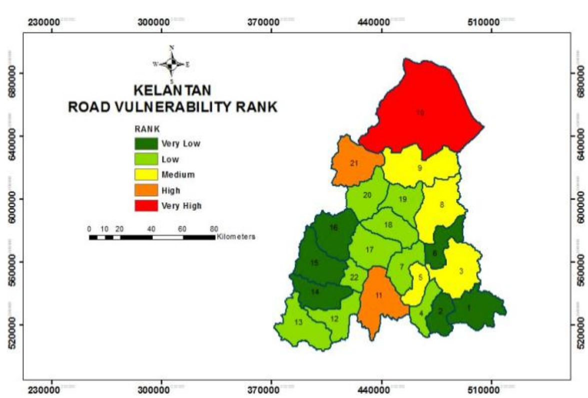

Figure 6: Road vulnerability map of Kelantan River basin

Road vulnerability index is determined by the road distance, road category and flood plain category that are weighted according to estimated life cycle costs and their location within the flood prone areas. Sub-basin 10 again had the highest vulnerability index compared to others because of the major roads network are mostly centralized and integrated within the major metropolitan areas. The lowest index category for road vulnerability index can be shown in Gua Musang region (green colour) were mostly less connected with main highway especially in the rural areas.

3.5 Market Vulnerability Index

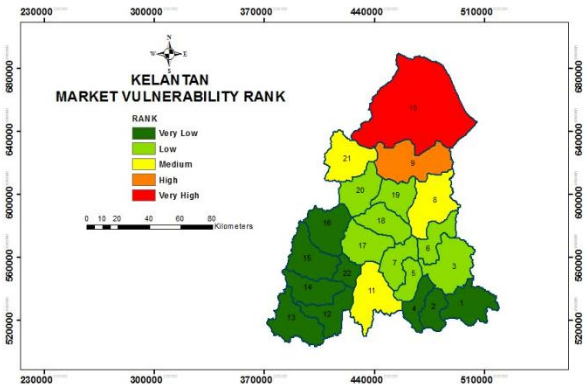

Figure 7: Market vulnerability map of Kelantan

Market vulnerability index is based on the weighted value of markets (rural, regional or urban) falling within flood-prone areas. Fig. 5 shows the highest indices reflect the importance of urban markets located in the large areas of high flood potential (low elevated plain).The most vulnerable sub-basins are those located at sub-basin 10 (major urban). The lowest ranking index for market is inverse, where the sub-basins with less transportation network is mostly less market concentration falling into the Gua Musang areas (e.g. sub-basins 12, 13,14 and 15).

3.6 Flood Depth-Inundation Area Vulnerability Index

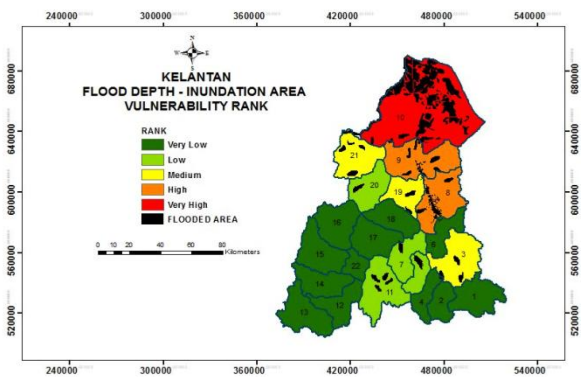

Figure 8: Flood depth and Inundation area map of Kelantan

Figure 6 shows that high rank zone located in built up area and low lying area which is at Kota Bharu region (sub-basin 10). The inundation area is wider though the flood depth is falls in medium risk category about to 3m compared to the worst affected sub-basin from recent floods which are Kuala Krai, Manek Urai and Dabong. Kota Bharu is highly risk and it represents an area where people are more exposed to flooding than those living in less developed area. Followed by Kuala Krai and Manek Urai areas (sub-basins 8 and 9), are also represent high index though the area is less populated but the inundation depth is the highest about 5 to 10 m. The very low index covers an area at Gua Musang region (dark green colour). It is observed that it is risk-free where no inundation in this area.

3.8 Overall Flood Vulnerability Index

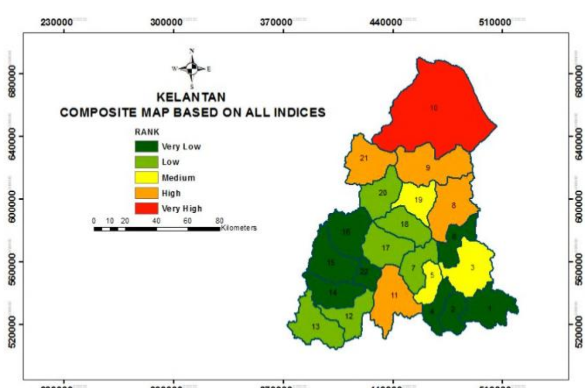

Figure 9: Composite map based on all indices of Kelantan

Figure 7 shows the composite map of Kelantan based on all indices. In overall, sub-basin 10 is the most vulnerable sub basin in terms of the threat of loss of human life and livelihood due to the flooding. This is primarily due to the large number of people living there and highly affected by the floods. Whereas, Gua Musang region (dark green colour) sub-basins group score the lower ranked index which means that they are slightly prone to flooding however they are potential to be the most erosion prone areas.

4.0 Conclusion

The importance findings of mapping vulnerability indices to flooding in Kelantan River basin through the selected indices including population, soil erosion and potential, road networks, market locations and flood depth & inundation area are summarized as follows:

4.1 There are several groups of sub-basins that consistently score high in two or more indices. It shows, the overlap of risk factors tends to define their status as the priority river basins.

4.2 Sub-basin 10 (Kota Bharu region) is the most vulnerable of all of Kelantan River basin in terms of the threat of loss of human life and livelihood due to the flooding. The areas with an active and high concentration of development activities and densely populated regions with large infrastructure investment are more vulnerable than the other areas.

4.3 The high erosion risk combined with protected areas is one of the group of sub-basins was identified in relation to the erosion risk index. These sub-basins respond directly to priorities for reducing erosion vulnerability and for protection of high priority of the forest reserve especially in Gua Musang region (sub-basins 14, 15, 16, and 22). The vulnerability index for these selected sub-basins group are slightly prone to flooding.

References

Alaghmand, S., Bin-Abdullah, R., Abustan, I., and Vosoogh, B. “GIS-based River Flood Hazard Mapping in Urban Area: A Case Study in Kayu Ara River Basin, Malaysia.” International Journal of Engineering and Technology 2 (2010): 488–500.

Hassan, A.J., Ghani, A.A. and Abdullah, R. “Development of flood risk map using GIS for Sg. Selangor Basin.” Universiti Sains Malaysia, Penang, 2006.

Khan S. “Vulnerability assessments and their planning implications: a case study of the Hutt Valley, New Zealand.” Natural Hazards 64 (2012): 1587– 1607.

Nasiri, H. and Shahram, S.K. “Flood vulnerability index as a knowledge base for flood risk assessment in urban area.” Journal of Novel Applied Sciences, 2, 2013, pp. 269-272.

NRE. “Flood and drought management in Malaysia.” Ministry of Natural Resources & Environment, Government of Malaysia, 2007.

Smith, S.E. and Hersey, D. “Analysis of watershed vulnerability to flooding in Haiti.” World Applied Sciences Journal, 4 (2008): 869-885.

11.4: COMPUTATIONAL MODELLING OF KELANTAN RIVER FOR DECEMBER 2014 RAINFALL EVENT

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1.0 Introduction

The extreme flood on December 2014 in Kelantan river was the worst in its history. This research involves calibration and validation of a hydrological model which will then be applied for the simulation of the inundated area for the 2014 rainfall event and to identify the possible main causes of the flood (rainfall, land use changes and tides) and quantify the contribution of each factors towards the flood. But, tides contribution towards the December 2014 flood has been shown to be very minimal and insignificant. Statistical analysis has shown that rainfall is the main contributing factor towards the flood, with ARI of more than 500 for several rainfall stations. Main outputs of this study are the inundation and velocity map for the December 2014 rainfall event.

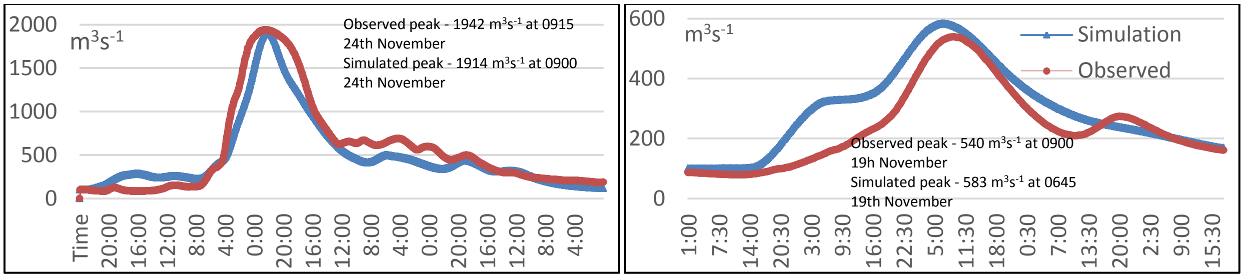
2.0 Methodology

The current study involves calibration and validation of a hydrological model (using HEC-HMS) of Kelantan river. The parameters involved will be optimized so that the simulated streamflow at the catchment outlets (Nenggiri, Lebir, Dabong and Guillemard streamflows stations) agree with the observed streamflow with rainfall data based on recent events (2011-2014) with high streamflows. The reason for high value of streamflows is to give reliable streamflow output to simulate the extreme rainfall of December 2014 event. Observed streamflow data cannot be applied for the hydraulics modelling due to missing data (some of the instruments was swapped away). Hence the need for the simulated streamflow.

Next, hydraulic modelling is applied using shallow water equations of FLOW-3D. The data inputs are streamflow and water level at the input boundaries and Lidar DEM as the topography. Once calibrated, the simulation produces the inundated area at three main villages in separate simulations; Dabong of Sungai Galas, Manek Urai of Sungai Lebir and Kuala Krai at the confluence of both the rivers. One main assumption in the model is the water level is forced to be the same as the observed flood marking for the December 2014 event. The velocity map was also produced, but no validation has been made on this.

3.0 Results and Discussion

As an example of result for the hydrological modelling, Figure 1 shows the calibrated and validated model for Lebir Streamflow Station. The efficiency index is very high at 90% for the calibration with very close results in terms of magnitudes and timing between the observed and simulated peak flow. The model manage to depict the rise and fall of the main peak, the base flow before and after it and also the small peaks. On the other hand for the validation of the model, which is crucial in which the optimized parameter is applied to another rainfall event, shows a lower match, but still within the satisfactory level of efficiency index (63%).



(a) **(b)**

Figure 1 Lebir river streamflow a) calibration for 19th November 2011 to 3rd December 2011 and b) validation for 17th November 2014 to 21st November 2014

Next, is the simulation of the December 2014 rainfall event. Only one station will be shown here. Figure 2 shows the observed and a few simulated streamflow options at Dabong from 17 December 2014 until 30 December 2014. Due to missing streamflow data, a few simulations were made. It has to be noted that the December 2014 rainfall event with its high intensity and long duration of rainfall would have caused the soil to be fully saturated, and the previously validated hydrological model might not be appropriate. After a few hydraulic simulations, the highest simulated streamflow of option 6 was chosen, assuming no infiltration loss.

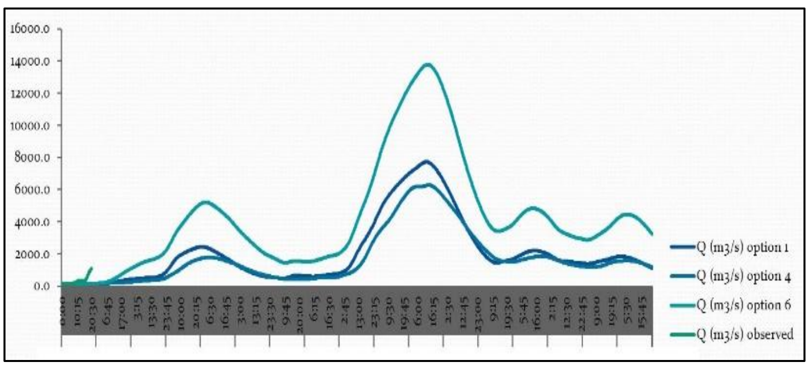


Figure 2 Observed and Simulated streamflow at Dabong (17 December 2014 until 30 December 2014)

For the flood modelling, Figure 3 shows the velocity and inundation map for the three villages mentioned. With the forced model (i.e. the water level is the same as the observed flood marking), the time and routes of the breaching river can be determined and also the timing for the increment of the inundated water level. As shown, each village's results are separated into 14 hours interval in order to see the change in water level and also the velocity. A video has been made, that can clearly show this. But, care has to be taken because the velocity maps have not been validated. A lot of assumptions have been made into this FLOW-3D software, such as only the main streams are taken into account as an input the domain. But to overcome this, only a small domain is chosen, around 10 km^2. Also because of this, the surface runoff not taken into account in the domain itself is minimal and negligible. Apart from this, desktop calculations have been made because the input streamflow into the numerical domains are not at the point of the simulated outlets of the HEC-HMS modelling.

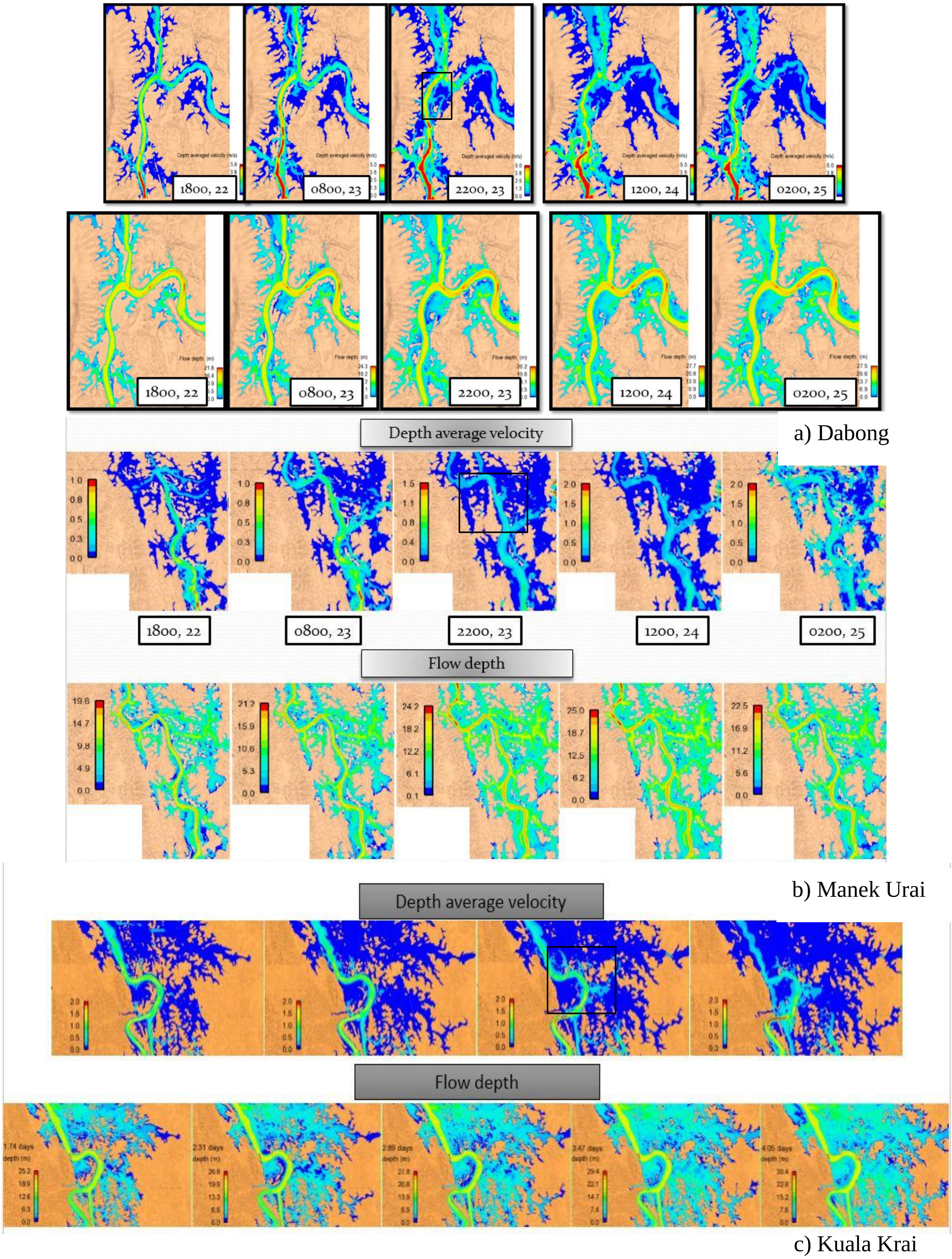


Figure 3 Map of depth average velocity and flow depth at a) Dabong, b) Manek Urai and c) Kuala Krai

The small black line boxes in the Figure 3 delineate the mainly populated area at each villages. From the simulation of Dabong, Sekolah Dabong and Klinik Kesihatan Dabong was inundated up to about 5 m and 3.5 m respectively due to river breaching mainly from the northeast side (around the Dabong Streamflow Station), starting from a gulley. For Manek Urai, the railway track near the railway bridge and SK Manek Urai was inundated up to about 7 m and 6 m respectively due to river breaching mainly from the north side (it is reported that SK Manek Urai is inundated up to three floors). For SK Manek Urai, the flood apparently started from the river breaching at the north side and flows alongside the main road southward (right side of SK Manek Urai), whereby the river is at the left side. This means it is not a direct breaching from the river. While for Kuala Krai, the Pasar Besar was inundated almost 8 m high. For the maximum depth averaged velocities, 3 to 4 ms^{-1} in the main channel and around 1.5 ms^{-1} at the inundated area at Dabong, and 1 to 1.5 ms^{-1} in the main channel and less than 0.5 ms^{-1} at the inundated area, for both Manek Urai and Kuala Krai.

4.0 Conclusion

4.1 Calibrated and validated hydrological model and hydraulic (not for the velocities)

4.2 Inundation area for the 2014 rainfall event for Dabong, Manek Urai and Kuala Krai have been mapped (Refer to the discussion and maps above).

4.4 Although not explicitly, rainfall is the main cause of the flood

4.4 Quantification of the factors are yet to be simulated due to the limitation of the chosen hydrological method

4.5 Further research is needed, especially to validate the velocity of the river and the breaching water and also the routes of the breaching water.

PROJECT 12 : LEBIR RIVER BASIN (SUB-BASIN OF KELANTAN RIVER) MULTI-LAYERED FLOOD RISK MAP

12.1: DETERMINATION OF LANDSLIDE AND EROSION MECHANISM AND INDEX IN LEBIR RIVER BASIN TRIGGERED BY EXTREME WEATHER

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1.0 Introduction

Flood brought more damage to people and the environment. Grievieng the loss of lives and properties are undeniable, but we often take for granted the damage to the banks of the river due to erosion during heavy current flow. In December 2014, major floods have hit Kelantan and cause the most devastating damage to the state (Figure 1). Severe damage can be seen on the banks of the river due to erosion from flooding (Figure 2). Erosion occurs naturally along riverbank when powerful action of adjacent moving water. Based on Pimentel et al. (1995), when the flow of the river through the bank with steep slopes (30% or more), the loss of soil due to erosion is increasing. Even on a relatively flat land conditions with only 2% slope, riverbanks are eroded primarily during heavy rain and flooding.

Landslides are one of the natural disasters that change the morphology and shape of the earth surface. It leads to property destructions, property damage and loss of life. Therefore, hilly steep and mountainous areas have been referred to landslides in order to mitigate in advance any possible damage cause by them. There are a few definitions about landslide hazards and one of them stated that it only considered as hazards when they threaten mankind (Lee and Pradhan, 2006). Besides that, probability of occurrence of a potentially damaging landslide phenomenon within a given period of time and a given area is a definition of landslide hazards propose by Mezughi et al. (2011). Preparation of landslide inventory and landslide susceptibility is very important in the management of landslide hazards; observation of landslide along the road including steep hills has been subjected to know potential areas that have possibility for landslide to occur (Mezughi et al., 2011).

Figure 1: Landslide and Slope Failures at Hulu Sungai Galas (Left). Erosion and Slope Failures at Sungai Lebir Riverbank (Right)

There are many techniques and studies on how to determine the relationship between landslide and parameters (Mohammady et al., 2012) by using GIS (Akgun and Bulut, 2007; Bednarik et al., 2012; Pradhan et al., 2012; Wan and Lei, 2009; Kayastha et al., 2013) which is used to evaluate landslide hazard and in production of landslide susceptibility assessment (Akgun et al., 2008) and erosion.

Statistical model also being used in landslide hazard analysis such as logistic regression model (Akgun et al., 2012; Bai et al., 2010), analytical hierarchy process (AHP) and frequent ratio (Shahabi et al., 2012). The objectives of this study is to develop a landslide susceptibility map for Lebir River Basin, to determine the changes of riverbank line due to erosion along Lebir River and to investigate the process and mechanism of debris flow due to landslide and erosion.

2.0 Methodology

2.1 Indirect Landslide susceptibility Mapping

Indirect landslide susceptibility mapping has a concept of controlling factors of future landslides that are same as previous observation of past events. This method was used by (Westen et al., 2003) to evaluate the importance of geomorphological information in the generation of landslide susceptibility maps by using GIS supported indirect bivariate statistical analysis and compared with landslide inventory and terrain factors. All landslides conditioning factors that can be mapped were entered into GIS and converted from vector to raster maps and analysed by using weight of evidence method (Bonham-Carter, 1991; Westen et al., 2001).

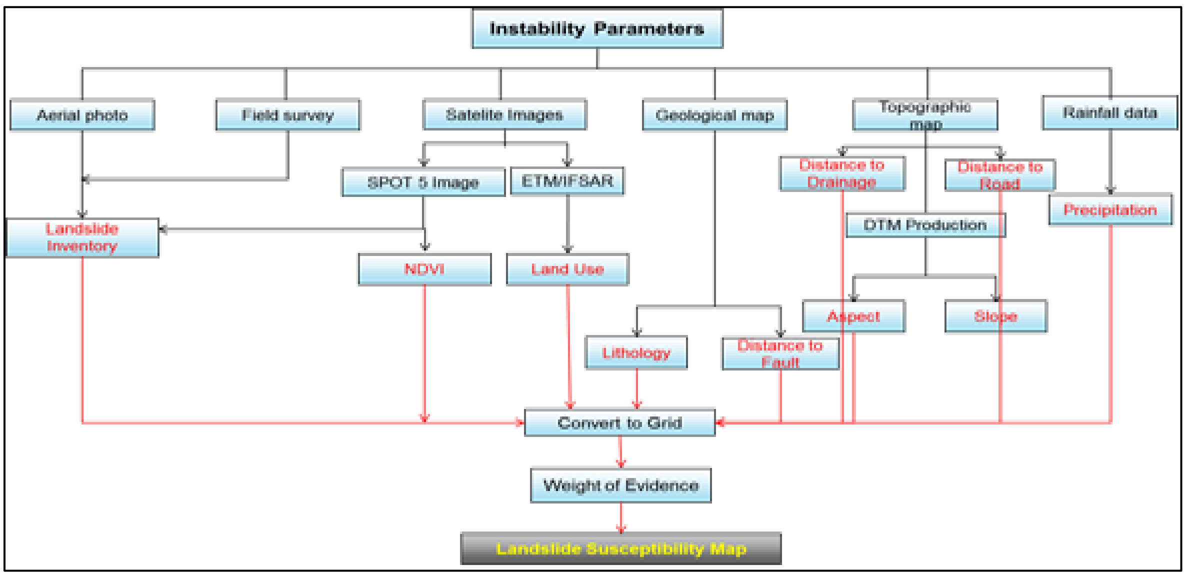

Figure 2: Methodology production of landslide susceptibility map

2.2 Erosion

Lebir River then divided into 12 segments and it's about 33 kilometres long. The riverbank line has been identified and delineated for all the SPOT 5 satellite image mosaics. The cross-sections were created at unequal distances from north to south, giving more consideration to morphometric changes of river. The location of these cross-sections is decided on the basis of visual analysis of temporal remote sensing images and major morphometric changes in river, with more dense cross-sections at locations where large changes in river bank. The identified riverbank lines for the left (West) and right (East) banks of the river, have been digitized using ArcMap Software. Two riverbank lines have been prepared for the years 2009 and 2015. The length of arcs of both the left and right banks for all above years have been calculated using GIS Software. Erosion area has been estimated through area estimation using GIS Software tools for polygon areas with the shifting bank lines in study period.

2.3 Debris Flow

In order to conduct the study on the debris flow, samples from the riverbank was collected and analyzed. The properties of the soil type then can be related to the mechanism of the slope failure and erosion, which contribute to the deposition of the debris flow into the river system.

3.0 Results and Discussion

3.1 Landslide Susceptability Map

Based on the result of the obtained susceptibility map, 22.76% (7.34 km^2) of the total area show very low landslide susceptibility whereas 19.95% (6.44 km^2) shows low landslide susceptibility map. Moderate, high and very high susceptibility zones make up 27.16% (8.76 km^2), 23.87% (7.70 km^2) and 6.27% (2.02 km^2) of the total area, respectively.

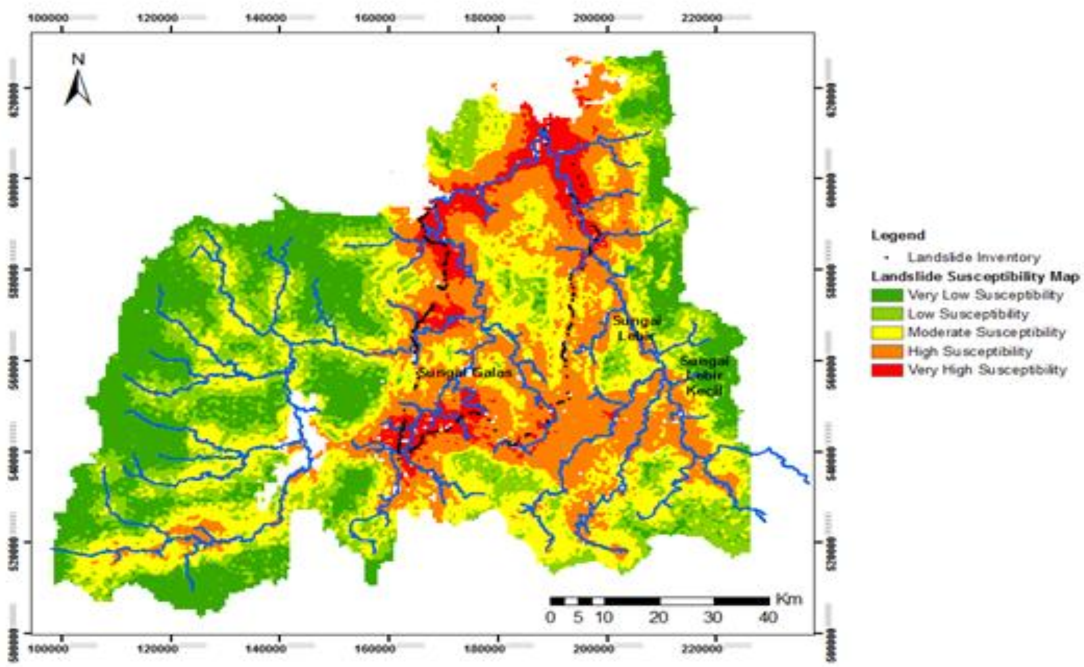

Figure 3. Landslide susceptibility map

3.2 Changes of River Bank Due To Erosion

Erosion results showed that there has been significant erosion in the river during a period before and after flood 2014. Erosion is more severe in the western bank compared with eastern bank and overall rate of erosion is 181514.53m^2 and 157160.93m^2 respectively (Table 1). The integration of riverbank lines before and after flood 2014 revealed that Lebir River has shifted its bank line drastically causing massive damage to the good agriculture, forest as well as habitat area on its both sides.

Table 1: Total Erosion area of West and East Bank

Segment No.	**Total Erosion m^2**	
	West (Left) Bank	**East (Right) Bank**
1	13860.24	4959.70
2	12076.80	8782.91
3	13472.93	11026.32
4	5272.72	13028.37
5	12428.50	4799.67
6	18175.19	15328.72
7	19784.44	8915.31
8	18959.50	21317.71
9	21497.33	4882.97
10	16273.48	37387.04
11	16933.29	9177.58
12	12780.10	17554.63

4.0 Conclusion

4.1 Ten landslide conditioning factors include geology (lithology), geomorphology (slope and aspect), land use, soil, distance to road, distance to drainage, distance to fault, NDVI, and precipitation was used to prepare landslide susceptibility, analyzed by using weight of evidence method (Bonham-Carter, 1991; Westen et al., 2001) applied using ArcGIS software.

4.2 This method calculates the weight for each landslide predictive factors which only contain two classes, based on the presence or absence of the landslide.

4.3 New landslide susceptibility map was produced with a result of very high susceptibility zone make up 6.27% (2.02 km^2) of the total area and for very low landslide susceptibility zone is 19.95% (6.44 km^2).

4.4 Compared to eastern bank, western bank having worse erosion with 181514.53m^2 of erosion overall rate and 157160.93m^2 is for eastern erosion overall rate.

4.5 Lebir River's bank line drastically changes after flood event in 2014 causing massive damage to the good agriculture, forest and habitat area for both sides.

References

Akbari, A., Mat Yahaya, F. B., Azamirad, M., & Fanodi, M. (2014). Landslide Susceptibility Mapping Using Logistic Regression Analysis and GIS Tools. EJGE , 1687 - 1696.

Akgun, A., Dag, S., & Bulut, F. (2008). Landslide susceptibility mapping for a landslide-prone area (Findikli, NE of Tutkey) by likelihood-frequency ratio and weighted linear combination models. Environ Geol , 54:1127 - 1143.

Gorsevski, P. V., Gessler, P., & Foltz, R. B. (2000). Spatial Prediction of Landslide Hazard Using Discriminant Analysis and GIS. GIS in the Rockies 2000 Conference and Workshop, (pp. 25 - 27). Denver, Colorado.

Guzzetti, F., Mondini, A. C., Cardinali, M., Fiorucci, F., Santangelo, M., & Chang, K.-T. (2012). Landslide inventory maps: New tools for an old problem. Earth-Science Reviews, 112(1-2), 42–66. doi:10.1016/j.earscirev.2012.02.001

Lee, S., Hwang, J., & Park, I. (2012). Application of data-driven evidential belief functions to landslide susceptibility mapping in Jinbu, Korea. Catena , 15 - 30.

Mezughi, T. H., Akhir, j. M., Rafek, A. G., & Abdullah, I. (2011). Landslide Susceptibility Mapping Using the Statistical Index Method and Factor Effect Analysis along the E-W Highway (Gerik - Jeli), Malaysia. Australian Journal of Basic and Applied Sciences , 847-857.

Mohammady, M., Pourghasemi, H. R., & Pradhan, B. (2012). Landslide susceptibility mapping at Golestan Province, Iran: A comparison between frequency ratio, Dempster-Shafer, and weights-of-evidence models. Journal of Asian Earth Sciences , 221-236.

PRADHAN, B., OH, H.-J., & BUCHROITHNER, M. (2010). Weights-of-evidence model applied to landslide susceptibility mapping in a tropical hilly area. Geomatics, Natural Hazards and Risk , 199 - 223.

Villarraga, C., Ruiz, D., Vaunat, J., & Casini, F. (2014). Modelling landslides induced by rainfall: a coupled approach. Procedia Earth and Planetry Science , 222 - 228.

Shahabi, H., Khezzri, S., Ahmad, B. B., & Hashim, M. (2014). Landslide susceptibility mapping at central Zab basin, Iran: A comparison between analytical hierarchy process, frequency ratio and logistic regression models. Catena , 55 - 70.

Samah, F. A. (n.d.). PAPER 10 : LANDSLIDES IN THE HILLSIDE DEVELOPMENT IN THE HULU KLANG ,, 148–162.

Pimentel, D. (2006). Soil Erosion: A Food and Environmental Threat. *Environment, Development and Sustainability*, *8*(1), 119–137. doi:10.1007/s10668-005-1262-8

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Sphpritz, L., Fitton, L., Saffouri, R., Blair, R. 1995'Environmental and economic costs of soil erosion and conservation benefits'Science26711171123

Thakur, P. K., Laha, C., & Aggarwal, S. P. (2011). River bank erosion hazard study of river Ganga, upstream of Farakka barrage using remote sensing and GIS. *Natural Hazards*, *61*(3), 967–987. doi:10.1007/s11069-011-9944-z

Sarma, J. N., & Acharjee, S. (2012). A GIS based study on bank erosion by the river Brahmaputra around Kaziranga National Park, Assam, India. *Earth System Dynamics Discussions*, *3*(2), 1085–1106. doi:10.5194/esdd-3-1085-2012

Sarkar, A., Garg, R. D., & Sharma, N. (2012). RS-GIS Based Assessment of River Dynamics of Brahmaputra River in India, *2012*(February), 63–72.

12.2: INTEGRATED APPROACH AND SOLUTION FOR FLOOD FATALITIES IN KELANTAN: AN APPLICATION OF COST BASED EVALUATION

Project Information

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1.0 Introduction

According to the Institute for Risk and Disaster Reduction (IRDR, 2014), flood is the overflow of river or water flow past the river banks of the floodplain (river flood), water levels are higher than normal along the coast and in lakes or reservoirs (beach flood), as well as a water reservoir at or near the area where it rains (flash floods). Floods that hit those area was seen not only affect the economic aspect, but also affecting the social aspects of the affected communities where the period of recovery will take a long time. When household face an environmental degradation, in this case flood event they can attempt to avoid it by allocating certain amount of monetary value to mitigate the effect to prevent the welfare change from occurring. Preventive or defensive expenditure (DE) can provide a good approximation of the welfare effects of a change in environmental quality if the DE and the environmental quality are perfect substitute. In this study, the preventive or defensive expenditure was estimated by the residents' willingness to pay (WTP) for flood risk prevention program by using the contingent valuation method (CVM). We also used the Geographic Information Systems (GIS) to link the economic valuation with geographical case analysis. The process of mapping by using the location data (coordinates) and the WTP for each respondent, the distribution of the willingness to pay for the population in the study area according to their respective locations can be seen clearly. Location (coordinates) for each respondent was identified using the Global Positioning System (GPS) to obtain the exact coordinates.

The main objectives of this study is (1) to provide the profiling of the flood victims, (2) to analyse damage cost and lossess of flood event in Sungai Lebir, Kelantan, (3) to estimate the defensive expenditure (DE) of flood risk prevention program using WTP approach, (4) to identify the distribution of population's WTP according to the location of each respondent using GIS and finally (5) to identify the relationship between the total cost damage caused by flooding with socio-economic variables in Kuala Krai, Kelantan.

2.0 Methodology

A questionnaire was designed to elicit the information of the flood event on individual and families. The questionnaires focused on three important parts. The first part, questions related to various socio-demographic and economic characteristics of the respondent. The second part, included questions that concerned flood related losses. It comprised monetary estimates of damage sustained by the household, loss of livelihood, impacts on community life, identification of the resources used or required in the preparation, preferred warning system and recovery from the flood. The third part focuses on the determination of willingness to pay (WTP) for flood preventing programs.

A primary data collection was collected by simple random sampling survey involving a total of 686 respondents who are the permanent residents in the areas nearby Sungai Lebir. The data obtained from the survey were analyzed using Statistical Package for Social Science '22.0 (SPSS). In addition, the secondary data was obtained from public information sources such as newspapers, internet, official reports, and from previous studies.

2.1 Statistical Data Analysis Method

Preventive Expenditure (PE)

In this study, Contingent Valuation Method (CVM) is applied to determine the residents' willingness to pay (WTP) for flood risk prevention program in assessing the consumer WTP by using the bid game format.

The WTP of the population will be estimated with the proposed price, BID to see whether WTP is above or below the price BID. In this study, the consumer's WTP which assessed using CVM will be used as the dependent variable that can be demonstrated through model formulated by Cameron (1988) as follows:

$$WTP_i = \alpha_0 + \alpha_1 bid_i + \alpha_2 age_i + \alpha_3 household\_size_i + \alpha_4 household\_income + \varepsilon \quad (1)$$

$$WTP_i = \frac{\alpha_0 + \sum \alpha_i \chi_i}{-BID} \quad (2)$$

Where,

WTPi	= respondents' willingness to pay (dependent variable)
X	= independent variable (i.e., age, household size, household income)
α	= estimated parameter
i	= individual who responds in the survey
α 0	= constant
BID	= BID or proposed price to be pay by respondent
age	= age of respondents
household_size	= number of household (person)
household_income	= household monthly income (RM)

When respondents were asked about the amount to be paid by the residents for flood risk prevention program, there will be the probability of the answers given by respondents whether they says "yes" or "no" to the question. This situation can be seen through the model formulated by Hanemann et al., (1991);

Prob {Yes} = Prob {WTP_{max}> BID} = 1- G (PRICE; $\boldsymbol{\theta}$)
Prob {No} = Prob {WTP_{max}< BID} = G (PRICE; $\boldsymbol{\theta}$)

Where, BID is the price proposed, while WTPmax is a willingness to pay the maximum that will be paid by residents and G (PRICE) is the cumulative distribution function of the WTP. From the above equation, if the price proposed, BID is more than consumer's actual willingness to pay, then the probability of the population to pay for flood risk prevention program at the proposed price is "no", but when the affordability of real users more than the price proposed, BID then the probability for residents to pay for flood risk prevention program at the proposed price is "yes".

Ordinary Least Square (OLS) Method

The Ordinary Least Square (OLS) method is used for regression analysis to identifying the factors that influence the damage caused by flood which experienced by the population in the study area. The data used in this analysis is the cross-sectional data obtained from the survey. The model used in the OLS analysis are as follows;

$$dmgproperty = f(early\_warning, awareness, socio-economic, socio-demographic) \quad (3)$$

$$\begin{aligned} dmgproperty_i &= \beta_0 + \beta_1 early\_warning2_i + \beta_2 early\_warning5_i + \beta_3 dis\tan ce \\ &+ \beta_4 awareness_i + \beta_5 household_i + \beta_6 noedu_i + \beta_7 income_i \\ &+ \beta_8 money\_cont_i + \varepsilon_i \end{aligned} \quad (4)$$

Where,

dmgproperty	= total cost of property damages due to flood impact
early_warning2	= prevention (sms)
early_warning5	= prevention (water level markers)
distance	= logarithm of distance
awareness	= respondents' awareness towards the existance offlood insurance (dummy)
household	= number of household
noedu	= level of education (1: no education or informal education 0: others)
income	= household income (RM)
money_cont	= monetary contribution for any flood prevention program
Race	= race (dummy)
ε	= error term
i	= individual

3.0 Results and Discussion

Table 1: Demographic Profile of Respondents

Items	Number: Person	Number: Percent (%)	Items	Number: Person	Number: Percent (%)
Sex			**Education Level**		
Male	388	56.6	No Education	85	12.4
Female	298	43.4	Primary School	259	37.8
			Secondary School	315	45.9
Age			Diploma/ Higher Certificate	23	3.4
<25 y/o					
26 – 45 y/o	29	4.2	Degree (Bachelor)	2	0.3
	203	29.6	Degree (Master/PhD)	2	0.3
46 – 65 y/o	331	48.3			
66 – 85 y/o	117	17.0	**Household Size**		
85 y/o>	6	0.9	< 5 person	443	64.6
Job			6 – 10 person	230	33.5
			11 – 15 person	11	1.6
Civil Servant	42	6.1	16 person>	2	0.3
Private Worker	59	8.6	**Household Income**		
Businessman	83	12.1	< RM 500	173	25.2
Farmer	99	14.4	RM 501 – RM 1, 000	246	35.9
Laborer	139	20.3	RM 1, 001 – RM 2, 000	206	30.0
Other	264	38.5	RM 2, 001 – RM 6, 000	61	8.9

Based on Table 1, an average number of household consists of five family members and the distribution of the respondents according to gender shows that male represents for 56.6% (388) of all respondents. With regards to respondent age group, 4.2 percent were in the less than 25 age group, 29.6 percent were between 26-45 years old, 48.3 percent were in the 46-65 age group, and the remaining respondents were more than 66 years old age group. Most of the respondents are self-employed, which consists of 264 respondents (38.5%). Approximately, 20.3 percent of the respondents work as a laborer. Other respondents consists of farmer, businessman, private worker and civil servant who represents 14.4 percent, 12.1 percent, 8.6 percent and 6.1 percent of the sample population, respectively. The education level of the respondents was generally low. About 12.4 percent have no education, 37.8 percent have completed primary school and 45.9 percent of the respondents have secondary education. The distribution of household income was as follows: 25.2 percent with less than RM500, 35.9 percent with RM501 – RM1, 000, 30.0 percent with RM1, 001 – RM2, 000, and 8.9 percent with RM2, 001 – RM 6, 000.

Table 2: Determinants of WTP for Flood Risk Prevention with Multivariate Regression

Variables	**Value of Estimated Parameter (α)**	**Significant Value**	**Standard Error**
Proposed Price	-0.049	(0.000)***	0.007
Age	-0.020	(0.001)***	0.006
Household Size	-0.096	(0.017)**	0.040
Household Income	0.001	(0.000)***	0.000
Constant	1.507	(0.001)***	0.455

Note: value of (***), (**) and (*) shows the confident level of 1, 5, and 10 percent.

Table 2 presents the output regression analysis showing the factor affected respondents' WTP. These factors are age of respondents, household size and household income where the estimated parameters (α) will be substituted into the equation (1) formulated by Cameron (1988) to evaluate WTP for each respondent. The minimum, maximum and average WTP can be identified as shown in Table 3.

Table 3: Willingness to Pay

	MINIMUM (RM)	MAXIMUM (RM)	MEAN (RM)
Willingness to Pay	1.78	122.66	23.60

Table 4: Factors Affect the Amount of Destruction Experienced by the Population Due to Floods

Variable	Coefficient	Std. Error	t-Statistic	Prob.
early_warning2	-5635.411*	3072.793	-1.834	0.067
early_warning5	-7292.858**	3229.691	-2.258	0.024
Distance	2555.821***	832.078	3.072	0.002
Awareness	-11436.18**	4812.663	-2.376	0.018
Household	836.147*	433.453	1.929	0.054
Noedu	6713.220**	3264.443	2.056	0.040
Income	-2.189*	1.322	-1.656	0.098
money_cont	38.997	40.139	0.972	0.332
Cons	34085.11***	5229.217	6.518	0.000
R-squared			0.032	
Adj R-squared			0.019	
# of obs			686	

*Note: dependent variable is total cost of property damage. ***, **, * indicates that significant at 1%, 5% and 10% respectively. The t-value are reported based on White (1980) heteroskedasticity-consistent covariance matrix. Other explanatory variables not reported here is (race).*

Based on results in Table 4, the early warning system such as the use of sms and water level markers has a negative correlation to total destruction. For most of respondent whom residential area in the range of 1 km from the river, they found that the use of the short messaging system (sms) is easy to access and to deliver the information immediately while the water level markers is easier to see and the locals will be more prepared and total destruction losses can be reduced. The nearer the residential location area to the river basin will increase the amount of destruction and damage up to RM2600 per household.

By having a group insurance scheme for disasters, with a minimum payment rate, the impact of the destruction and losses incurred by population can be minimized. Household size (household) shown to have a positive and significant correlation with the amount of destruction caused by the floods in 10 percent significance level. In Table 4 also shows *noedu* to have a positive relationship to the amount of destruction caused by the flood. Number of respondent without non-formal education and dropped out of school has proven that every person that has a low level of education will increase the total destruction since this group were less sensitive and less alert of the situation around them and also less prepared when floods occur.

Finally, the income and the total damage have inversed relationship. This shows that any increase in income at RM10 among residents in the disaster area, it will reduce the amount of RM22 destruction and damage. Although the residents' income in the flood prone area is increased but the increases is still small and cannot accommodate a destruction gap in the affected area.

4.0 Conclusion

The following are the summaries of the project:

4.1 The mean value of WTP for flood prevention program is RM23.60

4.2 The early warning system (sms and water level marker) is found to be significant with total destruction reduction for floods. In the future, with more and new R&D activity, we can improve the available technology for networking, communication services, especially during the bad and extreme weather conditions.

4.3 The location or distance of residents from the river is also found to be highly significant with the total destruction. In the future, the local government should have initiative to have new rules and regulations in controlling the new housing project in more safe area and relocating the existed houses to a safer area.

4.4 Insurance scheme especially for disaster is also found to be significant in reducing the total cost of property damage.

References

Auffret, P. (2003). High consumption volatility: The impact of natural disasters? *World Bank Policy Research Working Paper* 2962, January 2003.

Barbier, E.B., Acreman, M., and Knowler, D. (2007). *Economic valuation of wetlands: a guide for policy makers and planners,* http://liveassets.iucn.getunik.net/downloads/03e_economic_valuation__of_wetlands.pdf

Chan, N. W. (2012). Impacts of Disasters and Disasters Risk Management in Malaysia: The Case of Floods.

Cuaresma, J.C., Hlouskova, J. and Obersteiner, M. (2008).Natural disaster as creative destruction?Evidence from developing countries. *Economic Inquiry,* 46(2), 214-226.

Hanemann, W.M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses.*American Journal of Agricultural Economics.* 66: 332-34.

Jamal, O., and Khalid, A.R. (2002).*Environmental Economics.* Malaysia: The Malaysian University Consortium for Environment and Development (MUCED).

Larson, D M., Lew, D.K., and Onozaka, Y. (2001).*The public's willingness to pay for improving California's water quality.* Paper presented at Annual Meeting of Western Regional Project W-133. Miami: Florida.

Noy, I. (2008).The macroeconomic consequences of disasters.*Journal of Development Economics,* 88(2), 221- 231.

Pamela Kaval, J. L. (2004). Using GIS to Test the Relationship Between Homeowner Willingness to Pay to Reduce Wildfire and Landscape Characteristics.

Raschky, P A. and Schwindt, M. (2009).Aids, Natural Disasters and the Samaritan's Dilemma.*Policy Research Working Paper 4952.*

Schumacher, I. and Strobl, E. (2008) Economic Development and Losses due to Natural Disasters: The Role of Risk. Availableat: http://hal.archives-ouvertes.fr/docs/00/35/62/86/PDF/ cahier_de_recherche_2008- 32.pdf

Skidmore, M and Toya, H. (2007).Economic development and the impact of natural disasters. *Economics Letters,* 94, 20-25.

themalaysianinsider.com. (2014). *Mangsa banjir beberapa negeri naik pagi ini, jumlah keseluruhan 230,509.*

Tietenberg, T. (2000).*Environmental and natural resource economics* (5th Edition). United States of America: Addison Wesley Longman, Inc.

White, H., (1980). A Heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica 48* , 817-838.

12.3: FLOOD MODELLING OF LEBIR AND GALAS RIVER BASINS (SUB-BASINS OF KELANTAN RIVER)

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1.0 Introduction

This project examined the cause and effect relation for the December 2014 floods through rainfall-runoff parameters analysis. Continuous high rainfalls, geological setting and topography were the main factors studied. They triggered the basin wide extreme event which occurred twice in 88 years of flood records (1926-2014). Their spatial relation was examined via a flood map generated using water surface gradient interpolation along the river system. The flood map was overlaid on a background map composed of a mosaic of fine scale Google Earth images. Apart from establishing spatial relation of physical factors, the map was able to show human landscape affected by floods. The sizes of flooded areas were also calculated based this map.

2.0 Methodology

Factors such as extreme rainfalls, geologic control, land cover, boundary conditions, climate variability and change were examined. Stage hydrographs for 2004 and 2014 were analysed for peak stage, time to peak, flood stage travel time and attenuation sequence. Flood frequency analysis was conducted based on flood data from 1926-2014. The EV1 or GEV method was used to study flood return periods.

Peak stages from existing telemetric stations were interpolated based on water surface gradient concept in order to produce a flood map. The flood map was laid upon high resolution RGB satellite images obtained from Google Earth in order to show the human landscape affected by floods.

3.0 Results and Discussion

The December 2014 Kelantan floods occurred in two sequential waves. The first wave occurred from 18 to 19 December. It was a small event with flood levels not exceeding 2 m. The affected areas were limited to parts of Tualang, Kuala Krai, Kusial and Kota Bahru. The second wave was a very large event that occurred from 22 to 31 December. The flooded areas were extensive covering upper-central basin, lower and coastal plains, more than 220 km^2 in total area. Maximum flood depths ranges from 1.5 m to a striking 9.2 m. The worst hit area was the upper to central basin region, i.e. Kuala Balah, Gua Musang, Dabong, Manik Urai, Tualang and Kuala Krai.

Heavy orographic rainfall concentrated on the upstreams of Kelantan Basin from 14 December to 28 December. The resulting flood recurrence interval do not follow rainfall ARI because floods are not caused by rainfall alone but a combination of factors. The flood recurrence intervals range from 1/35 to 1/45 years. In the 88 years of stage records for various stations, extreme flood events (top 5%) accounted for 3 to 4.5% of flood events. Kuala Krai has the highest flood frequency, i.e. 1.4 event/year. This could be attributed to the location of Kuala Krai. It is the confluence of Lebir and Galas sub-basin (85.7% of the whole Kelantan River basin) and being located on the central part of the basin it has a narrow undulating valley on the eastern side and a steeper western flank.

The peak stage rise rate of the 2014 event is compared to a smaller recent event of 2004. The rise rates are not extreme, i.e. ranged between 0.03 to 0.23 m/hr and do not differ significantly between both events. The time to peak is generally the same for both events except for Tualang and Kuala Krai that had longer time to peak for 2014. The analysis suggests surface conditions like storage (surface and sub-surface) and topography exercise control over discharge characteristics.

The highlands are set up almost parallel to each other in a north-south orientation with the Titiwangsa range on the western flank. This setting creates elongated river systems with long trunk rivers and shorter tributaries. The steep slopes and short tributaries ensure quick outflows from sub-catchments into the trunk river system, i.e. Pergau, Nenggiri, Galas, Lebir and Kelantan. Hence, the trunk rivers could be overloaded quickly, overflow and cause flooding. Furthermore, the river valleys are narrow being flanked by steep hill slopes causing greater vertical diffusion of flood waters resulting in severe floods. This phenomenon becomes even worst in river confluences where flood flows combined. The worst affected areas in the 2014 events, e.g. Dabong and Kuala Krai, are situated on such setting. As a result of smaller lateral diffusion in central-upper basin valleys, the flood peak was not attenuated effectively until it went into the lower basin region, i.e. Kusial to Kota Bahru. The almost flat coastal plain ensured effective lateral diffusion and flood peak attenuation. The trunk rivers themselves have steep upstream gradient. The steeper bed gradient of the trunk rivers on the upper basin generate higher flow velocities hence larger flow rates with shorter conveyance time into the central basin.

The general flood map for the upper to central basin section is shown in Figure 1. The water surface elevation interpolation technique yielded acceptable results for areas with greater vertical diffusion. For coastal plains, the results were not satisfactory. The flood map indicated that the central-upper basin area being the most affected region. The general flood map is a GIS based map that could be zoomed in to see details (Fig. 2). It could be overlaid on satellite images extracted from Google Earth and other data sets such as topography and geology for the purpose of studying the relation between the spatial distribution of flood with physical factors as well as its impact on human landscape.

The detailed flood contour map as shown in Figure 3 is an example on how the map could aid in examining the flood impact by simply overlaying the flood map on a high resolution satellite image. It could be easily identified and computed that Kuala Krai town was almost completely inundated (about 80%) with flood depths between 5 to 10 m. By simply relating key infrastructures with the flood map, the effect of flood on the human landscape could be examined. In the case of Kuala Krai, Its function as a socio-economic, transportation and public services hub was completely crippled as key infrastructures as indicated in the map were either severely flooded or became inaccessible as the surrounding areas were flooded, e.g. Kuala Krai Hospital and the Fire and Rescue Department.

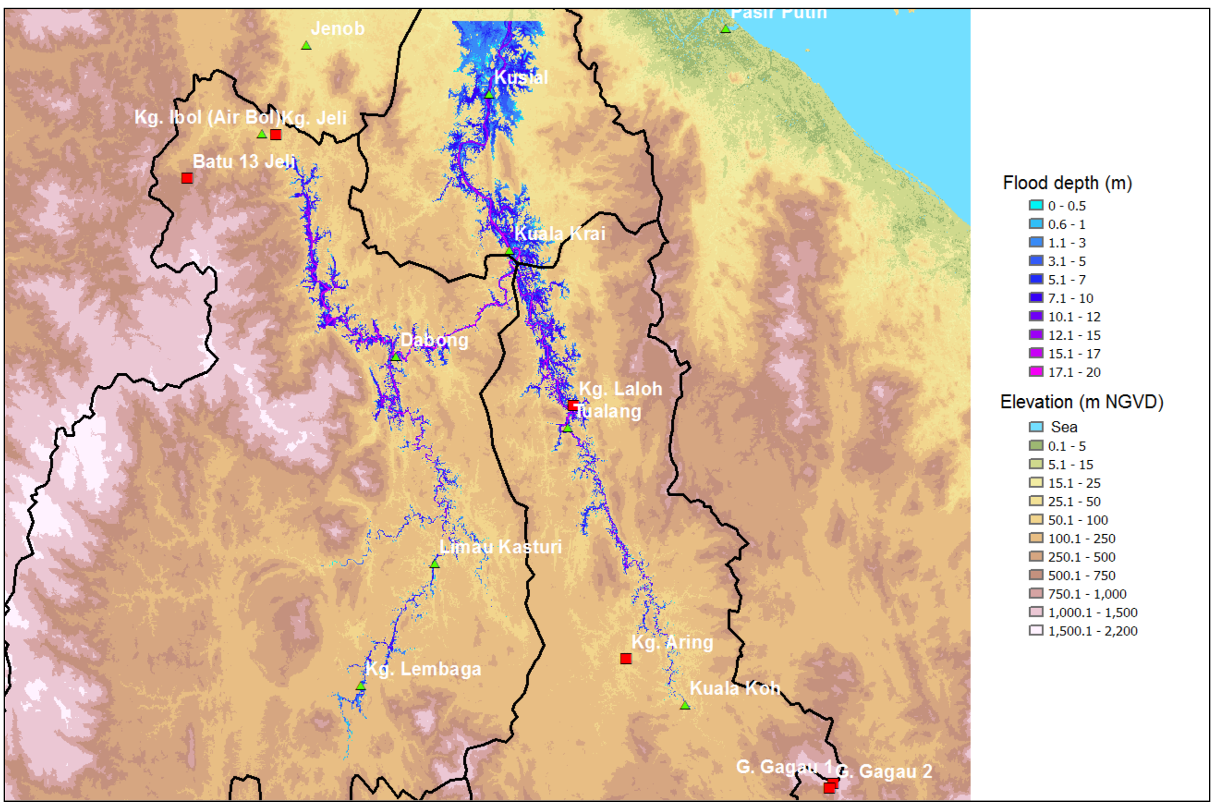

Fig. 1: Flood map of upper and central Kelantan River basin

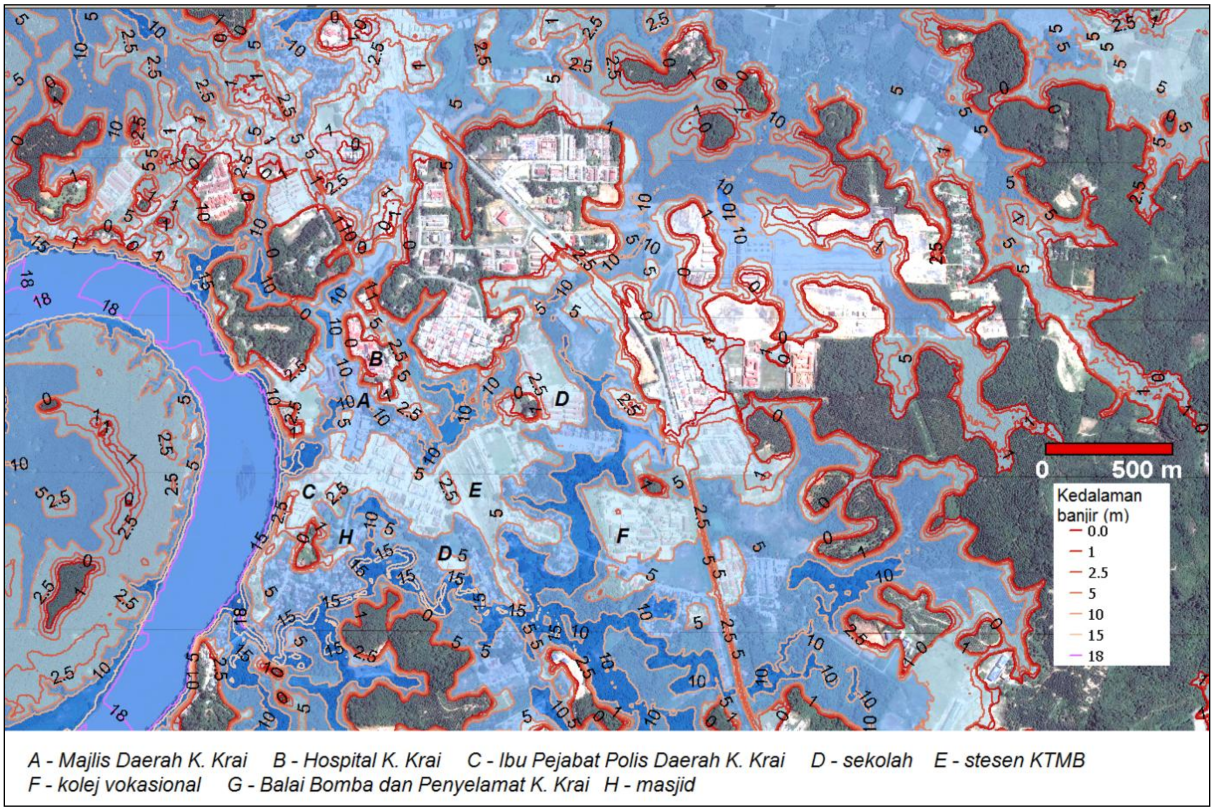

Fig. 2: Flood contour of Kuala Krai town

4.0 Conclusion

4.1 Prolonged heavy daily rainfalls on the upstream catchments of Lebir and Galas Rivers overcame the ability of storage systems to cope with the exceptional rainfall event.

4.2 Lebir and Galas sub-basins are located on highlands with steep gradient and bed slope, hence large outflows were generated during the exceptional heavy rainfall episode.

4.3 Narrow river valleys limited the storage areas for lateral diffusion of flood water compared to the wide coastal flood plain resulting in exceptionally high flood stages.

4.4 Flood recurrence interval analysis implied that the 2014 event although severe, it may not be considered as extreme beyond current records, hence not an exceptional event.

4.5 Comparative stage hydrograph analysis indicated that although the event was severe, it may not have exceeded the feedback mechanisms of the hydrologic system, hence in a physical-natural sense may not indicate a new system equilibrium.

4.6 Spatial relation between the flood event and physical factors was possible to be examined by using a flood map. A detailed flood map was produced using a simple GIS based method. These maps also could point out the effected human landscape and not just the physical areas.

References

Abdullah, K. (1999). “Integrated river basin management.” In: Chan, N.W. (ed) Rivers: Towards Sustainable Development, Proc. National Conference on Rivers '99, Penang, Malaysia, 14-17 October 1999, Penang, Universiti Sains Malaysia, 3-14.

Chan, N.W. (1997). “Increasing flood risk in Malaysia: Causes and solutions.” Disaster Prevention and Management: An International Journal, 6(2), 72 -85.

DID (1995). Current flood report: Pulau Pinang, Kedah and Perak. Hydrology Division of DID, Kuala Lumpur.

Drainage and Irrigation Department (2016, January 1). On-line hydrological data. Retrieved from http://infobanjir.water.gov.my/real_time.cfm

Google Earth V7.1.2.2041 (2016, January 1). Kelantan, Peninsular Malaysia, SIO, NOAA, U.S. Navy, NGA, GEBCO, Digital Globe 2015. Retrieved from http://www.earth.google.com

Lim, J. T. (1980). Effects of tropical cyclones on Malaysian weather. Malaysian Meteorological Service, Petaling Jaya.

Low, K.S. and Leigh, C.H. (1973). “An appraisal of the flood situation in West Malaysia.” In: Soepadmo, E. and Singh, K.G. (eds) Proc. Symposium on Biological Resources and National Development, Kuala Lumpur, Malaysia, 5-7 May 1972, Kuala Lumpur, Malayan Nature Society, 57-69.

Maene, L.M., Wan Harun, W.S., Abd. Manan, M.M., Maesschalck, G.G. and Lim, K.H. (1983). Register of soil physical properties of Malaysians soils. Universiti Pertanian Malaysia, Serdang.

Ooi, S.H. (1999a). Extreme weather in Malaysia. Malaysian Meteorological Service, Petaling Jaya.

Ooi, S.H. (1999b). Impacts of ENSO on monsoons over Malaysia. Malaysian Meteorological Service, Petaling Jaya.

Sooryanarayana, V. (1995). “Floods in Malaysia: Patterns and implications.” Malaysian Journal of Tropical Geography, 26(1), 35-46.

Sathiamurthy, E. (2013). Potential effect of sea level rise on Rambai River, Malaysia, WASJ, 22(3), 359-367

Sathiamurthy, E, Goh, K.C. and Chan, N.W., (2007), Loss of storage areas due to future urbanization at upper Rambai River and its hydrological impact on Rambai Valley, Penang, Peninsular Malaysia, Journal of Physical Science, Vol 18(2) : 59-79

Sathiamurthy, E. (2005), The hydrological impact of future urbanization in the Rambai River valley, Penang Malaysia, Journal of Physical Science, Vol 16(2) : 87-102

Town and Country Planning Department (2011). Rancangan Tempatan Jajahan Kuala Krai 2020 (Local Plan of Jajahan Kuala Krai), JPBD, Kota Bharu.

USGS (2004), Shuttle Radar Topography Mission, 1 Arc Second scene SRTM, USGS, Reston

12.4: DETERMINATION OF SEDIMENT TRANSPORT AND DEPOSITION PROCESS AND MECHANISM IN SUNGAI LEBIR BASIN DURING EXTREME FLOOD EVENTS

Project Information

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1.0 Introduction

Lebir River Basin situated in Kelantan had faced extreme flood event in December 2014. The situation has led to the introduction of changes and movement of sediment along Lebir River. This study was done to determine the composition of the sediment and changes as a result of this flooding. Five locations have been identified to be used as the sampling location. Simulation using HEC RAS software has been created to analyze the riverbed in Lebir River. Results of the study shows, the size of the sediment in Lebir River is between 0.75mm to 5.0mm and an average velocity is 0.224m/s up to 0.599m/s. Sediment-transport equations are used to compare sediment loads and energy. Predictions of channel changes are based on rates of erosion or deposition when future changes in the flow regime are expected. Transport equations used in HEC–RAS for this study include Ackers and White (1973), Meyer-Peter Muller (1948) and Yang (1973).

Objectives:

(1) To determine the cause and effect of high sediment load in Sungai Lebir during extreme flood.
(2) To identify the sediment distribution along the river of Lebir,

The aim is to study the cause and effects of the sedimentation transport and affected areas by erosion and also deposition. Data will be cooperated in multilayer flood risk map. Therefore, the findings of this study will also be used as a new approach for a prediction of the flood in the future.

2.0 Methodology

The research is divided into three phases as shown in Figure 1:

Phase 1: Field work data collection
Phase 2: Analysis data and images processing
Phase 3: Application of hydrological and sediment transport models

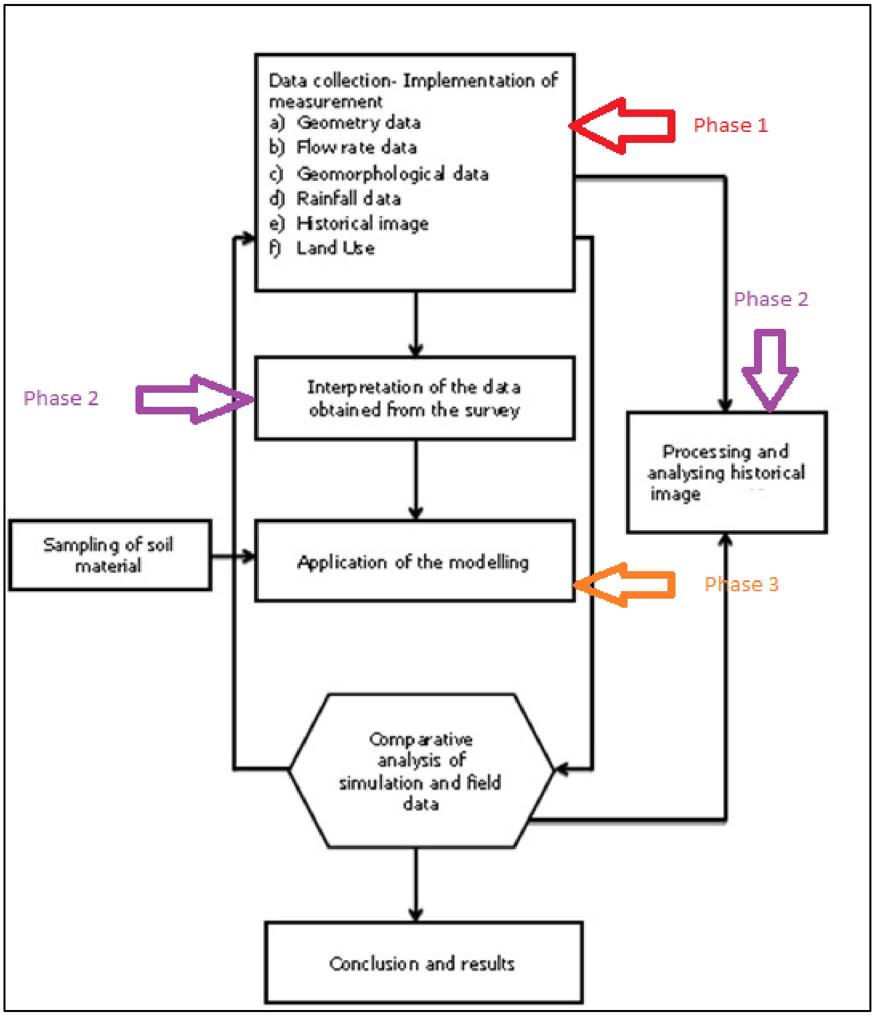

Figure 1: Phases of this research

3.0 Results and Discussion

3.1 Analysis of rainfall

The daily rainfall data for selected hydrological stations was obtained from the Department of Irrigation and Drainage from year 2008 to 2014. The data obtained is summarised in total monthly rainfall data as shown in Figure 2. In year 2014, Station in Kg. Lepan Labu (5422046) and also in Kg. Lebir Paloh (4922001) having the most number of rainfalls on December with the highest rainfall more than 400mm.

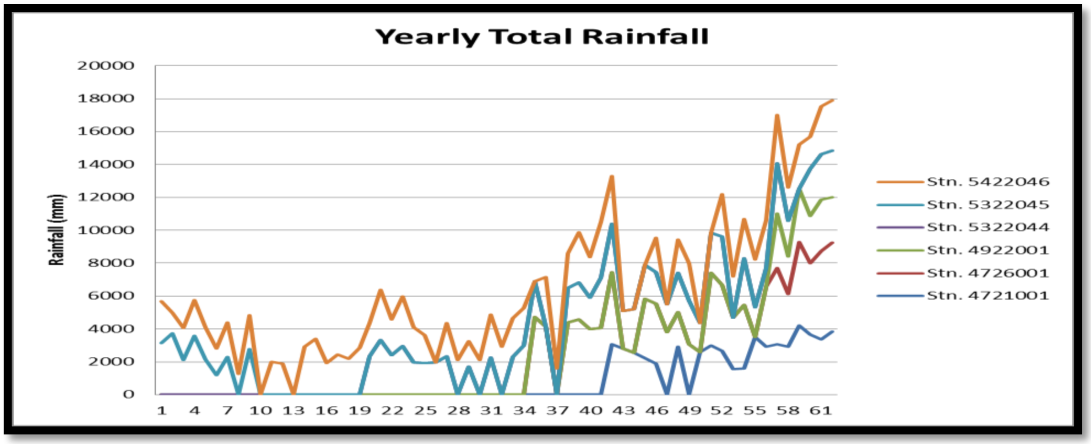

Figure 2

3.2 Erosion/deposition results

Based from the simulation result for 50 years return period, there are some changes of river bed in cross section 18000 m and 19000m when using Ackers White, Meyer Peter and Muller and also Yang Method. Figure 3-5 shows the changes or river bed at cross section 180000m and 190000m. Based from those three methods, it shows that the river bed was decrease after using the simulation for 50 years analysis on cross section 190000m. But at 180000m, there is some increasing of river bed because of the sedimentation and deposition process at that point.

These changes happen because of the heavy rainfall received during that time. The highest amount of flow will also contribute the sedimentation and erosion process along Lebir River. Figure 6 and 7 show the erosion and deposition take place along the river

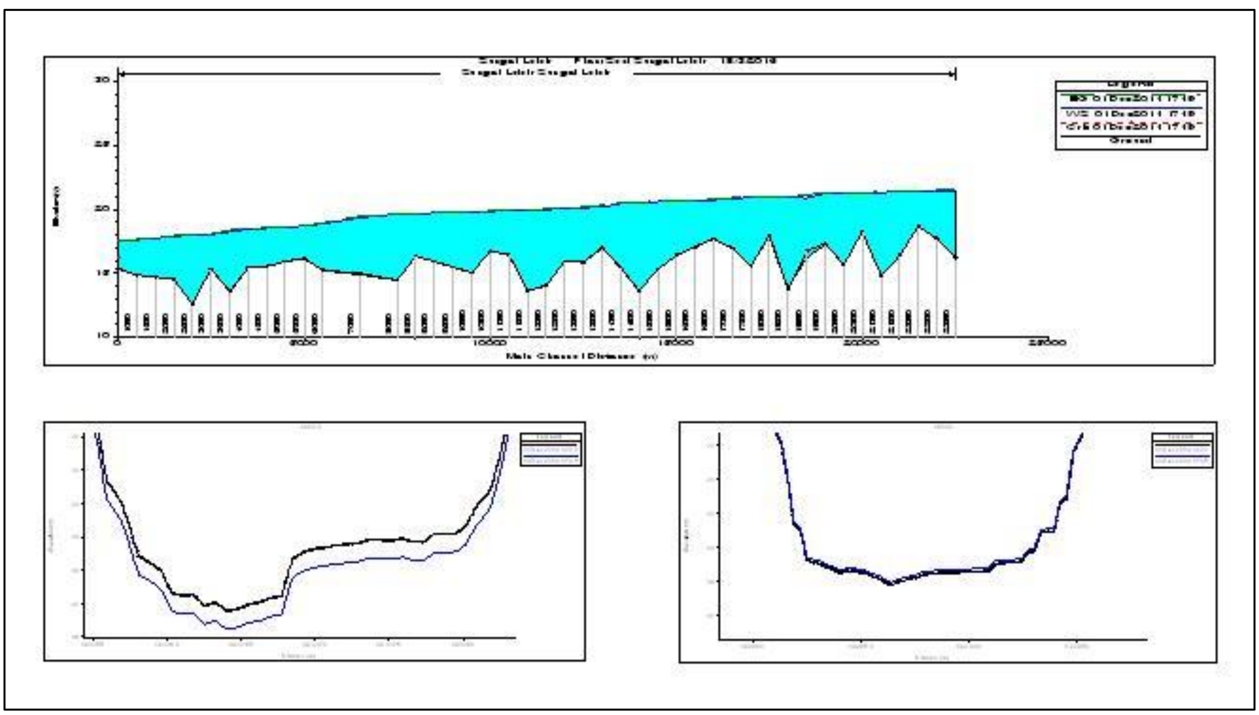

Figure 3. Water surface profile of sediment transport using the method of Ackers White for 50 years analysis

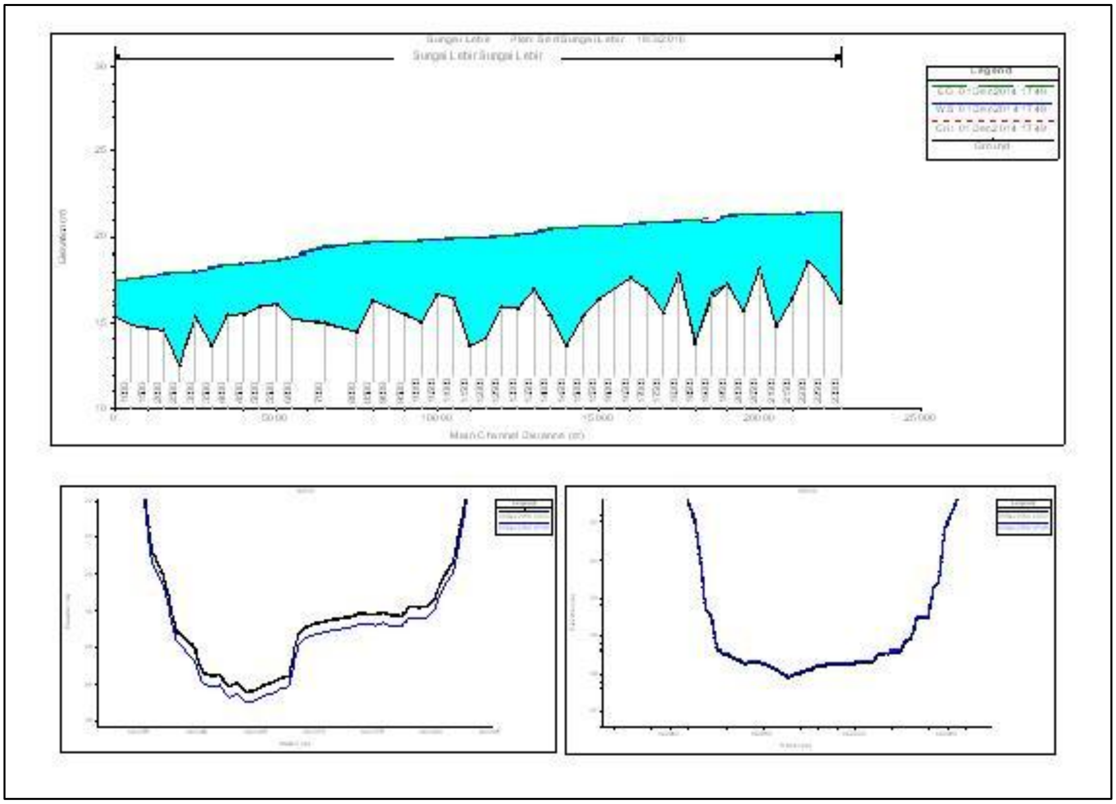

Figure 4. Water surface profile of sediment transport using the method of Meyer Peter and Muller for 50 years analysis

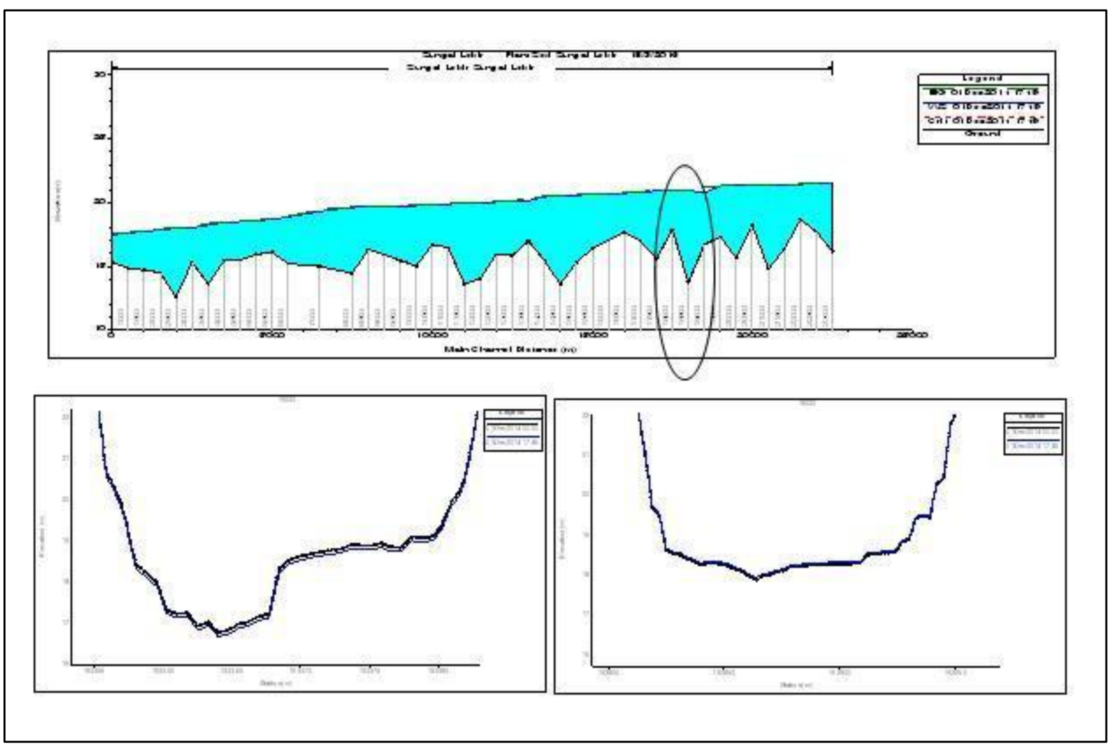

Figure 5. Water surface profile of sediment transport using the method of Yang method for for 50 years analysis

Figure 6 Erosion and deposition in Manik Urai
Figure 7 Erosion at PAHI

4.0 Conclusion

4.1 The data shows that within 7 years (2008-2014), the highest rainfall intensity is occurred in 2014. An excessively amount of water received by the Lebir basin leads to the most ever disastrous experienced as compared as the years before.

4.2 The river water flow and affected low level flooding area as well as high level ground level are transported the sediment through the river system and adjacent area of the river. In some places where the water flow is incapable to move the sediment, deposited of sand and mud are founded.

4.3 The results show the deposition and erosion of sediment are occurred along the river system by the water flow due to 50 years return period of rainfall.

4.4 The developed computation model for Lebir River system could be used for predicting the consequences of extreme flood event for future.

References

Alison, J. (1995). Humid Tropical Environmental. USA: Blackwell Publishers Ltd. Cambridge Massachusetts USA.

Hoong., C. C. 2007. Developement of Forecasting Model For Sungai Kelantan.

Udden, J. A. (1898). The mechanical Composition of Wind Deposit. Augustana Library Publications 1: Lutheran Augustana Book Concern, Rock Island, Illinois.

U.S.Army Corps of Engineers (USACE). 2001. HEC HMS Manual Application Guide - Hydraulic Engineering Centre Hydrologic Manual System. 70 – 78.