LAPORAN AKHIR

KAJIAN BENCANA BANJIR 2014

SOARING UPWARDS
MALAYSIAN HIGHER EDUCATION

KEMENTERIAN PENDIDIKAN TINGGI

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Institute of Environmental and Water Resource Management (IPASA)

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BAHAGIAN 3: MODELLING & EARLY WARNING SYSTEM (MEWS)

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MODELLING & EARLY WARNING SYSTEM (MEWS)

EMERGENCY RESPONSE ANALYSIS FOR HUMANITARIAN LOGISTICS

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1.0 Introduction

Weather-related disasters are becoming increasingly frequent, due largely to a sustained rise in the number of flood and storms. Flooding alone accounted for 47% of all weather related disasters from the year 1995 to the year 2015, affecting 2.3 billion people, with majority of 95% who live in Asia. In Malaysia, there are four main types of disasters, which are landslide, hurricane/strong winds, flood and flash flood. Among the four disasters, flood has the highest occurrence from the year 2010 to the year 2015. In the state of Kelantan on the east coast of Peninsular Malaysia, flood is an annual occurrence of varying severities. Malaysia's National Security Council (NSC) confirmed that the flood in 2014 was the worst recorded in the history of the state. It was described as a 'tsunami-like disaster'. Due to the annual occurrence of the flood and its disastrous damage in Kelantan, our scope of this paper is on Kelantan flood in 2014. We chose Kuala Krai as our case study due to its high population density and it was hit by the flood twice. Our focus is on managing disaster from the aspect of food delivery as flood directly affects the food supply by destroying its storage and infrastructure.

2.0 Methodology

This research uses the systems dynamics methodology. We collected data through several state government agencies in Kelantan because most of the data access applications are not available through online and each state government agency is responsible for different kinds of emergency responses. Malaysian National Security Council (MKN) is the leader for the series of emergency responses. Social Welfare Department (JKM) is responsible for the placement of evacuation centres, the registration of evacuees in each evacuation centre and distribution of food. Federal Development Department of Kelantan (JPP) is responsible for the road infrastructure quality including the bridges. Economic Planning Unit (UPEN) is responsible for disaster relief efforts such as economy recovery and repair of road infrastructure. Health campus of Universiti Sains Malaysia Kubang Kerian (USMKK) is one of the evacuation centres and the only functional hospital during the Kelantan flood in 2014. Therefore, we approached two departments of USMKK which are Pertubuhan Gabungan Bantuan Bencana NGO Malaysia (BBNGO) and Hal Ehwal Pelajar & Alumni (HEPA) for the collection of data. In addition, we approached some non-governmental organization (NGO) such as Malaysian Red Crescent Society (MRCS) as they provided assistance in distributing food to victims. In order to simulate the model, we construct the stock and flow diagram as follows:

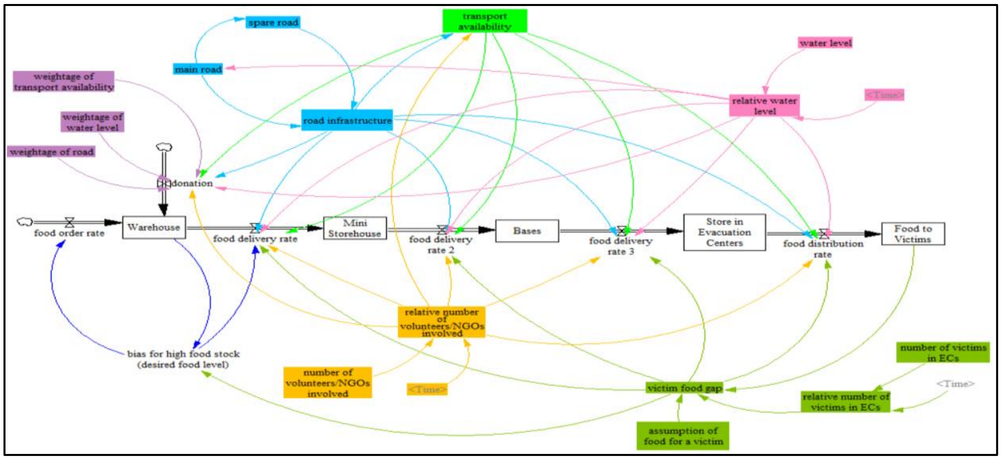

Figure 1 Stock and Flow Diagram of the Food Delivery System

3.0 Results and Discussion

After simulation of model, we tabulate the values and compare the graph of the stock variables, which are Warehouse, Mini Storehouse, Bases, Stores in Evacuation Centers and Food to Victims as Figure 2.

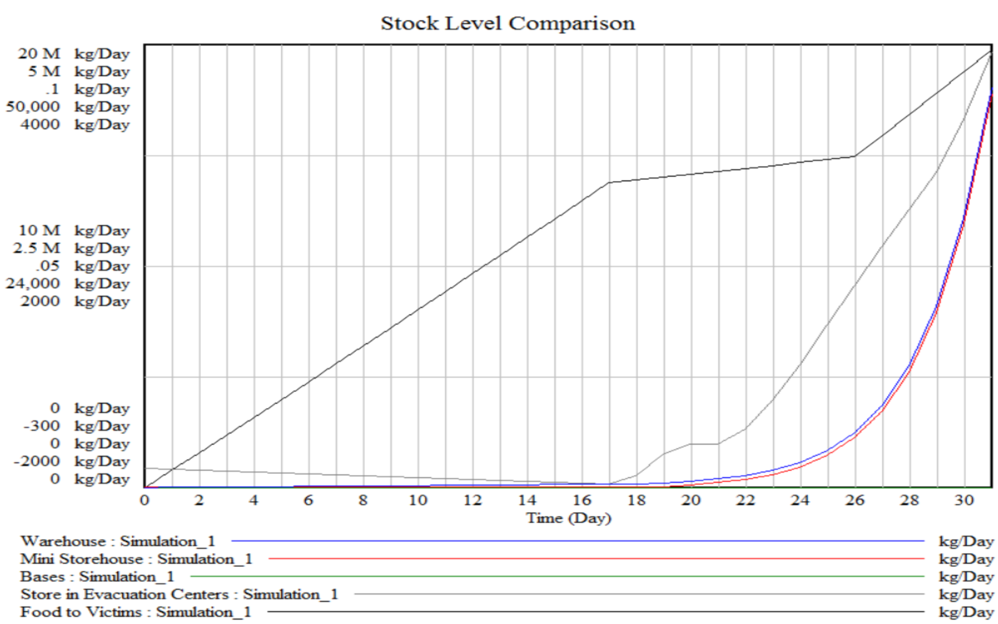

Figure 2 Stock Level Comparisons

For the food delivery rate and food distribution rate, we tabulate the values and plot the graphs for comparison purposes as in Table 2.

Table 2 Level of Each Delivery/Distribution Rate

Time (Day)	Food Delivery Rate	Food Delivery Rate 2	Food Delivery Rate 3	Food Distribution Rate
0	46.3554	46.3554	46.3554	154.518
1	53.7921	53.8671	53.8671	156.018
2	54.24	54.39	54.39	157.518
3	54.6879	54.9129	54.9129	159.018
4	55.1358	55.4358	55.4358	160.518
5	55.2117	55.5367	55.5367	161.018
6	55.2876	55.6376	55.6376	161.518

7	55.3635	55.7385	55.7385	162.018
8	55.4614	55.8614	55.8614	162.518
9	55.5593	55.9843	55.9843	163.018
10	55.6572	56.1072	56.1072	163.518
11	55.7632	56.2382	56.2382	164.018
12	55.8692	56.3692	56.3692	164.518
13	55.8502	56.3502	56.3502	164.518
14	56.2311	56.7311	56.7311	164.518
15	56.612	57.112	57.112	164.518
16	56.9929	57.4929	57.4929	164.518
17	729.249	1041.27	1041.27	25.8814
18	10883.3	2525.94	2525.94	26.1414
19	19288.9	1211.5	1211.5	26.4014
20	30328.1	50.4301	50.4301	26.6614
21	31560.8	1693.97	1693.97	26.8564
22	57456.3	3491.13	3491.13	27.0514
23	90188.5	4103.71	4103.71	27.2464
24	136472	4716.22	4716.22	27.4414
25	203572	4706.24	4706.24	27.8964
26	302948	4704.83	4704.83	185.518
27	450662	4627.61	4627.61	189.018
28	670943	4548.99	4548.99	192.518
29	1.00067e+006	6385.07	6385.07	195.518
30	1.49127e+006	8219.95	8219.95	198.518
31	2.22155e+006	10053.9	10053.9	202.518

4.0 Conclusion

4.1 Capacity of evacuation centers do not match the population of victims.
4.2 Food distribution and aid comes in spikes. It is either too much or too little throughout the affected period.
4.3 Standard operating procedures of emergency response assumes that the road infrastructure is still in working condition.
4.4 Centralized kitchen concept was not realized earlier.
4.5 Lack of coordination due to inability to forecast between Water Level → Road Conditions → Food Distribution Rate.

CONTROL OF TURBIDITY CURRENTS TO REDUCE RESERVOIR SEDIMENTATION USING OBSTACLES

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1.0 Introduction

Density currents are generated when fluid of one density is released into fluid of a different density (Marino et al., 2005). The density difference can be resulted from temperature gradients, dissolved contents, suspended particles or a combination of them. The currents are known as turbidity currents in case the main driving mechanism is obtained from suspended sediments (Simpson, 1999).

Sediment discharge of rivers flowing into reservoirs is typically very high during flood events. As the turbid flood flows to fresh water of the reservoir, the turbid inflow displaces the ambient water until it reaches a balance of forces and plunges under the water surface (Oehy and Schleiss, 2007), as seen in Figure 1. As the sediments accumulate, reservoir loses its storage volume which leads to elimination of flood and energy regulation capacity. Sediments can also damage dam power plants and block bottom outlets, thereby decreasing efficiency and increasing maintenance costs (Cesare et al., 2001).

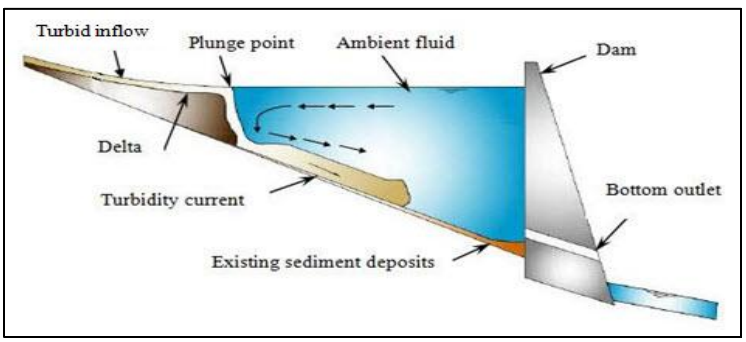

Figure 1:. Turbid inflow entering a reservoir

The leading edge of density currents is called head (also known as front) which is deeper than the following flow (i.e. body) and has a raised nose at its foremost point. The schematic of a density current propagating over a sloping bed and under a layer of stationary ambient fluid having a density (ρ_a) less than that of the density current (ρ_d) illustrated in Figure 2. The highest point of the front is known as its height (H_f) travelling with the velocity of U_f. For the body, the height and velocity are shown with h and u, respectively.

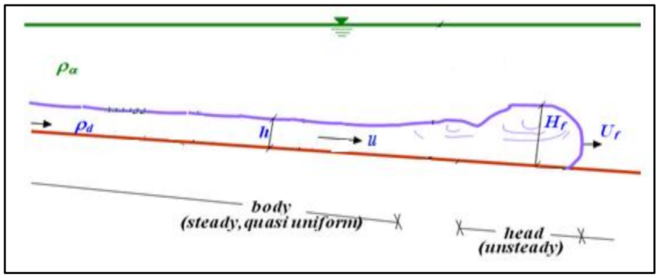

Figure 2:. Sketch of a density current advancing over a slope

The loss of storage capacity in dam reservoirs due to sedimentation caused by turbidity currents has been an issue of great concern and a topic of research (Fan and Morris, 1992;Kostic and Parker, 2003;Khavasi et al., 2012). Nevertheless, there has not been a substantial amount of work in the area of controlling these currents with arrays of obstacles, in particular, regarding the continuous part (i.e. body) of density currents. This research aims to develop a comparison between density currents dynamics over smooth bed and surfaces covered with arrays of obstacles. Also, the influence of different configurations of obstacles on the velocity structure of density current is investigated herein.

2.0 Methodology

To model density currents in the laboratory, a specific setting is required that could prepare dense fluids and maintain the steady state of density currents during the course of experiments. An appropriate experimental apparatus was prepared consisting of five main parts: water supply system, mixing tanks, head tank, flume and drainage system as seen in Figure 3.

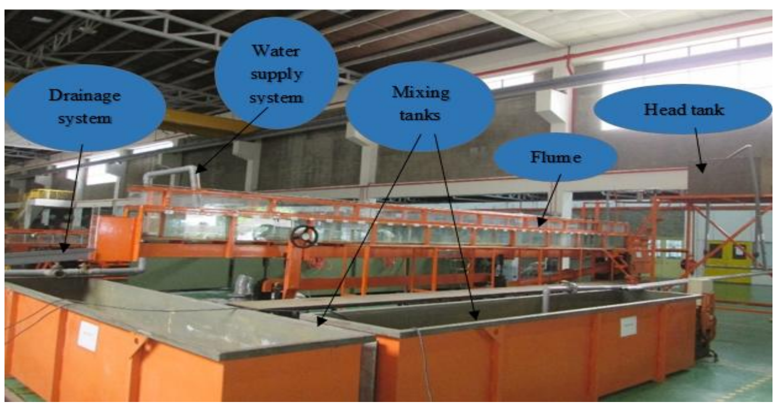

Figure 3:. Experimental set up

The flume was 10 m long, 0.3 m wide and 0.7 m deep. A sliding vertical gate divided the flume to two sections of unequal length. Upstream of the gate was filled with dense fluid and the long downstream section simulates a reservoir (see Figure 4) where a density current was propagating. Salt was dissolved in tap water inside the tanks until the required density was obtained and the solution was homogeneously mixed.

The dense flow discharge could be adjusted by the means of a valve and using an electromagnetic flow meter prior entering the flume. The experiments started with the sudden removal of the gate. The gate was opened 7 cm in all experiments. Experiments were performed with two discharges (Q= 0.5 and 1 L/s), having different bottom slopes (S=0.25%, 1% and 1.75%) and initial concentrations (C_{in}=5, 15 and 25 gr/lit). Rough beds (see Figure 5) were made of square beams of height (D) 1.2 cm perpendicular to the flow direction. Different spacing between the beams were chosen (i.e. λ=1.2, 4.8, 9.6, 19.2, 38.4, 76.8 and 153.6 cm) yielding seven rough beds having λ/D= 1, 4, 8, 16, 32, 64 and 128.

A Nortek Acoustic Doppler Velocimeter (ADV) with 10 MHZ acoustic frequency was used to record the velocity profiles in the body of density currents at three locations (X= 3 m, 4 and 5 m from the gate) along the centerline of the channel. Samples with SNR values less than 15 dB and correlation less than 70% were filtered.

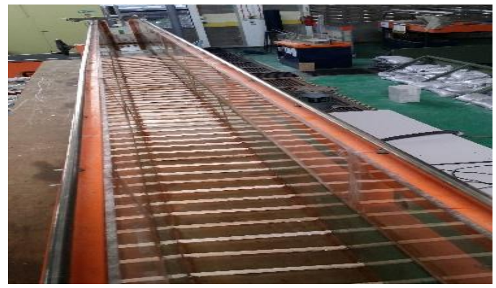

Figure 4: Density current flowing over smooth bed
Figure 5:. A rough bed (*λ/D* =8)

3.0 Results and Discussion

The main aim of this study is to investigate the influence of roughness elements on controlling density currents. Therefore, density currents flowing over roughness elements with various spacing were tested and compared. Stopping turbidity currents in a reservoir or influencing them in a way that the sediments are not deposited in important zones (e.g. in front of water intake structures and bottom outlets) increases the sustainability of reservoir operation significantly (Bühler et al., 2012).

Non-dimensional numbers are used to determine density current regimes. The densimetric Froude Number (Fr_{in}) is defined as $Frin=u_{in}/(g'h_{in}\ cos\theta)^{0.5}$ where u_{in} is the inlet velocity, h_{in} is the inlet opening height, g' is reduced gravitational acceleration and θ is the bottom slope. The reduced gravitational acceleration (g') is $g'=g(\rho_d-\rho_a)/\rho_a$ where g is the gravitational acceleration. In our experiments $0.29<Fr_{in}<0.97$. The inlet Reynolds number in these currents is defined as $Rein=u_{in}\ h_{in}/\upsilon$ where υ is the kinematic viscosity of inlet mixture. This can be rewritten as $Re_{in}=Q_{in}/b\ \upsilon$ where the b is the flume width. Hence, in our experiments, the inlet Reynolds Number for Q_{in}=0.5 lit/s and Q_{in}= 1 lit/s was equal to 1956 and 3912, respectively.The vertical velocity profiles were collected in laboratory experiments to investigate velocity structure in the body of saline underflows. The typical velocity profiles of density currents has an inner (wall) and outer (jet) region as seen in Figure 6 (Smooth bed, X= 3 m, S=1%, Q_{in}= 1 lit/s, C_{in}=25 gr/lit) where u is the velocity of the current at the depth of z. These regions are separated by maximum velocity (u_m). The distance above the bed where the maximum velocity occurs is referred to as h_m. In the inner region, the flow is mainly controlled by rigid boundary and bottom friction is the main influential parameter (Khavasi et al., 2012). The outer region is related to the interface or diffusion boundary at the top of velocity maximum.

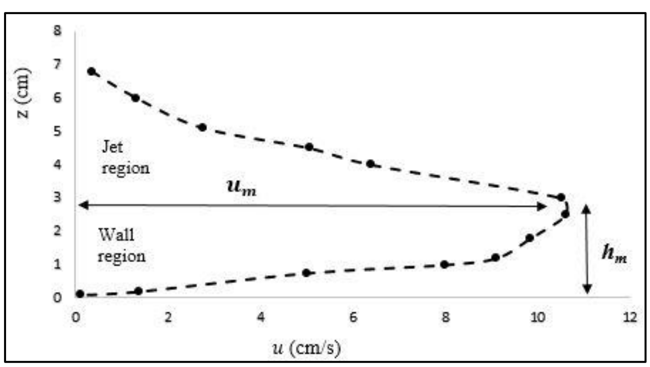

Figure 6:. Characteristics of the collected velocity profiles

The velocity profiles for selected number of experiments with the same initial conditions are illustrated in Figure 7 to discuss the influence of different rough beds. Rough beds caused two different behaviours in velocity profiles of the currents. For *λ/D* =1, 4, 8, 16; the retardation of the density current increased with the increase in the beams spacing. For these rough beds, increasing the spacing between elements increased h_m. This general rule was held up to a point *λ/D* =16. Density current propagating over *λ/D* =16 had the least velocity and maximum h_m.For λ/D =32, 64, 128; the controlling effect of the rough beds was reduced and hence the maximum velocity of the currents increased as the spacing between the beams became more. For these rough beds, increasing the spacing between elements also decreased h_m.

The maximum velocities for *λ/D* =32, *λ/D* =64 and *λ/D* =128 were similar to that of *λ/D* =8, *λ/D* =4, *λ/D* =1, respectively. However, the depths where the maximum velocities happened were less than them.In our experiments, there was a critical spacing (*λ/D* =16) above which increasing the distance between the elements had little effect on controlling the velocity of the currents. When the elements became too far apart (*λ/D* =128) the flow dynamics became similar to that over a smooth bed with the highly dispersed elements representing very small individual obstacles in the path of the current.

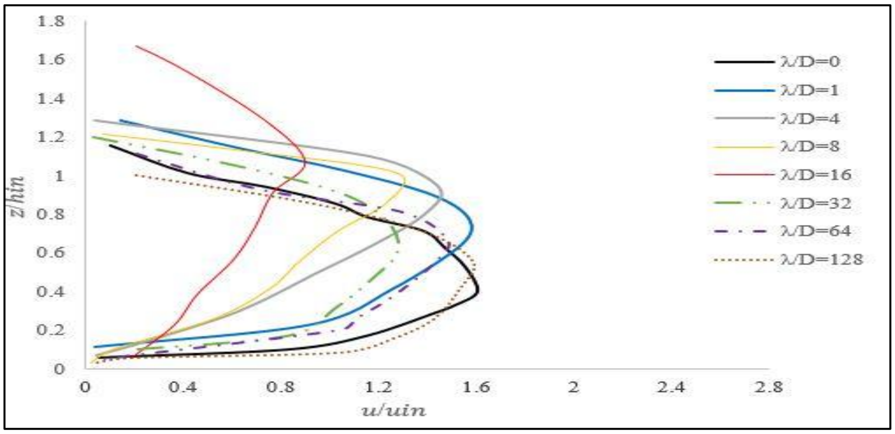

Figure 7:. Velocity profiles of density currents flowing over smooth and rough beds (S=1.75%, Cin=5gr/lit, X=4 m, Q_{in}=1 lit/s)

4.0 Conclusion

In dam reservoirs, flood-induced turbidity currents are the main driving mechanism for sediment transport. This study investigates controlling of turbidity currents with arrays of roughness elements. The conclusions of this study are as follows:

4.1 For density currents flowing over rough beds with *λ/D* =1, 4, 8, 16; increasing the spacing between the beams decreased the velocity of the currents.

4.2 The maximum retardation of density currents occurred for the currents propagating over the rough bed with λ/D=16.

4.3 For density currents travelling over rough beds having *λ/D* =32, 64, 128, the controlling effect of the rough beds was reduced and hence the velocity of the currents increased as the spacing between the beams became more.

4.4 Density currents had a velocity similar to that of the smooth bed when flowing over the rough bed with λ/D=128.

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TROPICAL FLOOD ESTIMATION MODEL DERIVED FROM TERMINAL DOPPLER WEATHER RADAR INFORMATION

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1.0 Introduction

Floods are among the most frequent and costliest natural disasters. Conditions that cause floods include heavy or long-steady rain for several hours or days that saturates the ground. Since the long term precipitation forecast is still not reliable enough, an accurate estimates degree of the extremity for upcoming flood events that might cause dangerous meteorological situations. The information from a rain gauge and radar data could be useful for decision maker as an additional information for flood warning system. This type of flood estimating technique is one of the techniques derived from an algorithm generated from rainfall rate, horizontal and vertical profile of radar reflectivity values. This algorithm was developed to estimate flood phenomenon derived from rain gauges and weather radar. The rainfall rate, cloud thickness value, the size of the cloud during the flood disaster was measured. In this research the rain gauge data and radar data on the duration of time over the flood area covered by meteorological radar and rain gauge was analyzed. The specific time can be the whole duration for the rain event before, during and after the flood tragedy. The procedure was applied to 14 days precipitation phenomenon observed in Kota Bharu, Kelantan (Malaysia) from 13 December 2014 until 26 December 2014 and was validate using the precipitation phenomenon observed in Kuantan, Pahang (Malaysia) during the extreme flood tragedy in December 2013. The derived algorithm acquired in this research is very useful to forecast the flood tragedy in the future and as a development model to be integrated into the radar system.

2.0 Methodology

The following assignments have to be performed in order to achieve the aforementioned objectives. In accordance with that purpose, it is anticipated that the radar data for the duration of at least 2 weeks will be acquired from Malaysia Meteorological Department (MMD). This duration is chosen to consider the precipitation activity before, during, and after the flood incident. This information about rainfall activity is important in order to identify relevant parameter of cloud characteristics that cause flood to occur. Relevant weather radar and available rain gauge data will be acquired (procured to be exact) accordingly. Rain gauge data is measured in mm/hr. All acquired radar data must first be converted into a readable format. The reason is that the radar data is in raw data format. This conversion must go through special software identified as IRIS that is used specifically to process the raw radar data. The rainfall rate during the extreme rainfall event is measured from the rain gauges. The size and the thickness of the cloud is identified from the radar data.

Subsequent task will then involve the development of algorithms capable of making forecasts of spatial rainfall for flood forecasting using the stated characteristics. The parameter of cloud characteristics, including the thickness and the size of the cloud together with the rainfall rate must be compared and analysed before the new proposed model capable of predicting flood in Malaysia be verified. The radar derived proposed algorithms of flood model will be assessed using field data.

In order to achieve the third objective, which is to validate the development model that is expected to be integrated into radar system. The proposed algorithm must be validated at other tropical flood event. Radar data for another flood incidents during the year 2013 at Kuantan is being utilized. This information justify and support the new proposed model. The flow process for Derivation Rainfall rate and cloud size is shown in Figure 1.1.

The phases of the work that will be involved in this proposed project are illustrated in Figure 1.2 below.

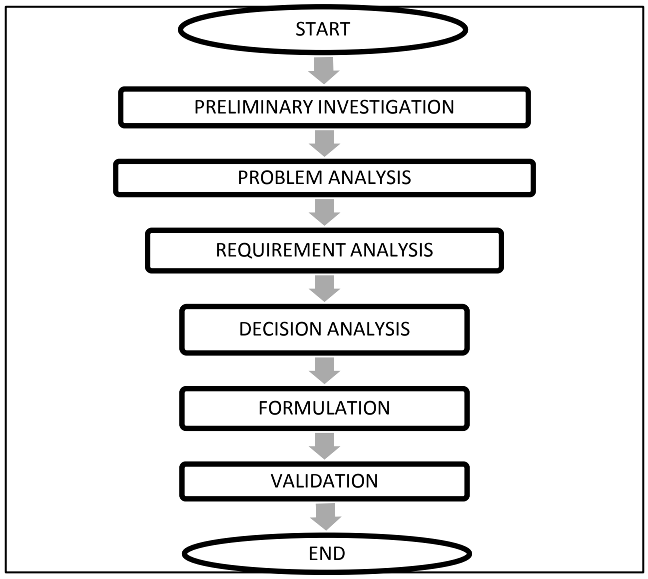

Figure 1.1 Flow Process for Derivation Rainfall Rate and Cloud Size

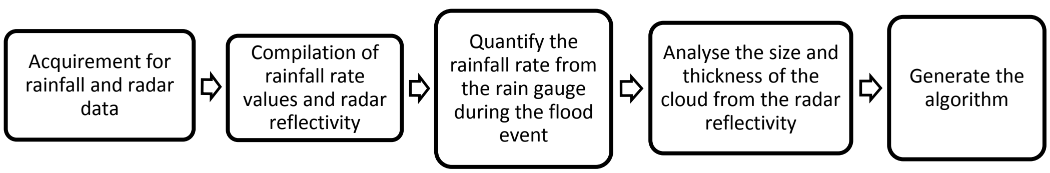

Figure 1.2 Flowchart for Methodology

3.0 Results and Discussion

The final model of the analysis would be,

$$Y' = B_0 + B_1X_1 + B_2X_2 + B_3X_3$$
$$Y' = -1.43 + 0.06X_1 + 5.28\text{x}10^{-5}\ X_2 + 0.0044\ X_3$$

Date	Time	Tested algorithm	Rainfall rate (mm/hr)	Thickness (km)	Size (km²)
2/12/2013	10:32:18	1	33.6	4.5	47337.5
	11:02:21	2	10.8	5.1	52609.5
	11:32:21	2	13.2	5	48740.9
	12:02:17	2	3.6	5.5	55002.4
	12:32:20	2	4.8	6.7	58776.2
	13:02:19	2	16.8	6.9	59281.5
	13:32:21	2	6	6	48789.1
	14:02:21	2	2.4	8	53736.0
	14:32:20	2	1.2	10	57986.7
	15:02:19	2	10.8	8.3	58292.0
	15:32:20	2	2.4	6.7	56601.8
	16:02:21	2	28.8	7.6	61340.2
	16:32:21	2	54	5.8	56283.3
	17:02:17	2	66	7	54193.5
	17:32:16	2	57.6	6.1	58311.4
	18:02:21	2	24	8.3	60370.1
	18:32:23	2	26.4	6.6	60560.5
	19:02:19	2	63.6	6.3	59119.2
	19:32:15	2	6	8.1	51550.2
	20:02:19	2	70.8	6.9	57681.5
	20:32:23	2	15.6	6.8	52257.6
	21:02:23	1	15.6	6.9	44910.3
	21:32:21	1	8.4	5.3	48056.9
	22:02:20	1	3.6	3.3	44928.5
	22:32:17	1	7.2	5	47015.6
	23:02:19	1	13.2	4.3	44360.3
	23:32:19	1	2.4	3.9	37624.4
3/12/2013	0:02:19	1	12	4.8	43613.4
	0:32:18	1	1.2	5.1	41839.9
	1:02:18	1	1.2	3.9	34724.6
	1:32:19	1	0	4.1	35288.5
	2:02:22	1	0	4.1	33523.4
	2:32:20	0	13.2	3.4	30573.3
	3:02:15	1	74.4	4.6	37832.1
	3:32:23	0	18	3	21113.0
	4:02:17	1	74.4	3.9	27957.2

From the tested algorithm result, it shows that the cloud appears during the flood incident is the cloud that can lead to flood disaster and the percentage for the flood to happen be more compared to the flood incident during the year 2014. As display in the Figure 3.2, the CAPPI view at 7.6 km height level and 200 km range distance for the cloud observed in Kuantan during the flood incident. The cloud is considered as absolutely huge about 60560.5 km^2.

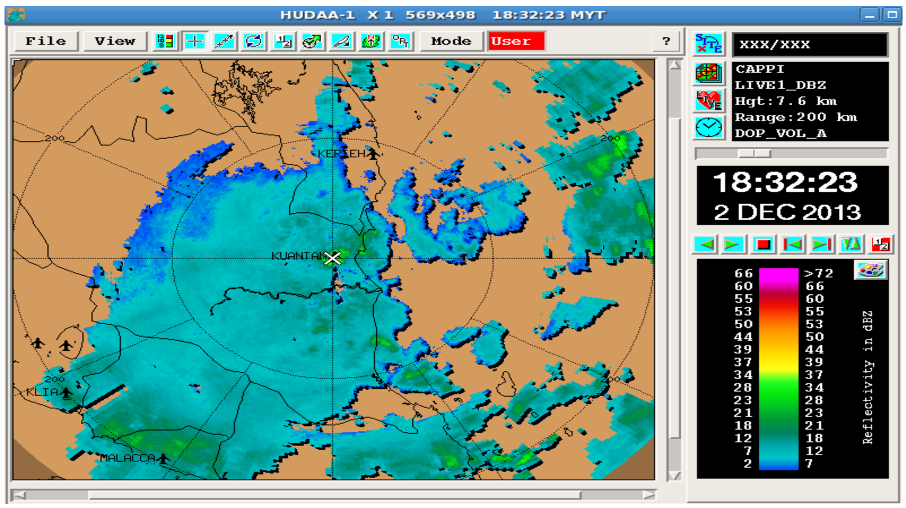

Figure 3.2 CAPPI View

4.0 Conclusion

4.1 The parameter of the cloud characteristics such as size and the thickness along with the rainfall rate during the Malaysian flood disaster 2014 was able to identify and characterize

4.2 Developing the coefficient that applicable to predict any rainfall activity that capable to cause flood disaster.

4.3 Algorithm modelled was capable to be integrated into radar system

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DISASTER SAFETY NET: EVALUATING MKN20 DIRECTIVE

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1.0 Introduction

The 2014 flood was the worst in the history of flood in Malaysia in 40 years with more than 300,000 people have been evacuated. This massive flood has caused severe damage to villager's residence, properties, livestock and crops, public infrastructure and business premises. In Malaysia National Security Council (NSC) has responsibility for controlling the national disaster management system including flood. The flood management system is based on National Policy and Mechanism in Disaster Management known as MKN 20 that was established in May 1997 and it was revised in 30 March 2012 to describe the role of various related stakeholders in more comprehensive and integrated, since the scope of the disaster management increasingly complicated and complex. This mechanism seems very systematic in managing the flood disaster, however historically it has commonly been considered as a government function and is largely based on top-down government-centered machinery (Chan, 1995). Thus there are questions arise, are these procedures are well understood by all levels of implementer, especially at the district level and how effective the procedures of *Arahan MKN 20* in managing 2014 massive flood if the knowledge of implementer about the procedure is doubted? In addition of government agencies, this disaster also attracted the participation of many volunteers to help flood victims. But do all these volunteers are trained in dealing with disasters of this magnitude? This scenario shows that there are many persons either from government agencies or volunteers in channeling the various types of assistances to flood victims. However how far the assistances reach the right target groups in a fair contribution? And if not where are the gaps that need to be improved to increase efficiency in the management of flood disaster? Therefore the objective of this study is to evaluate the effectiveness of Arahan MKN 20 in managing flood victims especially during and post-flood disaster 2014. Specifically research objectives are (i) to evaluate the response and emergency actions from responsible agencies in managing the flood victim; (ii) to assess the coordination of kinds distribution to the flood victims; (iii) to review other countries' mechanism in managing flood disaster especially Thailand and Japan and (iv) to propose suggestions for sustainable management of flood disaster in the East Coast of Peninsular Malaysia

2.0 Methodology

This study will use both secondary and primary data to elicit the study objectives. The secondary data from government reports, books, articles, newsletters and internet sources was used to capture the baseline information about the flood disaster in East Coast area. The primary will come from community survey. An interview with officers from agencies involved in flood management was conducted first in order to understand the scenario of flood in the study area. Then survey by using structured questionnaire were carried out in two states of Peninsular Malaysia namely Kelantan and Pahang since these states are mostly affected by flood disaster 2014. Survey on affected local communities in the district of Kuantan in Pahang and district of Gua Musang in Kelantan has been done to find out their perception on the effectiveness of the flood management and the coordination of kinds. These two districts was purposely chosen to analyse the scenario of flood management in urban and remote area, whereas Kuantan will represent the urban and Gua Musang will represent the remote area. The number of respondents that have been interviewed was 213 in Kuantan, Pahang and 159 in Gua Musang, Kelantan. The focus group discussion with various agencies involved in flood management such as MKN, local community representative, police, fire department, welfare department, education department, health department and other related agencies then have been conducted to discuss about the issues raised by the flood victims in order to improve the Standard Operational Procedure (SOP) of MKN 2O Directive. Finally descriptive analysis will be applied for primary data that has collected. The study will employ an analytical tool - Statistical Package for Social Scientist (SPSS) to process the responses from primary sources. With the aid of SPSS software the household responses will be coded and entered into a data analysis. Coding will be done to classify answers into meaningful categories and bring out essential patterns and make deductions from answers collated.

3.0 Results and Discussion

The evaluation of the effectiveness of Arahan MKN 20 in managing 2014 flood in the districts of Gua Musang and Kuantan are divided into pre, during and post flood situation that related to community. Pre and during-flood management represent the evaluation of response and emergency actions from responsible agencies in managing the flood victim. While post-flood situation represent the evaluating of coordination of kinds distribution to the flood victims.

As for pre-flood management procedure, respondents were asked with dichotomous question (yes or no) with regard to the pre-flood procedures listed in the PTO such as dissemination of information about weather condition, river/dam water level, location of flood warning board and siren, location of evacuation center, safe vehicle area, area patrol, alternative routes and road closure, and water/electricity supply disruption. Finding shows that the dissemination of pre-flood information is less efficient in remote area such as in Lebir, Gua Musang with only 32% to 50% of respondents state ‘yes’ for all questions listed imply that most of them didn’t informed about these information.

During the flood, the relocation rate of flood victims is low in remote area such as Sungai Lembing in Kuantan District (52%) and Lebir in Gua Musang District (34.9%) as compared with urban area such as Sungai Isap (100%) and Kampung Tiram (88%) in Kuantan district. This is due to limited capacity of evacuation center and asset to relocate the victims. For example at Lebir the capacity of the evacuation center is only for 100 people while the flood victims in that area is more than 400 families. On the contrary, the relocation rate in Bertam area, one of the remotest areas in Kelantan, is high (88.1%) due to a lot of villagers in Bertam had their own boats which formed the bulk of rescuer boats. At the evacuation center, based on flood victims’ self-perceived on procedures listed in the SOP for flood disaster management based on a scale of 1 = very dissatisfied to 5 = very satisfied, result showed the overall score mean values for all procedures is more than 3, i.e. in the range of modest and satisfied. This value is acceptable in the case of disaster situation at evacuation center. However flood victims in Bertam and Lebir in Gua Musang district were dissatisfied on some flood management procedures such as space allocation in evacuation center, distribution of food and non-food necessities, basic amenities, medical treatment, counselling service, and role played by evacuation center committee shown by their score means 2.36 to 2.95. This flood victim’s satisfaction level reflects the incompetency of management at the evacuation center. However from 22nd until 25th December 2015, the Gua Musang area was inaccessible as it was inundated. Communication, electricity and water supplies were cut off. Instead the place for food storage also sank causing insufficient food supply to flood victims. Gua Musang area was only accessible after three days of flooding. In this situation, the Penghulu had taken the initiative to manage the flood victims.

For the case on non-evacuees, the flood management procedures is only limited to food, medical and monetary aids. Even these assistance will reach to the victims when the flood began to recede. However most of them claimed that they did not received those kind of assistances especially flood victims from Bertam, Gua Musang and Sungai Lembing, Kuantan. This is because they were surrounded by water and no access for outsiders to get into the area to deliver aids for the victims. In order to ensure the flood management system is more holistic that can cover all scenarios of the flood, there is a need for an SOP for non-evacuees in MKN 20 Directive.

In term of kind distribution coordination, the Welfare Department plays a role in coordinating all assistance channeled to the evacuation centers. However, not everyone is aware about the aid delivery procedure and most of them approach the victims directly in distributing aids. The lack of information on aid coordination and distribution had led some victims to receive dumping assistances and some victims not receiving anything. In this case, volunteers should be provided with information, knowledge and training on the management of flood victims. The government also distributed Wang Ehsan of RM500 to the flood victims. Most victims received the Wang Ehsan payment within the specified period except victims in Sungai Lembing which only 34% of them answered ‘yes’ to the statement, even though many of them submitted their claim forms within a week after evacuation centers closed. Generally the reason why they did not receive the Wang Ehsan within the prescribed period was that aid distribution location is far away, no transportation provided, staying in rural areas, information lag, and overcrowded aid distribution venues, and old/fragile victims. However as an agency that responsible in registration of the flood victims, the Department of Welfare (JKM) facing problems relating to the overlapping of household head's name due to inefficient registration system that allow the victims to cheat by entering more than one name per household in order to obtain extra assistances. In order to avoid double payment to the affected households, JKM had to spend extra time to produce the final name list devoid of name-overlapping. This problem calls for a need to establish an integrated information system to allow the system to be more effective disaster management without any resource waste.

This experience has provided guidelines toward improvement of sustainable flood management especially on MKN20 Directives. Current MKN20 Directives only covers the case of 'normal' floods. Suggestions for improvement of flood management procedure can be categorized according to the stakeholders: (1) the community of victims, (2) government rescue agency, (3) non-governmental organization (NGO). Mechanisms in the floods management can be categorized as (1) education on disaster management, (2) the use of ICT in disaster management coordination between rescue agencies. Communities need to cooperate and engage in programs related to enhancing their awareness and preparedness capabilities organized by rescue agencies during the pre-flood phase. Every family should be accomplished with Family Disaster Plan and Disaster Supplies Kit that lists the procedures to rescue their family and property in the incident of flooding. However the success of this program depends on sufficient funds allocated by the government to finance this program and the active involvement of local communities. This program can also be co-sponsored by the NGO involved in the rescue work in the incident of flooding.

Government rescue agencies like the Department of Irrigation and Drainage needs to generate a mapping of flood risk areas. The ratio of rescue assets with the risk of flooding must be appropriate so that there was no shortage of assets in the flooded areas. Programs such as Spatial Decision Support System (SDSS), a comprehensive flood management plan that combines remote sensing technology, geographic information system and global positioning system can be used by rescue agencies since the coordination of flood management is critical aspect in the extreme case. To ensure the coordination of aid distribution to flood victims NGOs or individual that want to deliver their aids need to register with the rescuer agency at the scene. NGOs - such as the Red Crescent Society - also can get involved by organizing Disaster Preparedness Education at the school level in order to nurture students become a savior to their families through 1 Rescue for 1 family program. University students must not only involved during post-flood but also can help increase awareness and preparedness of disaster through Co-curricular program at university. The involvement of NGO can also focus on pre-disaster level, in addition to the during-flood situation.

4.0 Conclusion

4.1 Findings from the literature on flood disaster management (FDM):

(i) FDM in developing countries is still of a reactive-response nature, i.e. more to emergency response, rescue, and recovery

(ii) what is preferable is disaster management of a proactive and integrated nature, pointing to Japan's exemplary disaster management system

4.2 Information and data for this research were gathered from:

(i) interviews with agencies directly involved with flood disasters

(ii) questionnaire survey on 372 flood victims from Kelantan and Pahang

(iii) focus group discussion with all relevant agencies and flood victims to verify our findings and to solicit policy recommendations

4.3 Findings on pre-flood management:

(i) inefficient information dissemination in remote areas

(ii) low level of awareness and capacity-building of the flood-prone community

4.4 Findings on during-flood management:

(i) low relocation rate in remote areas due to capacity limitation of evacuation centres

(ii) victims from 2 of the 5 districts surveyed reported dissatisfaction with the inefficient management of evacuation centres

(iii) search-and-rescue operations hampered by lack of equipment/assets, where the lack is partly due to the sudden occurrence of such a large-scale flood

4.5 Findings on post-flood management:

(i) not all NGOs distributing in-kind aids were aware of the proper procedure, resulting in poor coordination of in-kind distributions

(ii) problems of inefficient registration system for the RM500 *Wang Ehsan* assistance due to overlaps of registered names of household head, and intentional fraudulent behavior of victims

4.6 Policy improvement recommendations for MKN Directive 20 and the Standard Operating Procedure for Flood Disaster Handling (*Peraturan Tetap Operasi Pengendalian Bencana Banjir*):

(i) improvement on these two policies are necessary because these policies are only suitable to deal with floods of the ‘normal’ category

(ii) need to readdress the issue and definition of the ‘*terkepung*’ category due to physical/geographical inaccessibility of flood victims; this term has only been coined during the 2014 year-end massive flood; the aforementioned standard operating procedure is inadequate in dealing with this category of victims in terms of search-and-rescue operations and food supply

(iii) improvement on the mechanisms of FDM can be made in terms of disaster management education, and the use of ICT for better coordination between rescue agencies

(iv) flood-prone communities need to be more involved in flood awareness programmes for better preparedness on their part

(v) rescue agencies such as the Department of Irrigation and Drainage needs to produce mappings of high-risk and flood-prone areas in order to come up with a more accurate food supply and equipment/asset allocation for each area

(vi) NGOs distributing in-kind aids should be registered to avoid duplication and redundancy in assistance/resources

FLOOD HAZARD ASSESSMENT USING MULTI CRITERIA EVALUATION (MCE) METHOD IN PENAMPANG AREA, SABAH

Project Information

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1.0 Introduction

The Penampang District of Sabah, East Malaysia is subjected to development pressure as the urban centre of Kota Kinabalu expands onto the Sungai Moyog floodplain. The subsequent transition of land use from rural development and cultivation of rice paddy to intensive urban development presents a range of social and environmental issues. Of particular concern to the area are the issues associated with flooding. In 2014 from October 7 to October 10, Penampang suffered its worse flood ever, since the last big flood in 1991. According to the District Officer of Penampang as many as 40,000 people from 70 villages were affected by the flood. The flood coincided with continuous heavy rainfall due to typhoon Phanfone and typhoon Vongfong. Another recent flood disaster in Penampang occurred on September 2007 and May 2013, affecting several villages.

The main objectives of this study are: a) to determine the Flood Hazard Level (FHL); b) to determine the factors contributing to the flood occurrences; and c) to recommend mitigation measures in order to minimize flood vulnerability & risk. It is hopes that the outcomes from this study can be an important reference document for the local authority and other relevant agencies for the purpose of urban planning and flood mitigation. An ad hoc, or reactive, approach to floodplain management has previously been standard practice. Insufficient control over floodplain development practice has led to a worsening of the flood problem. Until recently, floodplain management has only involved structural approaches to modifying flood behaviour. However, without planning, the structural flood modification only compensates for the poor development practice by restoring the flood behaviour to pre-development conditions. Ultimately, there is no net benefit.

2.0 Methodology

There are four (4) main phases involved, namely: a) Phase I: Selection and evaluation of criteria; b) Phase II: Multi-Criteria Evaluation (MCE); c) Phase III: Flood Susceptibility Analysis (FSAn); and d) Phase IV: Flood Hazard Analysis (FHAn)

2.1 Selection and evaluation of criteria

The main purpose in Phase I are database development. Firstly, soil samples were collected from the field will be analyzed their types in accordance with BS1377-1990. The next step is secondary data compilation and literature review. Lastly observation of Flood Hazard Identification (FHI) parameters was conducted through the fieldwork study.

2.2 Multi-Criteria Evaluation (MCE) technique

In Phase II, the choice of criterions that has a spatial reference is an important and profound step in Multi-Criteria Evaluation (MCE) technique. Hence, the criteria consider in this study is based on their significance in causing flood in the study area. Eigth factors are considered in relation to the causative factors, which are rainfall, slope gradient, topography, drainage density, landuse, soil textures, slope curvatures and flow accumulation.

Several questionnaires were distributed among experts in hydrology and hydraulics. The inputs obtained from those experts were further used in carrying out the pair-wise comparison technique in order to calculate the weights of each criterion. Pair-wise comparison is more appropriate if accuracy and theoretical foundations are the main concern. The technique involves the comparison of the criteria and as allows one to compare the importance of two criteria at a time. This very technique, which was proposed and developed by Saaty (1980) within the framework of a decision making process known as Analytical Hierarchy Process (AHP) is capable of converting subjective assessments of relative importance into a linear set of weights. The criterion pair-wise comparison matrix takes the pair-wise comparisons as an input and produces the relative weights as output. Further the AHP provides a mathematical method of translating this matrix into a vector of relative weights for the criteria. Moreover, because of the reason that individual judgments will never be agreed perfectly, the degree of consistency achieved in the ratings is measured by a Consistency Ratio (CR) indicating the probability that the matrix ratings were randomly generated. The rule-of-thumb is that a CR less than or equal to 0.10 signifies an acceptable reciprocal matrix, and ratio over 0.10 implies that the matrix should be revised, in other words it is not acceptable.

2.3 Flood Susceptibility Analysis (FSAn)

The initial step in Phase III is the delineation and conversion processes of data from the radar images (IFSAR). Phase III also covers the integration between criteria weights and maps, producing a Flood Susceptibility Analysis (FSAn) using spatial analyst, which determine the Flood Susceptibility Level (FSL) in different period (2002, 2008 and 2014).

All of the thematic maps produced were analyzed through the spatial analyst technique (raster calculator) based on Eq. (1) for LSL estimation and classification. The FSL calculation was carried out through a combination of input parametric maps in Eq. (1) with the GIS operations using a grid base.

$\sum$ [(32.53*Rainfall) + (22.74*Drainage Density) + (15.84*Flow Accumulation) + (11.08*Landuse) + (7.19*Elevation) + (4.89*Slope Gradient) + (3.35*Soil Textures) + (2.38*Slope Curvatures)] (1)

3.0 Results and Discussion

3.1 Flood Susceptibility Level (FSL)

Fig. 1 shows the results of Flood Susceptibility Level (FSL) data in year 2002, 2008 and 2014.The results of the FSL level for the Penampang suggest that in 2002, 65% of the area have very low susceptibility (VLS), 17% as low susceptibility (LS), 6% as moderate susceptibility (MS), 11% as high susceptibility (HS) and 1% as very high susceptibility (VHS). While in 2008, 62.74% of the area have VLS, 15.62% as LS, 15.49% as MS, 3.57% as HS and 2.58% as VHS. In year 2014, 40.49% of the area can be categorised as having VLS, 35.08% as LS, 18.21% as MS, 5.50% as HS and 0.71% as VHS.

In general, the VLS to LS areas refer to stable conditions from flood vulnerability/risk. In contrast, MS to HS areas are basically not recommended to be developed due to high flood vulnerability/risk. However, if there is no choice or the developer or the local authorities really want to develop these areas, some mitigation procedures to be introduced. VHS areas are strictly not recommended to be developed and provisions for suitable structural and non-structural works planning controlare recommended.

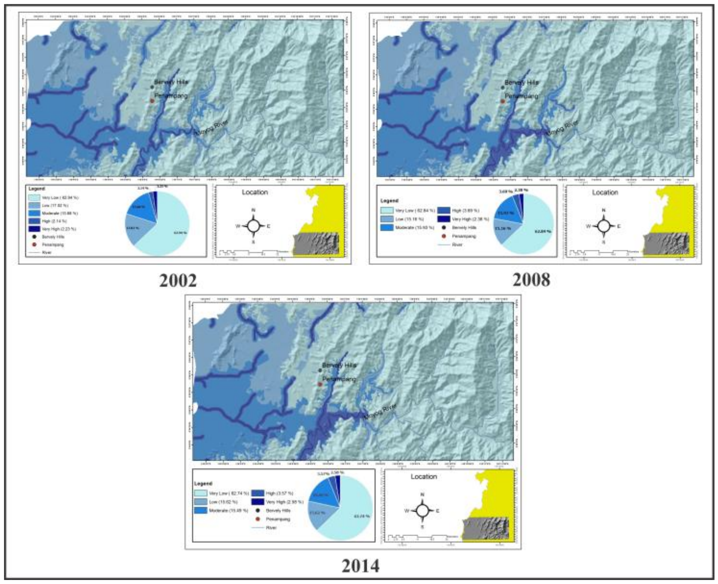


FIGURE 1 : Flood Susceptibility Analysis (FSAn) Maps of the study area (Year 2002, 2008 and 2014)

3.2 Flood Hazard Analysis (FHAn)

Flood Hazard Analysis (FHAn) is important for planning development activities in an area and can be used as supplementary decision making tools. Rainfall, elevation, slope, drainage density, flow accumulation, land use, soil texture, slope gradient and slope curvature were chosen as the most influential factors for evaluating the flood hazard to the municipality.

Fig. 2 shows the FHAn map of the study area. The map was prepared by overlaying the flood susceptibility maps in year 2002, 2008 and 2014 (Fig. 1). Based on the map, approximately 3.69% of total study area classified as very high hazard (VHH), 2.38% as high hazard (HH), 15.93% as moderate hazard (MH) and 15.16% as low hazard (LH), as vey low hazard (VLH) respectively.

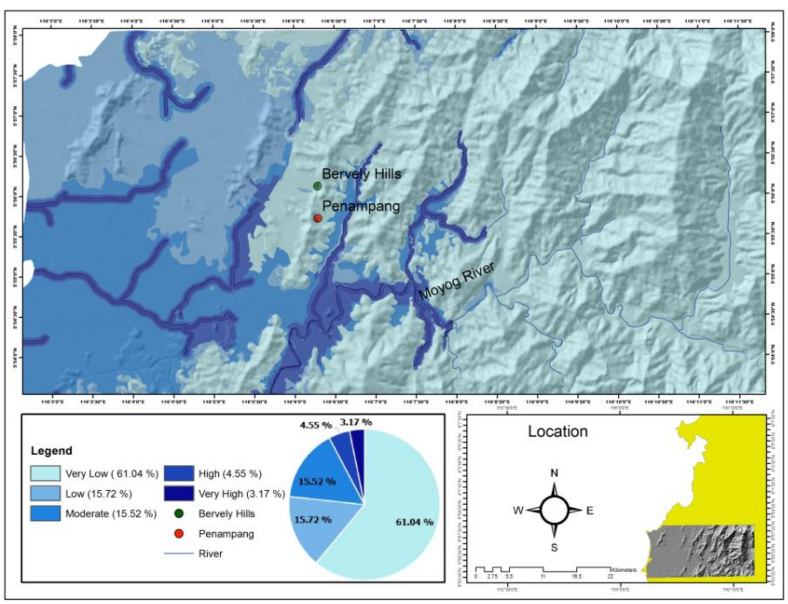
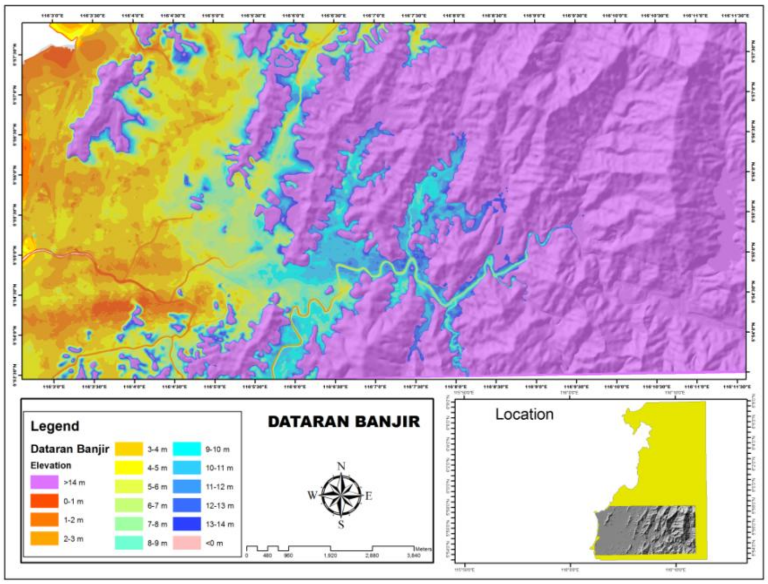


FIGURE 2 : Flood Hazard Analysis (FHAn) map of study area

The Sg. Moyog catchment covers an area of approximately 295km^2. The upper reaches of the catchment extend into the Crocker Range, with elevation exceeding 1,800m. From the headwaters, the Sg. Moyog meanders in a westerly direction through steep mountainous terrain, until it reaches the expansive lower floodplain at Dongongon. Fig. 3 shows the floodplain map of the study area. From this figure, most of the floodplain area is located at the western part of the study area. Across the Sg. Moyog floodplain, the main towns are Dongongon and Putatan. The largest village is Kampung Petagas with 3,500 people. Any kind of development and activities should be minimizes as the area is more prone to flood disaster.



Sources: (Department of Drainage and Irrigation, 2014)
FIGURE 3 : Floodplain map of study area

3.3 Validation for Flood Hazard Analysis (FHAn)

For validation of flood hazard models, two basic assumptions are needed. One is that flooded areas are related to spatial information, and the other is that future flooded areas will affected by a specific factor such as rainfall. In this study, the two assumptions are satisfied because the flooded areas were related to the spatial information and the flooded areas were triggered by heavy rainfall in the study area. The Flood Hazard Analysis (FHAn) result was validated using the Floodplain map (Fig. 3). The validation process is carried out by comparing the floodplain data with the Flood Hazard Analysis (FHAn) map (Fig. 2) through the Prediction Rate Curve (PRC) (Fig. 4). In order to create PRC, the flood index values in FHAn were calculated and all its cells were sorted in decreasing order. Then, the ordered cell values were divided into 100 classes. All of these 100 classes were weighted and were overlaid with the floodplain map data and then converted into the percentage format for each class. As a result of the calculation and interpretation, the average ratio of the areas under the curve was 0.839, and thus can be argued that validation prediction accuracy was 83.90% (Fig. 4). This means that the FHAn result that were carried out in this study have a good reliability ($0.8 < AUC < 0.9$) (Zhu et al. 2010).

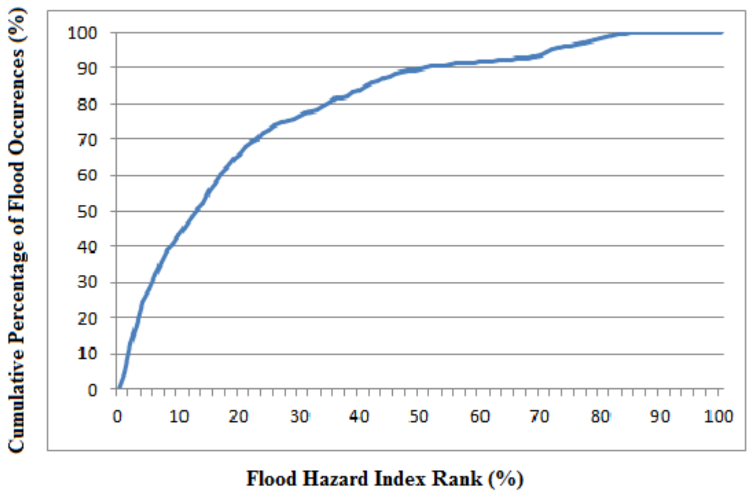


FIGURE 4 : Illustration of cumulative frequency showing flood hazard index rank (y-axis) occurring in cumulative percentages of flood occurrences (x-axis)

4.0 Conclusion

4.1 The results of this study indicate that the integration of MCE and GIS techniques provides a powerful tool for decision making procedures in FSL mapping, as it allows a coherent and efficient use of spatial data. The use of MCE for different factors is also demonstrated to be useful in the definition of the risk areas for the flood mapping and possible prediction. In overall, the case study results show that the GIS-MCE based category model is effective in flood risk zonation and management.

4.2 The developed framework model (Fig. 4) will be a very valuable resource for consulting, planning agencies and local governments in managing hazard/risk, land-use zoning, damage estimates, good governance and remediation efforts to mitigate risks. Moreover, the technique applied in this study can easily be extended to other areas, where other factors may be considered, depending on the availability of data.

4.3 The main causes of flooding in the study area are: a) Increased runoff rates due to the urbanisation; b) Loss of flood storage – development in flood plains and drainage corridors; c) Inadequate drainage systems; d) Constriction at bridges; e) Undersized culverts; f) Siltation in waterway channels from indiscriminate land clearing operations; g) Localised continuous heavy rainfall; h) Tidal backwater effect; and i) Inadequate river capacity.

4.4 Recognition that unplanned and uncontrolled development can increase the risk to life and damage to property is fundamental to successful floodplain management. Awareness of this issue is not just the responsibility of the local authorities, but all stakeholders, covering both public and private sectors. Whilst the land developer has the social responsibility for flood compatible development, the approving agencies share a portion of that responsibility through effective floodplain management, excised in a transparent, impartial manner.

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APLIKASI MEDIA SOSIAL SEBAGAI SISTEM AMARAN AWAL BENCANA BANJIR KEPADA PENDUDUK DALAM LEMBANGAN SUNGAI KELANTAN

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1.0 Introduction

Bencana alam merupakan suatu kesan bahaya daripada bencana semula jadi seperti banjir, puting beliung, gempa bumi, tanah runtuh dan letusan gunung berapi. Hakikat hari ini bahawa dunia menjadi saksi kepada banyak bencana banjir berlaku yang mengorbankan banyak nyawa akibat kurang tindak balas awal dan persediaan untuk menyelamat (Ibrahim, 2007). Selain itu, dunia telah dilanda dengan pelbagai bencana seperti Taufan Katrina di Amerika Syarikat, tsunami di Indonesia dan Jepun yang mengakibatkan kerosakan harta benda. Oleh itu, bencana alam yang semakin kerap berlaku diramalkan terus meningkat dari semasa ke semasa dan merosakkan sistem kitaran hidup manusia (Velev & Zlateva, 2006). Menurut Majlis Keselamatan Negara (2015) dan Ibrahim dan Fakru'l-Razi (2006) bencana merupakan sesuatu ganggu kepada kelangsungan aktiviti komuniti, melibatkan kehilangan dan kerosakan harta benda, kerugian ekonomi dan urusan negara serta kemusnahan alam sekitar di luar daripada kemampuan komuniti setempat. Hal ini menunjukkan bahawa bencana adalah sesuatu fenomena alam sekitar yang cukup serius. Pusat Penyelidikan di Epidemiologi Bencana (CRED) mengkasifikasikan bencana apabila melibatkan mangsa seramai 10 orang atau lebih dilaporkan meninggal, 100 orang dilaporkan terjejas dan membawa maksud kepada kerosakan ke atas masyarakat dan alam sekitar (United Nations, 2015; Ibrahim, 2007).

2.0 Methodology

Kajian ini menggunakan data primer melalui kaedah kaji selidik untuk mendapatkan maklumat mengenal pasti penggunaan aplikasi media sosial dalam kalangan masyarakat di dalam lembangan Sungai Kelantan. Selain itu, ia juga tertujuan untuk mendapatkan maklum balas mengenai penggunaan media sosial semasa bencana banjir. Seramai 250 orang responden telah telah dipilih untuk menjawab borang soal selidik yang diedarkan. Kaedah pensampelan yang telah dipilih adalah pensampelan rawak mudah dengan mengedarkan kepada masyarakat dalam kawasan mukim yang terlibat dengan bencana banjir. Teknik pensampelan rawak mudah merupakan kaedah pensampelan yang paling mudah dan ringkas (Fauzi et al., 2015). Tambahan lagi, pensampelan rawak mudah digunakan dalam penyelidikan untuk memastikan populasi mempunyai ruang dan peluang yang sama dan bebas untuk dipilih sebagai sampel kajian (Mohamad Suhaily Yusri et al., 2015; Chua, 2011). Kajian ini menggunakan analisis deskriptif iaitu kekerapan dan min serta dilakukan perbincangan mengenai respon komuniti melalui aplikasi media sosial semasa bencana banjir di kawasan Kuala Krai, Kelantan. Kekerapan digunakan untuk mendapatkan maklumat penggunaan media sosial semasa banjir. Manakala, min pula digunakan untuk mendapatkan tahap penggunaan aplikasi media sosial untuk berkomunikasi, berkongsi maklumat dan kolaborasi (Jadual 1).

Jadual 1: Penetapan skala min bagi komunikasi, berkongsi maklumat dan kolaborasi 3.0

Tahap	Skor
Tinggi	3.33 – 5.00
Sederhana	1.67 – 3.32
Rendah	0.00 – 1.66

Sumber: Mohammad Suhaily Yusri et al., 2015

3.0 Results and Discussion.

Hasil analisis yang dijalankan menunjukkan bahawa penggunaan aplikasi media sosial dalam kalangan bukan staf kerajaan hampir sama berbanding staf kerajaan (Jadual 2). Ini menunjukkan penggunaan aplikasi media sosial tidak terlalu bergantung kepada jenis pekerjaan seseorang responden kajian ini. Data yang ditunjukkan bagi keseluruhan aplikasi media sosial yang digunakan hampir sama sahaja terutama antara pekerjaan kerajaan, swasta, suri rumah, buruh dan penoreh getah yang menjadi responden dominan antara responden dalam kajian ini.

Jadual 2: Penggunaan aplikasi media sosial berdasarkan pekerjaan

Pekerjaan	Media sosial								
	Facebook	WhatsApp	SMS	Twitter	Instagram	Flickr	MySpace	YouTube	WeChat
Kerajaan	20	27	28	4	8	1	1	4	9
Pesara	2	4	7	0	0	0	0	0	0
Swasta	27	30	36	2	8	0	0	2	17
Suri rumah	20	25	39	5	8	3	3	5	16
Buruh	9	12	26	0	9	0	0	2	5
Penternak	2	2	0	1	9	0	0	1	1
Penoreh getah	22	29	44	5	6	3	3	5	13
Peniaga	9	14	18	1	2	0	0	2	6
Pelajar	2	2	5	0	0	0	0	1	2
Pemandu	1	2	3	0	0	0	0	0	1
Tukang jahit	2	3	3	2	2	1	1	1	1
Sendiri	1	2	6	0	0	0	0	0	1

Maklum balas masyarakat terhadap bencana banjir dengan menyebarkan berita mengenai bencana banjir semasa berlaku di Kuala Krai paling banyak menggunakan aplikasi *WhatsApp* iaitu seramai 96 orang (38.4%) dan diikuti aplikasi SMS seramai 70 orang (28%), *Facebook* seramai 56 orang (22.4%), *WeChat* seramai 14 orang (5.6%), dan masing-masing lima orang (2%) bagi *Twitter* dan *Instagram*, dua orang (0.8%) bagi *MySpace* dan *YouTube* (Jadual 3). Tambahan lagi, jikalau melihat kepada kekerapan bagi aspek keberkesanan dan efektif aplikasi media sosial dalam menyampaikan berita mengenai bencana banjir turut didominasi oleh aplikasi *WhatApps* iaitu seramai 115 orang (46%) dan diikuti oleh SMS seramai 68 orang (27.2%) dan seramai 48 orang (19.2%) bagi *Facebook* (Jadual 3). Bagi aplikasi media sosial yang lain hanya mewakili 7.6 peratus iaitu Twitter (6 orang), Instagram dan YouTube masing-masing 2 orang, MySpace seorang dan WeChat (8 orang).

Jadual 3: Penggunaan dan maklum balas komuniti Kuala Krai melalui media sosial

Media sosial	Penggunaan		Maklum balas komuniti	
	Kekerapan	Peratusan (%)	Kekerapan	Peratusan (%)
SMS	215	86.0	70	28.0
WhatsApp	152	60.8	96	38.4
Facebook	117	46.8	56	22.4
WeChat	72	28.8	14	5.6
Instagram	34	13.6	5	2.0
YouTube	23	9.2	2	0.8
Twitter	20	8.0	5	2.0
Flickr	8	3.2	0	0.0
MySpace	8	3.2	2	0.8

Analisis penggunaan aplikasi media sosial dalam kalangan masyarakat melibatkan aspek komunikasi, berkongsi maklumat dan membentuk kumpulan (kolaborasi) pula menunjukkan bahawa aplikasi Sistem Pesanan Ringkas (SMS) mendominasi ketiga-tiga aspek berkaitan semasa bencana banjir di Kuala Krai, Kelantan. Tambahan lagi, respon komuniti terhadap ketiga-tiga aspek komunikasi, berkongsi maklumat dan membentuk kumpulan (kolaborasi) didominasi melalui penggunaan aplikasi *Facebook*, *WhatsApp* dan SMS. Maklum balas awal daripada komuniti melalui penggunaan aplikasi media sosial semasa bencana banjir di Kuala Krai, Kelantan sangat penting untuk memberikan kesedaran dan persediaan awal kepada komuniti setempat supaya bersiap sedia dalam sebarang kemungkinan. Namun begitu, kekerapan penggunaan aplikasi media sosial untuk aspek-aspek berikut berapa pada tahap jarang (Jadual 3) dan analisis min berada pada tahap sederhana (Jadual 4). Selain itu, ia juga memberikan amaran awal dan bertindak sebagai sistem amaran awal yang efektif melalui proses penglibatan komuniti secara optimum (Collins & Kapucu, 2008). Hal ini demikian kerana, media sosial menjadi medium perbincangan dan perkongsian maklumat yang sangat pantas dan efisien, mencipta kepada kandungan perbincangan dan berkongsi maklumat. Velev dan Zlateva (2006) menjelaskan terdapat empat cara yang masyarakat boleh gunakan teknologi media sosial semasa bencana alam iaitu komunikasi antara kawan dan keluarga, mengemaskini situasi semasa bencana, menyebarkan kesedaran berkaitan bencana dan akses bantuan perkhidmatan semasa bencana.

Hasil analisis bagi aspek-aspek penggunaan aplikasi media sosial dalam kajian ini menunjukkan bahawa kesemua aspek penggunaannya berada tahap sederhana sahaja (Jadual 5). Walau bagaimanapun, berbanding antara ketiga-tiga aspek penggunaan tersebut mendapati bahawa aspek komunikasi berada pada tahap lebih tinggi (min=2.40, SD=0.89) berbanding aspek lain. Aspek berkongsi maklumat juga berada pada tahap sederhana (min=2.36, SD=103). Manakala, aspek kolaborasi (membentuk kumpulan) turut sederhana (min=2.30, SD=1.29).

Jadual 4: Kekerapan penggunaan media sosial bagi setiap aspek penggunaan

Kekerapan	Komunikasi		Berkongsi maklumat		Kolaborasi	
	Bil	%	Bil	%	Bil	%
Jarang-jarang	87	34.8	116	46.4	111	44.4
Kadang-kadang	67	26.8	83	33.2	70	28.0
Setiap hari	60	24.0	30	12.0	35	14.0
Setiap minggu	7	2.8	4	1.6	8	3.2
selalu	29	11.6	17	6.8	26	10.4

Jadual 5: Nilai min bagi aspek komunikasi, berkongsi maklumat dan kolaborasi

Aspek	Min	Sisihan Piawaian	Tahap
Komunikasi	2.40	0.89	Sederhana
Berkongsi maklumat	2.36	1.03	Sederhana
Kolaborasi	2.30	1.29	Sederhana

Walaupun ketiga-tiga aplikasi media sosial SMS, *WhatsApp* dan *Facebook* yang paling dominan digunakan oleh masyarakat dalam lembangan Sungai Kelantan sebagai respon awal terhadap bencana banjir bagi aspek yang dinyatakan, terdapat juga aplikasi media sosial lain digunakan. Sebagai contoh aspek komunikasi turut melibatkan aplikasi *YouTube* dan *WeChat*, aspek kolaborasi (membentuk kumpulan) melibatkan *Twitter*, *Instagram*, *MySpace* dan *WeChat*, dan respon komuniti Kuala Krai semasa bencana banjir melalui aplikasi *Twitter*, *Instagram*, *YouTube* dan *WeChat* dalam aspek berkongsi maklumat. Hasil analisis yang dijalankan ini mengambarkan bahawa kepelbagaian aplikasi media sosial digunakan dalam kalangan komuniti semasa bencana banjir berlaku.

4.0 Conclusion

Kajian yang dijalankan secara keseluruhannya mendapati bahawa:

4.1 Tiga aplikasi media sosial yang boleh digunakan oleh pihak berkuasa untuk digunakan sebagai alat sebaran amaran awal bencana banjir ialah Whatapps, Facebook dan Sistem Pesanan Ringkas (SMS).

4.2 Ini kerana penggunaan ketiga-tiga media sosial yang dominan ini adalah menyeluruh dari aspek pendidikan dan pekerjaan responden. Kebarangkalian ketersampaian maklumat adalah lebih tinggi berbanding dengan penggunaan media-media sosial yang lain.

4.3 Namun begitu penyebaran maklumat melalui aplikasi media sosial yang melibatkan penggunaan jalur lebar seperti Facebook, Whatapps dan WeChat hanya berkesan sebelum bencana banjir berlaku. Dapatan yang diperolehi menunjukkan penyebaran maklumat melalui SMS lebih berkesan semasa dan selepas bencana banjir berlaku.

4.4 Taburan penggunaan aplikasi media sosial berdasarkan ruangan pula menunjukkan bahawa terdapat perbezaan yang ketara antara mukim-mukim dalam lembangan Sungai Kelantan.

4.5 Hasil analisis menunjukkan penduduk yang berada dalam daerah Gua Musang lebih cenderung menggunakan SMS berbanding dengan penduduk dalam daerah Kuala Krai yang majoritinya menggunakan aplikasi Facebook dan Whatapps untuk berkolaborasi, berkomunikasi dan bertukar maklumat.

4.6 Dari aspek penyebaran berita palsu pula terdapat perbezaan corak pengetahuan kewujudan berita palsu dalam kalangan responden mengikut perbezaan tahap pendidikan. Majoriti responden yang mempunyai tahap pendidikan pada peringkat SPM, PMR dan UPSR tidak mengetahui kewujudan penyebaran berita palsu semasa bencana berlaku.

4.7 Penggunaan media sosial oleh masyarakat dalam lembangan Sungai Kelantan sebelum bencana berlaku majoritinya adalah untuk berkomunikasi dan berkongsi maklumat. Semasa bencana berlaku bentuk penggunaan media sosial lebih cenderung kepada mendapatkan pertolongan, mengetahui situasi semasa banjir dan penggunaan media sosial selepas bencana juga adalah untuk mendapatkan pertolongan dan mengetahui situasi terkini di lokasi bencana.

4.8 Secara keseluruhannya, kajian ini mencadangkan penggunaan tiga media media utama iaitu Facebook, SMS dan Whatapps sebagai alat penyebaran maklumat atau sistem amaran awal kepada masyarakat di lembangan Sungai Kelantan. Namun begitu, untuk mengelakkan berlaku penyebaran maklumat palsu penggunaan SMS adalah lebih berkesan berbanding media-media sosial yang lain.

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EMERGENCY AND RESPONSE PLANNING (ERP): SIMULATION ON COORDINATION OF INTER AGENCY IN FLOOD CATASTROPHIC EVENT

Project Information

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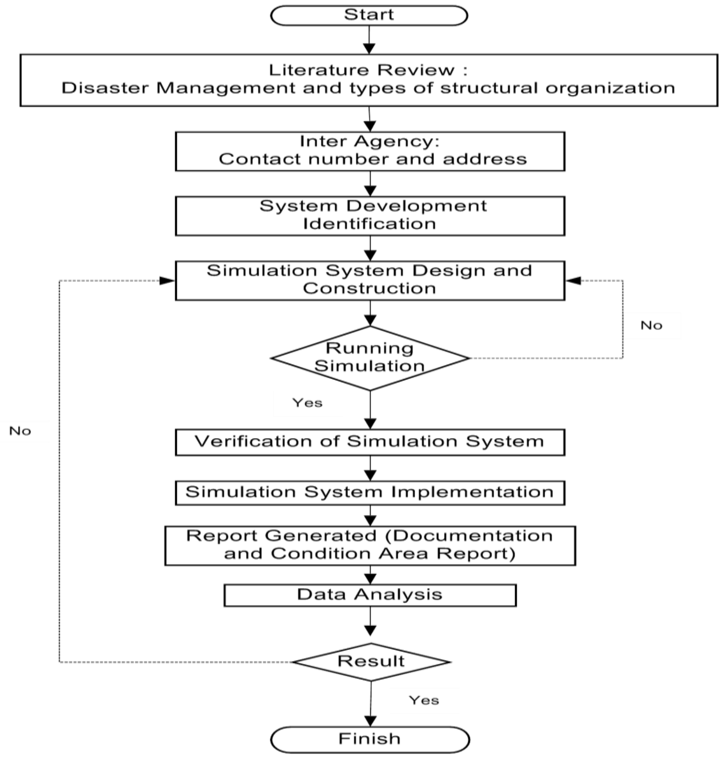
1.0 Introduction

In Malaysia, flood is the most significant of natural hazard (WECAM, 2013) and has continued escalate while the country is more developed and the current flood is occur at 2014. It affecting more than 15% of the total population in Malaysia and damage cost is estimated to be a million of Ringgit Malaysia. Thamer *et al.,* (2011). According to EM-DAT (2011) , the frequency of major flooding in Malaysia for the past 50 years, frequency of occurrence, the number of killed, affected and damage loss. Highest frequency of flood has occured in Kelantan or Terengganu area with the percentage area is 38%, followed by Johor of 19% Kedah of 14% and the other state is below than 10% from the total area. However, flooding that occurred on 2014 is higher than 2010 such as reported by awani (2014) that involve 100,000 peoples flood victims. This study focus on data for communication and how to coordinate the interagency were really need to ensure the efficiency and the proper management to cater the flood victims.Thus the delivery of information system for residents' indispensable. Existing detection system not able to deliver the information directly to resident. So it will take more longer times to deliver the information through siren, media such as newspaper, television, or radia to resident. It makes resident lack of time to respond to safe their life and their important goods. Nowadays Mobile wireless devices such as smartphones have become a widespread and typical asset. Flood warning using mobile application that able to give sign via mapping will help the early warning system. This project were identify and listed down all the contact number of state, district and area (Whole country). System was develop and it can found and free access: http//interagensibanjirmalaysia2.weebly.com. System for mobile application has been develop to ensure the data information were given by using GPS.

2.0 Methodology



Concept of flood warning using mobile application

3.0 Results and Discussion

Table 1: Summary of Role, Confidence and Satisfaction level of respondent toward agencies

	Role	Confidence	Satisfaction
MKN	3.33	3.40	3.17
POLIS	3.66	3.62	3.43

BOMBA	3.63	3.94	3.83
HOSPITAL	3.61	3.54	3.63
JPAM	3.77	3.80	3.65

4.0 Conclusion

4.1 This project were identify and listed down all the contact number of state, district and area (Whole country)

4.2 1 council and 4 related agency were evaluate by the despondence and show that the role, confidence level and satisfaction were between 3.17-3.94.

4.3 System were develop and it can found and free access: http//interagensibanjirmalaysia2.weebly.com

4.2 System for mobile application has been develop to ensure the data information were given by using GPS.

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UNDERWATER GROUND MAPPING FOR FLOOD DISASTER USING ULTRASONIC SENSOR

Project Information

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1.0 Introduction

Ultrasound or sonar propagation in waters is greatly influenced by the interaction with both the water surface and the bottom surface. This interaction can be used as a tool for detecting small targets on or beneath the seabed or for examining the physical properties of the surface [1].

Visualization of acoustic wave fronts started to be the object of intensive research in the 1960s. The understanding of acoustic wave fronts and their interaction with objects is important for optimizing both the performance of acoustic sources and detectors and for the generation of structures, surfaces and materials with particular acoustic absorption and scattering characteristics [2]. Moreover, the visualization of acoustic wave fronts represents a reliable test for transducer design or periodic control, i.e., to check if the properties of the generated sound beam still persist over a long-term period [3].

The normal occurring flood water in Malaysia is atypically muddy and full of debris. It is not as clear as normal water. It comprised of sand, mud and many other floating and submerged materials which will hinder the soundwave to not bounce back to the receiver. Other than the flood water condition, the flood current, temperature of the water and the distance of flood-bed are other factors affecting the ultrasonic speed. The stronger the occurring flood current, more noises recorded ultrasonically which will affect the reading. In term of temperature, ultra wave can move smoother if the temperature is warmer. The higher the temperature, better waveform will go through. Lastly, the flood-bed will affect the reading if it comprised of soft sedimentation such as moss or mud, the wave would probably not bounce back.

2.0 Methodology

The concept of the system will be the concept of the autonomous underwater vehicle (AUV) which uses acoustic transmission to map the underwater ground. The same concept used for this project using ultrasound transmission.The prototype uses a 200 kHz frequency which is suitable for the condition on flooded area and the condition of the boat used by the search and rescue (SAR). The ultrasonic are able to penetrate to the smallest resolution object which in this case the minimum resolution is 7.5mm.

$$\lambda = c/f$$

Where λ is the wavelength, c is the speed of sound in water and f is the ultrasound frequency

3.0 Results and Discussion

Three experiments were conducted to find the viability of mapping the underwater depth information and to convert them into mapping data before relaying them to ground station. The results from the three experiments conducted using materials as shown below.

Figure 1: Prototype sensor

3.1 No object

The first experiment is to ensure the prototype does not have any error. The prototype will move along the water tank.

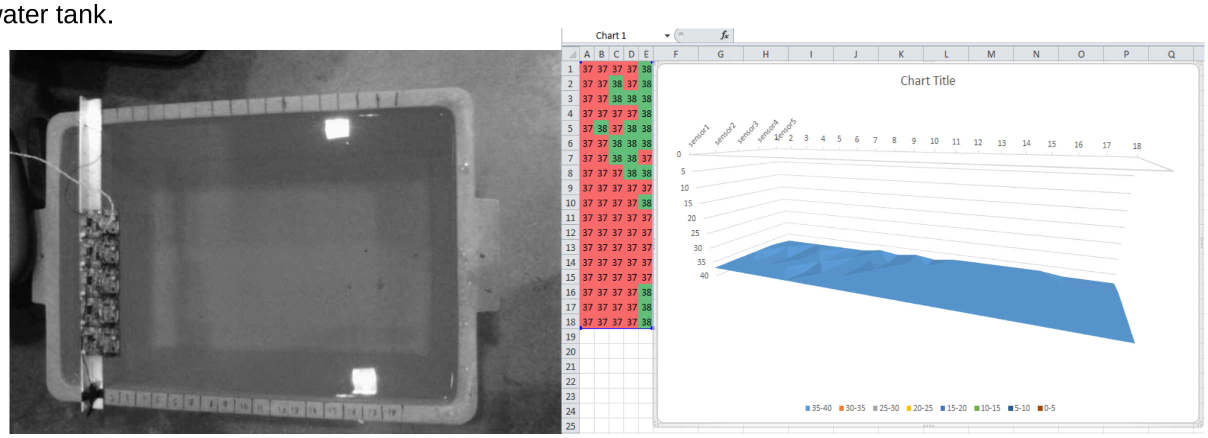

Figure 2: Sensors with empty water tank

In this result we can see that the sensors are functioning. The depth of the water in the tank was confirmed by the sensors.

3.2 Brick as an object

The second experiment is to test the prototype with an obstacle in the water. We used brick because it's a solid material and will easily bounce back the sound signal.

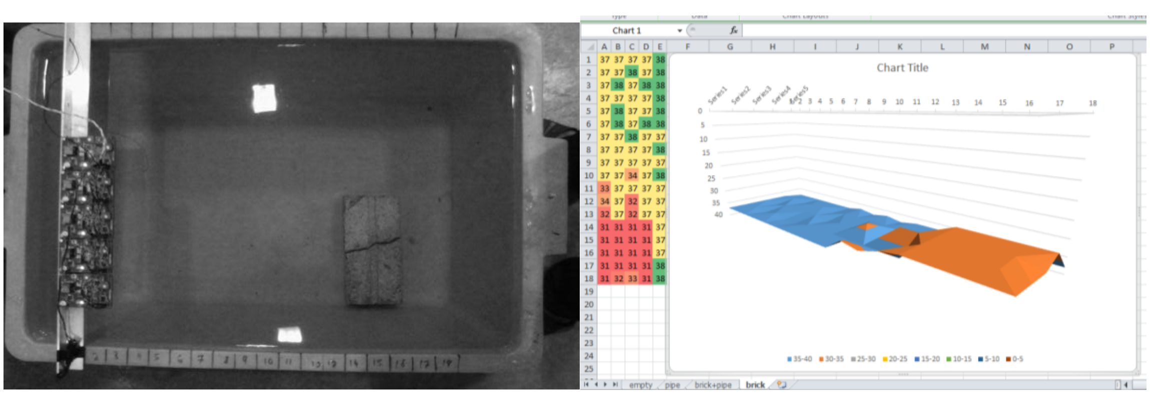

Figure 3: Sensors with brick as object

In this mapping result, the sensors detected the brick at the frequency of 200 kHz due to the thickness of the brick which is more than 3.75mm. The data was processed by the software program to create a shallow part on the map where in figure 6.2 the blue section is deeper than the orange section.

3.3 Brick and PVC Pipe as an object

The final experiment is to test out the brick and PVC pipe together as obstacles.

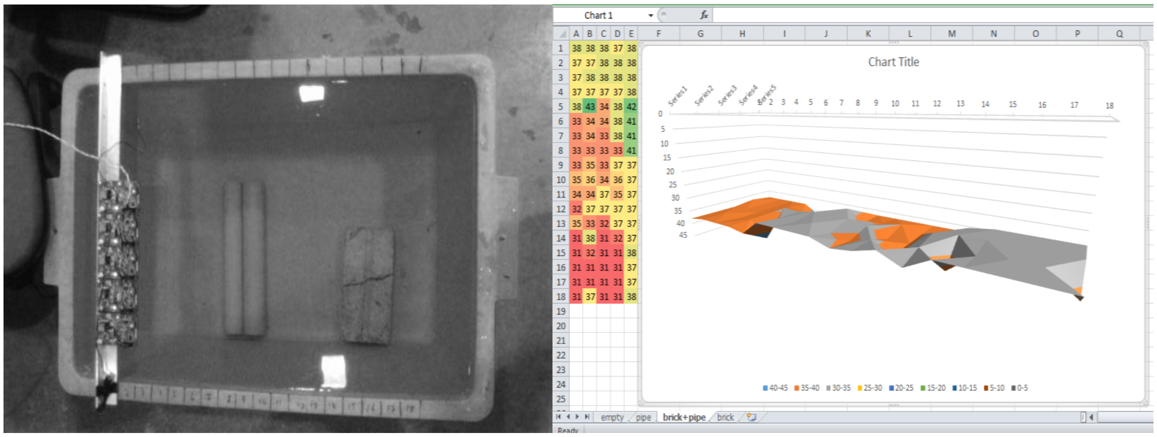

Figure 4: Sensors with brick and PVC pipe as object

In this experiment, the sensors need to pass by the two obstacles, namely PVC pipe and the brick. The result showed that the brick is clearly mapped to be shallow while the PVC pipe, the data indicated that there are some parts that are not detectable. This is due to strength of the sensors frequency of 200 kHz which will penetrate an object that is less than 7.5mm, not bounced back.

4.0 Conclusion

From the present study, the followings can be concluded:

4.1 The results collected from the three experiments using the water tank as simulated flood situation showed the system can be applied to actual flood area.

4.2 More sensors can be installed to get wider map view of depth.

4.3 Mapping of obstacles in the deep and shallow areas can be improved using multi-angle shapes to be more accurate.

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RAPID ASSESSMENT METHOD OF FLOOD DAMAGE USING SPATIAL-STATISTICAL MODELS

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1.0 Introduction

The December 2014's flood has caused huge damage of close to RM 1 billion to the country, exclusive of RM 78 million for cleaning operations in Kelantan. A report quoted that about RM 200 million was estimated for the damage of infrastructure in Kelantan (The Star, 2/2/2015). According to Urban Wellbeing, Housing and Local Government Minister, Datuk Rahman Dahlan, between 2,000 and 3,000 houses in Kelantan were destroyed in the worst flood ever in decades (Azura, 2015). More than 200,000 victims were affected by the massive flood which claimed 21 lives (Anon, 2015).

One of the main concerns of flood is to estimate the extent of damage to properties and other assets. It is an intricate task to perform since damage assessment needs itemized identification and estimate of affected objects. Some studies resort to only assessing flood impact without being able to provide the monetary estimate of the damage (see for e.g. Ab-Jalil and Aminuddin, 2006; Pradan, 2009). Therefore, it is vitally important to devise a rapid assessment method that can provide a reliable method for estimating the monetary loss as soon as flood strikes in a particular location. Flood damage assessment itself is not a new thing; there has been a substantial body of literature dealing with it. However, the techniques are difficult to generalize since they vary and case-to-case.

By applying empirical damage or loss functions meant for compensation, relief, and/or insurance purposes, flood damage rapid assessment method (FD-RAM) seeks to estimate the expected monetary damage as soon as a disaster strikes (Poser and Dransch, 2010). In case of flood, these models calculate the expected damage as a function of inundation depth, building characteristics, and possibly further parameters such as water contamination (Poser and Dransch, 2010).

2.0 Theoretical Background

2.1 Flood Damage Model

For any property, expected physical damage (EPD) is generally modelled as:

$$EPD = f(SD, CD) \qquad (1)$$

where SD is structural damage and CD is content damage. SD comprises damage to land/soil and building while CD can refer to any type and/or amount of 'content' asset. Therefore, 'content' can comprise any moveable asset inside or outside a building such furniture, radio, television, appliance, vehicle, clothes, money, etc. Damage to land/soil is difficult to ascertain. For example, the eroded soil of a land parcel may need to be replaced. Consequently, it incurs re-fill cost. However, the amount of nutrients that is being washed away from a farm as well as re-fill cost are difficult to measure. In the same manner, the number of trees/crop damaged by flood is not easy to quantify.

To overcome the above difficulty, a survey based approach is proposed adopting the model as shown in equation (1). A sample survey needs to be conducted to collect data on the quantum of damage of each property or item at a particular site. For landed properties such as residential, office, and commercial, structural as well as content damages are taken as some percentages of property value. In general, equation (1) can be re-expressed as:

$$\begin{aligned} EPD &= SD + CD \\ &= (.p1*ALV + .p2*ABV) + .p3*(ALV + ABV) \qquad (2) \end{aligned}$$

where ALV = assessed land value; ABV = assessed building value; .p1, .p2, and .p3 = certain defined "proportion" or "percentage" property component's damage in decimal form. ALV, ABV, and any other 'content' asset can be estimated by replacement cost approach. Alternatively, market value (MV) of property can be used in place of ALV and ABV if sales data are available.

For agricultural properties, damage can occur to land/soil (structure) and tree/crop (content). Again, it is difficult to ascertain damage to these elements. For compensation purposes, land/soil damage can be estimated as a percentage of market value of a particular type of agricultural property but tree/crop damage is much more difficult to estimate. The general formula for damage estimation of agricultural properties with immature trees/crop is modified from equation (2) as follows:

$$\begin{aligned} EPD &= SD + CD \\ &= \text{land/soil} + \text{tree/crop} \\ &= .q1 * MV + n[(c-d)(1+i)^t] \end{aligned} \tag{3}$$

where MV = market value of a particular type of agricultural property (alternatively, actual replacement cost can be used); .q1 = a defined proportion in decimal form; c = cost of replacement new of the tree/crop; i = discounting rate; t = age of immature crop; n = number of damage trees/crop.

However, this formula cannot be used directly without modification based on the type of agricultural property under view. For example, damage to annual and perennial crop such as banana, maize, rubber, oil palm, cocoa, and orchard trees need to be estimated by "individual" tree counting – a daunting, if not impossible, task in FD-RAM. As another example, the immaturity period is different for different crops. For instance, the immature period for oil palm is four years, rubber five years, while for some orchard trees, this period may be up to seven years.

A sample survey in the disaster area is needed in order to compute the reasonable figures of all the above damage components. Specifically, a priori information is needed to compute .p1, .p2, and .p3.

2.2 Rapid Damage Assessment Procedure

The whole procedure of rapid assessment of flood damage is part of the general concept of decision support system promoted by Malczewski (1997). Ideally, it should become part of national disaster management programs of any country troubled by the disaster. The actual implementation of flood damage rapid assessment method is rather complex. It has two main components, namely mapping component and spatial modelling component.

The mapping component has the following mapping activities: boundary of study area; and distribution of poor population; sampling points to compute asset value, particularly building and land value. Geographic Information System (GIS) is a standard method for flood mapping through various kinds of software such as ArcGIS, MapInfo, Idrisi, etc. One of the most widely used GIS software is Environmental System Research Institute's (ESRI) ArcGIS 10.x.

The spatial modelling process has the following modelling activities: flood inundation coverage/flood modelling based on rainfall-runoff method; spatial flood damage-estimating model; and general damage estimate. Fundamentally, we can specify flood damage-estimating model in a number of ways (Messner *et al*., 2007; Merz *et al*., 2010; Green *et al*., 2011). Factors such as flood depth, velocity, duration, water contamination, precaution, and warning time can be included. However, inclusion of flood factors cannot be generalized and is very much determined by data availability.

One potential spatial flood damage-estimating model is Geographically Weighted Regression (GWR) originally developed by Fotheringham *et al.* (2000; 2002; 2005). Suppose we had some location in the study area, perhaps one of the data points, where (x,y) are the coordinates of its position. We can rewrite the model, in vector form as:

$$V(x,y)W = W(x,y)a + W(x,y)Z + W(x,y)e \tag{4}$$

where *V* is value of damage, *a* is regression's intercept, *Z* represents hydrological, physical, environmental, and socio-economic variables/factors, W is spatial weight matrix, *e* is error term, and is some measure of spatial component of data points. This relationship is fitted by least squares to give an estimate of the parameters at the location (x,y) and a predicted value. This is achieved through the implementation of the geographical weighting scheme. The weighting scheme is organized such that data nearer (x,y) is given a heavier weight in the model than data further away.

Using OLS, the parameters for a linear regression model is obtained by solving:

$$\beta = (Z^T Z)^{-1} Z^T V \tag{5}$$

The parameter estimates for GWR are solved using a weighting scheme:

$$\beta(g) = (Z^T W(g)X)^{-1} Z^T W(g)V \quad (6)$$

The weights are chosen such that those observations near the point in space where the parameter estimates are desired have more influence on the result than observations further away. Two functions we have used for the weight calculation have been (a) bi-square and (b) Gaussian. In the case of the Gaussian scheme, the weight for the i_{th} observation is:

$$w_i(g) = \exp(-d/h)^2 \quad (7)$$

where *d* is the Euclidean distance between the location of observation *i* and location *g*, and *h* is a quantity known as the bandwidth. (There are similarities between GWR and kernel regression). One characteristic that is not immediately obvious, is that the locations at which parameters are estimated need not be the ones at which the data have been collected.

The resulting parameter estimates are mapped in order to examine local variations in the parameter estimates. One might also map the standard errors of the parameters estimates as well. Hypothesis tests are possible - for example one might wish to test whether or not the variations in the values of a parameter in the study area are due to chance. The bandwidth may be either supplied by the user, or estimated using a technique such as cross validation technique. The (x,y)s are typically the locations at which data are collected. This allows a separate estimate of the parameters to be made at each data point. The resulting parameter estimates can them be mapped.

Flood Loss Estimation Model for the private sector (FLEMOps) on the meso scale (Thieken et al., 2008) is applied with some adaptation to the location situations. This model calculates the damage ratio for residential buildings as a function of inundation depth classified into five classes and building characteristics, i.e. three buildings types and two building qualities. To be applicable on the meso scale, mean building composition and the mean building quality per municipality were derived and the resulting damage ratios are multiplied by total asset values disaggregated to land use units (Thieken et al., 2005).

Spatially assessed flood damage by kriging technique is used in performing data analysis. A modified Ordinary Least Squares technique, kriging adopts weights to the surrounding measured values to derive a prediction for an unmeasured location. The general formula for both interpolators is formed as a weighted sum of the data:

$$\hat{Z}_{(S_0)} = \sum_{i=1}^{N} \lambda_i Z(S_i) \quad (8)$$

where $\hat{Z}_{(S_0)}$ = weighted sum of values; $Z(S_i)$ = the measured value at the i*th* location; λ_i = an unknown weight for the measured value at the ith location; s_0 = the prediction location; N = the number of measured values.

In the kriging technique, the weights (represented by λ_i) are based on both the distance between the measured points and the prediction location and also the overall spatial arrangement of the measured points. To use the spatial arrangement in the weights, the spatial autocorrelation must be quantified.

In the ordinary kriging, the weight, λ_i depends on a fitted model to the measured points, the distance to the prediction location, and the spatial relationships among the measured values around the prediction location. The following section briefly discusses how the ordinary kriging formula is used to create a map of the prediction surface and a map of the accuracy of the predictions.

There are a number of kriging techniques discussed in the literature. However, to avoid cumbersome discussion, we would only adopt ordinary kriging in this study. Ordinary kriging estimates the unknown value using weighted linear combinations of the available sample (Isaaks and Srivastava, 1989):

$$\hat{v} = \sum_{j=1}^{n} w_j * v \qquad \sum_{i=1}^{n} w_i = 1 \quad (9)$$

The error of i*th* estimate, r_i, is the difference of estimated value and true value at that same location:

$$r_i = \hat{v} - v_i \quad (10)$$

The average error of a set of k estimates is:

$$m_\tau = \frac{1}{k}\sum_{i=1}^{k} r_i = \frac{1}{k}\sum_{i=1}^{k} \hat{v}_i - v_i \tag{11}$$

The error variance is:

$$\delta_R^2 = \frac{1}{k}\sum_{i=1}^{k}(r_i - m_R)^2 = \frac{1}{k}\sum_{i=1}^{k}\left[\hat{v}_i - v_i - \frac{1}{k}\sum_{i=1}^{k}(\hat{v}_i - v_i)\right]^2 \tag{12}$$

However, we cannot use the equation because we do not know the true value $V_1,...,V_k$. In order to solve this problem, we apply a stationary random function that consists of several random variables, $V(x_i)$. X_i is the location of observed data for i > 0 and i ≤ n. (n is the total number of observed data). The unknown value at the location X_0 we are trying to estimate is $\tilde{V}(x_0)$. The estimated value represented by random function is:

$$\tilde{V}(x_0) = \sum_{i=1}^{n} w_i * V(x_i)$$

$$R(x_0) = \tilde{V}(x_0) - V(x_0) \tag{13}$$

The error variance is:

$$\tilde{\delta}_R^2 = \tilde{\delta}^2 + \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \tilde{C}_{ij} - 2\sum_{i=1}^{n} w_i \tilde{C}_{i0} + 2\mu(\sum_{i=1}^{n} w_i - 1) \tag{14}$$

$\tilde{\delta}^2$ is the covariance of the random variable $V_{(X0)}$ with itself and we assume that all of our random variables have the same variance while μ is the Lagrange parameter.

In order to get the minimum variance of error, we calculate the partial first derivatives of the equation (11) for each *w* and setting the result to 0. The example of differentiation with respect to *w* is:

$$\frac{\delta(\tilde{\sigma}_R^2)}{\delta w_1} = 2\sum_{j=1}^{n} w_j \tilde{C}_{1j} - 2\tilde{C}_{10} + 2\mu = 0 \qquad \sum_{j=1}^{n} w_j \tilde{C}_{1j} + \mu = \tilde{C}_{10} \tag{15}$$

All of weight w_i can be represented as:

$$\sum_{j=1}^{n} w_i \tilde{C}_{ij} + \mu = \tilde{C}_{i0} \tag{16}$$

For each *i, 1 ≤ i ≤ n*

We can get each weight W_i through equation (13). After getting the value, we can estimate the value located in X_0. We can use variogram instead of covariance to calculate each weight of equation (12). The variogram and minimized estimation variance are:

$$\gamma_{ij} = \tilde{\delta}^2 - \tilde{C}_{ij} \tag{17}$$

$$\tilde{\delta}_R^2 = \sum_{i=1}^{n} w_i \gamma_{i0} + \mu$$

The kriging module includes two variogram models:

Spherical

$$\tilde{\gamma}(h) = \begin{cases} C + C\left(1.5\frac{h}{a} - 0.5\left(\frac{h}{a}\right)\right)^3 & if\,|h| \le a \\ C_0 + C_1 & if\,|h| > a \end{cases} \tag{18}$$

Exponential

$$\tilde{\gamma}(h)=\begin{cases}0 & if\,|h|=a\\ C_0+C_1\left(1-\exp\left(\dfrac{-3|h|}{a}\right)\right) & if\,|h|>a\end{cases} \tag{19}$$

Nugget effect **(c_0)**

Though the value of the variogram for h = 0 is strictly 0, several factors, such as sampling error and short scale variability, may cause sample values separated by extremely small distances to be quite dissimilar. This causes a discontinuity at the origin of the variogram. The vertical jump from the value of 0 at the origin to the value of the variogram at extremely small separation distances is called the nugget effect (Isaaks and Srivastava, 1989).

Range **(a)**

As the distance of two pairs increases, the variogram of those two pairs also increases. Eventually, the increase of the distance cannot cause the variogram to increase. The distance which causes the variogram to reach plateau is called range (see Figure 1).

Sill **(C_0 + C_1)**

It is the maximum variogram value which is the height of plateau (see Figure 1).

Distance **h**

It is the distance between estimated location and observed location.

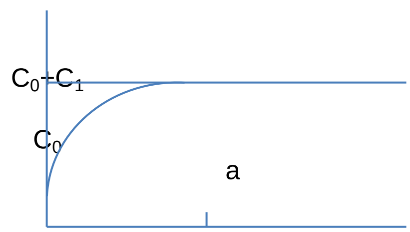

Figure 1: An Example of Exponential Variogram Model

Equation (16) can be written in matrix notation as **V * W = D** where V is (n+1) x (n+1) matrix which contains the variogram of each known data. The components of last column and row are 1 and the last component of the matrix is 0; W is (n+1) matrix which contains the weight corresponding to each location. the last of component of matrix is Lagrange parameter; and D is (n+1) matrix which contains the variogram of known data and estimated data. The last component of the matrix is 1.

Since V and D is known, we can get the unknown matrix W by **W = invert(V) * D**. Applying equation (13), we can get the estimated value on a specific location. We also can get the error variance from the square root of equation (17).

3.0 Methodology

A sample-based flood damage survey was conducted in early 2015 in Kuaka Krai and Dabong. This study area was chosen because it was the most severely-hit sub-region of the state of Kelantan. Furthermore, state-wide FD-RAM was not possible due to data and financial limitations. Sample-based field inspections were conducted to estimate flood damage to buildings, trees, and other items. Since it was very difficult to account for each item damaged by flood, this study was confined only to estimating damages of residential and agricultural properties. Some moveable assets categorised as “contents” (e.g. furniture, house appliance, equipment), were, however, accounted for. As many as 336 geo-referenced sites (longitude and latitude in metres) within the flood inundated river corridors were sampled and mapped as “survey points” shape file (see **Figure 2**).

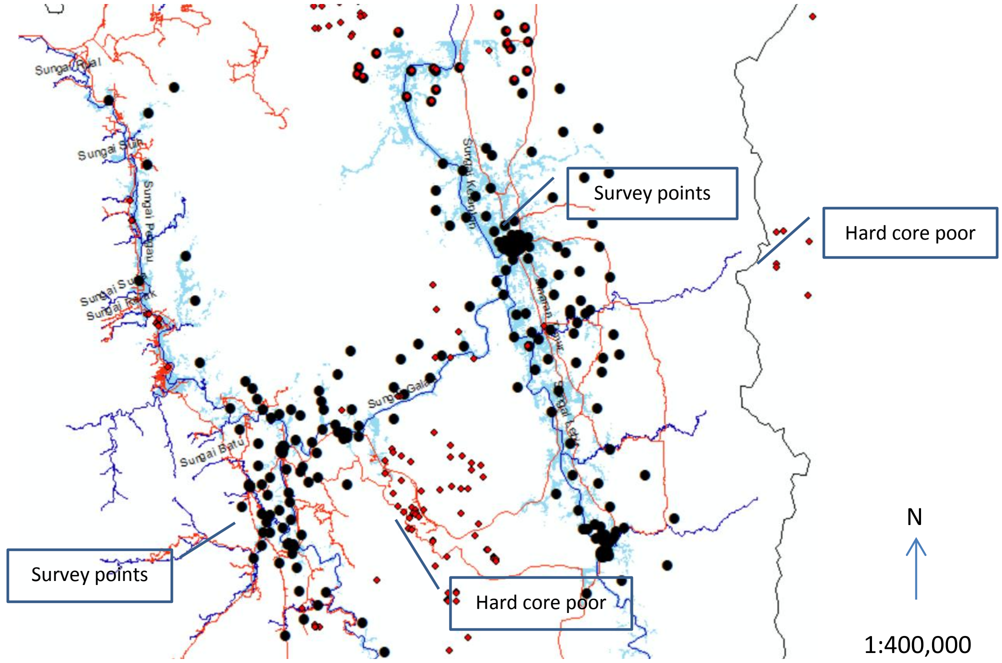

Figure 2: Survey points shape file in the selected study area. These survey points include locations of some hard core poor's homes (smaller dots)

Data on flood-related factors were collected at each sampled location, namely land value (asking price) (RM/acre); building value (replacement cost new) (RM/unit); proportion of structural damage (%); proportion of content damage (%); current use (forest, agriculture, natural vegetation, urban, transport, built-up); use activity (rubber, oil palm, orchard, water body, road, vacant, residential); structural type (soil, building); content type (tree, building, miscellaneous items); and flood depth (feet). All of the information was formatted as attribute table of the "survey points" shape file in ArcGIS software. The purpose of this shape file was to enable spatial modelling of flood damage using Geographically Weighted Regression (GWR) technique based on the following specification:

TotDmg = f(Curuse, Activ, Structy, Contyp, Flo_dep) (18)

where TotDmg = Total flood damage (RM); Curuse = Current use; Acti = Use activity; Structy = Structural type; Contyp = Content type; and Floo_dep = Flood depth (feet).

Damage estimation according to of property type is given as in equations (1) and (2) above. Spatially assessed flood damage by kriging technique was used in performing data analysis.. Flood damage was calculated as follows:

TotDmg = ContDmg1 + ContDmg2 + StrDmg1 + StrDmg2

where ContDmg1 = CD_P x Buildv x ef; ContDmg2 = CD_P x Landv x ef; StrDmg1= SD_P x Buildv x ef; StrDmg2 = SD_P x Landv x ef. [ef = 1 IF sampled point = Residential/building; ef = 0 IF sampled point = Agriculture/forest]

where CD_P = % of content damage; SD_P = % of structural damage; Landv = land value (RM/unit); and Buildv = building value (RM/unit).
In the damage assessment process, the following guide was used:

ContDmg1 = content damage for residential/building

ContDmg2 = content damage for agricultural crop/forest
StrDmg1 = structural damage for Residential/building
StrDmg2 = structural damage for agricultural crop/forest

Building value was estimated based on replacement cost new (RCN) of the original building. This was a challenging process since RCN cannot easily and accurately be estimated. Although the ideal method was to base value estimates on official government valuation, this was not possible due to resource constraints. The regression procedure for the above specification followed the steps as outlined in equations (4) through (17). GWR was run to relate flood damage (content & structural) with their influencing factors, namely current land use (Curuse), land use activity (Activ), property structural type (Structy), and flood depth (Flo_dep).

Once outputs were generated, superimposition process was performed whereby land use map was overlaid on modelled flood, and GWR-kriged flood damage estimate. A manual process of identifying, listing, and estimating damages of various types of properties was carried out using this superimposed map. (See example in Figure 3.)

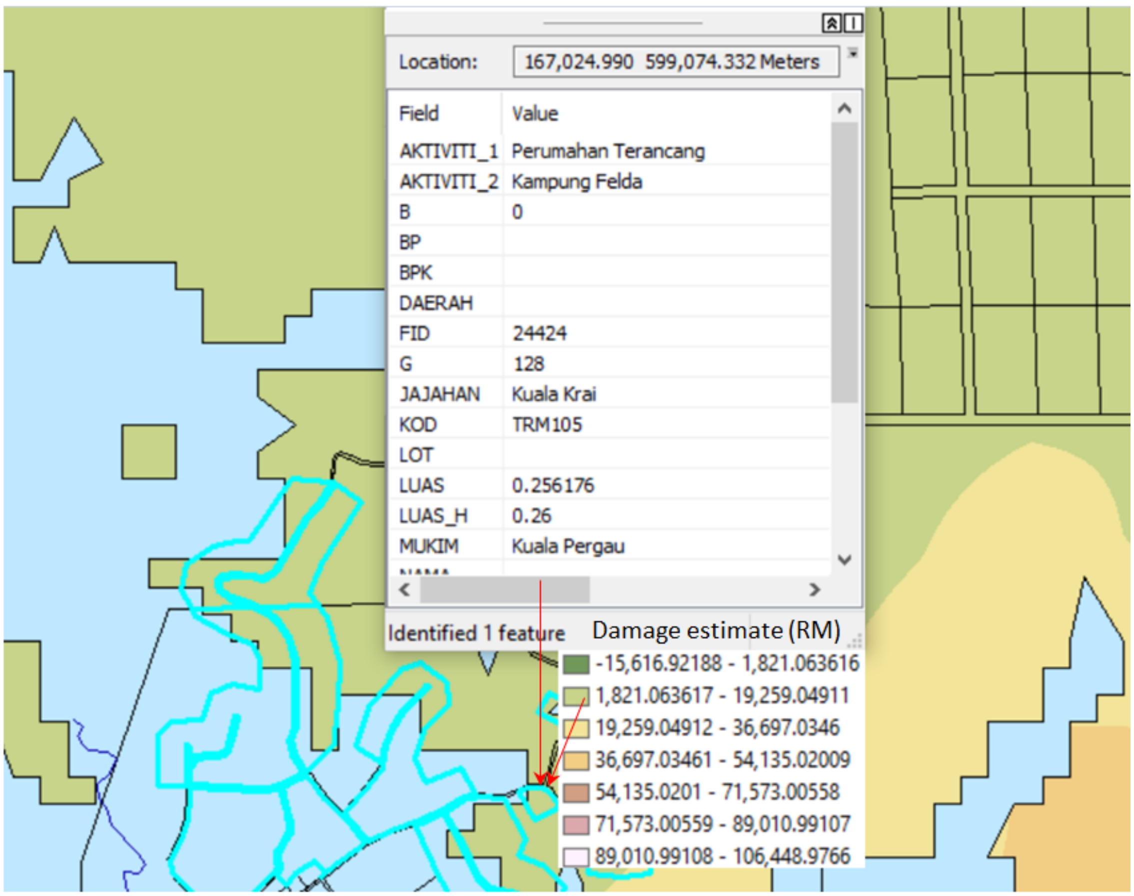

Figure 3: Screen shot of an overly of land use, modelled flood, and GWR-kriged flood damage estimate

4.0 Results and Discussion

Figure 4 shows flood hazard superimposed on GWR-kriged flood damage map over the study area.

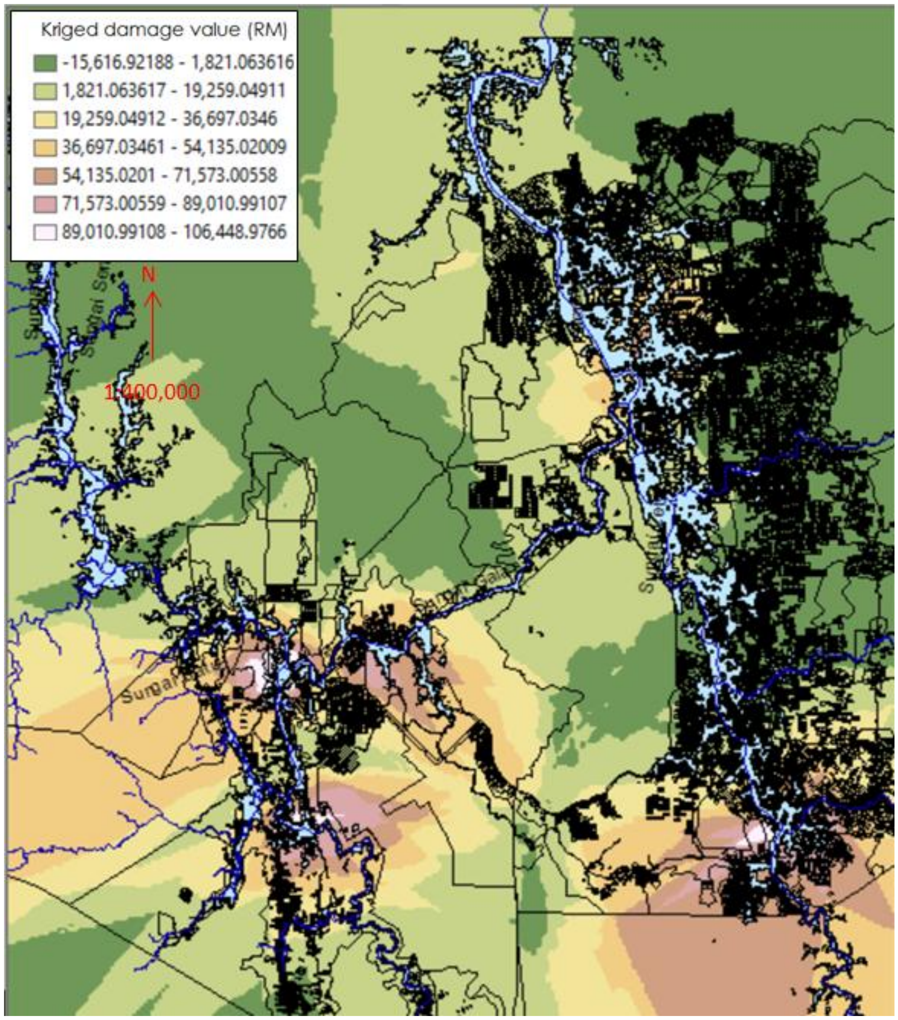

Figure 4: Flood hazard superimposed on GWR-kriged flood damage map

Flood damage and, thus, flood risk is higher in densely populated locations such as urban or residential areas. Besides, sites closer to river banks (say, less than 1 km) were mostly exhibited greater flood depth. Other factors also contribute to the magnitude of damage.

The regression results are shown in Table 1. The performance of the GWR was very modest with a local R^2 of only 0.58. This reflects the shortcoming in modelling spatial relationship of flood damage since, apart from land use factors, many other hydrological and geomorphological factors were not included in the model specification due to data limitation.

From **Table 1**, flood depth was found to be significantly influencing flood damage. Content type was also significant to property damage while other land use factors did not show statistical significance. With respect to content type, miscellaneous contents of moveable property such as furniture and appliances could have incurred damage of RM 31,221 more than other types of contents such as trees and vegetation whenever there was flood inundation in the study area.

Table 1: General statistical results of Geographically Weighted Regression (GWR)

VARNAME	VARIABLE	DEFINITION
Bandwidth	26,115.340592	
Residual Squares	506,075,220,856.614	
Effective Number	15.870035	

Sigma		3,9697.86226				
AICc		8,105.709384				
Dependent: TotDmg				Total flood damage (RM)		
Local R^2	0.58					
R^2 Adjusted	0.56					
Residual	1,480.77					
Standard Error	38,692.17					
Std. Residual	0.03					
Sample size	336					
	Coefficient	Std. error	t-value	Min	max	95% confidence
Intercept	-26,585.93	5,681.39	-4.68	-31,286.39	-16,581.87	332.69
Current use (Curuse)	24,545.44	21,285.12	1.15	18,093.14	42,160.54	574.24
Activity (Acti)	13,029.86	17,976.61	0.72	-4,936.35	21,905.10	523.05
Structural type (Structy)	8,150.71	19,128.44	0.43	-5,129.26	32,765.70	1,103.62
Content type (Contyp)	31,221.04	18,104.81	1.72	15,234.98	36,765.76	396.62
Flood depth (Floo_dep)	5,547.52	873.03	6.35	3,659.86	6,808.20	97.33

By manually using the GIS map, various types of properties were identified and listed together with their corresponding damage (see Table 2). Many places were severely inundated, more than 70% in some cases.

Table 2: Flood inundation over some selected land uses in the study area – GIS analysis

Land use	Total area (ha.)	Total inundated area (ha.)	Approx (%)	Structural Damage (%)	Content Damage (%)	Area Affected (structural) (ha.)	Area Affected (content) (ha.)
Kediaman:							
Kampung Felda	310.16	92.26	30	0	45	0.00	1.45
Kampung Setinggan	0.67	0.18	27				
Kampung Tersusun	112.36	90.33	80	55	61	0.76	0.85
Kampung Tradisi	147.21	128.23	87	70	72	6.00	6.18
Perumahan Strata	0.03	0.03	100				
Perumahan Bukan Strata	56.89	43.01	76	80	94	1.00	1.17
Perumahan Kakitangan	10.54	10.27	97				
Perumahan Ladang/Estet	42.11	11.52	27				
Perniagaan dan Perkhidmatan:							
Perniagaan Terancang	31.71	20.91	66	50	60	0.02	0.02
Perniagaan Tidak Terancang	30.26	22.17	73				
Pertanian:							
Getah	74233.19	46415.61	63	30	7	5326.82	1242.92
Kelapa Sawit	8825.22	5947.63	67	0	11	0.00	354.53
Padi	373.67	172.03	46				
Dusun	5671.7	2795.32	49	63	90	3.71	5.30
Tanah Terbiar (Pertanian tidak diusahakan)	746.82	643.37	86	0	5	0.00	0.39
Industri:							

Industri Terancang	94.44	66.68	71				
Industri Tidak Terancang	71.77	51.42	72				
Infrastruktur dan Utiliti:							
Bekalan Air	8.38	7.1	85				
Bekalan Elektrik	352.68	270.79	77				
Pengairan dan Perparitan	12.4	6.87	55				
Telekomunikasi	2.06	1.11	54				
Institusi dan Kemudahan Masyarakat:							
a) Keagamaan							
Masjid	21.45	10.46	49				
Surau	2.6	1.31	50				
Tokong	0.36	0.36	100				
Kuil	0.27	0.16	59				
b) Kegunaan Kerajaan/Badan Berkanun:							
Pejabat Kerajaan/Agensi Kerajaan	46.15	35	76	50	60	0.03	0.03
Badan Berkanun	37.5	37.4	100	50	60	0.03	0.03
c) Keselamatan							
Balai Polis	5.02	5.02	100				
Balai Bomba	0.4	0.4	100				
Pondok Polis	4.71	3.89	83				
Kem Tentera	7.3	7.3	100				
d) Kesihatan							
Klinik Kesihatan	9.07	9.07	100				
Klinik Desa	6.3	2.23	35	0	0	0.00	0.00
Hospital	4.23	4.23	100				
e) Pendidikan							
Tadika	4.82	2.02	42				
Sekolah Rendah	130.07	91.36	70	30	50		
Sekolah Menengah	55.8	49.24	88				
Sekolah Agama	13.76	9.31	68				
Institut Latihan	0.33	-					
f) Perkuburan							
Islam	46.3	34.75	75	60	65		
Cina	11.06	11.06	100				
Hindu/Sikh	0.58	0.58	100				
g) Lain-lain Kemudahan Masyarakat							
Balai Raya	1.75	1.25	71				
Dewan Serbaguna Awam	0.79	0.26	33				
Dewan Orang Ramai	0.95	0.67	71				
Perpustakaan Awam	1.66	0.39	23				
Lain-lain:	0.85	0.21	25				
Pusat Rukun Tetangga Kuala Krai							

Pusat Aktiviti Rukun Tetangga							
Pusat Sumber KEMAS / Pusat Literasi Komputer							
Pusat Kominiti Desa							
Dewan Rukun Tetangga Taman Gucil Jaya							
Pengangkutan:							
Jalan	1338.65	1082.19	81	60	56		
Stesen Bas	0.29	0.29	100				
Stesen Keretapi	4.36	4.36	100				
Penternakan dan Akuakultur	44.67	2.37	5				
Tanah Kosong	836.17	633	76	63	46		
Hutan	28916.39	70860.78	55	0	0		
Tanah Lapang dan Rekreasi	900.69	835.07	93	55	54		

* Expressed as number of units rather than area of land (ha.)

No data were available on the map

To further illustrate the use of FD-RAM, **Figure 5** took a group of hard core poor people as a case. The map indicates that the hard core poor group experienced low to severe flood damage. Most of them experienced a total flood damage of about RM 10,000/household. This a was quite small figure and was not surprising as many of them did not own high-value property. Nonetheless, this damage was about 26 times their monthly income and can be considered a huge suffering for a hard core poor family. The model, however, suffered from prediction inaccuracy and, thus, overstressing on damage figure may not be desirable due to possible over- or underestimation in the assessment process.

Not all of hard core poor in the study area were affected by flood and, thus, those hit must be identified. This was done by picking the affected hard core poor's homes from the map via clipping menu available in ArcGIS. In this case, modelled "flood polygon" layer was clipped onto "survey points" layer. The resulting clipped layer was then superimposed on another layer, namely kriged estimated total flood damage (ETFD). **Figure 5** shows the locational distribution of hard core poor which was superimposed over kriged values of estimated total flood damage (ETFD) modelled using Geographically Weighted Regression based on equation (17). By this way, the hydrological and physical aspects of flood were factored into flood damage-estimating model.

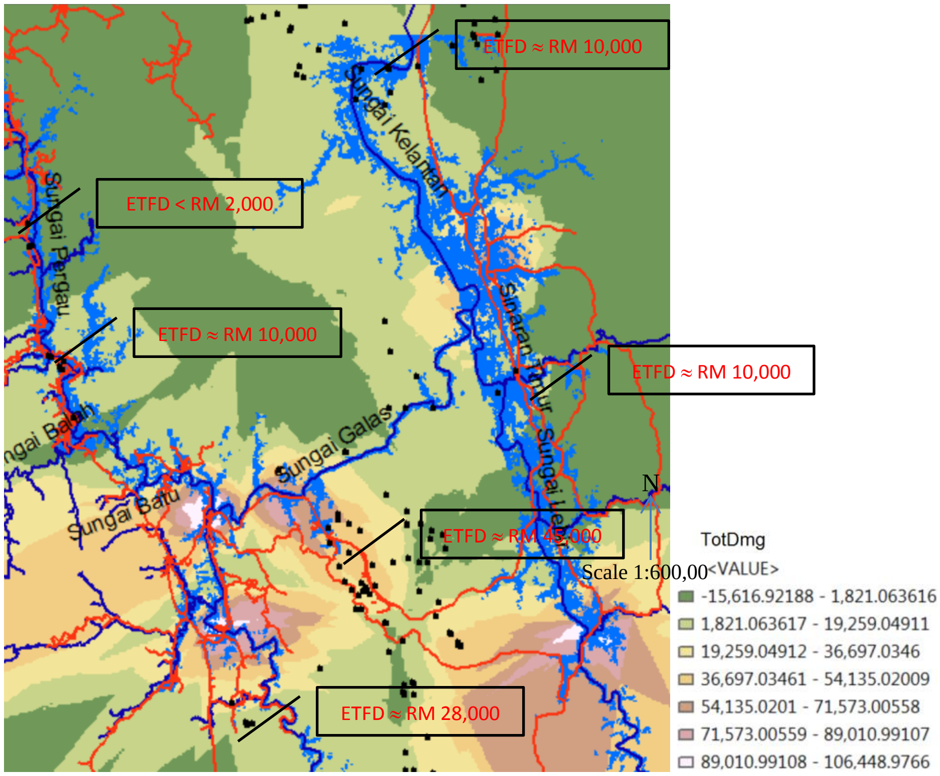

Figure 5: Kriged value of estimated total flood damage (ETFD) based on Geographically Weighted Regression among hard core poor (black dots) in the study area. Figures shown are middle-values of ETFD.

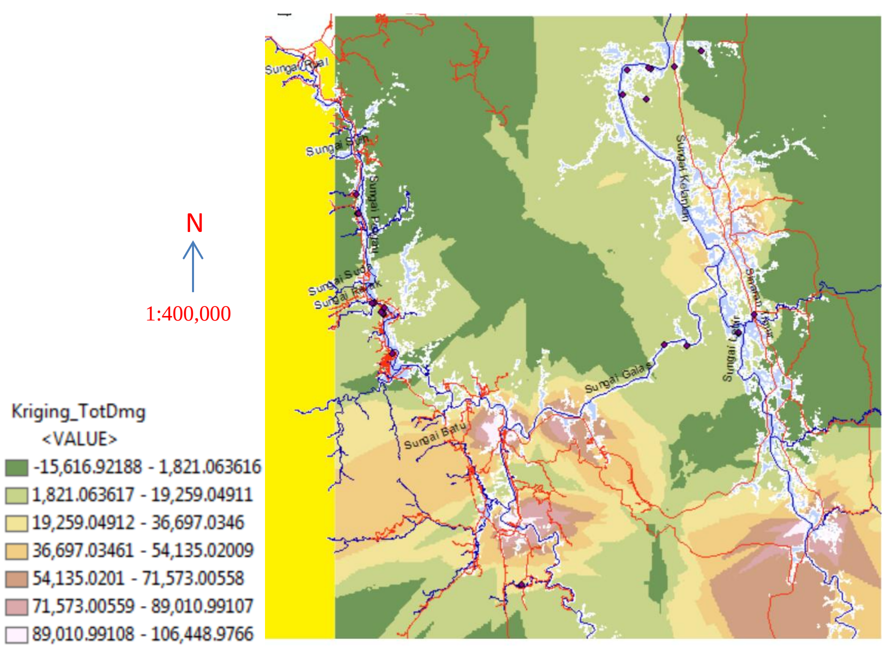

Figure 6: Identification of flood-hit hard core poor by ArcGIS procedure

4.0 Conclusion

Although accurate estimate was not the focus of this study, being able to derive some initial figure of flood damage is an important aspect of emergency relief and recovery program by the authority. The ability of knowing the ‘possible’ amount of damage at a specific site is an additional useful piece of information to the government.

The usefulness of rapid damage assessment of flood disaster largely depends on the completeness of data and accuracy of damage-estimating model. The correct GWR model specification that will result in satisfactory results was rather difficult and the available body of literature was not that useful to identify all the correct variables to include. Trial and error specification and test of the candidate variables such as those of geomorphological, hydrological, physical demanded a lot of data collection that was not possible due to resource constraint.

Accurate identification of ‘itemised objects’ affected by flood is always a problem of flood damage estimation. In this study, only content and structural damage of certain types of property/asset were quite conveniently accounted for their respective owners their respective owners their respective owners. Moveable assets such as vehicle, machinery, agricultural tools, etc. were not easily taken into account for various technical reasons. Assignment of damages of crops and animals to their respective owners was also difficult especially for those whose properties/assets were located on different sites away from their living premise.

Estimating flood damage was very challenging particularly in choosing the most appropriate approach of valuation. Cost, market and investment approaches are legitimate bases of asset valuation but none can be suitable for all situations and for all property types. Detailed examination of the property is thus necessary before deciding on the appropriate approach to valuation. This was simply not possible in rapid damage assessment procedure.

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A FEASIBILITY STUDY OF A DISASTER MANAGEMENT HUB USING PREDICTIVE-ANALYTICS AND MODELLING TECHNIQUE BASED ON CROWDSOURCED DATA

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1.0 Introduction

Information are crucial to assess situations during disaster time. Furthermore, a clear assessment and judgment call can be established as a result of a clear flow of information. The use of social media has enabled its users with near real-time update of happenings around the globe. One of the benefits of a socially connected community is that pools of user generated information are abundant during an event of a natural disaster. Studies from recent disaster events such as the Queensland and Australian floods, the Christchurch earthquake and the Japan earthquake have shown that crowd source information could be used and can be treated as the first response point to gain important information of the disaster in terms of crowd, aid and recovery. In our study, we have examined the possibility of applying localized crowd source information pool to manage flood disaster in Malaysia. The study considered the feasibility of implementing a crowdsourced based on two factors which are community preparedness and infrastructure readiness with regard on the use of the Ushahidi framework as the crowd source engine. We also presented a standardized operating procedure that could be applied in conjunction with the implementation of the proposed framework to effectively manage the situation should the need arise.

2.0 Methodology

Briefly, our study followed this for steps extensively:

1. Identification and preparation phase
   - Identify flood disaster management requirement based on prevention, preparedness, response and recovery of previous event.
   - Identify participants ranging from volunteers, NGO and local authorities to set up the test case crowd sourcing framework.
   - Identify proper method of information verification for each pool of data collected based on previous events.
2. Framework deployment based on the identified requirement
3. Simulated testing based on scenarios.
   - Alpha testing
   - On site testing with collaborators
4. Feasibility Analysis
   - Produce a manual of standard operating procedure for crowd source volunteer and also the authorities on how the collected data need to be used and utilised during the actual event.

3.0 Results and Discussion

3.1 The crowdsource hub could assist the related authorities to visualize and assess the situation on the field in near real time.

3.2 Reports visualization are done based on the number of response for call and rescue, supply and resource allocation and the capacity of the relief centers. This could greatly enhance the decision making of the officials during resource allocation and rescue effort during the disaster. It can also assist the restoration works based on the visualized information displayed on the map.

3.3 Although it is based on the concept of crowdsourcing, the center of control should still be maintained by the authority. Proper standard operating procedures still need to be followed according to the MKN arahan 20 document.

3.4 Its constraints are the portability of the system and accessibility to the application for technologically challenged area. This must be considered for future enhancement and research possibilities.

4.0 Conclusion

The hub can be utilized based on gathered information from the community and also the relevant authorities to visualize the situation and channel relevant assistance effectively during disaster. Although the main focus of the paper is for flood disaster, the hub can also be used for other disaster under the MKN 20 jurisdiction that can benefit the community and also nation as a whole. The factors affecting its feasibility are mainly technological and logistics. Those factors must be considered to ensure its optimal execution during disaster.

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RESQ BANJIR: A MOBILE APPS FOR EMERGENCY RESCUE, EVACUATION AND RELIEF CENTER MANAGEMENT

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1.0 Introduction

A quick disaster response for relief needs after such disaster is vital to alleviate a disaster's impact in the affected areas. In Malaysia, the management of disaster is executed through the committee system aptly called The Disaster Management and Relief Committee (A. Bahari et.al, 2007). One of the main issues faced during a disaster especially for the SOS notification is the difficulties that victims faced in sending emergency requests from their current location due to infrastructure failure. Such limitation has led to the difficulty in locating the victims and coordinating the required rescue operation with the rescue teams (N. W. Chan, 1995, M. Abdul Malek, 2005, SMSBanjir, 2014). Such limitation led to the difficulty in locating the victims, which affected the effectiveness of coordinating a rescue and evacuation operation.

In this research, we develop ResQ Banjir application which consist of Flood Rescue & Evacuation Operation Management (FREOM) and Flood Relief Centre Management (FRCM) to assist in flood disaster management. In these system, we exploits the existing and emerging technologies on smart phones and tablet such as sensors, cameras, GPS, SMS, Location Based System (LBS) and Augmented Reality (AR).

2.0 Methodology

The system was developed based on spiral model System Development Life Cycle (SDLC) approach, where a number of prototypes were produced at the end of each cycle. Each prototype was reviewed and improved until completed. In this research 5 different apps will be developed individually: SOS/SMS banjir, Relief Center Management, Rescue & Evacuation Management (Server), Rescue & Evacuation Operation and AR Tumpat. This research involves 5 stages to develop the proposed ResQ Banjir apps: system analysis, existing apps enhancement and extension, design and development of new module, pilot implementation and testing, and finally assessment and documentation stage.

The initial stage of the development will focuses on the understanding of the existing rescue operations and relief center management with its SOPs. In this stage, users system needs will be identified and analysis of the present system will be done. Next, customization, enhancement and extension of the existing apps particularly "Sistem Penjejakan Jemaah Haji Hilang SMS/GPS" and "Sistem Penjejak Lokasi Makkah AR" will be done based on the users requirements identified. Unit testing will be conducted after the enhancement completed.

For the development of Relief Center Management; we will develop it based on Sahana system architecture and database design. This will enable the apps to be integrated with Sahana especially for data sharing. Users system needs will be identified and analysis of the present system will be done. A total of 11 modules will be developed. Debugging and unit testing process will be involved in the new module development stage. After the completion of system testing; a pilot implementation on the proposed system will be conducted. During the pilot implementation, the proposed system will be tested from various aspects such as performance testing, usability testing, functionality testing, security testing, etc. The pilot testing was done in Tumpat, Kelantan with the assistant of Pejabat Tanah & Jajahan Tumpat, Kelantan. Finally, in the last stage of the research, an evaluation report, system manual and documentation will be prepared.

3.0 Results and Discussion

We have developed the ResQ Banjir System consists of two major applications, which are:

1) the Flood Relief Center Management (FRCM), and
2) the Flood Rescue & Evacuation Operation Management (FREOM).

The FREOM system is a web and mobile apps based system consist of the Rescue & Evacuation Management System (server) for rescue and evacuation operation monitoring & management at the flood operation centre; SOS/SMS Flood apps for sending SOS help by victims; ResQ Banjir Skuad Penyelamat apps which is used by rescue teams to locate and rescue flood victims, and an Augmented Reality (AR) guidance system for location direction navigation guide. The system module consists of the following functions:

- support rescue and evacuation activities;
- flood victims are able to alert rescue and evacuation center their GPS position via SMS (show on map)
- tracking of rescue unit position (show on OSM map)
- tracking of rescue vehicles position (show on OSM map)
- direction and distance guide using AR and smart phone compass technology
- navigation guide
- database of flood information and point of interest (POI) which will be display on the map.
- coordinates rescue and evacuation operation.

FRCM is a web based system which integrates a number of features such as flood relief center registry, shelter activation and management, inventory management and disbursement, and relief aid and goods supplies management. The FRCM consists of the following functions:

- Registration – relief center, staffs, volunteers, victims
- Relief Aid and Goods Supplies
- Asset, Resource and Inventory
- Relief and Human Resource Request
- Shelter Activation and Management
- Information and resource sharing between relief center
- Dashboard info.

We conducted a simulation testing that involves the overall capability of the applications in Jajahan Tumpat, Kelantan. Both systems seem to be working in an efficient manner although there are some issues that exists. The two system (FREOM and FRCM) works in tandem during a rescue and evacuation operation. The system’s mapping component is capable of showing an overall map of the flood affected area, provide additional map information such as POI (point of interests), favorite points and access to specified places in the area. The system can also provide compass support and navigation guide to the identified places/victims. For tracking the flood victims, a victim can send an SOS alert via their Subscriber Identity Module (SIM) card number as its identity, along with other data such as their GPS coordinates and message to the Rescue & Evacuation Management System server using a mobile phone. The FREOM application provides two alternative connections for the user to use depending on the available communication channels: mobile-internet or SMS. The system then indicates the nearest rescue team to the victim and identifies the suitable team for the current operation. The central operation centre would then send a notification on the location of the victim as well as the instruction to proceed with the rescue operation.

The FREOM system would also send a notification to the victim by providing the status of the rescue operation such as estimated arrival time and vehicle type. During the rescue operations, the devices utilized by the rescue teams would send intermittent location notifications to the FREOM system that enables the operation centre to track the team’s locations at any given time. Such tracking capability would enable a more efficient rescue operation to be executed based on the victim’s location.

Once the rescue team arrives at the victim’s location, they could trigger a safety notification to the FREOM system. The FRCM system would then notify the rescue team the location of the closest shelter that could receive the victims. The system identifies the shelters based on relevant information such as available space and necessary resources that would allow sufficient assistance to be provided to the victims upon arrival to the centre. Such information would mitigate the issue of overflowing rescue centres and low food / medical supplies that may affect the wellbeing of the rescued victims.

In order to better support the rescue mission, we developed an Augmented Reality (AR) technology based apps; AR Tumpat. This application can help the rescue team and associates for better tracking the flood victims. This application will show the direction and distance of the target object. Besides that, it can also provide information about the target object. At the same time, the flood victims can use this application to find the nearest rescue centres and other point of interest (landmarks) around them.

For the development of Relief Centre Management application, we developed it based on the Sahana system architecture and database design. This would enable the application to be integrated with the Sahana architecture especially for wide data sharing between centres. The Flood Relief Centre Management application is a standalone decentralized management system. The data entered into the tablet will be sent/updated to the database server of Disaster Management System at the state or national level whenever internet service is available. This intermittent updates will allow a centralized data collection about existing relief centres to be collected. The data collection enables an effective coordination of the relief operation at a higher management level. Within this application, an application Info dashboard would be developed that allow users to get real time information about the relief centres such as statistical information, current needs and more. The application would also allow users to input information about the flood or response to the needs of the relief centre. These information will be updated to the application through the Application server.

4.0 Conclusion

It is predicted that there will be a positive impact on the effectiveness and efficiency of rescue operation during flood with the implementation of the ResQ Banjir apps. Our application is capable to operate on mobile devices such as smartphones and tablets which are more suitable for most rescue and evacuation operations. With the use of SMS, GPS and Augmented Reality (AR) technology on smart phones; locating victims and tracking rescue teams will speed up the rescue and evacuation operations; besides improving the coordination of the rescue and relief efforts.

The Relief Center Management apps could enhanced the operations of the center. With the use of ICT, related decision making processes would be more effective as various information such as the status of relief centers and surrounding areas could be updated in real-time to various rescue agencies and to the public. With the support of the system, most of the issues faced by Relief Center Management such as shortage of food, waters and medical supplies, crowded evacuation centers and inaccurate information could be mitigated or even solved.

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SISTEM DAN APLIKASI MOBILE PANTAS AMARAN BENCANA BANJIR

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1.0 Pengenalan

Bencana banjir yang berlaku telah meninggalkan kesan yang mendalam kepada mangsa. Kerosakan harta benda dan kehilangan nyawa orang yang tersayang terjadi kerana mangsa gagal mendapat maklumat pantas dan tepat tentang bencana banjir yang akan melanda. Pihak berkuasa tidak mempunyai mekanisma pantas untuk memaklumkan status dan amaran banjir. Siren yang dibunyikan tidak difahami dan tidak meliputi semua kawasan banjir, manakala makluman melalui tv dan radio gagal memberi apabila tiada bekalan elektrik. Ditambah pula maklumat yang disampaikan hanya berbentuk satu hala sahaja sedangkan mangsa juga perlu menyalurkan maklumat pantas seperti meminta bantuan. Pada ketika ini terdapat kajian yang telah dijalankan menggunakan kaedah yang hampir sama iaitu menggunakan SMS utk memaklumkan amaran banjir namun sistem tersebut hanya bergantung kepada SMS satu hala sahaja dan ini merupakan antara faktor kajian lepas gagal menjadi realiti. Sedangkan sistem yang dibangunkan ini boleh berhubungan dengan sistem kawalan banjir agensi kerajaan yang sediada dan iaberhubungan secara dua hala, iaitu boleh menghantar SMS kepada bakal mangsa banjir malahan is membenarkan mangsa banjir menghantar SMS kecemasan kepada sistem bagi membolehkan mereka menerima bantuan. Pada ketika ini aplikasi mobile yang ada hanya berbentuk 'pull' iaitu semua maklumat mestilah diminta oleh pengguna dan maklumat yang diberi juga tidak semuanya relevan kepada pengguna. Sistem yang dibangunkan ini menggunakan Sistem Pengkalan Data Perkomputeran iaitu pengkalan data 'database' yang lengkap untuk tujuan penghantaran yang lebih cekap dan efisyen dan berhubungan secara langsung dengan aplikasi mobile yang telah dibangunkan ini.

2.0 Metodologi

Pembangunan sistem dilakukan dengan 2 fasa. Fasa pertama melibatkan pembangunan Pembangunan Sistem Pengkalan Data Perkomputeran manakala fasa kedua adalah melibatkan pembangunan aplikasi mobile untuk telefon pintar.

Pembangunan Sistem Pangkalan Data Perkomputeran dibangunkan dengan setelah semua data yang terlibat dikumpul dan dibentuk semula. Pangkalan data yang digunakan untuk menyimpan semua data ialah MySQL. MySQL dapat menampung data yang banyak dan pantas. Selain itu ia juga boleh digunakan pada banyak platform.

Pembangunan Aplikasi mobile juga dibangunkan. Ini adalah untuk memudahkan bagi pengguna telefon pintar. Aplikasi ini amat mesra pengguna. Pengguna juga boleh daftar baru dengan menggunakan Aplikasi ini selain dari melihat rekod sms yang telah dihantar dan menghantar SOS.

Rajah 1 : Proses Sistem dan aplikasi mobile pantas amaran bencana banjir

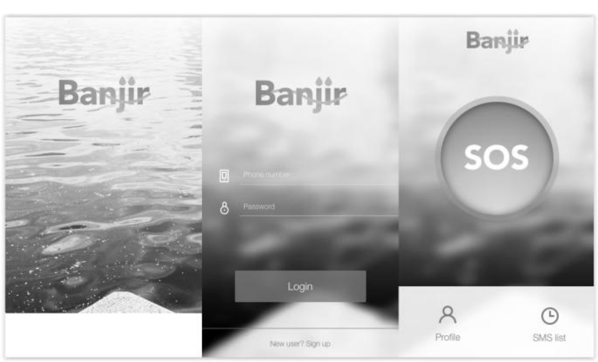
Bagi penggunaan SMS, satu modem PE, telah dicipta untuk tujuan menghantar SMS. Dengan menggunakan Wavecomm Chip, modem ini dapat menghubungkan server dan pengguna melalui SMS. Terdapat dua pengguna iaitu penduduk dan admin dalam sistem ini.

3.0 Hasil dan perbincangan

Web

Dengan adanya platform Web, pengguna dapat mendaftar, mengguna dan melihat segala maklumat berkaitan banjir di web ini. Pengguna juga boleh mengakses profil mereka untuk tujuan konfigurasi.

Android/iOS



Pengguna juga boleh menggunakan aplikasi untuk telefon pintar, mereka perlu masukkan perisian banjir ini ke dalam telefon mereka terlebih dahulu. Aplikasi ini juga mesra pengguna di mana ia mempunyai antaramuka yang ringkas dan mudah untuk digunakan.

Khidmat Pesanan Ringkas (SMS)
Untuk penggunaan SMS pula, anda perlu mendaftar terlebih dahulu dengan menggunakan laman web atau aplikasi. Anda juga boleh mendaftar secara SMS dengan menaip REG [email] dan hantar ke server. Untuk menghantar mesej kecemasan((SOS), anda boleh menggunakan format berikut SOS-

[msg]-[lokasi] dan hantar ke server. Semua maklumat disimpan pada satu pangkalan data bagi memudahkan pengguna mengakses sistem walaupun berada dimana saja dan bila bila masa. Maklumat yang disimpan telah dienkrip bagi tujuan keselamatan.

4.0 Kesimpulan

Dengan adanya sistem amaran banjir ini, perkara-perkara seperti berikut dapat dicapai: -

4.1 Pembangunan prototaip mampu mengurangkan risiko bencana banjir.
4.2 Amaran banjir lebih awal dapat menyelamatkan benda-benda penting daripada musnah akibat banjir
4.3 Keselamatan harta benda dan nyawa dapat diselamatkan terlebih dahulu.

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DEVELOPING LONG-RANGE, AUTO RECHARGEABLE RADIO SENSOR NETWORK

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1.0 Introduction

Predictive environmental sensor networks provide complex engineering and systems challenges. These systems must withstand the event of interest, remain functional over long time periods when no events occur, cover large geographical regions of interest to the event, and support the variety of sensor types needed to detect the phenomenon. Current technologies, either suffer from limitations of sensor networks such as low communication range and energy usage, or use large-size solutions which are both expensive and hard for installation and maintenance.

2.0 Project Background

Early flood detection technologies are in two categories: telemetry and sensor networks. Most of the early commercial solutions for flood detection is based on telemetry. In telemetry, each device on the field, senses a phenomena and sends it to the central management. To have long range communication, usually these devices are equipped with radio. These sensor devices usually do not have in-device decision making or process on the sensed data. Moreover, they are not able to communicate with each other to pass the data and have decision if anything happen to them (Basha, Ravela, & Rus, 2008). An example of telemetry is (ICIMOD, 2012) where two very big devices have been used for sensing. In contrast to telemetry, sensor network is a decentralized network, where sensors communicate with each other to pass the data toward the main station. This modern technology is more robust to errors and changes inside the network. However, there are several problems for current solutions on sensor networks such as energy, short range communication and the size as discussed in following.

Wireless communication is short range and is not suitable when the area of monitoring is vast. One way to tackle the problem of wireless communication is to used wired sensor network. This solution is applicable in areas which cabling is possible and an instance of such solution is (Aziz, Hamizan, Mehat, & Haron, 2009). The best way to tackle the wireless problem is to use radio rather than wireless. Although the bandwidth of radio is limited compared to wireless, it provides much longer communication range. (Basha & Rus, 2007) developed a radio sensor network, where each device has the size of a 1m2 with fence around it for protection. It also needed to be connected to electricity power line. It is clear that such work is not applicable in rainforests for flood detection. Another solution is provided by (Bielsa, 2012), where sensors are able to survive for about a week. These devices are more practical when they are used as mobile sensor devices for short term installation.

3.0 Methodology

In previous researches which have been done by this group, we developed an environmental sensing device for indoor data collection. Nine devices have been created and tested in a green mosque for data collection. In another research using the same concept, an indoor building inhabitance localization method has been developed. Using the experience we have for developing sensor devices and the available program for routing, the steps needs to be taken for current proposal is as follow:

1. To develop a low cost radio sensor device
2. To develop ad hoc network routing program in the device.
3. To develop energy maintenance program inside the sensor.
4. To evaluate the developed prototype.

4.0 Findings

All the objectives for this grant have been achieved. A new way of detecting flood based on the saturation of soil moisture combined with AI algorithm to detect the possibility of flood. The features of the device includes cheap radio sensor network, early flood detection on its origins and long lasting service and fault tolerable against disasters.

The developed product features are: Early flood detection, Self - organized ad hoc network, Hybrid with GSMS network for reliable message delivery, Long lasting network for long term area monitoring, Online soil moisture presentation in web. The novelty in developing such product lies in developing data collector nodes and the sink node, using the water saturation level in soil for predicting the flood, hybrid network: radio sensor network and SMS packet delivery, highly optimized energy efficient devices and packet optimization and compression for fast and energy efficient data delivery. The developed early flood detection devices have been used in real environment using artificial rain (firefighting pipelines and rain itself) and it showed that devices are able to detect the saturation of water inside the soil and predict the flood.

FIGURE 1: The developed prototype for Data Harvesting Device (DHD)

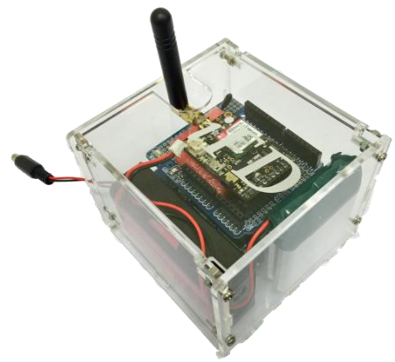

FIGURE 2: The developed prototype for Data Collector Device (DCD)

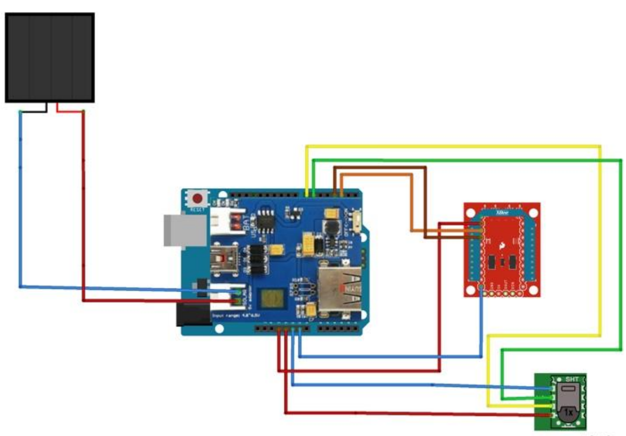

FIGURE 3: DHD Schematic Board Scheme

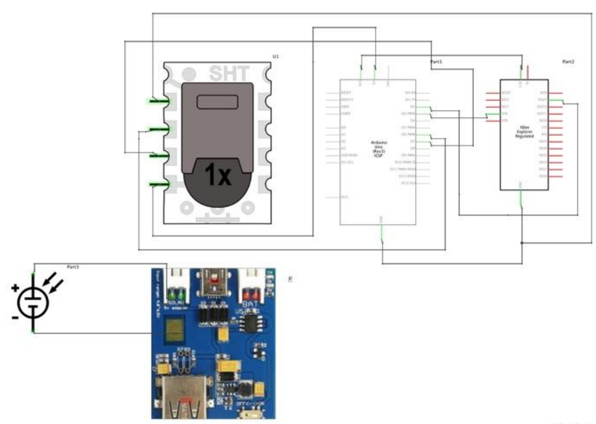

FIGURE 4: DHD Connection Scheme

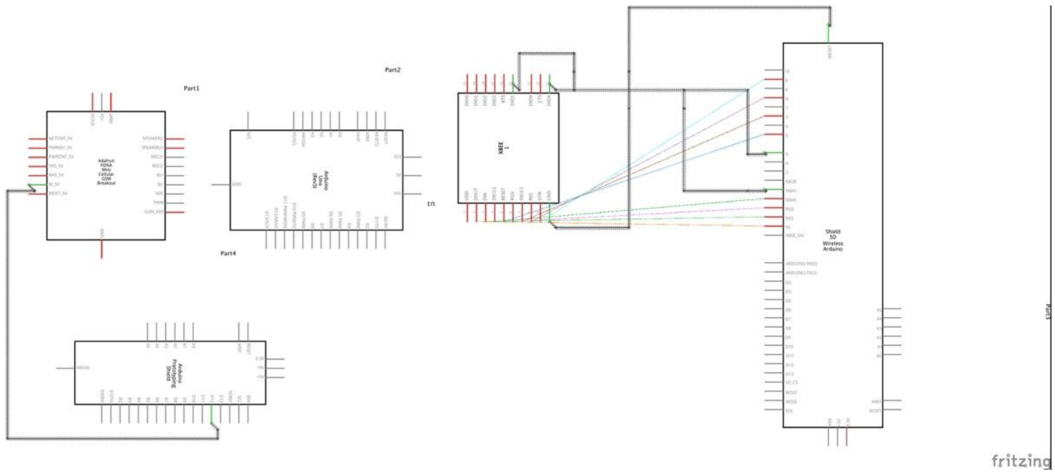

FIGURE 5: DCD Schematic Board Scheme

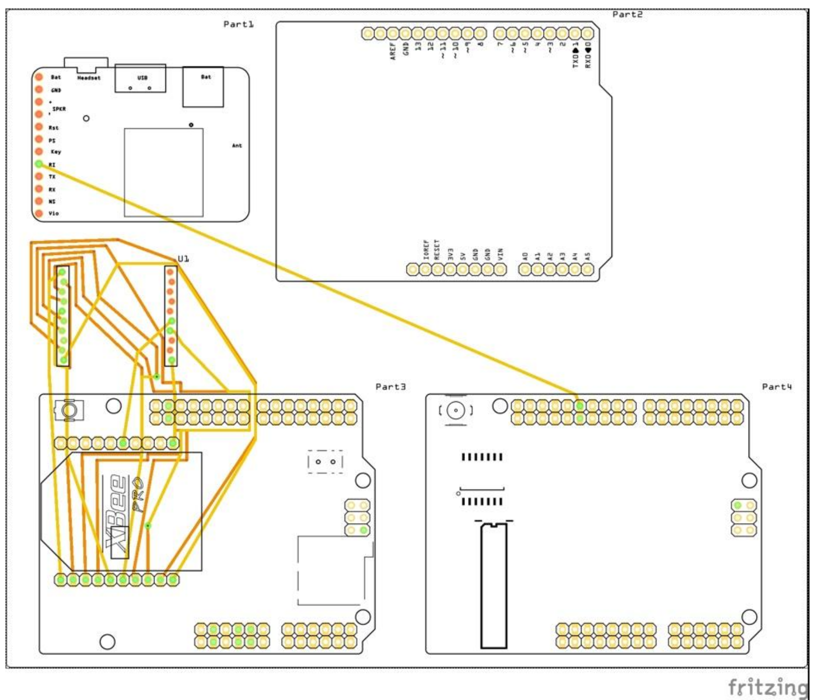

FIGURE 6: DCD Connection Scheme

The developed prototype contains three devices. The first one is Data Harvesting Device (DHD) which will be installed ono the river basin to collect the soil moisture of the land (Fig. 1). For an area of 10km2 1000 DHD are needed to be installed in the area. DHD is very small and cheap in price and can be easily be hidden from the eye of trespassers. DHD is collecting the soil moisture with weather information and temperature of the soil. Then, using a new algorithm compress the data and send it to nearest DHD in order to be passed to Data Collector Device (DCD). DCD (Fig. 2), is the second developed device which will be placed close to the area of data collection. For an area of 10Km2, 50 DCD are needed. DCD collects the data sent by DHDs, compresses them and sends it to the server computer to be analyzed for early flood detection warning system. The schematic presentation of developed hardware for DCD and DHD are presented in Fig.3 to Fig.6.

5.0 Conclusion

In this project, an early flood detection system has been developed consists of two different devices for data harvesting and collection as well as a sink for receiving data at the main server. The simulation and evaluation of the devices showed that the developed prototype has the ability to collect and send the soil moisture in order to be analyzed for flood warning system. The prototype won several innovation prizes during the years 2015 and 2016 including INATEX 2015 Bronze Medal, MRCIE 2015 Silver Medal and MTE 2016 Bronze Medal.

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INTEGRATED RIVER BASIN MONITORING AND FLOOD WARNING SYSTEM

Project Information

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1.0 Introduction

Flood is a common natural disaster that occurs all over the world. Giant floods can bring massive destruction and damages to the affected areas. During a state of emergency, time management is very crucial in order to minimize the impacts of the disaster. Lack of data such as precise locations of affected areas may cause interruptions and delay in conveying information and executing all the necessary actions.

Flood has been studied under various considerations and methodologies such as wireless sensors network (Chang et. al, 2006; Hughes et. al, 2003; DeRoure et. al, 2005), embedded system with middleware (Hughes et. al, 2005), Internet-based real-time data acquisition (Chang et. al, 2002) and flood modelling and forecasting (Creutin et. al, 2003; Sapphaisal, 2007; Zhang et. al, 2002). All these methods are proposed to improve the accuracy of flood monitoring systems. In addition, implementation of an improved real-time flood monitoring system can reduce the damage caused by floods (Islam et. al, 2014). Monitoring water level, or river stage and rainfall rate at river basin give a huge advantage as early predictions of flood occurrence can be done before the water reaches the general populations. Using the data and information from the monitoring process, flood warnings can be generated to notify the public about the likelihood of flood occurrence.

Integrated River Basin Monitoring and Flood Warning System is an integrated system with the abilities to monitor coastal, river water level and rainfall rate as well as to give warnings when there are high possibilities of flood occurrence to the related authorities and the public by exploiting all the information. It is an interactive and informative system which can integrate different types of data from Department of Irrigation and Drainage (DID) as well as tidal forecasting data from Department of Survey and Mapping Malaysia (JUPEM) in order to deliver high performance and reliable information on the flood prediction.

2.0 Methodology

This research used river stage and rainfall rate data from telemetry stations in Kelantan, which are available on DID website. Hourly data from a total of 25 stations were retrieved from the website and recorded in the database. Two solutions were provided throughout the research period; desktop-based application and web-based application. Both solutions were developed using open-source software and tools. Desktop-based application was developed using Visual Basic language in Visual Studio Community 2015 whereas the web-based application was assembled using PHP language and PostgreSQL was used as the database.

A collection of online hydrological data which consists of Kelantan's rivers water level from DID can be retrieved from the department's website. The regularly updated data are stored in a database, in which it is then exported to be displayed in the desktop application and web application. Desktop application is designed for the use of specific registered users while web application is meant for the public access. Figure 1 illustrates the system's overall structure.

Tide forecast tables for Kelantan waters, which obtained from Getting station, Kelantan, was provided by JUPEM. The tables were then stored in the database. Flood warnings can be generated based on the status of current river water level and rainfall rate.

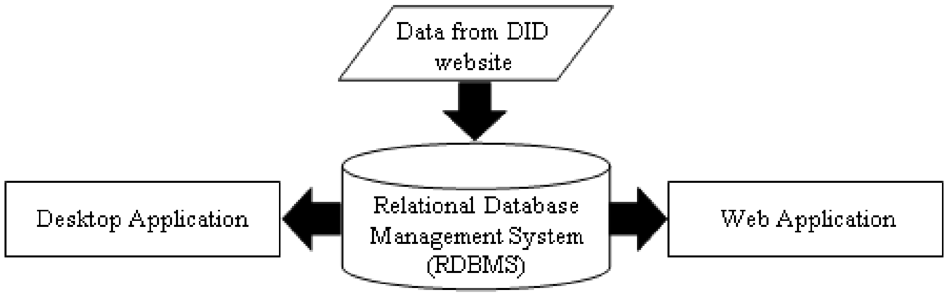

Figure 1. Overall Structure of the System

3.0 Results and Discussion

A desktop application and its web-based application, called 'Integrated River Basin Monitoring and Flood Warning System' were programmed. The desktop application is made accessible only for registered users with different levels; administrators and operative employees. An additional privilege to add new registered users, edit or remove existing users is given to the administrator. Figure 2 shows the login page of the desktop application, where only registered users with legal username and password can log into the system. Users whom are intended to have access to the system need to contact the administrator to get the username and password. Information of users such as name, position, staff ID and email address are required upon registration.

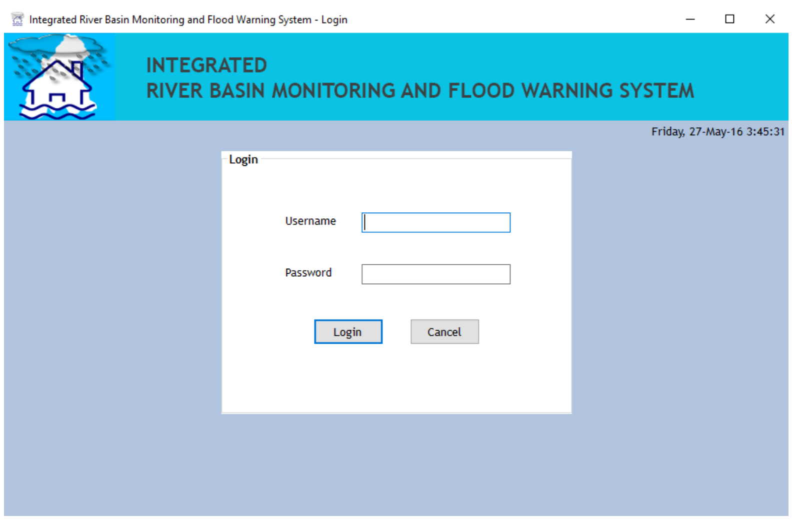

Figure 2. Desktop Application's Login Page

Figure 3(a) shows the main page, in which the locations of the hydrological telemetry stations are shown on a map along with some information of each station in a pop-up, as in Figure 3(b). In this figure, information for Kuala Krai Station such as its GPS coordinates, district in which it is located, as well as related river and river basin are popped-up.

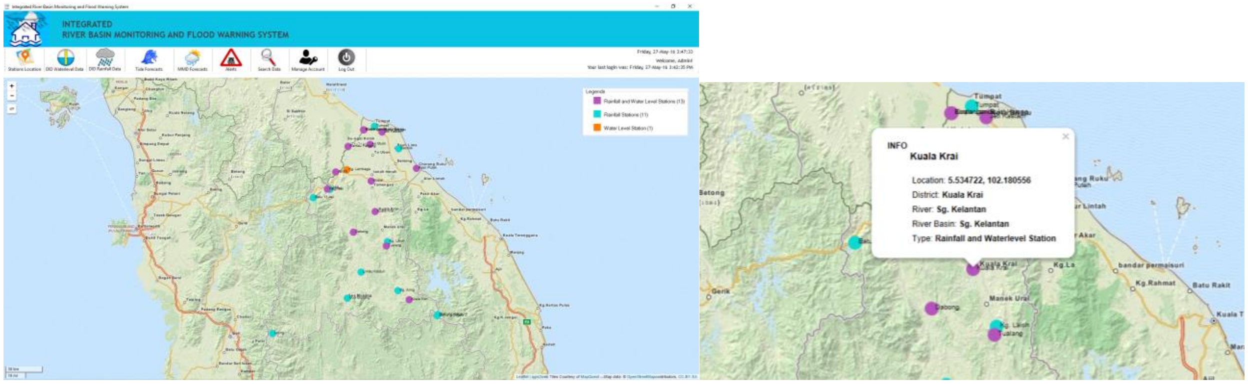

Figure 3:(a) Stations' Location on Kelantan Map and (b) Kuala Krai's Station Information

In Figure 4(a), all the data obtained from DID website are displayed in a table. River levels are monitored according to mainly three levels; alert, warning and danger levels while rainfall rate is monitored according to certain values as per determined by DID. The 'Status' column will show the status for the latest data updated. Status of the river level will change to 'alert', 'warning' or 'danger' if the river level value exceeds the predetermined values of alert, warning and danger levels respectively. 'Normal' status will be shown if the river level stays below the alert level. Otherwise, if the station is offline, it will show 'no data available' status. Rainfall rate is displayed in the unit of millimeter per hour (mm/h) and it is collected accumulatively starting at midnight for each day as shown in Figure 4(b). 'No Rain' status will be shown if the station does not receive rainfall since the midnight of the day. Status 'Light rain', 'Moderate Rain', and 'Heavy Rain' will be updated if the rainfall rate of the day is in the range of 1-10 mm/h, 11 – 30 mm/h, and 31 – 60 mm/h respectively. If the rainfall rate exceeds 60 mm/h, status 'Extreme Rain' will be shown.

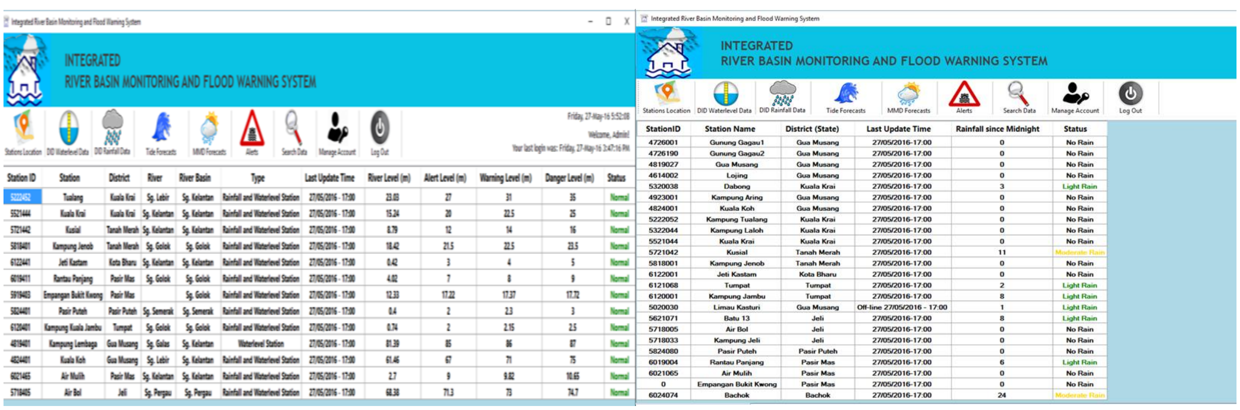

Figure 4.(a) River Water Level Data and (b). Rainfall Rate Data

Tidal prediction is shown for a period of one week. Hourly heights predictions for Geting Station are displayed along with times and heights of low and high water in Figure 5(a). Figure 5(b) shows the weather forecast for Kelantan waters for a week.

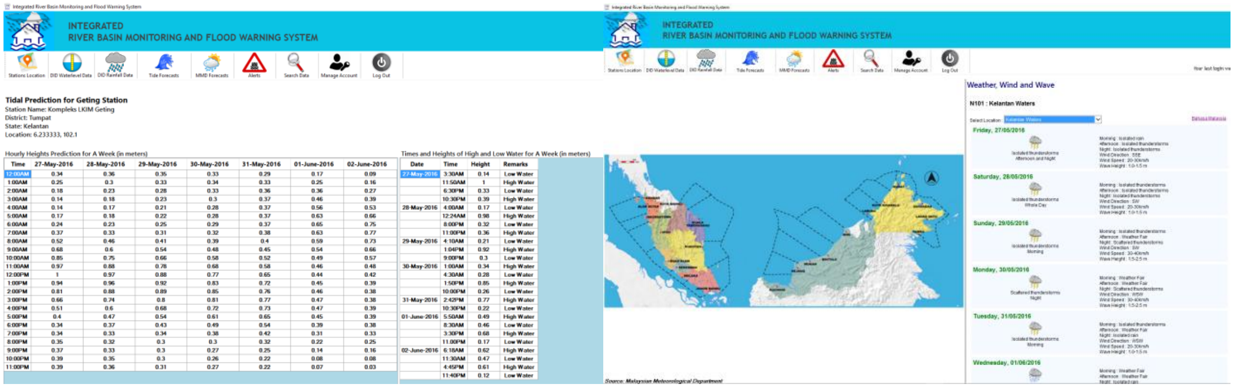

Figure 5:(a) Tidal Prediction Table and (b) Weather Forecast for Kelantan Waters

Figure 6(a) shows the main page of the web application. Users will be shown their current locations in order to identify whether they are nearby the monitored areas. When clicking on the 'Kelantan Station' button, users will be redirected to water level stations on Kelantan Map, which is set as the default display (Figure 6(b)). Users can choose to view waterlevel stations, rainfall stations or tidal prediction by clicking the options in the tabs. Besides, Users can get information about each station along with its current value and status by hovering the cursor on the marker. Users can also zoom in by clicking in the marker to view detailed location of the station. Some links to important portals and websites are also provided so that users can get access to any other information fast and easy.

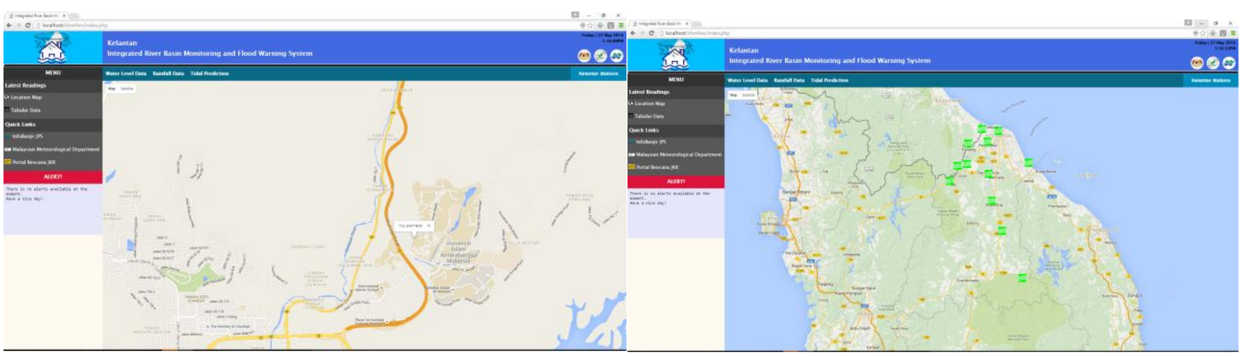

Figure 6:(a) Default Main Page and (b) Default View after clicking 'Kelantan Station' Button

Figure 7(a) shows the water level stations after clicking on the Water Level Data tab and Figure 7(b) shows information of Kuala Krai by hovering the cursor on the marker. Figure 8(a) shows the rainfall stations after the Rainfall Data tab is clicked and Figure 8(b) shows the information of Kusial station and its current rainfall rate value and status. For tidal prediction, users can choose to view the hourly tidal predictions or times and heights of low and high waters by clicking on the buttons respectively. Figure 9(a) shows the hourly tidal prediction after clicking on the Tidal Prediction tab while Figure 9(b) shows the times and heights of high and low water by clicking on its button.

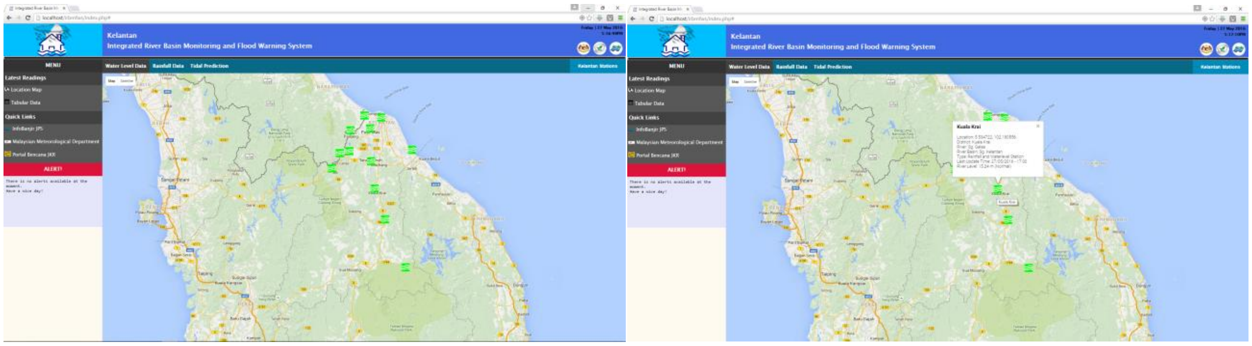

Figure 7:(a) Water Level Station and (b) Pop-up information of Kuala Krai Station

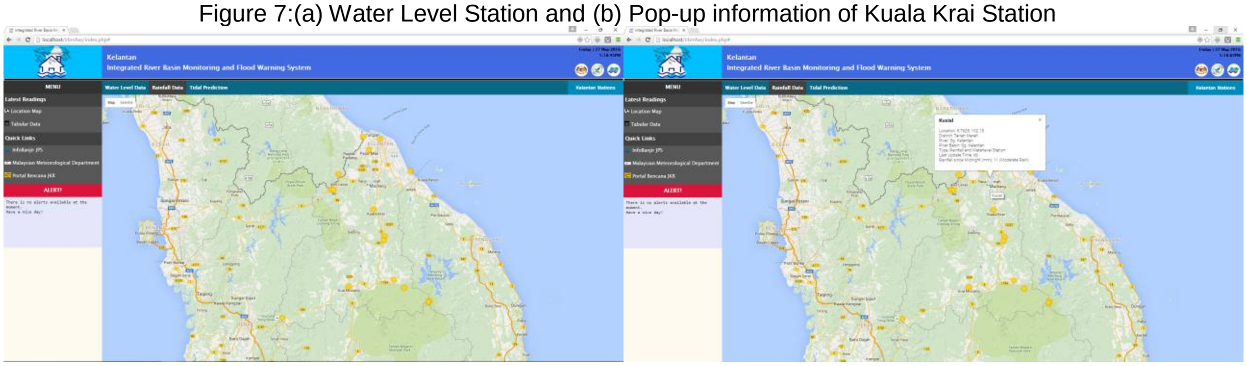

Figure 8:(a) Rainfall Stations and (b) Pop-up Information of Kusial Station

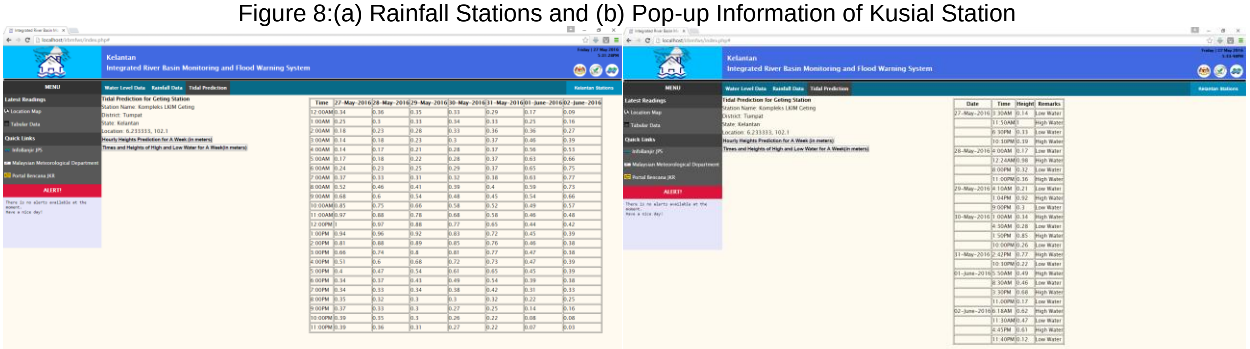

Figure 9: (a) Hourly Tidal Prediction and (b) Times and Heights of High and Low Water

4.0 Conclusion

4.1 The most suitable tools, software and equipment were determined through a detailed investigation and comparison.

4.2 The compatibility of rainfall rate and water level data as well as tidal forecast data with the selected database was identified.

4.3 The multiple types of data were integrated into one fusion centre.

4.4 Desktop application for integrated river basin monitoring and flood warning system was developed.

4.5 An interactive and informative web-based application for integrated river basin monitoring and flood warning system was built.

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INSPiRE: INTERACTIVE DAM SAFETY DECISION SUPPORT SYSTEM FOR FLOOD DISASTER REDUCTION

Project Information

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1.0 Introduction

Dams are often referred to as monolithic hydraulic structures that serve human needs and activities. Despite, dams can also impose risks to the public. In line with current global awareness of water security, the aspect of dam safety has drawn increasing attention from the public as it constitutes the element of a country's national security. Loss of human life is generally accepted as the most important consequences; therefore it often dominates dam safety decisions (Othman, 2006; Myers, 2002). It was also being outlined by the Chief Government Security Office (CGSO) Malaysia which is an important arm under Prime Minister's Office of Malaysia, dams are considered as one of the 15 national strategic targets (CGSO, 2013).

Dam safety programs are vital to minimize the impacts of dam failure and to ensure that all related personnel are ready and equipped with action plans in the event of dam failure. Lifesaving missions could only be successful if the relevant SOPs have been tested and refined with proper sense of coordination between the dam owner and all other critical agencies (Lariyah et al., 2014).

Based on statistical analysis of 534 dam failures from 43 countries before 1974, it was reported that earth-rock dam failure accounted for the largest proportion of all failures which related to 49% overtopping, 28% seepage in dam body and 29% seepage in foundation (Graham, 1999). In Malaysia, there are almost 51 recorded dams (60% of the dams are of earthfill type) under different ownerships (Othman, 2006). To-date we have not experienced any failures with the dams. Nevertheless, as dams in Malaysia continue to age, it is time that we take notice of the conditions of these dams from the safety perspective. Therefore, it is very important to ensure the dam in operated at its designed water level. Few cases of flooding due to dam spill or release has been reported worldwide and summarized in Table 1.

TABLE 1: Historical flooding issues due to dam operational release

Year	Area / Dam	Cause of Flooding	Impacts
January 2009	City of Pacific, Washington (Mud Mountain Dam)	• Heavy rain and melting snow • 11,700 cfs peak outflow released	• 112 residential and 10 commercial properties affected, with damages of $5 million and $10 million.
May 2010	Nashville & Davidson County, Tennessee (U.S. Army Corps of Engineers' Cordell Hull, Old Hickory, and Cheatham Locks &Dams)	• Major precipitation across the region • Limited flood storage capacitates all three dams	• Floodwaters on the Cumberland and its main tributaries, including the Harpeth, Red, Stones, Caney Fork, and Obey Rivers.
2011	Minot, North Dakota (Rafferty and Alameda Dams)	• Heavy summer rainfall caused the spillway gates as Rafferty Reservoir were fully opened and releasing a peak flow of 26,000cfs into Minot	• 12,000 residents were evacuated • USD 600M damage to property and infrastructure
October 2013	Bertam Valley (Sultan Abu Bakar Dam)	• Heavy rains in the Cameron Highlands brought on	• 3 dead and one missing • Muddy waters washed

		flash flooding caused an overflow into Lake Ringlet that bring maximum levels	away nearly 100 cars and destroyed some 80 homes
November 2014	Bertam Valley (Sultan Abu Bakar Dam)	• Heavy rain caused increasing amount of domestic & agricultural waste lower the capacity	• Five died and five injuries • 100 damaged houses

In order to mitigate the hydro hazard due to dam break, UNITEN has developed a new software known as INSPIRE (Interactive Dam Safety Decision Support System). INSPIRE as intelligent Dam Safety is developed to address emergency situations which demand fast, decision making and effective multi-agency collaboration due to dam break event. The fundamental role of INSPIRE is to provide an integrated system that may be used by dam operators as an interactive emergency response plan to mitigate the risk of dam failure. Therefore, INSPIRE is a decision support tools aimed to support the decision processes regarding dam safety event. The DSS enables simple, efficient & practical early warning system to alert and notify all stakeholders in the event of dam related disaster. INSPIRE is aimed to help to provide timely warning to reduce catastrophic impact to the downstream area which means that the emergency management would be more efficient and more lives will be saved in a dam break event. In the long run, INSPIRE will help the multi-stakeholders capacity for effective and efficient management in the event of a dam related disaster. In terms of commercialization value, a market study has been done and comparison was made to similar system available in the market as shown in Table 2.

TABLE 2: Comparison with other similar software in market

Software	Criteria				
	Dam Break Modeling	**Interactive**	**Does Not Require Deep Engineering Knowledge**	**Database of Dam Break Study**	**Emergency Response Plan**
DAMSAFE	√	√		√	
DSS WISE	√			√	
SAGE B		√			√
Dam Break Emergency Response Information System		√	√	√	√
INSPiRE	√	√	√	√	√

2.0 Methodology

The dam safety information is different from one dam to another. The development of INSPiRE system requires planning of user interface which allows flexibility of dam properties, to suit the different requirement from the dam owner. Therefore, the development of INSPiRE software is designed as integrated system to mitigate the risk of dam failure (Figure 1a), and will be based on the different module, as shown in Figure 1. In order to allow system flexibility with several level of security, the software was also designed to be equipped with certain level of permission with different authentication level.

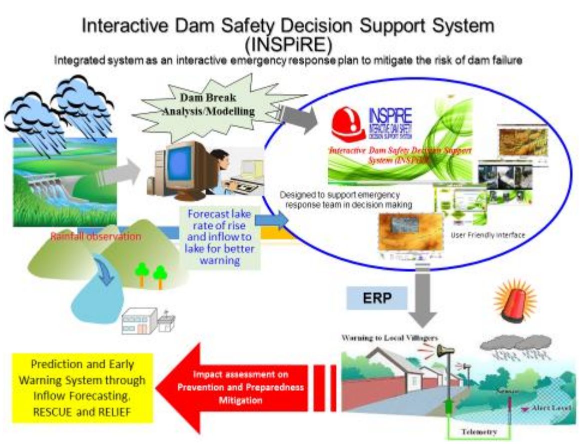


FIGURE 1(a) : INSPiRE Concept

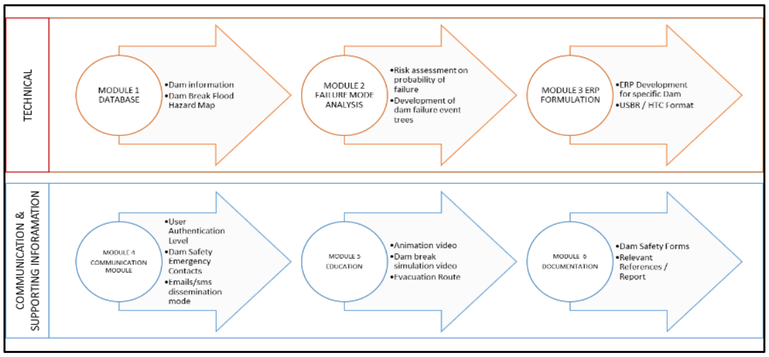


FIGURE 1(b): INSPiRE Modules

i) Module 1 (Database): Development of Database for INSPIRE Decision Support System (DSS)
INSPIRE Dam Safety DSS has develop dam safety database database for different dams. The list of dams are as shown in Table 3:

TABLE 3 : List of Available Dam Information

<table>
<tr><th>Dam</th><th>Dam Operator</th></tr>
<tr><td>Sultan Abu Bakar Dam</td><td rowspan="8">Tenaga Nasional Berhad</td></tr>
<tr><td>Jor Dam</td></tr>
<tr><td>Mahang Dam</td></tr>
<tr><td>Temengor Dam</td></tr>
<tr><td>Bersia Dam</td></tr>
<tr><td>Kenering Dam</td></tr>
<tr><td>Chenderoh Dam</td></tr>
<tr><td>Pergau</td></tr>
<tr><td>Bukit Merah Dam</td><td>Drainage and Irrigation Department, Malaysia</td></tr>
<tr><td>Pedu Dam</td><td rowspan="3">Muda Agriculture Development Authority</td></tr>
<tr><td>Muda Dam</td></tr>
<tr><td>Ahning Dam</td></tr>
</table>

Among the data available inside the database are as follows:

i. Dam Emergency Response Plan
ii. Dam Standard Operating Procedure
iii. Flood Hazard Map
iv. Dam Monitoring Equipment
v. Dam Design
vi. Dam failure mode & triggering level
vii. Dam Emergency Personnel

ii) Module 2 Failure Mode Analysis
Failure Modes Analysis has been used extensively in performing risk assessments. For a risk assessment the probability of failure and the consequences of failure are used to calculate the risk of loss of life or property damage for a particular dam or project. In order to evaluate the probability of failure for a dam, the failure modes must first be identified. Identifying the failure modes is typically performed by a team of experts who brain storm on different ways that the dam could fail. This brain storming includes identifying the events that would occur leading to failure. The results are usually presented as event trees. Currently, dam faliure modes for all dams listed above has been identified. In general, three main dam failure modes was used to run dam break simulation are follows Flood Loading, Earthquake Loading and Normal Loading / Clear Day Failure. Figure 2 shows the critical reservoir level based on overtopping dam failure mode.

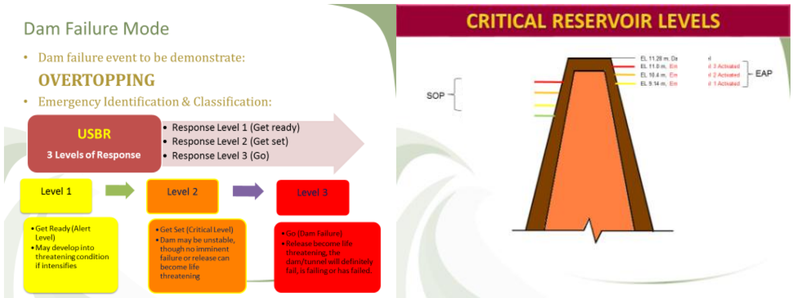


FIGURE 2 : Example of Dam Failure Mode

iii) Module 3: Formulation of Emergency Response Plan (ERP)
Development of ERP for specific dam are following USBR or Hydro Tasmania standard. Currently, we have obtained information of available dam safety guideline around the world. This enable us to understand the concept of dam safety regulations parcticed by dam owners and operators. Table 4 lists the dam safety guidelines from different countries.

TABLE 4: List of Dam Safety Guidelines

Guideline	**Country**
Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners	Inter-Agency Committee on Dam Safety (ICODS), USA, 1998
Guidelines on Dam Safety Management	Australia National Committee on Large Dam Incorporated (ANCOLD).
On-site Plan for Reservoir Dam Incidents – Guidance on Reservoir Emergencies	Department of Environment, Food, and Rural Affairs (DEFRA), United Kingdom (UK)
Guidelines for Development and Implementation of Emergency Action Plan for Dams	Government of India, Central Water Commission Dam Safety Organization, 2006.
Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners (ICODS)	USA
Guidelines on Dam Safety Management by Australia National Committee on Large Dam Incorporated (ANCOLD)	AUSTRALIA
On-site Plan for Reservoir Dam Incidents – Guidance on Reservoir Emergencies	United Kingdom
Guidelines for Development and Implementation of Emergency Action Plan for Dams	INDIA

We have also made comparison between USBR and HTC format as shown in Figure 3, and also identify countries that has develop the ERP similar to the ICODS and ANCOLD guidelines as shown in Table 4.

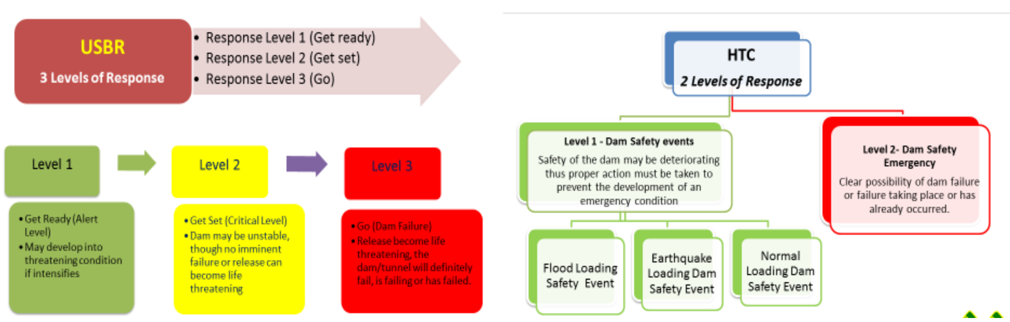


FIGURE 3: Comparison of Emergency Identification and Classification between USBR & HTC Format

iv) Module 4: Communication Module

In order to provide timely warning to dam owners and agencies in the event of dam safety emergency, INSPIRE was designed with its own email system integrated inside of the application. Among the features in communication module incluse:

- Multiple email recipients
- User authentication to avoid false alarm
- The information of user, location, water level date and time is taken directly from theapplicatio to prevent any information error / unwanted data redundancy

Figure 4 shows screen shot of INSPIRE system under communication module.

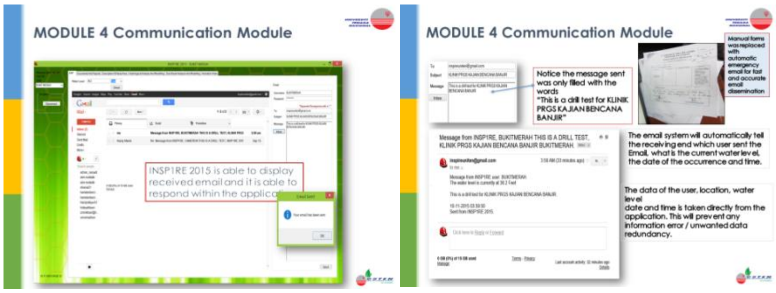


FIGURE 4 : Screen shot of Communication Module

v) Module 5: Education Module

It is important that all dam personnel are familiar with their task and responsibility during dam safety emegencies. Thus, Eduction Module provides animation video as part of the INSPIRE system. It also aims to create awareness on dam safety to dam personnel. Figure 5 shows example of animation on dam safety tutorial for Bukit Merah Dam.

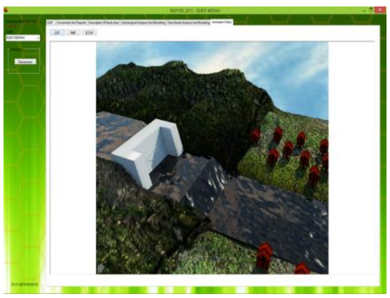


FIGURE 5 : Dam Safety Animation for various emergency level

vi) Module 6 : Documentation

Documentation module provides dam safety Emergency Response Plan manual for user references. User are able to upload the latest revision of dam safety manual into the system. Apart from that, this module also provides informations such as relevant reports and dam break flood hazard map. This module allows user to rely on one stop information rercources during emergency events. Figure 6 shows screen shot documentation module.

FIGURE 6: Documentation Module

3.0 Results and Discussion

INSPIRE Dam Safety Decision Support System (DSS) has develop dam safety database for different dams. Currently, INSPiRE is being developed for two TNB Hydro Schemes, which are Cameron Higlands-Batang Padang Hydroelectric Scheme and Sungai Perak Hydroelectric Scheme, which consist a total of 8 dams. The system was also developed for Muda Agricultural Development Authority (MADA), who owns and operated 3 dams and Drainage and Irrigation Department (DID). INSPiRE will contribute towards the sustainability of dam's owner as corporate reputations can be ruined through dam structural failures that can affect the economy of the nation and enhance the quality of life of the people. The 4 key elements of INSPIRE are shown in Figure 7:

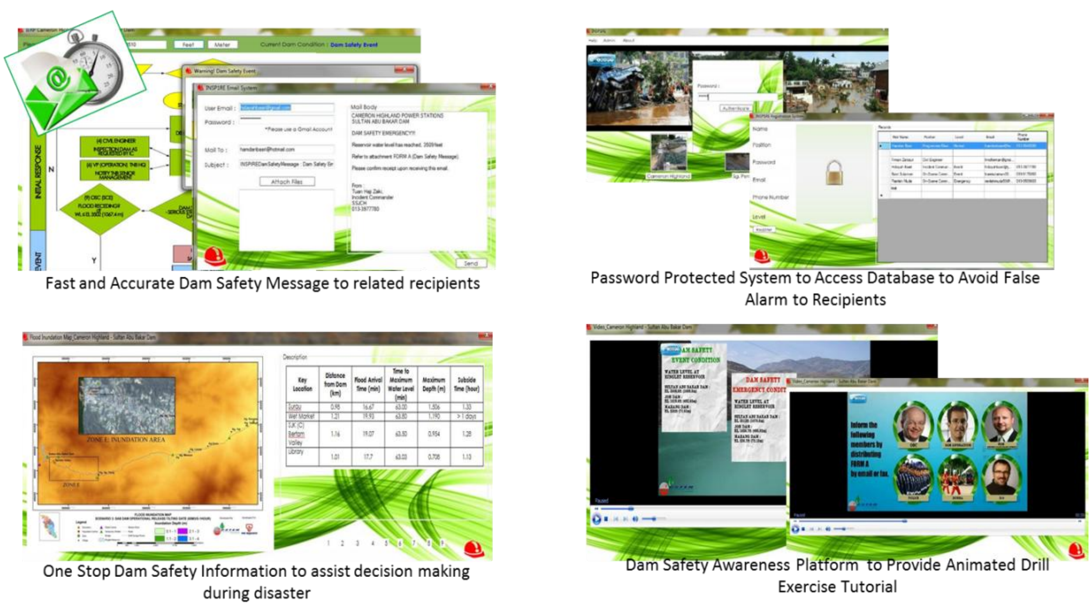


FIGURE 7: Key Elements of INSPIRE Software

Currently, we have obtained information of avalibale dam safety guideline around the world. This enable us to understand the concept of dam safety regulations parcticed by dam owners and operators. Table 5 lists the dam safety guidelines from different countries.

TABLE 5: List of Dam Safety Guidelines

Guideline	Country
Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners	Inter Agency Committee on Dam Safety (ICODS), USA, 1998
Guidelines on Dam Safety Management	Australia National Committee on Large Dam Incorporated (ANCOLD).
On-site Plan for Reservoir Dam Incidents – Guidance on Reservoir Emergencies	Department of Environment, Food, and Rural Affairs (DEFRA), United Kingdom (UK)
Guidelines for Development and Implementation of Emergency Action Plan for Dams	*Government of India, Central Water Commission Dam Safety Organization, 2006.*
Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners (ICODS)	USA
Guidelines on Dam Safety Management by Australia National Committee on Large Dam Incorporated (ANCOLD)	AUSTRALIA
On-site Plan for Reservoir Dam Incidents – Guidance on Reservoir Emergencies	United Kingdom
Guidelines for Development and Implementation of Emergency Action Plan for Dams	INDIA

TABLE 6 : List of Countries which adopts ICODS & ANCOLD Guideline

ICODS	ANCOLD
USA	Australia
Canada	Malaysia (TNB)
India	Philippines (San Roque Dam)
Turkey	Fiji (Monasavu Dam)
South Africa	
Jordan	
Argentina	

i. Product Testing & Verification

In order to ensure the software meets the user requirement, product testing and verification was done with various dam owner and agencies. Table 7 list the product and verification activities and Figure 8 shows the pictures during the emegency exercise with dam owner and government agencies.

TABLE 7 : Software Testing & Verification

DATE	TYPE OF EMERGENCY EXERCISE	DAM	OWNER
1 Nov. 2012	Drill Exercise (Internal)	Sultan Abu Bakar Dam (Cameron Highlands Hydro Scheme)	**TNB**
21 – 22 Oct. 2013	Drill & Tabletop (Agencies)	Temengor Dam (Sg Perak Hydro Scheme	**TNB**
15-16 April 2014	Tabletop Exercise (Agencies)	Sultan Abu Bakar Dam (Cameron Highlands	**TNB**

		Hydro Scheme)	
14 Mei 2015	Tabletop Exercise (Agencies)	Bukit Merah Dam	**DID**
2 Sept. 2015	Functional Exercise	SAB Dam	**TNB**
28 Sep. 2015	Evacuation Drill (Agencies & Community)	Sultan Abu Bakar Dam (Cameron Highlands Hydro Scheme)	**TNB**
8 Oct. 2015	Tabletop Exercise (Agencies)	Kenyir Dam	**TNB**
27 Oct. 2015	Drill Exercise (Internal)	Pedu Dam	**MADA**
1-2 Dec. 2015	Tabletop Exercise (Agencies)	Pedu Dam	**MADA**

ii. Product Benchmarking

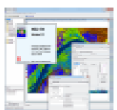
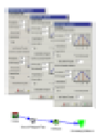
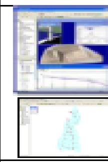
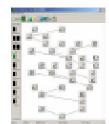
Model	HEC-FIA	iPresas	MOUSE	DAMRAE	INFO WORK LIFESIM	HSPF	INSPIRE
							
Primary author/ organisation & Country	Corps of Engineers (HEC), California, USA	iPRSAS, VALENCIA, SPAIN	DHI Water Environment Health, Denmark	Corps of Engineers (HEC), California, USA	Wallingford Software Ltd, United Kingdom	U.S.EPA (US Environmetal Protection Agency)	UNITEN, Malaysia
Versions	First: 1998 Latest: Version 2010	First: 2000 Latest: Version 4, 2009	First:1983 Latest: Version 9, 2007	First: 2001 Latest:Version 2009	First:2007 Latest: Version 10.5, 2009	First:1966 Latest: Version 11, 1997	Version 1, 2012
Routing level	Simple Storage, Hydrologic, Hydraulic	Simple Storage, Hydrologic, Hydraulic	Hydrologic, Hydraulic	Simple Storage	Simple Storage, Hydrologic, Hydraulic	Simple Storage, Hydrologic	Simple Storage, Hydrologic, Hydraulic
Simulation Type	Single event	Single event, Continuous	Continuous, Single Event	Continuous	Continuous, Single event	Continuous, Single event	Continuous, Single event
Failure Modes	Yes	Yes	No	No	No	No	Yes
Data-base for Local Data and ERP	No	No	No	No	No	No	Yes
Disaster Damage Analysis	Yes	Yes	No	No	No	No	Yes
Detail Design of Dam ERP for Pre & Post Disaster	No	No	No	No	No	No	Yes (DID Manual/ICOLD)
Price (RM)	20,000	60,000	40,000	5,000	60,000	10,000	50.000

FIGURE 9 : Product Benchmarking

TABLE 8: INSPiRE Benchmarking

Software	Criteria				
	Dam Break Modeling	Interactive	Detail Engineering Knowledge	Database of Dam Break Study	Emergency Response Plan
DAMSAFE	√	√		√	
DSS WISE	√			√	

SAGE B		√			√
Dam Break ER System		√	√	√	√
INSPiRE	√	√	√	√	√

iii. Commercialization Strategy

Short term commercialization strategy was planned for INSPIRE software as shown in Figure 9.

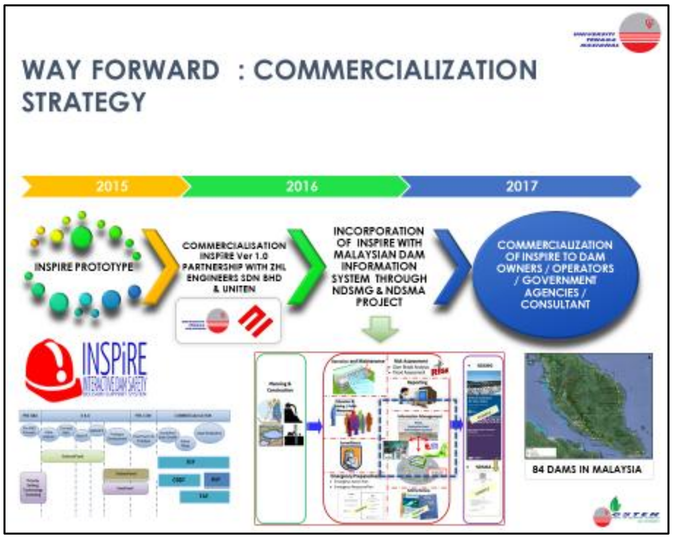


FIGURE 10: INSPIRE Commercialization Strategy

4.0 Conclusion

INSPiRE has been successfully developed to address emergency situations which demand fast, decision making and effective multi-agency collaboration due to dam break event. INSPiRE helps to provide timely warning to reduce catastrophic impact to the downstream area which means that the emergency management would be more efficient and more lives will be saved in a dam break event. In the long run, INSPiRE will harness as well as help the multi-stakeholders capacity for effective and efficient management in the event of a dam related disaster. Apart from that, important dam break information such as flood arrival time, time to max flood depth, max flood flow velocity, max flood inundation depth, and flood extent also included in the software. INSPiRE would be a powerful tool for the decision makers, as it can help to save time and enhance the effectiveness of decisions.

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INTEGRATED MOBILE SOLUTION FOR ALERT, SEARCH & RESCUE (A-SAR)

Project Information

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1.0 Introduction

The project aim is to enhance preparedness and response by improving coordination and enhancing the capability of those organizations involved in flood rescue via early detection and integrated communication using ICT. The project will provide an organizational capability and structure to enable the delivery of a coordinated national response to flooding incidents, such that organizations can work together to minimize the loss of life and injury and to reduce the physical and financial effects of consequential loss and collateral damage.

The desired outcome from the Project is that organizations involved in Flood Rescue will have additional capabilities and capacity to respond to major flooding incidents so that they will be able to:

i. Deal with the consequences of major flooding, by having the appropriate operational capability ready.
ii. Maintain the capability over the long term so that it is available whenever required.
iii. Deploy resources swiftly once a flooding incident occurs
iv. Command, control and communicate at major flooding incidents, from assessment and initial response, through to the management of recovery and reestablishment of preparedness
v. Introduce national mutual aid and standards such that the organizations can communicate and coordinate information via single channel.

2.0 Methodology

Data Acquisition: Water Overflow Detection & Impact Data Collection:

The integrated system to detect water catchments volume and forecast overflow would be the first phase of trigger in this solution. Besides analyzing data such as rainfall, River & Dam water level Data, the regional population census data has to be updated on timely manner. Population data needs to be classified according to their zone of habitant or their address. Mobile contact no would be one of the important attribute selections. The Land & Flood Plain data will support the system in identifying the possible zone of flooding, water flow direction and water channeling routed. By gathering these spatial data, system would be able to mark zonal impact and further be prepared for mitigation plans according to the hazard level. One of the most important data feed is the Access Route & Transportation allocation data. Information such as access roads, public transportations, diversion route and reachability to the population can be identified. This data integration would map the population and logistics, indirectly support plans for evacuation.

Data Preprocessing: Selection, Cleaning, Transformation & Integration:

This phase is highly important as any missing data or noisy data could lead to inaccurate prediction. Domain experts and department authorities are required to share their knowledge in data selection and ensure that accuracy values are set at the optimum standards. All data from various sources will be integrated under one schema. A centralized data warehouse will be created and data will be ready for analytics. The data comes from various sources (cloud data, batch processed, real time, etc.).

Infrastructure & Data Ware House:

Supporting various types of data (structured, unstructured, spatial, etc.) could be overloading during data request. Data analytics and mobile communication needs fast and prompt query processing over secured channel. To support a good architecture at an affordable cost, cloud computing is adapted. Infrastructure as a Service (IaaS) is a form of cloud computing that provides visualized computing resources over the Internet. IaaS is one of three main categories of cloud computing services, alongside Software as a

Service (SaaS) and Platform as a Service (PaaS). Infrastructure as a Service gives us an advantage of managing our Applications, Run times, Security & Integration as well as the database.

Data Analysis Engine:
The engine development is the functional area of the integrated solution. Online Analytical Processing (OLAP) is a technique to visualize consolidated data and drill down into the specific details or roll up to view the generalized summation. Prediction / Forecasting are a technique under supervised learning which has predefined class labels. This technique can be well embedded to manage Water Overflow, River Overflow and Speed, Evacuation Plan & Navigation, Resource Procurement & Distribution, Volunteer / Assistance Requirement & Placement.

Modeling:
Data Visualization Tool (for Mobile & Web Portal) is available via open source channels and paid enterprise tools. The best modeling tool would be essential to demonstrate data, let it be hypothetical or precise data. The modeling tools should be able to synchronize with mobile alert, customized to the type of data sent and the hazard level.

Disaster Simulation Test
Testing a real-time scenario could lead to tremendous cost and unnecessary lose. The best option for disaster management test is simulating the process. Mobile alert & Communication can be tested by pumping into test data and evaluation of the reach. Test data could be past data or real-time data which is used and directed following a standard operating procedure. With the simulated data, a rescue exercise can be planned.

3.0 Results and Discussion
The solution is incomparable to any existing solutions as it is customized to manage Flood disaster in Malaysia, focusing on specific region. Nevertheless, the solution is developed dynamically to manage all key users, locations, and basic functional areas in all flood disaster management. Thus, it is capable of expansion of use in other regions in Malaysia or can evolve as a benchmark for any flood SAR worldwide.

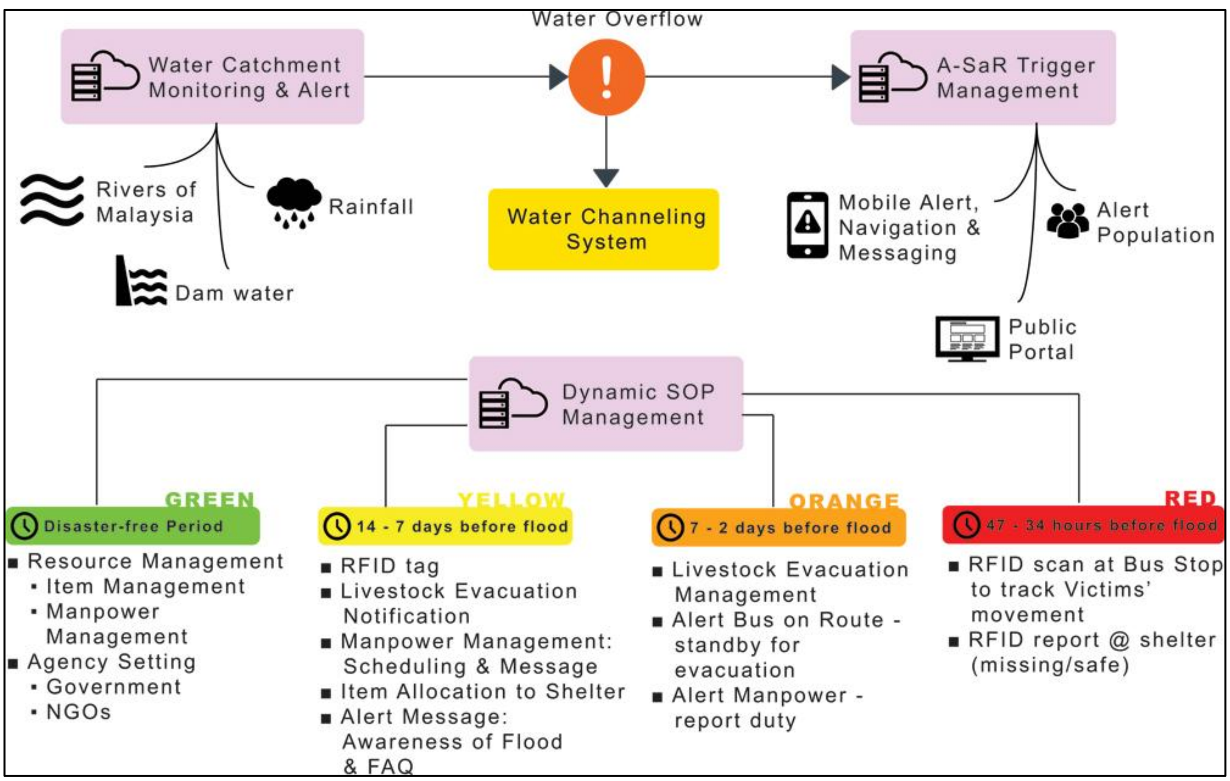

Figure 1. A-SaR Components

Government Agency Unit Core Functionality:

1. Monitoring & Water Channeling : A precaution solution to warn the water levels in catchment areas, forecasting possible overflow (flood alert) and proposing water diversion or channeling to distribute water to dry area within the region.
2. Failing to manage overflow, Flood warning can be predicted before occurrence based on historical data analytics. This encourages early warning to the affected areas, preparation of logistics and immediate aids, and budget allocation by government.
3. Mobile / handheld devices will be an added value for this solution as it can alert each key user, creating awareness even though they are not online with the system. This rule out all parties blaming each other for not being effective in handling a disaster.

Voluntary / Other Unit Core Functionalities:

1. As described my MERCY (9th January 2015) report, basic assistance during the disaster focused on Health Care, Water, Sanitation and Hygiene, Food and Nonfood items.
2. A centralized information center for media coverage & public awareness
3. Donation request and distribution. Compilation of items needed, location and quantity would be identified and updated in real-time to avoid wastage & unauthorized campaigns

Special Features:

1. Blending the mobile disaster system application with features such as customizing information in order to adapt each victims need or (i.e.: sending a mass general SMS SARS panic alerts to the population without considering the user's location, wealth condition / age and other peculiar information could just generate more panic).
2. For End User
   - Flood Disaster Safety Tips (FAQ containing recommended safety tips)
   - Identify & Navigate nearest reachable Rescue/Evacuation Center (To recommend navigation based on accessibility conditions)
   - Flood Disaster Reporter (To propagate any potential disaster information to nearest Rescue/Evacuation Centre)
   - Emergency SOS (To send an SMS containing GPS Coordinates to a list of contacts)
   - Tourist Helper (To confirm safety of a route)
3. For Government Staff
   - Track Help Requests (To know location of people stranded in their territory)
4. Social Media enabled (RSS feeds, Facebook, Twitter, etc.) for immediate awareness to the nation.

By doing that the mobile disaster management system applications will probably become more appealing to the public and as a result increase people's trust and contribution on timely manner.

4.0 Conclusion

We cannot prevent the flood disaster; however we make better use of the current web and mobile technologies and promote future advances. As mobile devices become more common nowadays, the government has the chance to provide first responders and citizens with the tools necessary to save lives during this threatening event. Hence this prototype hopefully can be considered to be one of the major solutions to manage the disaster before, during and after the event.

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MODELING THE EFFECT OF LAND USE/COVER CHANGES IN FLOOD SOURCE AREAS ON DOWNSTREAM FLOOD PEAK OF KELANTAN RIVER BASIN

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1.0 Introduction

Quantification of the effect of land use and land cover change on the runoff dynamics of a river basin has been an area of interest for hydrologists in recent years. Little is known so far if there is a well-defined quantitative relationship between the land use properties and the runoff generation mechanism. Different methodologies have been implemented in attempts to fill in the deficiency of knowledge in the subject, but no general and credible method has been established yet to predict the effect of land use changes on hydrology in a watershed (Kokkonen and Jakeman, 2002).

Although the use traditional statistical trend analysis of recorded flood data has been reported to register a great success in detecting non-stationary hydrologic response of a watershed, it is unable to calculate the change. Another setback of the trend analyses is their inability to predict the effect of land use and climate change. Hydrologic models are considered the most appropriate tools in evaluating and predicting hydrologic response variation at catchment level (Saghafian et al. 2007).

The use of computer models for evaluating the effect of land use change on runoff has been in use for over four decades. For example; Onstad and Jamieson, 1970; Hookey, 1987; Bultot et al., 1990; Anderson, 2000; Toriman et al., 2009; Amini et al., 2011; Basaruddin et al., 2014; Khalid et al., 2015. In recent years there is growing concern for studies regarding climate change at the global scale, where models are considered the major back bone for predicting hydrological changes based on land use at the catchment scale. For example; Mah et al., 2011; Alaghmand et al., 2012; Kabiri et al., 2013; Basarudin et al., 2014.

During early December, 2014, heavy rainfall occurred for many days that resulted in catastrophic flooding in several part of the east coast state of Peninsula Malaysia. Many claims that illegal logging and unrestricted land cover conversion without consideration of environmental repercussions, has alters natural hydrologic systems of the basin. But there is no data to support or refute this argument for the basin. Following this flood event, a study was initiated to investigate whether past and present land use changes in the watershed may have increased, or will change, the flood hazard of Kelantan river basin.

Specifically, relative increase/decrease of the flood peaks is of primary interest. The study also attempts to identify flood source areas with respect to flood occurrence at the downstream reaches for further flood control planning. Land use maps corresponding to a 30-year period are prepared and HEC-HMS rainfall-runoff model is calibrated and applied to quantify the impact of past and present land use change on downstream flood peaks. The model was later used to determine the contribution of various sub-basins on downstream flood peaks.

2.0 Methodology

This study used rainfall data and streamflow data from Kelantan River basin. Kelantan river basin has an annual rainfall of about 2383±120 mm, a large amount of which occurs during the North-East Monsoon between mid-October and mid-January.The estimated runoff for this area is 500 m^3 s^{-1} (DID, 2000). Hourly river discharge data over 31 years was used to determine flood peaks and its corresponding volume and duration

Mann–Kendall test was employed to detect annual trends in precipitation and AMF data. Statistically non-significant increasing and statistically significant increasing trends were obtained for the annual maximum series of 24-hour precipitation and AMF data respectively. Soil series map and three land use maps corresponding to 1984, 2002 and 2012 were obtained from the Department of Irrigation and Drainage, Malaysia (DID) for land use analysis. Each of the land use map was intersected with the soil series map to calculate curve number (CN) using ArcCN script in ArcGIS Zhan and Huang (2004).

In this study, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) ASTER GDEM with 30 m resolution was used for hydrologic model simulation. The HEC-HMS was used to simulate the hydrologic response of the watersheds in this study. SCS curve number (CN) method was used to determine infiltration. The model was calibrated and validated using extreme rainfall events selected for the year 2014 to simulate the effect of different land uses (1984, 2002 and 2013) on the 2014 flood.

3.0 Results and Discussion

Land use changes were studied from 1984 to 2002 and from 2002 to 2013 in each of the four studied catchments using GIS. The land use classes were categorized into forest, paddy, agriculture, grassland, urbanization, cleared land, mangrove swamp, secondary forest, rivers, ponds and lakes and mining. Tables (1-8) shows the result of the land use analysis. The results indicate that conversion of forest to agriculture is the major land use change observed in all the four catchments. The total area of cultivated lands has increased non-uniformly across the catchments. In Galas basin, there is 51% reduction in forest from 1984 to 2002, while in Pergau forest was found to reduce from by 19.32% in the same year period. While forest was observed to reduce in this year sequence, grassland was observed to increase by 15.77% in Galas and 7.11 in Pergau. Little reduction in forest land use was observed from 2002 to 2013 for Galas basin (3.4%) and 7.11% for Pergau basin. While the major land use change observed was decrease in grassland from 15.85% to 0.46% in Galas and from 12.33% to 0.53% in Pergau for the same year under study. Other land use that that were observed to increase in all the studied years and locations are urbanization and cleared land.

Table 1: Land use change in Galas basin from 1984 to 2002

Land Use type	1984 (%)	2002 (%)	1984 Area (km^2)	2002 Area (km^2)	% change
Forest	98.39	47.38	27552.05	740.80	-51.01
Paddy	0.005	0.00	1.32	0.00	-0.005
Agriculture	1.18	35.07	329.96	567.57	33.89
Grassland	0.08	15.85	23.08	257.07	15.77
Urbanization	0.01	0.45	0.85	7.34	0.44
Cleared land	0.33	0.72	93.49	11.62	0.39
Secondary Forest	0.00	0.35	0.00	0.56	0.35
Rivers, Ponds and Lakes	0.00	0.02	0.00	0.26	0.02
Minning	0.000	0.16	0.00	2.54	0.16

Table 2: Land use change in Galas basin from 2002 to 2013

Land Use type	2002 (%)	2013 (%)	2002 Area (km^2)	2013 Area (km^2)	% change
Forest	47.38	44.04	740.80	714.99	-3.34
Paddy	0.00	0.00	0.00	0.00	0.00
Agriculture	35.07	43.19	567.57	701.14	8.12
Grassland	15.85	0.46	257.07	745.39	-15.39
Urbanization	0.45	1.67	7.34	27.18	1.22
Clearedland	0.72	0.13	11.62	2.11	-0.59
Secondary Forest	0.35	9.03	0.56	146.55	8.680
Rivers, Ponds and Lakes	0.02	0.46	0.26	7.52	0.44

Minning	0.16	1.01	2.54	16.43	0.85

Table 3: Land use change in Pergau basin from 1984 to 2002

Land Use type	1984 (%)	2002 (%)	1984 Area (km^2)	2002 Area (km^2)	% change
Forest	86.3	66.98	19725.24	1530.66	-19.32
Paddy	0.22	0.16	5.02	3.68	-0.06
Agriculture	7.2	25.72	164.49	587.73	18.52
Grassland	4.78	12.33	109.32	281.89	7.55
Urbanization	0.06	0.6	1.42	13.81	0.54
Clearedland	1.44	0.51	32.84	11.65	-0.93
Secondary Forest	0.00	0.03	0.00	0.80	0.03
Rivers, Ponds and Lakes	0.00	0.26	0.00	5.98	0.26
Minning	0.00	0.19	0.00	4.45	0.19

Table 4: Land use change in Pergau basin from 2002 to 2013

Land Use type	2002 (%)	2013 (%)	2002 Area (km^2)	2013 Area (km^2)	% change
Forest	66.98	59.87	1530.66	1368.13	-7.11
Paddy	0.16	0.03	3.68	0.75	-0.13
Agriculture	25.72	26.64	587.73	608.7	0.92
Grassland	12.33	0.53	281.89	12.18	-11.8
Urbanization	0.6	0.71	13.81	16.34	0.11
Cleared land	0.51	0.48	11.65	11.04	-0.03
Secondary Forest	0.03	0.005	0.8	0.12	-0.025
Rivers, Ponds and Lakes	0.00	11.19	0.00	255.78	11.19
Minning	0.26	0.32	5.98	7.39	0.06

Tables 5-8 shows the past and present land use changes in Lebir and Nenggiri catchments. Reduction in forest is the major land use change observed in both Lebir and Nenggiri catchments from 1984 to 2002. In Lebir forested area reduced from 88.46% to 63.55% signifying a reduction of 24.91%, while Nenggiri the percentage of forested areas reduce was 17.69% for the same year under study. Unlike forest that was found to reduce, agriculture recorded an increase of 15.77% in Lebir and 2.49% in Nenggiri. Grassland was also found to be on the increase in both Lebir and Nenggiri from 1984 to 2002 where an increase of 10.92% and 14.84% occurred respectively. From 2002 to 2013 forested recorded a small decrease of 2.91% in Lebir and an increase of 6.98 in Nenggiri. The major land use change observed is decrease in grassland for both Lebir and Nenggiri while urbanization and cleared land all witnessed a small increase.

Table 5: Land use change in Lebir basin from 1984 to 2002

Land Use type	1984 (%)	2002 (%)	1984 Area (km^2)	2002 Area (km^2)	% change
Forest	88.46	63.55	2919	2096.09	-24.91
Paddy	0.00	0.004	0.00	0.14	0.004
Agriculture	8.29	24.06	273.54	793.68	15.77
Grassland	1.06	11.98	34.99	395.11	10.92

Urbanization	0.02	0.45	0.61	14.73	0.43
Clearedland	2.18	0.04	71.82	1.45	-2.14
Secondary Forest	0.00	0.06	0.00	0.20	0.06
Rivers, Ponds and Lakes	0.00	0.0001	0.00	0.003	0.0001
Minning	0.00	0.001	0.00	0.05	0.001

Table 6: Land use change in Lebir basin from 2002 to 2013

Land Use type	2002 (%)	2013 (%)	2002 Area (km^2)	2013 Area (km^2)	% change
Forest	63.55	60.64	2096.09	2000.79	-2.91
Paddy	0.004	0.00	0.14	0.00	-0.004
Agriculture	24.06	30.44	793.68	1004.45	6.38
Grassland	11.98	0.32	395.11	10.42	-11.66
Urbanization	0.45	0.45	14.73	14.84	0
Clearedland	0.04	1.29	1.45	42.56	1.25
Mangrove swamp	0.06	0.00	0.2	0.00	-0.06
Secondary Forest	0.00	6.41	0.00	211.5	6.41
Rivers, Ponds and Lakes	0.0001	0.33	0.003	10.89	0.3299
Minning	0.001	0.02	0.05	0.66	0.019

Table 7: Land use change in Nenggiri basin from 1984 to 2002

Land Use type	1984 (%)	2002 (%)	1984 Area (km^2)	2002 Area (km^2)	% change
Forest	98.22	80.53	3852.88	80.53	-17.69
Paddy	0.00	0.00	0.00	0.00	0.00
Agriculture	1.41	3.9	55.46	3.9	2.49
Grassland	0.37	15.21	14.51	15.21	14.84
Urbanization	0.00	0.09	0.00	0.09	0.09
Clearedland	0.00	0.15	0.00	0.15	0.15
Mangrove swamp	0.00	0.00	0.00	0.00	0.00
Rivers, Ponds and Lakes	0.00	0.001	0.00	0.001	0.001
Minning	0.00	0.004	0.00	0.004	0.004

Table 8: Land use change in Nenggiri basin from 2002 to 2013

Land Use type	2002 (%)	2013 (%)	2002 Area (km^2)	2013 Area (km^2)	% change
Forest	80.53	87.51	3148.76	3431.51	6.98
Paddy	0.00	0.00	0.00	0.00	0.00
Agriculture	3.90	5.99	152.4	234.69	2.09
Grassland	15.21	0.86	594.87	33.51	-14.35
Urbanization	0.09	0.22	3.62	8.66	0.13
Clearedland	0.15	0.51	5.99	19.86	0.36

Mangrove swamp	0.00	0.00	0.00	0.00	0.00
Secondary Forest	0.00	3.96	0.00	155.17	3.96
Rivers, Ponds and Lakes	0.001	0.45	5.99	17.74	0.449
Minning	0.004	0.51	0.19	19.99	0.506

3.1 Effect of Land Use on Flood Peak

The HEC-HMS model was used to predict land use effects on floods of the major catchments in Kelantan river basin using the 2014 flood as the basis for this study. First the, the maximun daily rainfall were used at the rainfall staations mentioned in section 2.5 above were statistically analyzed and the daily storm depths corresponding to different return periods were estimated. Inverse distance squared method was used to determine the spatial distribution of design rainfalls. The model was run for 1984, 2002 and 2013 land use conditions to see the extent of different land use changes on the 2014 flood. The effect of different land use conditions on the outflow peak discharge is investigated for storms with return periods from 5 to 100 years in the major catchments studied in this study.

4.0 Conclusion

The effect of different land use conditions on the outflow peak discharge is investigated for storms with return periods from 5 to 100 years in the major catchments of Kelantan river basin and the results of the findings are.

4.1 Comparison of the land uses in Kelantan river basin have shown that forest have been coverted into cultivated areas and grasslands, that leads to increase in flood volume.

4.2 All the catchments experienced significant land use changes especially forest in the past 30 years. Galas recorded the highest decrease in forested areas with 54.35%, followed by Lebir (27.82%), Pergau (26.47%) and Nenggirri (24.67%)Lebir catchment gives the highest contribution of flow followed by Nenggiri, Galas and Pergau in that order.

4.3 Galas subbasin is the subbasin with the highest increase in urbanization with 1.66% for the period under study.

4.4 Flood peak for the 5 year return period in Lebir subbasin corresponding to 1984, 2002 and 2013 is 5439.47 m^3/s, 7058.16 m^3/s and 7168.57 m^3/s respectively.

4.5 Since the effect of location and other factors, particularly the spatial distribution of rainfall, were incorporated, it is evident that the flood peak generated by this catchments are more pronounced under 2013 land use in almost all the studied catchments.

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FLOOD WATER LEVEL PREDICTION MODELING USING NNARX STRUCTURE FOR SG PAHANG BASIN

Project Information

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1.0 Introduction

There were a total of 58 events of natural disaster in Malaysia for the period between years 1980 to 2010 that claiming a total of 1,239 lives of the 640,000 people affected. These data were based on statistics provided by United Nation Officer for Disaster Risk Reduction (UNISDR). From all different categories of natural disasters considered, flood accounted for over half the registered events. Floods contribute to 8 out of 10 disaster events with the highest human exposure and affect over 85 % of all the disaster-stricken people. Floods are thus the primary hazard which affecting Malaysia, in particular the west coast of Peninsular. Therefore, an accurate and reliable flood prediction model is very much needed to provide early warning for residents nearby flood locations for evacuation purposes. However, current trends in flood prediction only involve flood modeling because no prediction time was mentioned and discussed. Furthermore, in Malaysia there is none of flood model or flood prediction model developed yet. An existing system in the Department of Irrigation and Drainage Malaysia is only the alarming system which alarms the users only when the water level exceeds the danger limit. Based on these scenarios, the research objective is to obtain a flood water level prediction model for Pahang flood prone area using Neural Network Autoregressive Model with Exogenous Input (NNARX) structure. The samples used for model training, model validation and model testing were carefully selected. In order to obtain good flood water level prediction model, all samples must be the data when flood events happened. All samples were real-time data that were obtained from the Department of Irrigation and Drainage Malaysia upon special request. From carefully selected samples, several optimal flood prediction times were suggested for flood location in Pahang. Model validation and model testing were conducted to observe the prediction performances. The optimal prediction time was selected based on the results of prediction performances. Results show NNARX model successfully predicted flood water level ahead of time.

2.0 Methodology

The samples used in model development were divided into three sets namely: training; validation; and testing samples. The model was first obtained using training samples and then validate using validation samples. The new testing samples were then fed to the model to verify the performance of the proposed model. Figure 1 shows the general block diagram of flood water level prediction model for Pahang flood prone area using neural network model structure. Four inputs were fed to the Neural Network model to predict flood water level ahead of time.. The prediction time, T_p can be set at any value that is significant for evacuation purposes. The input water levels were normalized between +1 and -1 before fed into the model to keep the water level within the same range. Later, the water levels were denormalized back to obtain the actual predicted flood water level value at the output. The value of prediction time, T_p can be set at any normal water level condition at flood location before the water level started increasing. ST1, ST2, ST3 and ST4 represent four upstream rivers and x represents current water level at flood location. $\hat{y}$ represents predicted water level at flood location.

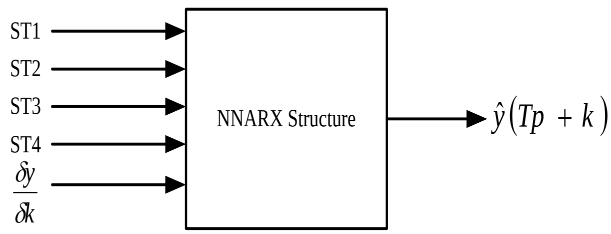

Figure 1 NNARX Structure for Flood Water Level Prediction

3.0 Results and Discussion

3.1 Modeling using 10 hours Prediction Time

Figure 2 shows 10 hours prediction result of NNARX model using Gradient Descent (traingd) as training algorithm. The actual water level is under predicted at early time steps, k. However, the models still able to predict the actual water level quite good at the rising stage till it reaches peak water level stage from time steps 1000 till 1200. Nevertheless, NNARX model under predicted actual water level at low frequency segment when the flood water level drops from peak to normal water level. At this segment, it can be clearly seen that NNARX model only able to predict at linear section thus producing Best Fit of 80.1068% as given in Table 1.

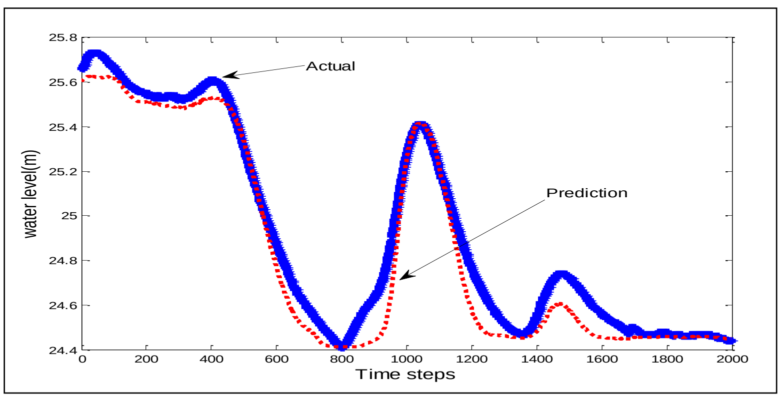

Figure 2. 10 hr Flood Water Level Prediction of NNARX Modeling Result

Table 1 : Performance Indices Result for T_p = *10 hr*

Training Algorithm	Best Fit (%)	RMSE (m)	V (m)	FPE (m)
traingd	80.1068	0.0901	0.0081	0.0081

Another set of samples have been applied to test the developed NNARX model. This samples fulfilled the same criterion as training and validation samples and the time range is between 14/11/2014 21:00:00 till 12/12/2014 15:30:00 with the total number of 4000 samples. It is important to select the testing samples in the same year as training and validation samples. This is due to the fact that the longer the time difference between those samples then more physical changes on river basin and thus will effect the performance result. Figure 3 shows the flood water level prediction after testing samples were applied to the model obtained from Figure 2. It can be observed that the NNARX model leading the actual flood water level by 10 hours. However, the predicted flood water level is not in good agreement with the actual water level, thus mapping for both graphs need to be done for RMSE analysis.

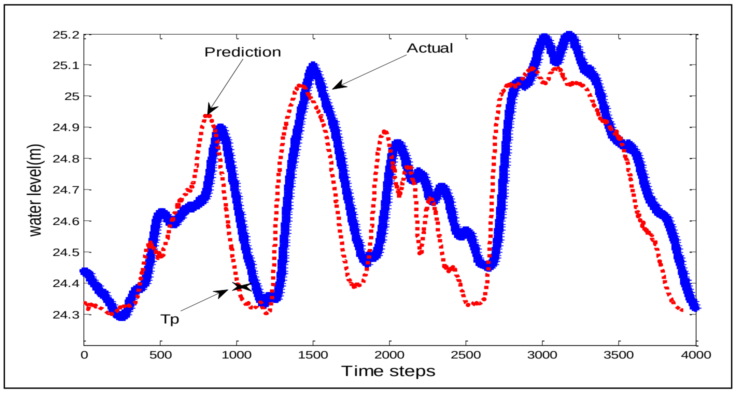

Figure 3. 10 hr Flood Water Level Prediction of NNARX Model Test Result

Figure 4 shows the mapping for both the predicted and actual flood water level graphs for RMSE analysis. As expected from the results from Figure 6, the comparison between the predicted and actual water level did not show any significant results because NNARX model cannot predict the actual water level at any segments thus producing RMSE value of 0.0695 meter.

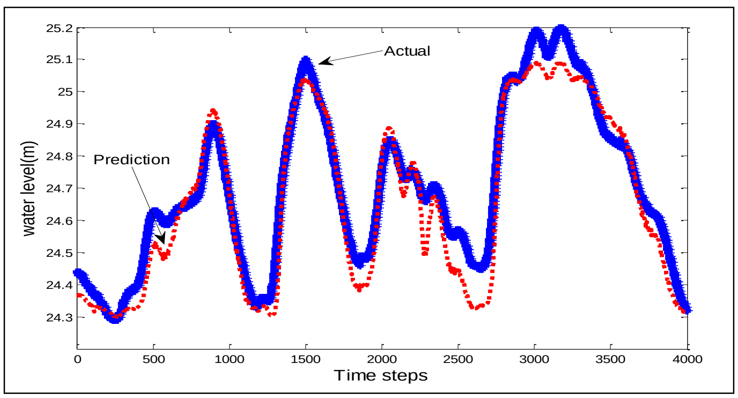

Figure 4. Mapping of the Predicted and Actual Water Level for RMSE Analysis

3.2 Modeling using 15 hours Prediction Time

Next, the prediction time, T_p was increased furthermore to 15 hours for performance analysis. Figure 5 shows flood water level prediction result using *traingd* as training algorithm. The results have shown good agreement between predicted and actual water level at high frequency section however the NNARX model under predicted the actual water level at low frequency section. The model is trained using Tan-Sigmoid (tansig) as transfer function for input, hidden and output layers whereas the number of nodes for hidden layer is set to 25 to meet the error goal of 0.00001m. Despite the error goal was not converged, the NNARX model still manage to provide good Best Fit value of 84.82% as shown in Table 2.

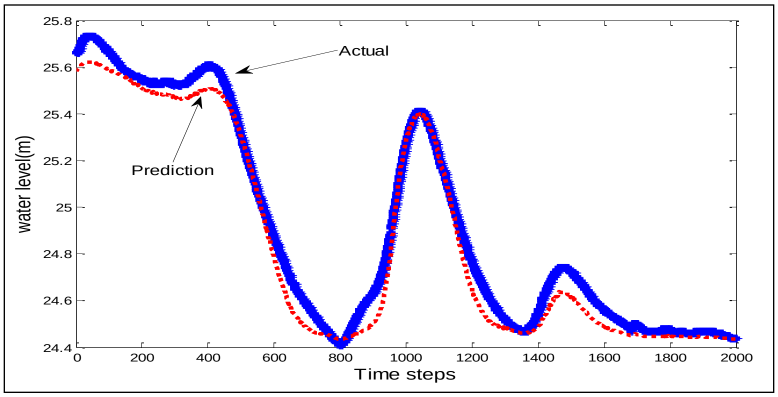

Figure 5. 15 hr Flood Water Level Prediction of NNARX Modeling Result

Table 2 : Performance Indices Result for T_p = *15 hr*

Training Algorithm	Best Fit (%)	RMSE (m)	V (m)	FPE (m)
traingd	84.82	0.0687	0.0047	0.0047

Using the same model structure as in Figure 5, the testing samples were applied to the NNARX model to evaluate the performance result. From Figure 6, it can be seen that the performance of NNARX model is degrading compared to T_p = 12 hours. The model shows slightly different pattern trend from the actual water level. For detailed analysis on NNARX model performance, mapping for both predicted and actual water level need to be done. Figure 7 shows mapping of both graphs for RMSE analysis. Generally, NNARX model only manage to track actual water level at time steps 400 till 1490.

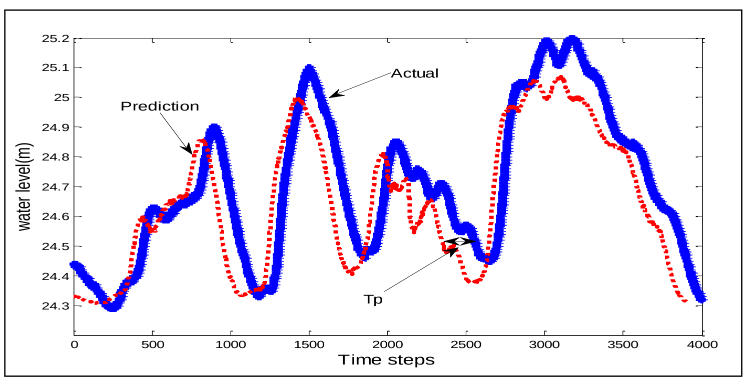

Figure 6. 15 hr Flood Water Level Prediction of NNARX Model Test Result

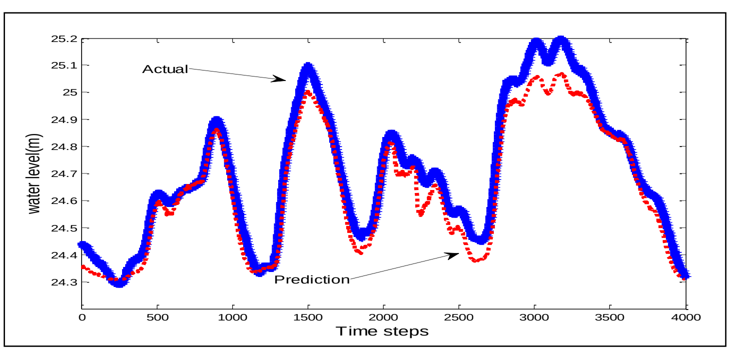

Figure 7. Mapping of the Predicted and Actual Water Level for RMSE Analysis

4.0 Conclusion

4.1 The flood water level prediction model using existing Neural Network Autoregressive with Exogenous Input (NNARX) model has been successfully developed and tested for flood prone area in Pahang.

4.2 The NNARX model had shown satisfactory performance in all assessments including model validation and model testing. The performance result shows that 15 hours is the best prediction time for flood water level prediction in Pahang.

4.3 However, 10 hours prediction time were still reliable for flood water level prediction model.

4.4 Variations value of prediction time were tested starting from 3 hours till 24 hours, but the optimal prediction time for Sungai Pahang basin is between 10 to 15 hours.

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A COUPLED HYDROLOGIC-HYDRAULIC MODEL FOR SIMULATION OF FLOOD INUNDATION EXTENT AND DEPTH IN KELANTAN RIVER BASIN

Project Information

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1.0 Introduction

The first half of northeast (NE) monsoon is one of the most spectacular climatic period of Malaysia when east coastal region of Peninsular Malaysia receives 50%, often as much as 70% of its total annual rainfall (Yik et al., 2014). The heavy rainfall events occurred 3 to 4 times in the seasons with each episode usually lasts for 3 to 5 days (Moten et al., 2014). The large rainfall episodes often amount to several hundreds to over a 1000 mm rainfall and cause devastating flood in the east coastal region (Yik et al., 2014). The state of Kelantan, as one of the eastern coastal states is the most severely affected region due to NE monsoonal flood. The Kelantan River regularly overspills its banks during the NE monsoon and cause floods in the most parts of the state. The historical records show that the river basin which covers 85% of the state suffered from floods in almost every year, among those, the floods in 1926, 1967 and 2014 are the most severe. Some other records of flood experiences in the country as a whole available in literature with the State of Kelantan inclusive are; 1931, 1947, 1954, 1957, 1963, 1965, 1969, 1971, 1973, 1983, 1988, 1993, 1998, 2001, 2006, 2007, 2008, 2009 and 2010 (Khan et al., 2014).

The recent monsoonal rain driven flood (December 2014) in Kelantan was the worst in the county's recent history. Two consecutive heavy rainfall episodes in the last half of December 2014 caused severe floods with Kelantan as the worst affected area. Most parts of the state were inundated and hundred thousand people were forced to evacuate. The flood severely affected the food supplies, electricity, clean water, sewerage, health care and other emergency services and caused an unprecedented public outcry. The severe devastation appealed for urgent scientific solution to this recurrent natural hazard.

Though heavy rainfall episodes are considered as the major cause of flood in the region, unprecedented severity of recent flood drawn attention to some other likely factors such as changes in land use, changes in climate, high tides, insufficient drainage and lack of flood protection system as the possible causes of amplification of flood induced by monsoonal rainfall. It has been reported that precipitation in the Kelantan River basin has increased in the wet season and decreased in the dry season significantly in recent years (Adnan and Atkinson, 2011). This has caused increase in streamflow in both the upstream and downstream sub-catchments of the basin (Adnan et al., 2014). Basarudin et al. (2014) reported that recent activities involving land use changes from lowland forest to vegetation and urban area have contributed to increase floods in recent decade in the river basin. Adnan et al. (2014) reported that land use change, predominantly deforestation for agricultural purposes, has potentially caused some increases in hydrological response over time in the upstream area of Kelantan River Basin.

The objectives of the present study are (i) to simulate the flood inundation extent and depth at the upper sub-catchment of Kelantan river basin using a coupled hydrologic – hydraulic model; and (ii) to assess the impacts of landuse change on flood peak and volume in the basin. Of the six catchments in the Kelantan river basin, Sg. Galas was chosen for the research. The selection is guided by the basic philosophy that peak discharge being generated at any point of the upstream sub-catchment propagates to the lower reaches with consequence of occurrence of flooding at this region. In addition, records had shown higher rainfall amounts in the stations within and around the catchments than the rainfall stations in the neighbouring catchments (Nenggiri and Pergau), and more so, deforestation in the region is generally believed to be more than the two other catchments. It is therefore believed that simulation of runoff at this upstream sub-catchment will help to develop early warning system for emergency preparedness.

2.0 Methodology

The study area Sg Galas is one of the six sub-catchments in the Kelantan river basin. The area lies between Longitudes 101.923^{0}E, 102.188^{0}E and Latitudes 4.622^{0}N, 5.534^{0}N with elevations vary between 25 m and 1351 m above the mean sea level. The upper reaches of the basin consists of forested mountains and the lower reaches with lowland forest as well as limestone hills (Basarudin et al., 2014). Sg. Galas consists of nine sub-catchments namely: Sg. Asap, Cheweh, Chiku, Galas, Kelasa, Kerak, Ketil, Kundor and Nireh as shown in Figure 1. There is no streamflow station in Sg. Galas catchment, and therefore, two other catchments namely, Sg. Nenggiri and Pergau were included for calibration and validation, since these two gauged catchments have common outlet with the studied catchments.

A field reconnaissance of the drainage basin was carried out to identify the physical features of the basin, such as the drainage networks, soils and geologic conditions, landuse and vegetative cover. The hydraulic roughness characteristics of the drainage basins in extreme flow conditions were also examined, considering overbank flows. The channel can be described as incised in most cases, while the banks are inhabited, cultivated or remained forested. The river bed is more than 60 m wide at the upstream and about 120 m at the lower reaches, covered with coarse, medium to fine sand and silt. In situ permeability test using permeameter to establish the hydraulic conductivity of the soils under different land use conditions was also conducted.

For effective simulation and in-depth understanding of the scenarios, coupled hydrologic and hydraulic model was developed using XPSWMM software. Preparation of inputs for the model is described below.

2.1 Hydrologic data

The rainfall data for the study was acquired from the Department of Irrigation and Drainage (DID), Malaysia. Continuous records of 5mm rainfall from automatic stations are available for the study area. The data was converted to hourly data as the appropriate interval for the model. Hourly rainfall data for selected events such as; 2008 flooding in at Sg. Galas di Dabong was used for the calibration while 2009 January episode for validation. Eighteen selected rainfall stations spread across the catchments with consistent data were used (Figure 2). It is to be noted that the distributions of rainfall stations at the study catchments are sparsely distributed and several stations contain missing data. These do not conform to standard norms required for accurate simulation and thus remained a limitation.

In order to effectively simulate flow in Sg. Galas, streamflow data available at three locations in the catchments were used for calibration and validation of the model. These are Sg. Pergau in Batu Lembu, Sg. Nenggiri in Jam. Bertam and Sg. Galas in Dabong. It is of note that Sg. Galas in Dabong is the common outlet of the catchments and thus records combined flow from the catchments (Figure 2).

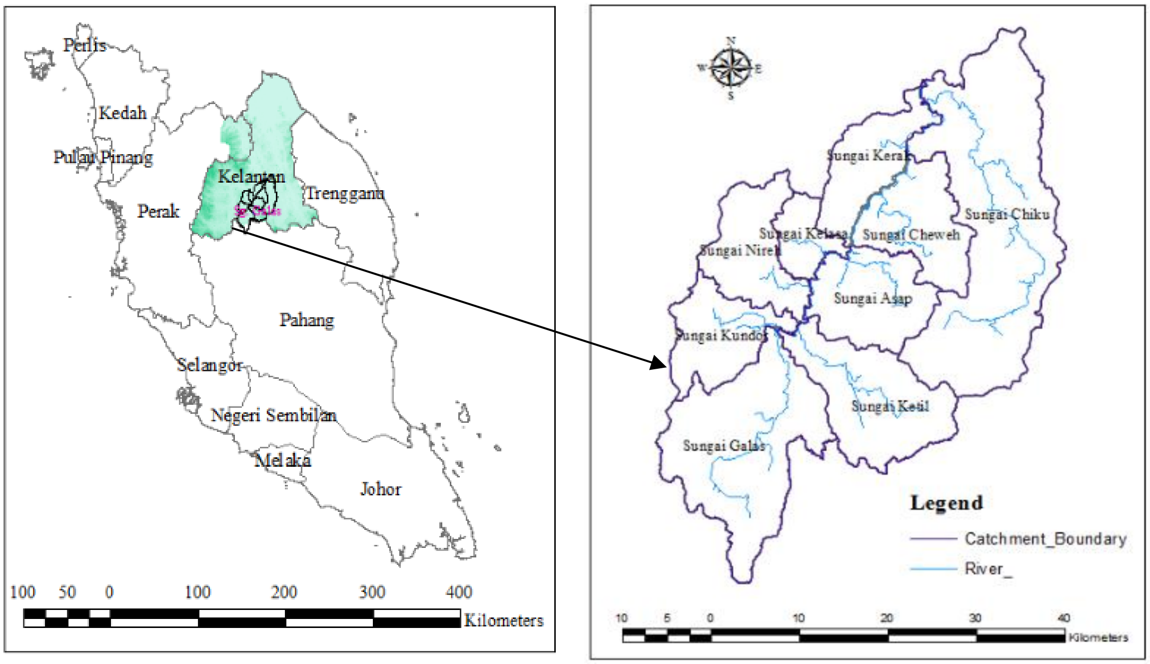

Figure 1: The study area map

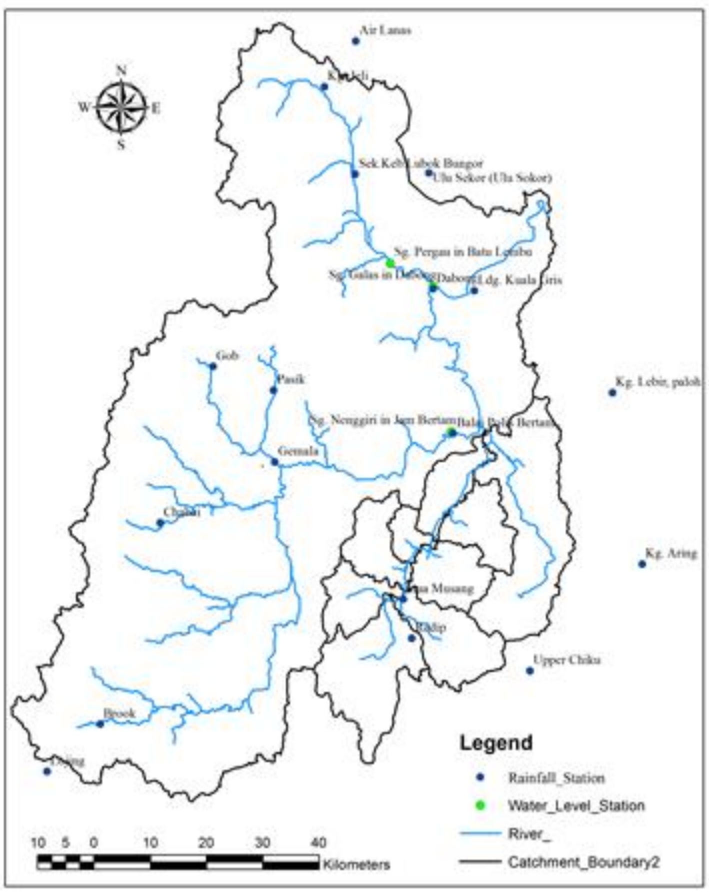

Figure 2: Rainfall and streamflow gauging stations used for study

2.2 Geomorphologic characteristics

High resolution DEM data is required for better accuracy in hydrological modelling. However, as the high resolution DEM data was not available, the best recourse available resources were used. The LiDAR data of 3m resolution for the major rivers and 30m resolution USGS DEM were used to generate drainage network and topographic features of the study area. The geomorphologic characteristics formed part of the pertinent data required for hydrologic studies, which include catchment area, slope and width. These are properties were derived from ASTER DEM data obtainable from US Geographical Survey (USGS) website using geographical information system (ArcGIS 10.3).

2.3 Land use and land cover

The relationship between land use and land cover is known to be dynamic and rarely in a stable equilibrium (Niehoff et al., 2002). The land use and land cover play major role in controlling the catchment's hydrologic response (Veldkamp and Fresco, 1996). Quantifying various flood parameters in the catchment, requires in-depth study of land use in order to understand the influence of natural and man-induced factors in recent flooding. Therefore, the land use maps for the study area were obtained from the Department of Agriculture, Malaysia (DOA). The land use maps for the years from 1980's to till date were collected. From the available maps, growth in land uses in the catchment was detailed. Figure 3(a - e) shows changes in land uses in Sungai Galas catchment.

2.4 Soil data

The soil property of a catchment constitutes one of the major factors to its hydrologic response to runoff volume during and after rainstorm events. Soil texture determines the water-holding characteristics of a soil as well as the infiltration capacity of a soil layer. Therefore, studies to ascertain the characteristics of the soils are important. There are basically three major soil series in the studied catchments. These are: Charang Hungus/Lubok Kiat, Durian/Munchong/Bungor and Rengam/Jerangau. However, Charang Hungus is the dominant soil type in the catchments. Description of soil series are given below:

Charang Hungus/Lubok Kiat: The soils are characterized in the field by light grey clay with clay content ranging from 35 – 60%. The soils have moderate structure, plastic consistency having poor drainage characteristics. The hydraulic conductivity of the soils under different land use conditions as determined from the field test are between 3.8×10^{-5} to 4.0×10^{-4} cm/s.

Durian Munchong Bungor: The soils are in groups 2, 1 and 6 respectively according to 26 Malaysia soil series. The textural classifications of the soils are silty clay loam and silt loam. These are typically B and C hydrologic soil group (HSG).

Rengam Jerangau: These soils are in group 6 according to 26 Malaysia soil series. They are clay and sandy clayey soils belonging to HSG C. Figure 5 shows the soil map of the study area.

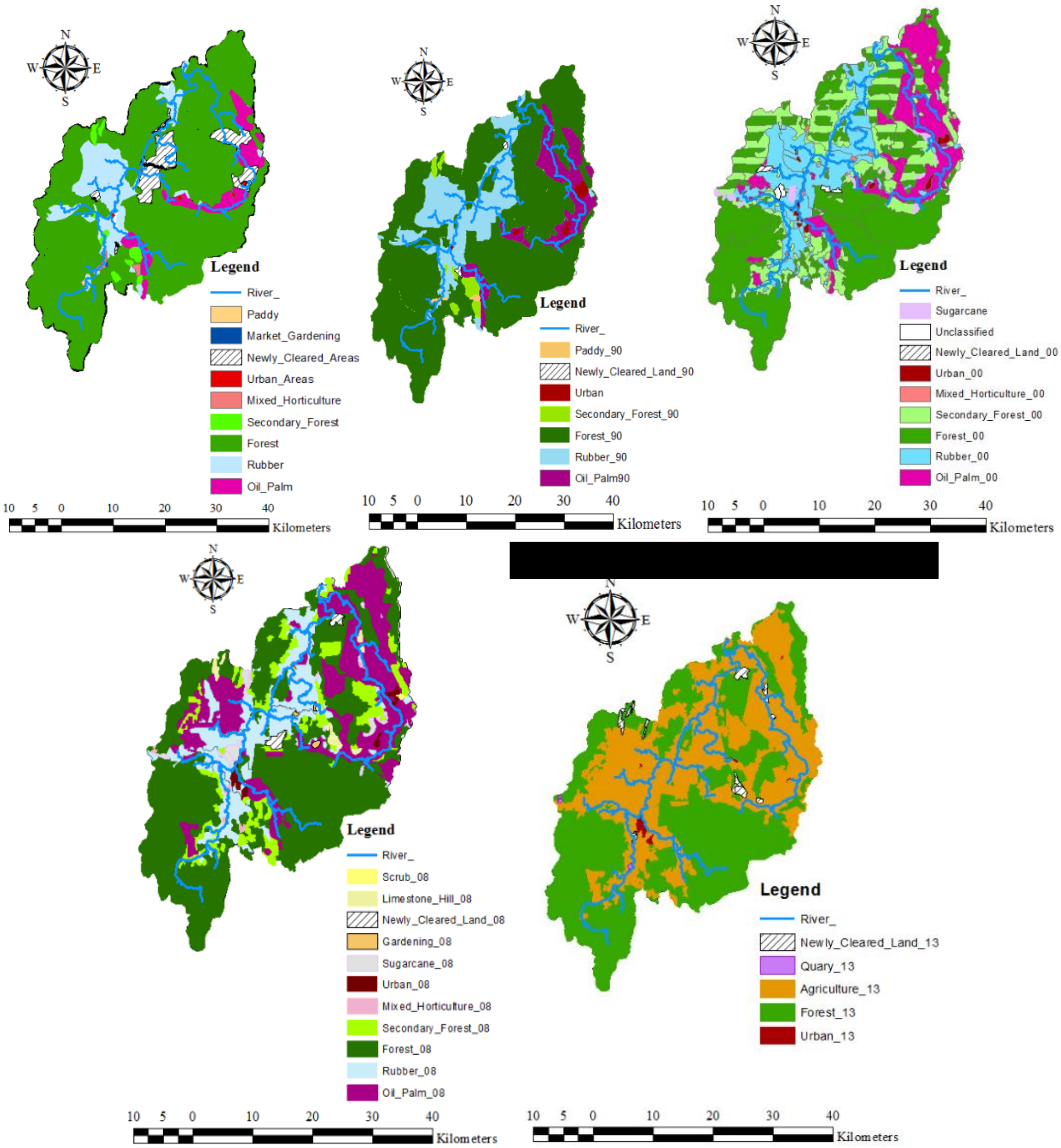

Figure 2: Changes in land uses in Sungai Galas catchment over time

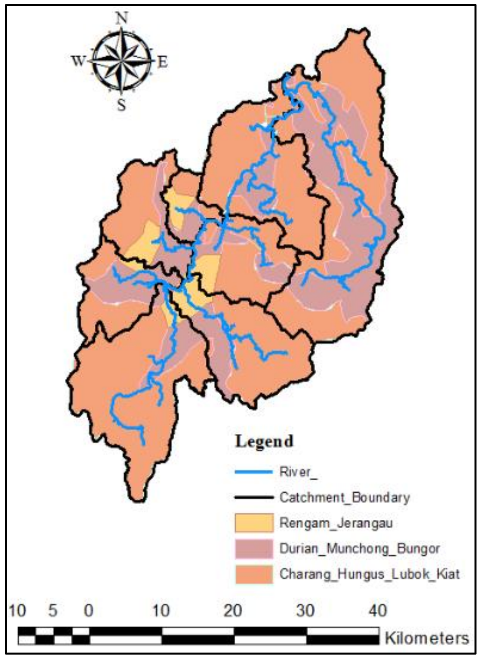

Figure 3: Soil map for the study area

3.0 Results and Discussion

The summary of the pertinent data for the model calibration and validation as well as the results from the simulation are hereby presented and discussed below.

Catchment characteristics

The characteristics of the study catchment are given in Table 1. The catchment consists of nine sub-catchments with total area of 160,276 ha. The characteristics of each sub-catchment were extracted as input parameter for the model. Width of the catchment is an important characteristic and should never exceed 10000m. Based on this, the catchments were further sub-divided into smaller unit areas such that the same catchment can have different rainfall data, and other catchment properties depending on the size and requirements.

The land use maps were used to derive changes in forest areas in the study catchment. Figure 6 shows the variations in forest area in the region over time.

Table 0-1: Catchment characteristics

Sub-Catchment	Area (ha)	Slope (%)	HSG
Sg. Asap	13,667	0.975	C
Sg. Cheweh	13,067	0.478	C
Sg. Chiku	46,767	0.262	B
Sg. Galas	29,419	1.357	C
Sg. Kelasa	10,604	0.248	B
Sg. Kerak	4,975	0.347	C
Sg. Ketil	18,449	2.260	C
Sg. Kundor	11,111	0.442	B
Sg. Nireh	12,217	0.143	B

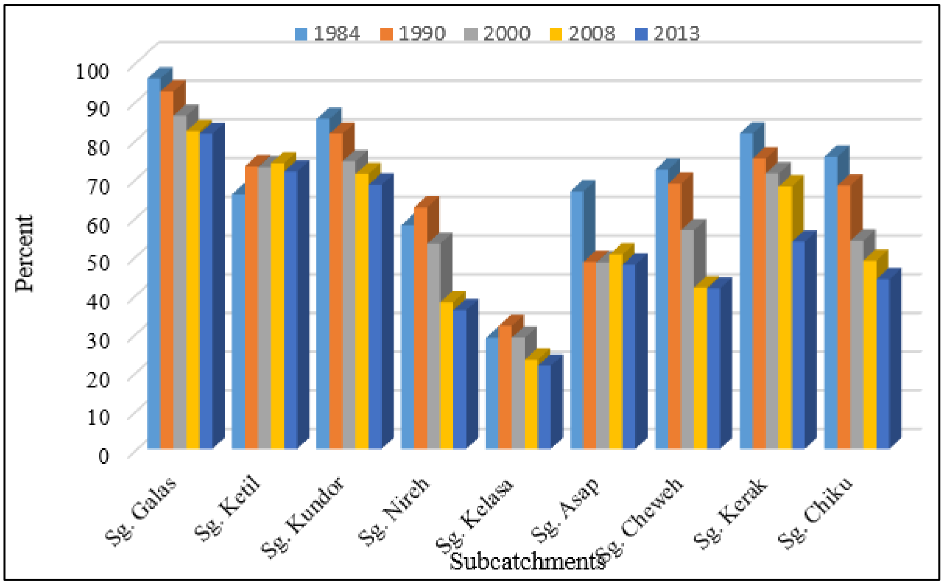

Figure 6: Variations in forest in the region over time

3.1 Model calibration

To calibrate the model, the flood event of 25-30 Nov., 2008 was used. For 1D coupled hydrologic – hydraulic model, rainfall, catchment area, slope, catchment width, percentage of impervious area, CN, depression storage, Manning's roughness coefficient and evaporation data were used. The initial abrasion of 0.2 along with the CN and others aforementioned parameters were used to represent the infiltration data for the model using SCS method. In simulating the hydraulic model, channel cross sectional data, longitudinal length, slope as well as manning's coefficient was used. Figure 7 shows the calibrated hydrograph for Sg. Galas at Dabong Station.

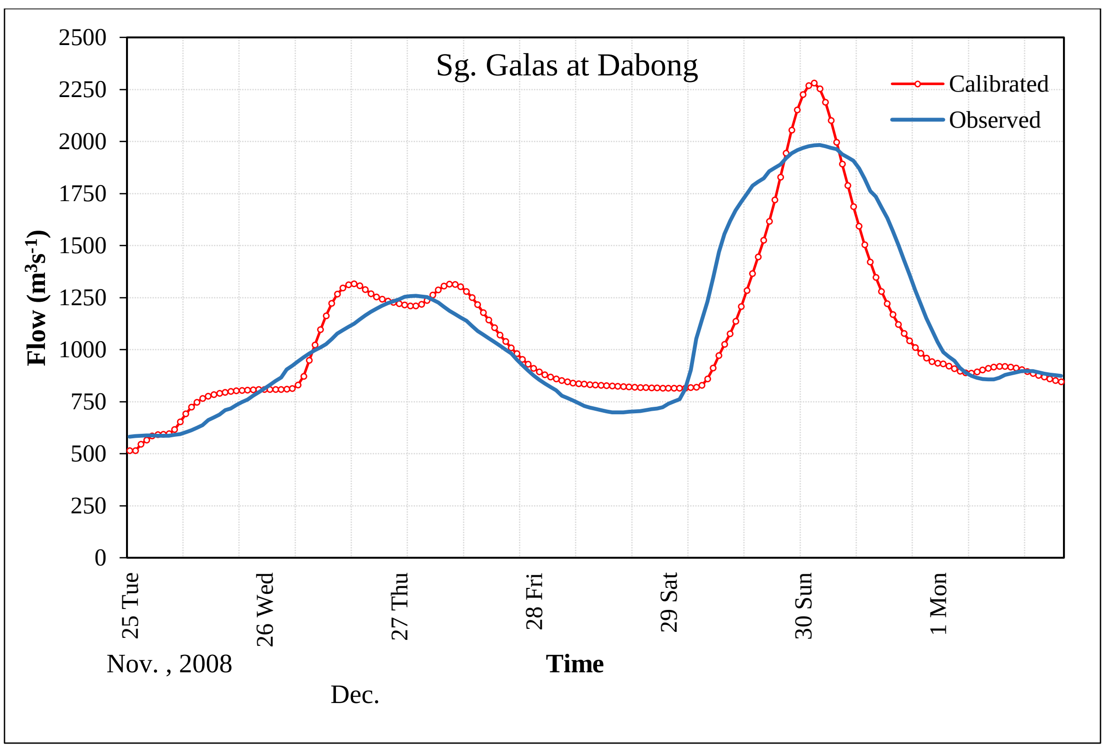

Figure 7: Observed and calibrated hydrograph at Sg. Galas in Dabong in November, 2008

The parameters of the model were adjusted until calibrated flow matched excellently with the observed flow. The hydrograph has two peaks as seen in the figure. The first peak occurred on Thursday, 27th November 2008 with maximum of 1258.94 m^3s^{-1}, which did not however resulted to any flood, while the second one was on the Sunday, 30th November 2008, which caused flood. Peak flow simulated by calibrated model was 2280.34m^3s^{-1} as compared to the observed value of 1982.75m^3s^{-1}. It was noted that both the rising and recess limbs of the calibrated hydrograph was steeper than the observed and hence a little higher value of peak discharge was simulated. The times to peak for observed and calibrated flows were 124 hrs and 122 hrs, respectively starting from 25th November 2008.

3.2 Model Validation

The validation of the model was carried out using the January 2009 flood event (01-06 January, 2009) having relatively similar characteristics in terms of the peak discharge as well as the span of the event. Because of the closeness of the events, it was assumed that the land use characteristics remained unchanged. Using the same rainfall stations as those for calibration, the hydrographs produced at Dabong and Nenggiri stations are shown in Figures 8 and 9, respectively.

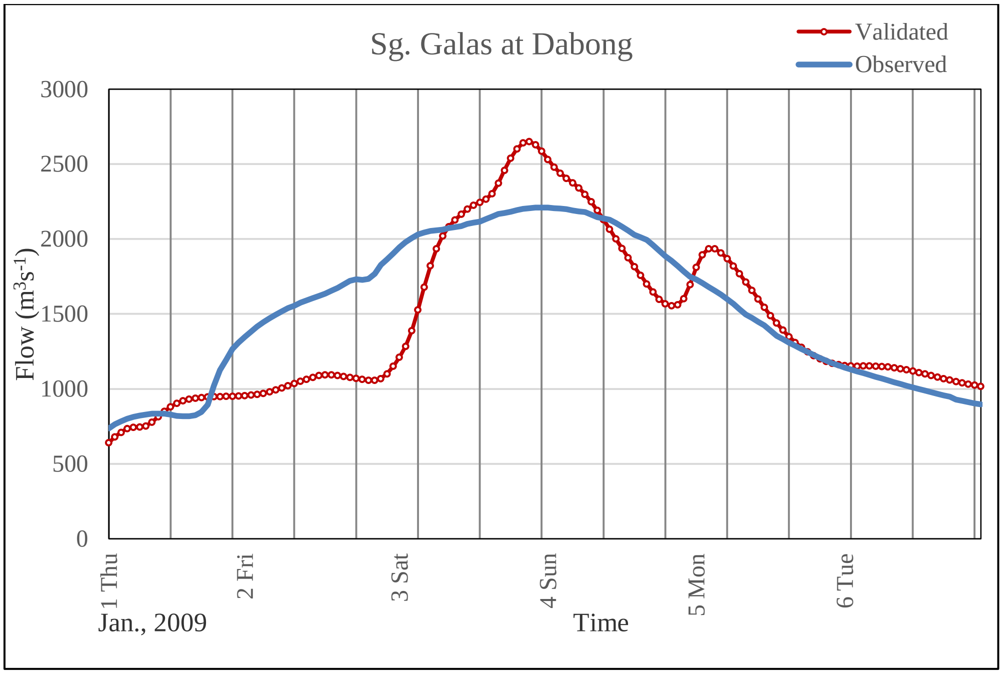

Figure 8: Observed and validated hydrograph at Sg. Galas in Dabong, January 2009

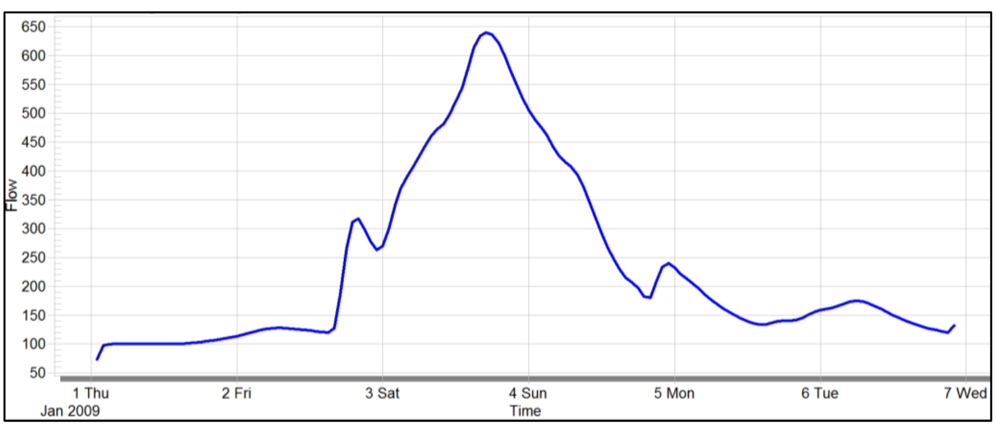

Figure 9: Observed and validated hydrograph at Sg. Galas outlet, January 2009

3.3 December, 2014 flood scenario

The essence of the current study is to quantify various flood parameters in Sg. Galas catchment during the 2014 flood event. The torrential rainfall which caused the devastating flood began on the 16th December 2014. The extreme rainfall continued for the next ten days. This event gave persistent raise in water levels in the upstream rivers among which is Sg. Galas at Dabong. The highest recorded level at this station was 46.47 m which was far above the danger level of 38m. During the episode, the peak discharge was as high as 11052 m^3s^{-1}, where the flood magnitude of approximately 2000 m^3s^{-1} always resulted flooding. Figure 10 show the flows from Dabong station during flood period.

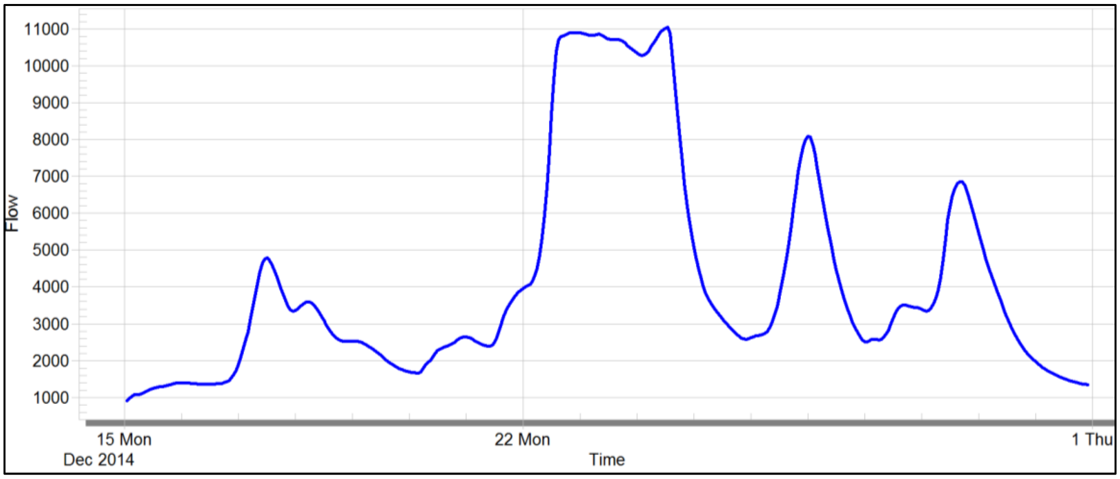

Figure 4: Simulated hydrograph for Sg. Galas in Dabong, December 2014

4.0 Conclusion

The elements of a flood cause-consequence chain are interrelated in the downstream and upstream parts of a river network. There is no doubt that changes in an upstream part of a river have a strong impact on downstream river sections. Therefore, to understand the cause and mechanism of flood generation, it is required to pay more attention on hydrological changes in upstream sub-catchments of a river basin. Kelantan River basin has six major sub-catchments. Considering the availability of long-term data, a sub-catchment located in the upstream of the river basin known as Sg. Galas catchment was selected for the present research. To effectively simulate the flow from Sg. Galas catchment; two more catchments, namely, Sg. Nenggiri and Sg. Pergau were included as those two catchments have common outlet with Sg. Galas at Dabong station and flow records are available at gauging stations in these two catchments. Therefore, discharge data at these two catchments were also used for the calibration and validation of model.

A coupled hydrologic-hydraulic model was used in the present study to fulfill the objectives. The calibration and validation of the model suggested its suitability for use. The model input parameters were rainfall, catchment area, slope, catchment width, percentage of impervious area, CN, depression storage, Manning's roughness coefficient and evaporation data. Furthermore, channel cross sectional data, longitudinal length, slope as well as manning's coefficient were used in simulating the hydraulic model. The model was run with different land use data available for series of years in order to quantify the impacts of land use change on flow peak and volume. The results show that flow peak and volume reduced 0.74%, 3.12%, 5.71% and 6.71% for the years 1984, 1990, 2000 and 2008, respectively compared to that in year 2014 when same rainfall episodes were considered. These are small reductions considering a peak discharge of over 3000 m^3s^{-1} from a catchment having an area of approximately 160,276 ha, where contributions of peak flow of 600 m^3s^{-1} in the catchment results flood. This means that impact of land use change in flood peak and volume in the study area is negligible. The present study also analyzed the effects of floods from the catchment. The study identified the far reaching effect of flooding from the catchments due to backwater effect occasioned by repulsive force from the fast moving main channel flow to its tributaries which have less volumes as well as slower velocities. Overall, the model is found to simulate the inundation extent and depth appropriately, thereby providing a measure which can be used to suggest mitigation measures.

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FORMULATION OF A TRUST EVALUATION ALGORITHM USING TRUST MODEL FOR PEER COMMUNICATIONS TO IMPROVE INFORMATION RELIABILITY DURING THE DISASTER ENVIRONMENT

Project Information

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1.0 Introduction

During the event of a disaster, dissemination and sharing of information such as location and situation of the disaster are very much sought after. With the presence of ICT applications and smartphone devices, dissemination and sharing of information can be carried out with ease. Everybody can post and share information about the disaster they are currently experiencing. Although this freely sharing of information is good, it does give rise to one critical issue. Can we trust and verify the information obtained from these technologies? How do we ensure that the information being transmitted is genuine? It was discovered that in order for help to be sent immediately, people may resort to fabricated information so as to make the authority believe that they are in great danger.

In gathering data from users, crowdsourcing is considered as the most suitable approach. This term was coined by Jeff Howe [1] and further refined by other researchers [2]. This approach allows users to give their feedback easily as in data collected in Haiti earthquake in 2010 [3, 4]. This approach was also adopted in other well-known disasters such as the Queensland & Australian Flood, the Christchurch Earthquake and the Japan Earthquake [5].

Based on the abovementioned scenarios and our interviews with the victims of Kelantan's flood, the rescue centres were lacking the necessary methods to check for the trustworthiness of the data captured from the victims. As such, all incoming data (raw data) are always considered as trustable. It is always possible that there exists unreliable, untrusted or fake data, among the huge amount of data being captured form the public. Should the authority acted on this untrusted data, their effort to save the real victims may be hindered.

2.0 Methodology

a) Reviewing of the trust evaluation requirements and constraints for information reliability
In this phase, information reliability characteristics and disaster information systems will be identified and analyzed. In addition, special requirements and constraints related to flood scenario will also be studied.

b) Reviewing of the current trust models.
In this phase, various trust models be studied and analyzed. The focus is to find the models that would be suitable in the disaster environment.

c) Designing and developing the lightweight trust evaluation algorithm
Inputs from the earlier phases will be used to design and develop the algorithm Some modifications to the selected trust model will be carried out to suit our aim to propose lightweight algorithm.

d) Evaluation of Algorithm
The developed algorithm is analyzed and evaluated to ensure of its usability.

3.0 Results and Discussion

Taking into consideration of the Kelantan big flood, it was discovered that the GPS location and user information are needed in order to ascertain the trust of the transmitted information.

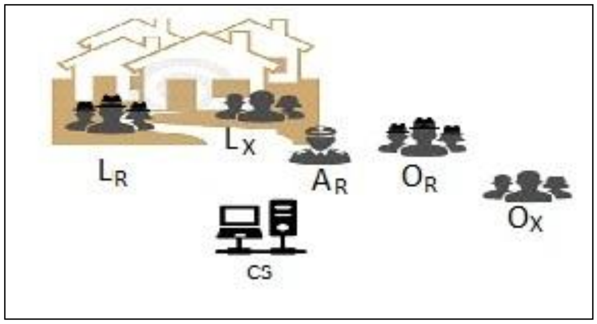

Fig. 2: Available users

In Figure 2, the possible users available during the flooding scenario are displayed. These users are categorized based on their physical location and whether they have registered with the rescue center. Local users are those located within the disaster area and Outside users are those outside the disaster area. Description of each category of users is provided in Table 2. Each type of user is assigned with a trust value based on their level of reliability. The more reliable the user, the higher the trust value will be. In Figure 2 & Table 2, the most reliable user is Ar (Registered Authority) and highest trust value of 1.0 is assigned to them.

The registered authority (Ar) has a full trust value since they are the authorized personnel to handle the rescue operation. As for the local user, a high trust value (0.7 & above) [6] is assigned to them since they are currently experiencing the disaster.

Table 2: Types of users**.**

User Type	Explanation	Trust Value
Lr	Local Registered User	0.8
Lx	Local not Registered User	0.7
Or	Outside(non-local) Registered User	0.6
Ox	Outside(non-local) not Registered User	0.5
Ar	Authority Registered User	1.0

We propose the following formula for calculating the trust of information received from various individuals affected by flood situation. An initial value of 0.5 is initially assigned to all areas. Whenever a user reports a flooding in a respective area, the trust value (meaning the possibility of flood in that area) will be increased accordingly. Likewise, if a user report that an area is not flooded, the trust value of that area will be reduced accordingly.

NATV = CATV + (UTV * AHTV) or NATV = CATV - (UTV * AHTV)
Where,
NATV = New Area Trust Value; CATV= Current Area Trust Value
UTV = User Trust Value; AHTV = Area History Trust Value
+, if reported flooding, -, if reported not flooding

NATV refer to the new area trust value. CATV refers to the current trust value of the respective area. UTV refers to the trust value of the user. Different user is assigned with different trust value. Local registered users are given a high trust value of 0.8, since they are registered and currently in the disaster area. Local users, but not registered is given a slightly lower trust value of 0.7, since the authority would not be able to immediately ascertain their identities. The same concept is used for outside users whereby Outside but registered user is given 0.6 and Outside but did not register is given 0.5 trust value. AHTV refers to the historical flood situation for the disaster area. There are three historical flood situations namely, frequently flooded, seldom flooded and rarely flooded of which is assigned 0.03, 0.02 and 0.01 trust value respectively. The value for each situation is assigned to ensure that the overall trust value would increase linearly instead of exponentially.

Fig. 3: Threshold values

Based on literature reviews [7,8,9], we have adopted a value of 0.7 as a threshold for high trust value. The distance between 0.7 to 1.0 is 0.3. Using the similar distance from 0, we have opted to define 0.3 as the threshold for not flooded. Trust values between 0.3 and 0.7 indicate an Alert level for the particular area. Areas with 0.7 & above trust values, indicates that they are experiencing serious flooding and need immediate attention. The rescue centers can focus their rescue efforts on those critical areas (trust values exceeding the Upper Treshold).

4.0 Conclusion

Important findings of the research works are summarized as follows:

4.1 A huge amount of information is communicated to the rescue centers during a disaster and information via mobile devices is significantly large. The rescue centers do not have sufficient mechanism to ascertain the truthfulness of the information received.

4.2 The method to calculate the trust value for each information received was developed using the GPS coordinate, user data and historical data. Information received can be ranked based on calculated trust values. Rescue centers can focus their rescue efforts on the critical areas.

4.3 A prototype was developed to demonstrate the workability of the developed trust algorithm.

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A COMMUNITY-BASED STUDY ON THE EFFECTIVENESS OF FLOOD EMERGENCY WARNING SYSTEM IN MALAYSIA

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1.0 Introduction

Floods contribute to the highest percentage of natural disaster occurrence in Malaysia. It also produces the highest impact to the people and economy. The total number of people affected by major floods in Malaysia reached millions and the damage costs estimated to billions of Ringgit Malaysia. One of the ways to reduce the risk from flood disaster is to implement an effective flood early warning system. An effective warning system will help significantly in reducing numbers of loss lives and assets. In order to do this, assessing current effectiveness of the flood early warning system is crucial. Questions arise whether the disseminations used are effective in reaching the community. By conducting surveys and questionnaires, the effectiveness of current early warning system and the preparedness of the Malaysian people towards flood can be assessed.

2.0 Methodology

Subsequent to the big Yellow flood of the December 2014 Kelantan, a set of critical questions were developed and put into survey to obtain preliminary assessment right after the flood. Through the preliminary assessment, a more detailed and revised survey questionnaire were developed particularly for a larger-scale public survey. Tests were conducted to screen out difficult and unsuitable technical terms as well as assessing the time taken by respondent. The final set of questionnaire was then developed. Convenience samplings were conducted randomly across 9 districts in Kelantan. A total of 567 respondents were obtained.

3.0 Results and Discussion

Three questions related to flood awareness were asked. One important question include whether the people were aware of the coming flood season. Slightly more than half answered 'No' (Figure 1). Even if the results are compared in terms of age and education levels, similar assessment can be observed. This shows that generally the awareness of the people on flood season in Kelantan is not significantly biased by age and education levels. Results however showed that slightly majority of the people aged less than 18 were aware of the flood season. This is contributed by the sample taken from one of the primary school in Kelantan (Sekolah Kebangsaan Cenderung Batu, Wakaf Baru, Tumpat Kelantan). Information gathered from the school teacher suggest that the reason majority of the students answered 'yes' is due to regular flood occurrence in their villages; whether it be minor or major. The North-east monsoon is experienced every year from November to March. The season overlaps with the school final vacations in Malaysia which usually starts in December. The associations of the monsoon season to the school final vacation indirectly force the students to remember and be aware of the flood season ('*Musim Bah*' or '*Musim Tengkujuh*' among the locals). Moreover, many of the parents are fisherman. Hence, most of the students are exposed to information related to the monsoon. A different perspective can be seen by viewing the results based on the locations. Majority of the people located in Kuala Krai and Machang were aware of the flood season as compared to other locations. The least percentage of awareness is from Tanah Merah and Pasir Mas.

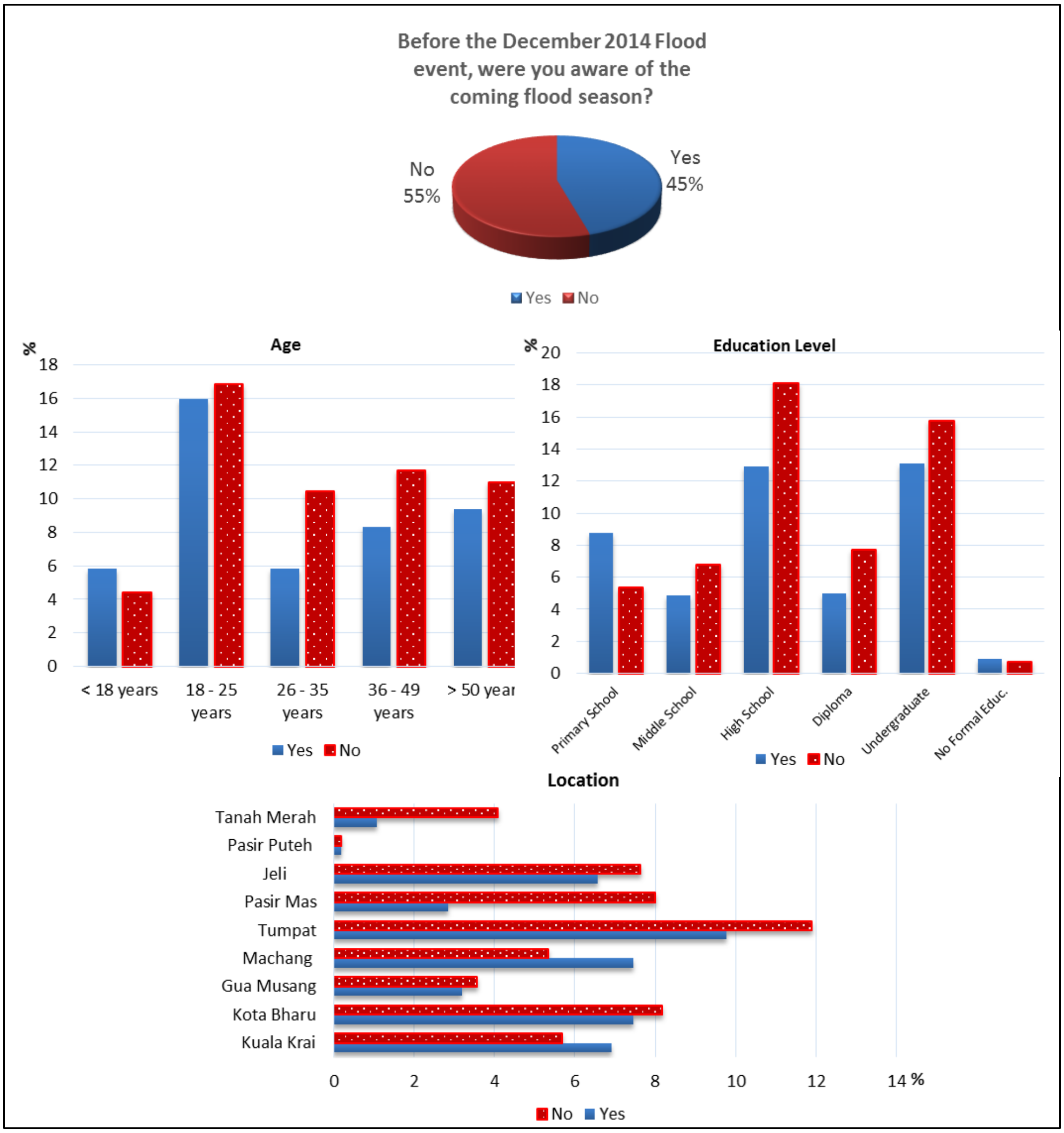

Figure 1: Awareness on coming flood season.

3.1 Flood Early Warning System

Two main important questions related to flood early warning system are; 1) Were people aware of the existence of a flood warning system by the authorities; and 2) Did they received any warnings on extreme rainfall or flood during the December 2014 flood event. Subsequent to those questions important details gathered from the questionnaire also include which medium of the early warning system they knew, and; from which medium and who they received the warnings from. Analyses from the question on whether the people were aware on the flood early warning system by the authority show majority with 67% were not aware of it (Figure 2). From the 33% of people answered ‘yes’, majority of them knew it from the media social of Facebook (38%), followed by website (34%), the rest is from the sirens situated near rivers and others. Exposure of the flood warning system through social media was expected to be high for young generations (Under 30 year of age). Results however showed even majority of the respondents with age up to 49 years old selected Facebook. This could signify the power of media social as an information bridge besides websites.

In order to assess how effective available warnings were prior to the December 2014 flood, the people were asked on whether any warnings reached them. Despite the lack of awareness on available flood early warning system, warnings did reached 56% of the people (Figure 3a). Majority of the people who received the warnings received it through the medium of television (52%), followed by 18.6% through rumors. By associating the medium the warnings received with whom they received it from (Figure 3b), majority of the respondents who received the warning through TV had chosen they received it from the meteorological agency, followed by from the public. The fact that majority of the respondents also chose public were not expected. Another point concerned is warnings received through rumors were initially expected to be received from the public; however majority was from the AJKK. This shows the importance of local community association and could signify the importance of giving early warnings to the local village committee to further spread the information. Another interesting outcome is on SMS as the medium of the warnings. The percentage of people received the warning through SMS is higher compared to from the radio. Majority of the respondents choosing SMS as the medium it received chose the public as whom they received it from.

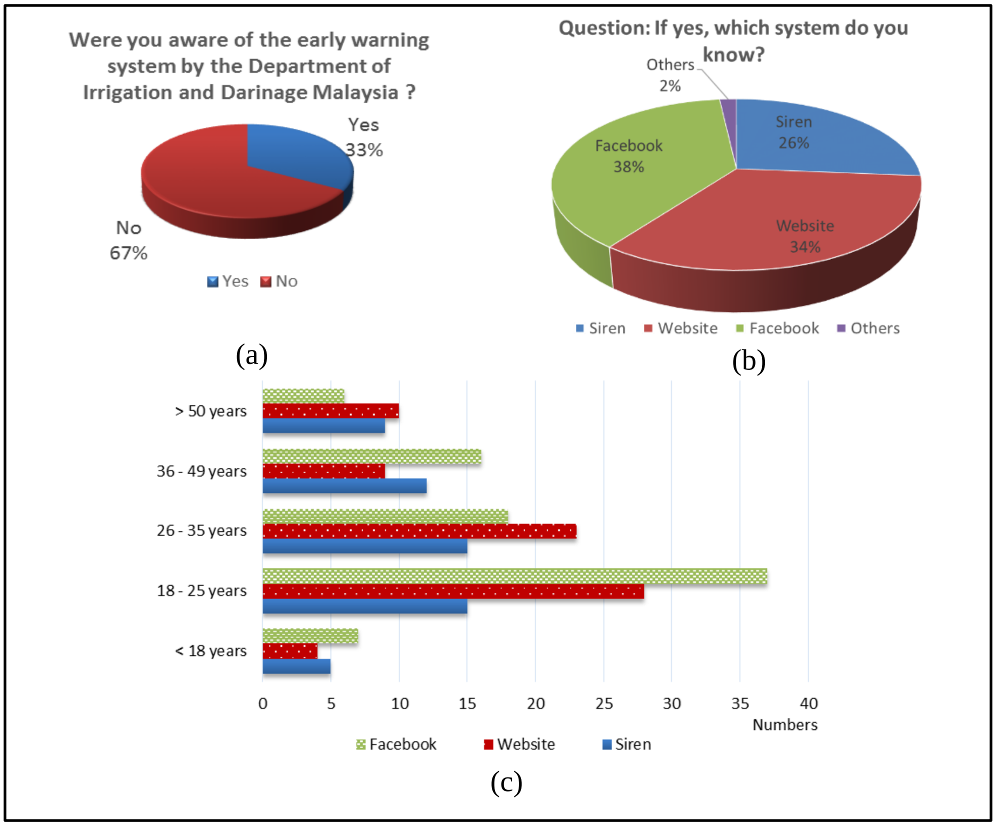

Figure 2: Awareness on existing early warning system

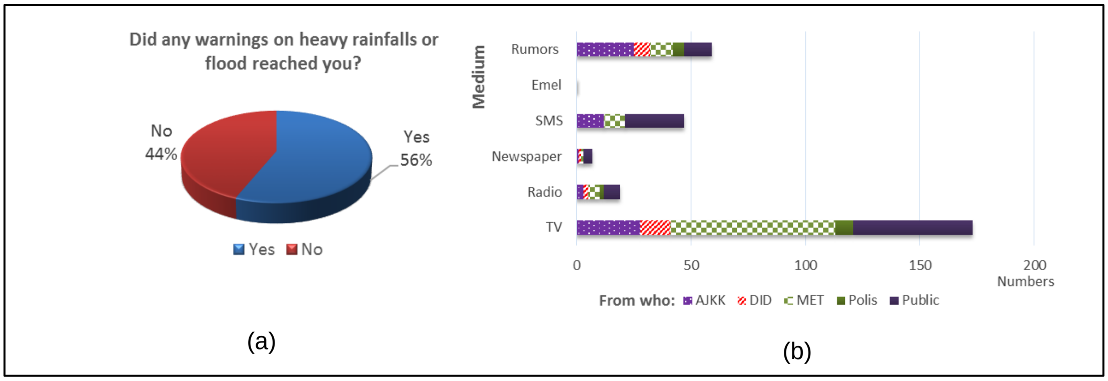

Figure 3: Effectiveness of existing early warning system

4.0 Conclusion

4.1 Despite the lack of awareness on available flood early warning system, warnings did reached 56% of the people. Among the 56%, the effectiveness of the early warning system highly depends on the dissemination method.

4.2 Warnings received through television and rumors were the highest.

4.3 Rumors or warnings received among the people are majority received through the local village committee

4.4 Importance of considering giving early warnings directly to the local village committee to further spread the information.

FLOOD OCCURRENCE REDUCTION MEASURES BY RUNOFF PREDICTION BASED ON LAND USE SCENARIO ANALYSIS USING SCS-CN METHOD AND GIS FOR KELANTAN RIVER BASIN

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1.0 Introduction

Runoff potential is fundamental information in water resource planning and management. The estimation of runoff potential for large river basins could be complicated due to variability of land cover, soil properties and rainfall pattern. Integrated river basin management approach is critical to ensure the conversion of area with high infiltration capacity such as forest into other land use types (low infiltration capacity) should not reach the hydrological function limits of the basin. This study was aimed to estimate runoff potential using SCS-CN and GIS by simulating land use and rainfall intensity for Kelantan River Basin (12940km2). 30 years (1984-2014) climate and hydrological data of the basin obtained from DID (57 stations) and MMD (23 stations) were analyzed. The land use was classified into eight classes; forest (9007km2), oil palm (1352km2), rubber (1626km2), paddy (178km2), other agriculture (386km2), urban (108km2), open area (151km2) and water bodies (135km2). SCS-CN for each land use was obtained from the previous studies in tropics e.g. Thailand, Malaysia, China and India. The land use change from 1994 to 2014 was analysed based on land use map, Landsat-5 and SPOT-5 satellite imageries. Forest area in KRB was declining by 14% whereas oil palm and rubber/Timber Latex Clone (TLC) were increased by 150% and 22%, respectively. The land use conversion of whole basin to forest, rubber, oil palm and urban has changed the runoff by -30, +42, +107 and +204%, respectively. The eastern and middle part of Gua Musang and Jeli, the middle part of Kuala Krai and some part of Kota Bharu, Machang and Tanah Merah were identified as the sensitive areas that significantly increase excess runoff at the river basin scale. Future simulation for sensitive areas identification will consider different scenarios (e.g. land use conversion on higher elevations, steeper slopes and shallow soil areas) with different rainfall intensities based on economic projection until 2050. The identified sensitive areas should be protected and taken into account for the integrated land use planning and management at river basin scale.

2.0 Methodology

This study estimated runoff for 1994, 2004 and 2014 used the SCS-CN formula as the rainfall, P is the input and CN value is the abstraction and an output is excessed rainfall after abstraction that become runoff, Q. The higher rainfall intensity (61mm/hour) was used for estimating runoff considering the highest rainfall intensity in KRB recorded at Kg. Tandak station (71.1mm/hour) on 24th December 2014. CN were determined based on NEH-4 as follow (McCuen, 1982 and 1989): (a) identify the land use, treatment class, and soil type in the basin. A soil can be classified based on the minimum infiltration rates; (b) identify the antecedent moisture condition based on 5-day antecedent rainfall (SCS, 1985); (c) determine the CN-value for each land use classes from Table TR-55 (SCS, 1986). CN values for KRB were obtained from the previous tropical research by referring to the soil hydrological index in the area, land use type and antecedent moisture condition in KRB.

Initially, the land use of the basin was classified into 8 land use types and was adopted from the previous tropical research by referring to National Engineering Handbook Section 4, Hydrology (NEH-4) i.e. urban, open area, oil palm, rubber, paddy, other agriculture, forest and water due to limited information of curve number in tropical. The land use classification for 10 years interval (1994, 2004, and 2014) were processed and digitized used SPOT-5 satellite imagery (2004 and 2014) and Landsat-5 satellite imagery (1994), supporting with land use map obtained from DOE (1984, 1990, 2002, 2004 and 2014) as reference. The ground truthing was conducted to clarify and calibrate the land use classification processing, there are 135 ground truthing points was selected and observed scattered around KRB and the rate of the accurate point is almost 95% from the processed land use classification with the actual land use. Then, the soil classification of the KRB categorized into hydrologic soil group (Fig. 3), consist of Group A, B, C, and D which A (highest infiltration rate) and D (lowest infiltrate rate). As CN is also varied with antecedent soil moisture conditions, the antecedent moisture condition (AMC II) were used as it represents moderate moisture conditions and recommended for most hydrologic analysis (Clopper, 1980). CN map with integration of the land use, hydrologic soil group and AMC has been mapped for each year in 1994, 2004 and 2014.

The runoff potential simulation was simulated whole land use in 2014 into a single land use i.e. forest, rubber, oil palm and urban based on important land use classes in KRB using different rainfall intensities classes (light: 1, moderate: 11, heavy: 31, very heavy: 61mm/hour) by DID (2015).

3.0 Results and Discussion

Land use reclassification using Landsat-5 satellite imagery for 1994 showed KRB consists of forest (81%), rubber (9%), oil palm (4%), paddy (2%), other agriculture (2%), water (1%), urban (0.4%) and open area (0.6%). In 2004, there was declining of forest area (72%), in inverse other land uses were increasing rubber (11%), oil palm (10%), paddy (2%), other agriculture (5%), water (1%), urban (0.8%) and open area (1.2%). Forest area continuing to decline in 2014 to 69%, there was slight decreasing of paddy (2%) and open area (1%) in 2014 (SPOT-5). Similar trends of growing trends particularly for oil palm (10%), other land use e.g. rubber (13%), other agriculture (4%), and water (1%) and urban (1%) showed slight increment. In brief, the land use change (1994-2014) analysis (Fig. 1) indicates that forest was declining by 14% and paddy by 22% since 1994. On the other hand, oil palm and rubber plantations were increased by 150 and 22%, respectively. Growing population and economics have boosted the land conversion to other land uses, there were also an increment observed for other agriculture land (90%), open area (414%) and urban area (228%).

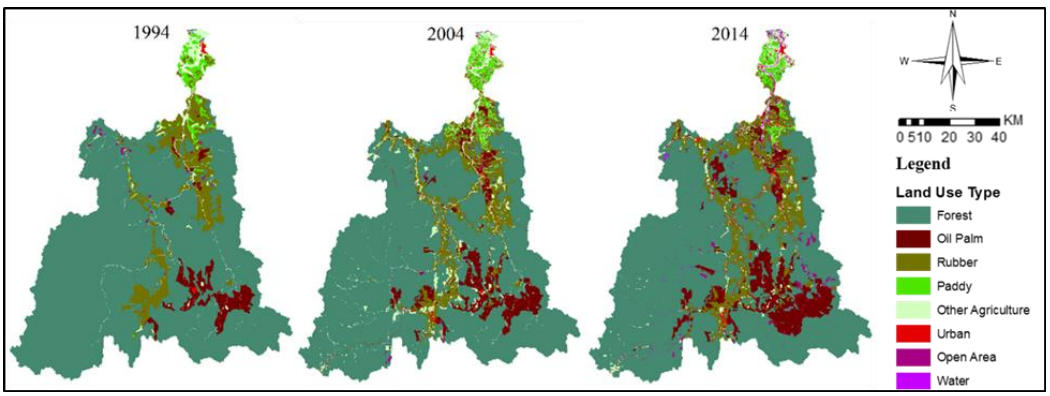
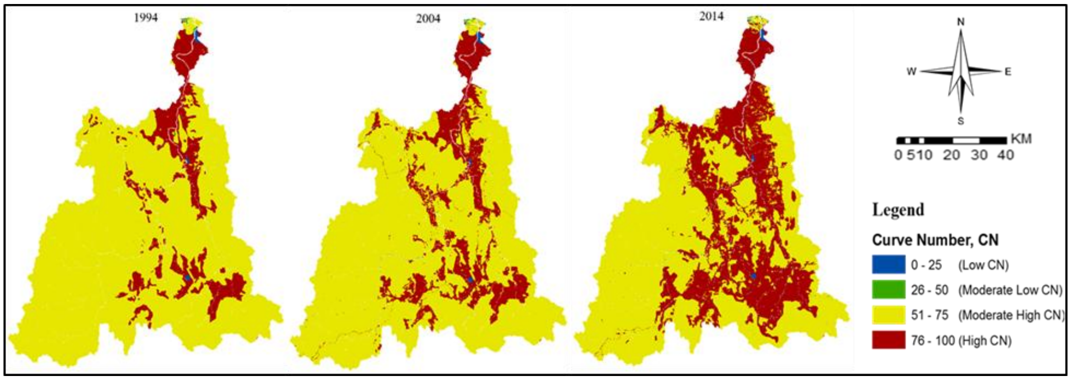


Figure 1: KRB land use changes based on SPOT5 and Landsat 5 satellite imagery for year 1994, 2004 and 2014 shown an extension of oil palm and rubber area over time

The CN in KRB (Fig. 2) ranging from 39 to 93 (Faizalhakim et al., In preparation; SCS, 1986). The higher CN values indicates higher runoff potentials. The larger area with higher CN values within KRB was observed over time (1994-2014) due to deforestation and forest conversion to other land uses (e.g. oil palm, rubber, other agriculture, open area and urban) (Fig. 1). In 1994, most of KRB area (65%) covered with moderate high CN (yellow) and 30% of KRB covered with high CN value area (red) (Fig. 2) which is located in the area which covered with urban, paddy, oil palm and rubber with the HSG C and D. There are small extension of the high CN value area in 2004 due to increasing of oil palm and rubber area. Interestingly in 2014, the ratio of high CN and moderate CN area is same due to decreasing of forest area leads to expansion of agriculture land i.e. oil palm and rubber. If this trend continues, KRB will mostly covered with high CN which indicates high runoff.



Source: (Faizalhakim et al., In preparation)

Figure 2: CN generated in KRB for 1994, 2004 and 2014, showed the extension area of high CN (red) and the diminishing of moderate high CN area (yellow) over time (1994 to 2014)

Runoff potential estimation using very heavy rainfall intensity by DID Malaysia (2015) I_{60}=61mm/hour for 1994, 2004 and 2014. The runoff depth in KRB for 1994, 2004 and 2014 are ranging from 0.00–45.21mm distributed over the KRB. As results, the larger area with very high runoff, high runoff and moderate runoff potential was observed over time (1994-2014) (Fig. 3). This is related to oil palm and rubber expansion, and increment of urban and open area with the higher CN values that increase the area with high and very high runoff potential particularly in the middle and eastern part of Gua Musang, small part in Jeli and Kuala Krai. There are also high runoff potential observed in floodplain part of KRB i.e. Kota Bharu and Tumpat. The area consists of urban and paddy fields on clay soil with permanently high water table (HSG D). Overall, the runoff volume (m^3) (Table 1) shown an increment of 14% over time from 1994 to 2014 for whole KRB.

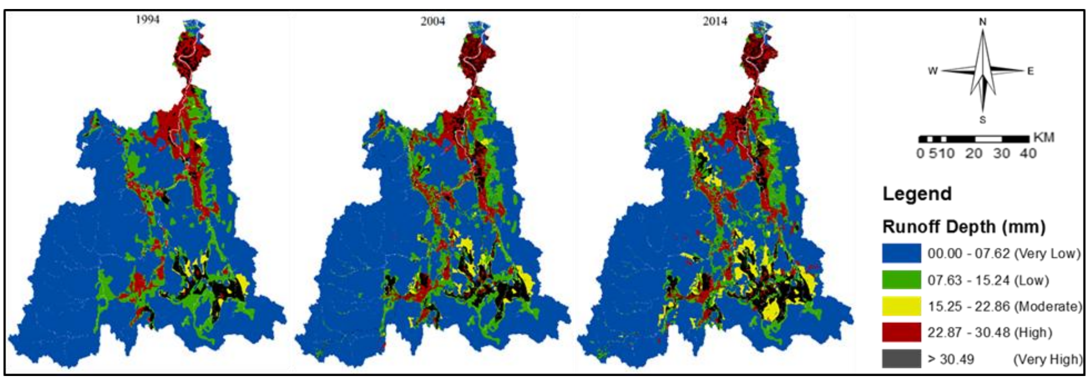


Figure 3: Estimated runoff potential using hourly I_{60}=61mm/hour showed the increasing trends of area with high runoff potential particularly in east part of Gua Musang, Kuala Krai, Machang, Tanah Merah, Pasir Mas and Kota Bharu area.

Table 1: Runoff depth (mm) for KRB ranging from 0.00 – 45.21mm, runoff volume (mil m3) increased by 14% for ten years interval: 1994, 2004 and 2014)

Year	1994	2004	2014
Runoff Depth (mm)	0.00–33.27	0.00–45.21	0.00–41.91
Runoff Volume (mil m^3)	123.40	135.19	144.42

4.0 Conclusion

Important findings of the study are summarized as follows:

4.1 The land use of the KRB changed intensely in the 1994 and 2014 with the decreasing of forest area from 10,481 to 9007km2 (-14%) and expansion of oil palm plantations and rubber estates from 540 to 1352km2 (+150%) and 1330 to 1626km2 (+22%), respectively.

4.2 The results shown that the impact of land use changes was significantly increased runoff potentials and extension area of high runoff potentials within two decades (1994-2014) due to land use changes.

4.3 The clear effects were observed if the whole KRB converted to: (i) oil palm plantation, (ii) rubber estates and (iii) urban area, lead to high runoff potential.

4.4 If the whole basin covered by forest, it potentially reduces the runoff potential, but in certain areas with HSG D produced higher runoff potential.

4.5 The major influencing factors of runoff including rainfall intensity, land use types, and soil hydrologic conditions and characteristics.

4.6 The eastern and middle part of Gua Musang and Jeli, the middle part of Kuala Krai and some part of Kota Bharu, Machang and Tanah Merah were identified as the sensitive areas that significantly increase excess runoff at the river basin scale.

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LONG TERM ANALYSIS OF TIDAL RANGE, HIGH TIDES AND SELECTED ESTUARINE WATER LEVEL IN EAST COAST OF MALAYSIA

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1.0 Introduction

Summary of actual tide range measurements should be important in verifying cyclical changes in tide potential that may alter Earth's climate on short and long timescales (Keeling et al., 1997, Keeling et al., 2000). The tidal duration and magnitude of the high and low tides can also signify the effect of climate change. Hence, a summary of long-term tidal information, in general, is useful for assessing climate change impact to the hydrodynamic behaviour of beaches and estuaries, particularly in the East Coast of Malaysia that are subjected seasonal flooding.

The fundamental question here is how the spring tidal range (STR) and mean sea level (MSL) changes over decades? The present study focuses on the trends in STR and MSL surrounding the East Coast of Malaysia and compares with previous local studies. Additionally, to further understand the tidal intrusion in Kelantan River Estuary, a field study was conducted to collect the water level and salinity data along a 12km stretch of Kelantan River Estuary.

2.0 Methodology

2.1 Secondary data collection

The data were collected from Jabatan Ukur dan Pemetaan Malaysia (JUPEM). The present study compiled more than 25 years worth of hourly water level/ tidal observation records for four tidal stations in the East Coast namely; Geting (GET), Kelantan, Cendering (CHD), Terengganu, Tanjung Gelang (NKP), Pahang and Tanjung Sedili (SED), Johor.

The observed water levels are used to calculate the tidal range on a monthly basis. Since there are two spring tides and two neap tides in every lunar month, only maximum monthly tidal range is taken for the yearly averaging. The tidal ranges discussed in this section are; yearly averaged monthly spring tidal range (STR), spring tidal range during the wet season (WTR) and spring tidal range during the dry season (DTR). The selected months for WTR are November until March, which is during the North East Monsoon Seasons that bring heavy rainfall to the East Coast of Malaysia. The selected months for DTR are May to September, which are dry periods with relatively low rainfall (South West Monsoon).

2.2 Primary data collection and fieldwork

The December 2014 flood in Kelantan was associated with the coincidence of high tides. The tidal records did show the presence of spring tides a few days before the big flood and contribute to the rising limb of the flood. However, there are no abnormalities in the tidal range during the heavy rainfall, but there is a small increase in the local mean sea level at that time. Hence, there is a need to understand the tidal intrusion in Sg Kelantan and the characteristics of Sg Kelantan River estuary ideally prior, during and after the Northeast monsoon. In this study a field work was conducted prior to the monsoon season focusing on the last12km stretch of Kelantan River, starting at the inlet of river mouth to upstream of the river.

The data were limited to secondary water level records at Geting (from JUPEM) and Jeti Kastam (from DID) and primary water level measurements at three stations namely; Jabatan Laut, Medan Ikan Bakar and Tambatan Diraja. Local water level and salinity data were obtained by using Water Lever Logger and YSI Water Quality instruments respectively. During fieldwork, the water level was recorded from 23 October 2015 till 22 November 2015 at the three stations, shown in Fig. 1. The salinity was measured on 24 October 2015 and 25 October 2015 at 7 cross sections. The distance from every cross section was approximately 2km apart starting from the river mouth until 12km upstream (Fig. 1).

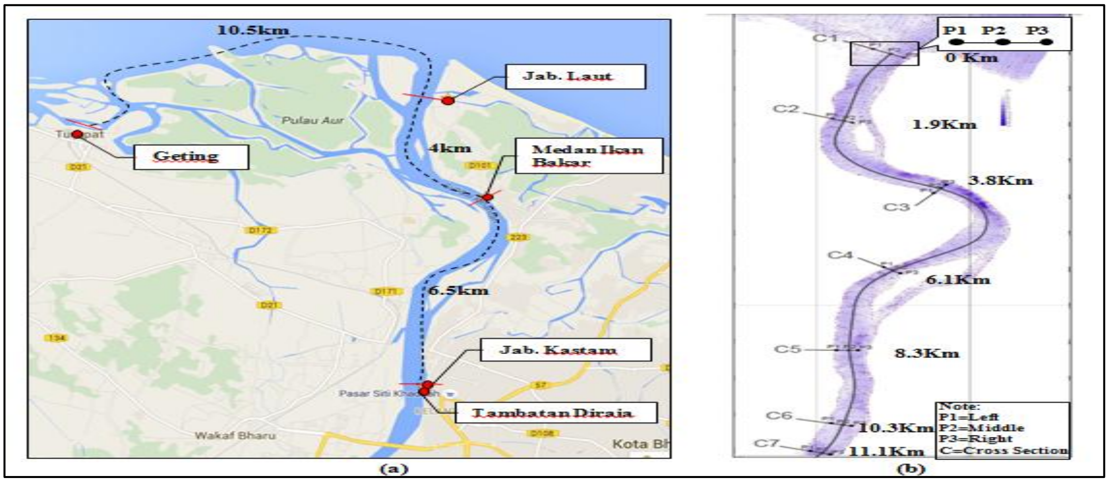

Figure 1: Study Location- Kelantan River. (a) Water Level Stations
(b) Salinity measurement sections.

1.0 Results and Discussion

3.1 Mean Sea Level (MSL)

MSL is critical in the determination of the susceptibility of flooding and or inundation at the river mouth. The increase in MSL increases chances of flooding and saltwater intrusion into a nearby river. In this study, the hourly water levels data are averaged over the record durations to get the local mean sea level (LMSL). A unique trend is identified along the East Coast whereby the LMSL is highest around Tanjung Gelang, 2.8m, and decreases towards northerly and southerly stations (Table 1). The LMSL at northerly stations decreases by 21% and 18% for Chendering (LMSL=2.2m) and Geting (LMSL=2.3m) respectively. The southerly stations, Tanjung Sedili (LMSL=2.4m) indicate a lesser decrement of 14% from Tanjung Gelang. Chendering exhibits the lowest LMSL, which is 60cm lower than Tanjung Gelang.

The yearly mean sea level (YMSL) variations in Figure 2 illustrates an increasing trend similar to the previous studies (NAHRIM, 2010, Jeofry & Rozainah, 2013). The fitted linear trend analysis suggests that the rate of sea level rise (SLR) in Chendering is the highest, 0.36cm/year. However, the differences are insignificant with the other stations (Table 1) The root mean square error (RMSE) between the computed YMSL using the linear trend and actual data are in the order of 2cm, indicating good predictions using linear trend. The rate of SLR predicted by the present study is about 1mm/year higher than Jeofry & Rozainah (2013), but the majority of NAHRIM's prediction (2010) are larger than the current and previous study.

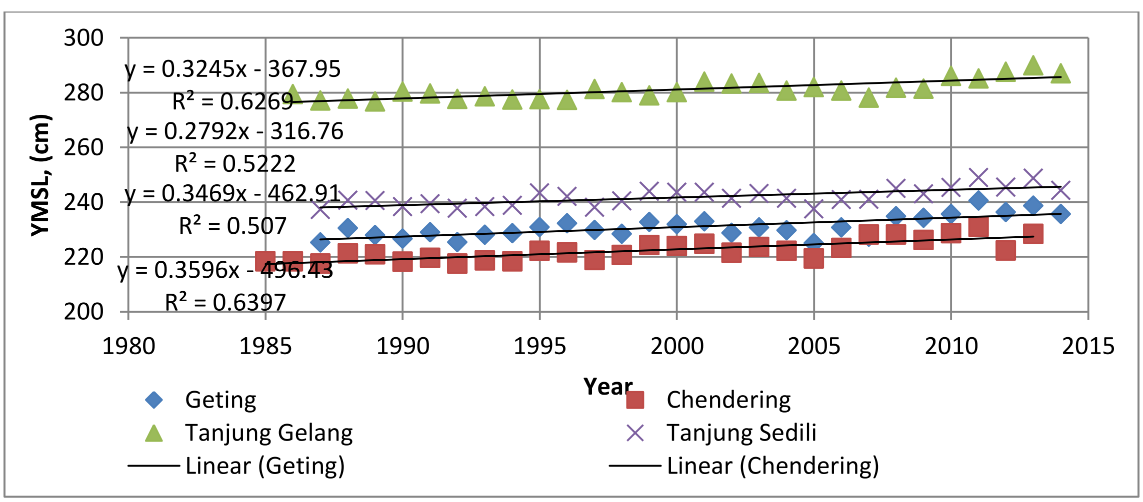

Figure 2: Trend of yearly mean sea level.

Table 1: LMSL and estimated rate of SLR based on linear trend analysis

Station	Duration	LMSL (cm)	Estimated rate of SLR (cm/year)	RMSE between predicted and measured YMSL (cm)
Geting, Kelantan	1987-2014	231.01	0.347	2.76
Chendering, Terengganu	1985-2013	222.64	0.360	2.26
Tanjung Gelang, Pahang	1986-2014	281.09	0.325	2.17
Tanjung Sedili, Johor	1987-2014	241.85	0.279	2.16
Average		**244.15**	**0.328**	

3.2 Tidal Range

It is known that the water level observations include non-tidal effects from winds, atmospheric pressure and river flow on the water level. Hence, to detect the seasonal influence, the tidal range are calculated during wet and dry seasons. The overall concept is that the during high runoff periods (wet season), the river flow raises the mean sea level, reduces the tide range, and distorts the tide curve asymmetrically, which affect the average tidal range in comparison to dry season. As oppose to YMSL, the STR, WTR and DTR does not illustrate any increasing or decreasing trend, instead fluctuates about their mean value but with insignificant (Fig. 3). The insignificant % difference are found between STR, WTR and DTR (Table 2), where Tanjung Gelang indicate/exhibit the highest average STR, WTR and DTR, about 3m and decreases southeasterly and northeasterly. The STR, WTR and DTR decrease by about 15-18% at Tanjung Sedili (≈2.5m), 23-24% at Chendering (≈2.3m) and further reduce by 55-56% at Geting (≈1.3m). The insignificant differences between the STR, WTR and DTR signify that the seasonal variations (limited to dry and wet seasons) have a negligible impact on the ocean tides or there be a time shift in the seasonal months and duration.

Among the east coast stations, tidal ranges in Geting indicate the lowest followed by Chendering, suggesting that flooding in Kelantan and Terengganu may not be strongly due to the tidal intrusion but perhaps due to wave setup and or wave pumping action. However, the speculations deserve extensive further analysis that requires combined record investigations to quantify the contribution of different forcing conditions (i.e. waves, ocean currents, the wind) to the previous flooding in the East Coast. The local estuary morphodynamics may also influence the flooding.

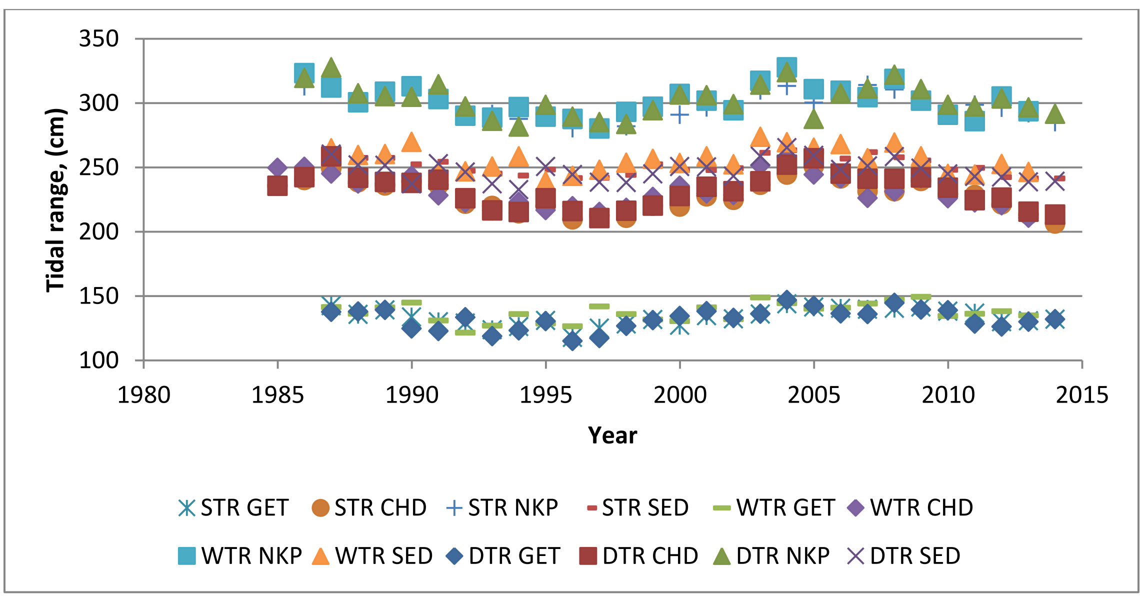

Figure 3: Tidal ranges trend

Table 2: Tidal ranges values

Station	STR (cm)	%Difference relative to STR Tanjung Gelang	DTR (cm)	%Difference relative to DTR Tanjung Gelang	WTR (cm)	%Difference relative to WTR Tanjung Gelang	%Difference relative to DTR
Geting	133.45	-55.4	132.14	-56.3	137.17	54.6	3.8
Chendering	228.22	-23.7	232.20	-23.2	231.63	23.3	-0.24
Tanjung Gelang	299.37	0.0	302.14	0.0	301.81	0.0	-0.21
Tanjung Sedili	251.15	-16.1	247.39	-18.2	255.87	15.2	3.43

- ve sign indicate decreament and + ve sign indicate increment

3.3 Tidal intrusion in Kelantan River Estuary

The December 2014 flood in Kelantan was associated with the coincidence of high tides. The tidal records did show the presence of spring tides a few days before the big flood and contribute to the rising limb of the flood in Kelantan. However, there are no abnormalities in the tidal ranges during the heavy rainfall, but there is a small increase in the local mean sea level at that time. Hence, there is a need to understand the tidal intrusion in Sg Kelantan and the characteristics of Sg Kelantan River estuary ideally prior, during and after the Northeast monsoon.

Salinity measurements conducted before the North East demonstrate the longitudinal pattern of average surface salinity along the 12km stretch of Sungai Kelantan (Fig. 4). The salinity decreases from river mouth towards the upstream of the river and reaches 0.0 ppt at 11km upstream. The trend of the salinity is asymmetrical on both right and left side of the river, partly due to the different flow depth, river bed profiles and freshwater discharge from the riverside housing. Therefore, under heavy rainfall, higher river discharge may suppress the length of tidal intrusion even more.

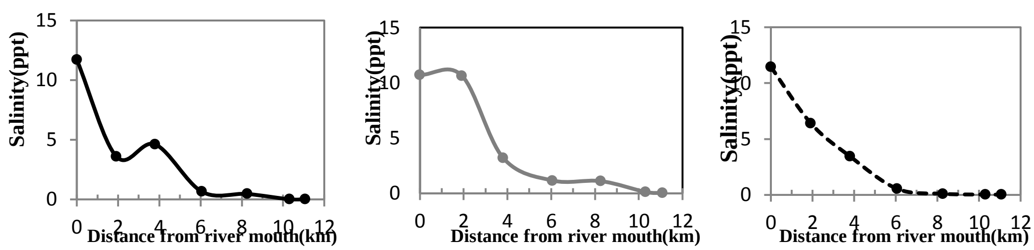

Figure 4: Salinity along the downstream of Kelantan River.

The tidal range calculated from secondary data (Table 3) and recorded from field measurement (Table 3) indicate below 1.5m. According to Davies (1964), for estuary with tidal range <2m, it can be classified as micro-tidal estuary where the tides are too small to influence the estuary water level.

Table 3: Tidal range at 5 stations from field record

Station	**Tidal Range (m) during spring tides**	
	3 Nov 2015	**15 Nov 2015**
Genting	0.9	1.2
Jab. Laut	1.1	1.1
Medan Ikan Bakar	1.2	1.1
Jeti Kastam	1.2	1.2
Tambatan Di Raja	1.3	1.1

Geomorphology of Kelantan River Estuary can be classified as a bar-built estuary. The formation of sand bar or spit between the coast and the ocean can be seen at profile section of A-A' (Fig. 5). The profile section is obtained from a part of field survey (Sa'ari, personal communication, December 2015) between coordinates 688 150m N to 688 300m N. Bar-built estuaries occur when sediment are deposited from cross-shore transport by ocean waves and currents. The sand bar acts to reduce the wave and tidal actions at the river mouth. However, higher river discharge during the wet season is likely to wash the sand bar away. The wave setup or wave pumping action could contribute to coastal flooding when waves overtopped the sand bar. This condition may occur during Northeast Monsoon if the low-pressure system develops offshore and drive greater wind and larger wave than the usual.

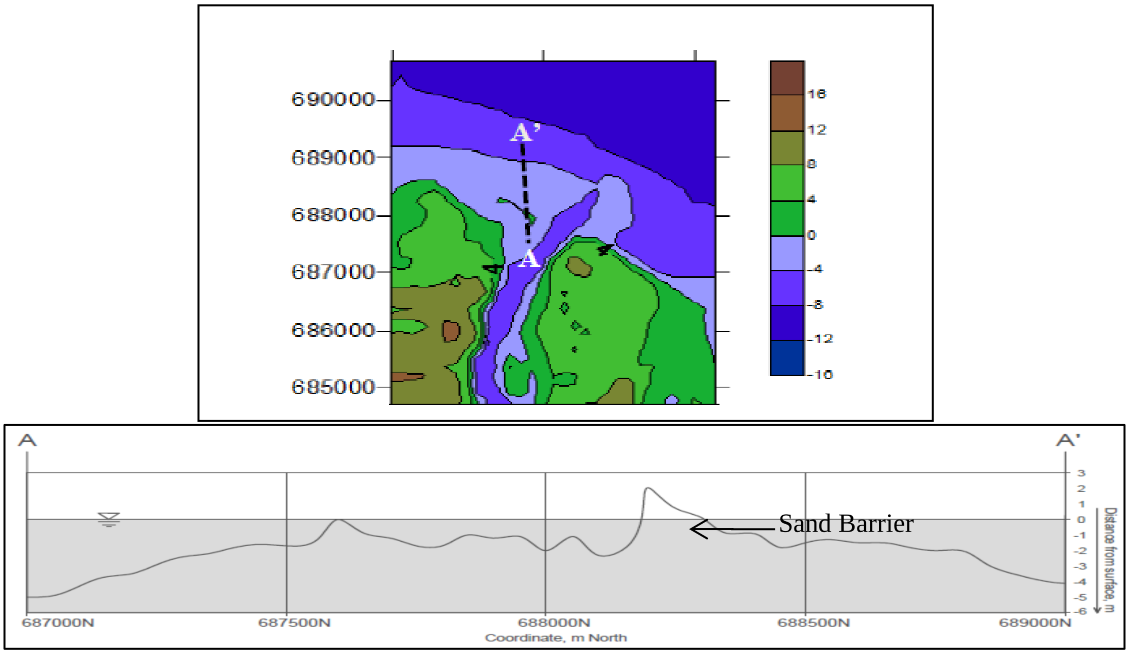

Figure 5: Estuary of Kelantan River. Top: Location of section A-A'. Bottom: Profile view of a section of A-A' using plotting range scale of the 50m interval.

4.0 Conclusion

A long-term summary of more than 25years of hourly tidal records for four East Coast tidal stations are presented and analysed. The findings are listed below:

4.1 the local mean sea level is highest around Tanjung Gelang, 2.8m, and decreases towards northerly stations by 18-21% and southerly stations by 14%

4.2 The predicted average rate of sea level rise from linear regression for the East Coast is 0.328cm/year 1mm/year higher than Jeofry & Rozainah (2013), but the majority of NAHRIM's (2010) prediction. The largest rate of sea level rise is in Chendering, 0.36cm/year.

4.3 Insignificant % differences are found between values of spring tidal range, wet tidal range and dry tidal range, signifying that the seasonal variations have negligible impact to the ocean tides.

4.4 Tanjung Gelang exhibits the highest average spring tidal range, wet tidal range and dry tidal range and the tidal ranges decrease towards northeasterly stations by 55-56% and southeasterly stations by 15-24%.

4.5 Salinity measurements before the wet season in Kelantan River Estuary suggest that the tidal intrusion under normal conditions is up to about 11km upstream.

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FLOOD HAZARD MAP UTILIZING PUBLIC DOMAIN INUNDATION HYDROLOGICAL (RRI) AND HYDRAULIC (HECRAS) MODELS AND GIS

Project Information

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1.0 Introduction

Sungai Kelantan catchment is one of the major catchment in Malaysia which is located at the North Eastern part of Peninsular Malaysia. The maximum length and breadth of the catchment are 150 km and 140 km respectively. The length of Sungai Kelantan is about 248 km long starts at Bnajaran Titiwangsa and endup in the South China Sea. It drains an area of 13,088 km2 and occupies more than 88 % of the State of Kelantan. There are six sub-catchments in Sungai Kelantan namely Galas, Nenggiri, Pergau, Guillemard Bridge, Kuala Krai and Lebir. The entire catchment contains large areas of tropical forested mountains, lowland forest and limestone hills. In 2014, two extrem precipitation events were hit the Sungai Kelantan catchment between 15th and 21st December 2014 with daily rainfall between 100-300mm while on 22nd and 24th December 2014 the daily rainfall up to 500 mm. The consequent of these extreme rainfall events, a prolong and extrem flooding occurred during these periods that cause 25 death and around RM2.81 billion losses.

2.0 Methodology

This study applied a 2D Rainfall-Runoff-Inundation (RRI) model(Sayama et.al. 2010) to simulate the flood in December 2014 in the Sungai Kelantan catchment. This model has been used intensively in Bangkok, Upper Citarum watershed, Kabul and Pakistan flood events (Sayama et al, 2012; Sayama et al, 2015; Nastiti et al 2015; Ruangrassamee et al, 2015). The ground gauge rainfall and field survey of rivers cros-sectionals data were used as input to the model. The RRI model interface allowed preparation of geometric data for import into RRI and generation of GIS data from GRASS GIS. A digital elevation model (DTM) represented by a triangulated irregular network (TIN) then generated by RRI. The automated procedures for extracting geometric data proved consistent and efficient for the development of floodplain scenarios. GRASS GIS data generated is used to identify and visualize potential impacts to induced flooding to the adjacent floodplain. The model performance was investigated compared with a remote sensing flood extent map (Edlic Sathiamurthy, 2015). The overall objectives of this study as follows:

1) Conduct RRI model simulation over the Kelantan River basin to investigate the model ability to show flood inundation areas detected by satellite remote sensing;
2) Identify flooded areas that are not detected by remote sensing but indicated by model simulation;
3) Quantify the effect of flood inundation on streamflow discharge and its peak arrival time.

Finally, all the simulation results could be generated into a flood hazard map and further, delineation of flood plains could be generated as well. The final output is a floodplain delineation that considered flood inundation due to downstream river contractions. In view of this, research into flooding represents a pressing concern and should be seen as one of the most important applied roles of the hydrological sciences and as a tools towards future sustainability development.

2.1 Flood Mapping of Kuala Kerai Extream Flood

Field survey on the flood depth had been conducted from 2nd until 4th March 2015. It was conducted with several researchers from Disaster Prevention Research Institute, Kyoto University, Japan.

Table 1: Flood Mark Depths in Kuala Kerai, Tangga Kerai and Tualang

Location		Reading1	Reading2	Average
Kuala Krai	Depan Pasar	3.851	3.940	3.896
	SMO bookstore	5.020	5.042	5.031
	Pasar Besar	3.615	3.588	3.602
	Pondok	3.964	4.150	4.057
	Kedai Singer	4.997	5.110	5.054
	Bank Islam	5.484	5.164	5.324
	Avon Dealer	4.861	5.032	4.947
	Oppo Bank Islam	5.062	5.049	5.056
	Caltex Petrol Station	4.406	4.206	4.306
Tangga Krai	Lan's Jean Repair	4.706	4.668	4.687
	Rumah Tepi Sungai Galas	2.947	2.787	2.867
Tualang	Rumah MERCY Malaysia	5.318	5.295	5.307
	Kampung Hujung Tualang	5.689	5.702	5.696

Table 1 indicates that the maximum water level in Kuala Kerai area reached more than 5 m from the existing ground level. The worst water level was found in the Kampung Hujung Tualang area with maximum height of 5.696 m. These values will be used to check inundation level of RRI model in the model calibation purposes.Paragraphs immediately following their headings are to be justified on both sides with 0.5cm indentation for first lines. Insert single line spacing throughout the entire document.

2.2 Measurement of River Morphology and Velocity using ADCP

The initial task for research activities is collected available data especially meteorological and catchment characteristics. The meteorological data were available from Bahagian Pengurusan Sumber Air & Hidrologi, JPS Malaysia for rainfall and stream flow. However, the cross-sectionals of Sungai Galas and Sungai Lebir are not available. Therefore, a field survey was conducted several times on the 10-12 of June 2015, 27-29 of July and 3-5 of August 2015.

2.3 Modelling of Rainfall Runoff Inundation

Rainfall distribution is an important input for RRI Model. Two main input data need in order to used RRI model namely rainfall and topography data. This study used ground gauge rainfall for the rainfall data. This data was interpolated over the Sungai Kelantan catchment by the Theissen polygon method. Topographic data used in this study were obtained from HydroSHEDS (30-s resolusion) (Lehner et al. 2008). The model also requires information on river channel locations and cross-sections. The flow accumulation data sets included in HydroSHEDS. For the river cross-section, a field survey using ADCP was conducted. The regression parameter for the river width was estimated at several locations, based on Google Earth images, while the depth parameters were estimated by ADCP survey depth. The observed rainfalls from seventeen rain gauges were spatially interpolated over the Sungai Kelantan catchment using the Inverse Distance Square (IDWS) Method. With the collabration of Kyoto University, a monthly simulation was conducted for the period 1st December 2014 (00:00) to 1st January 2015 (00:00).

3.0 Results and Discussion

The initial results are presented from RRI are shown in Figures 4 a, b, and c. Digital Elevation Model (DEM), flow accumulation (ACC), and flow direction (DIR) were the topography input for RRI Model. DEM, ACC, and DIR were obtained from Hydrological data and maps based on Shuttle elevation Derivatives at multiple scale (HydroSHEDS).

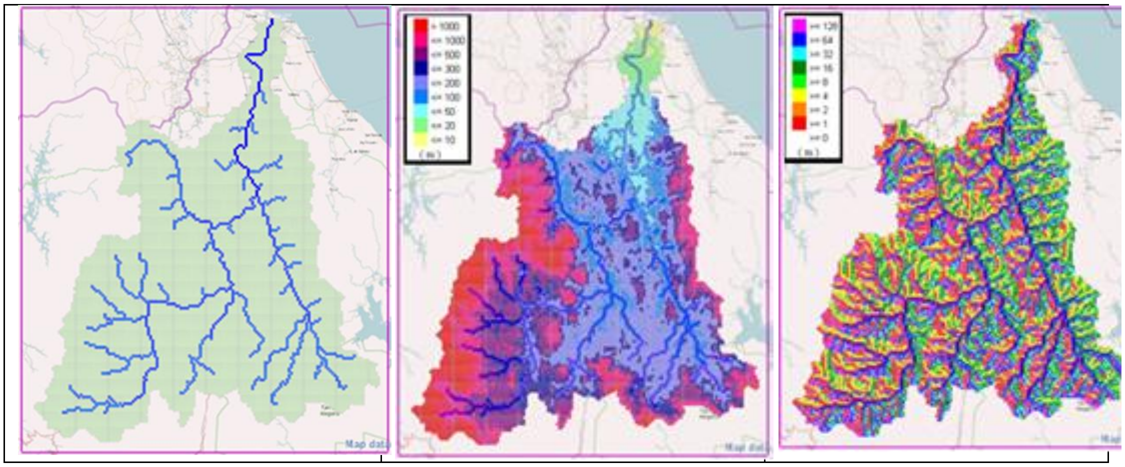

Figure 4: a) Delineation of Sungai Kelantan and its tributaries, b) Digital Elevation Map (DEM) for Sungai Kelantan and its tributaries and c) Calculated Flow Direction for Sungai Kelantan Catchment

3.1 Findings of Rainfall Runoff Inundation

The remote sensing image in Figure 5 indicates a large-scale inundation in Kuala Krai, Dabong, Kuala Balah and Manik Urai areas. Meanwhile, Figure 6 is the simulated og the maximum flood inundation by RRI for a monthly simulation. Further, Figure 7 shows the superimposed of inundation areas and simulated RRI inundation results. The good agreement of remote sensing observed data and RRI simulation indicates that the majority of the inundation flooded area could be well identified and simulated. However, a small different of flooded areas at Kuala Balah and Dabong could not well simulated possibly due to the underestimated discharge or overestimated width and depth or meshing size of the simulation scale give a low visual resolution.

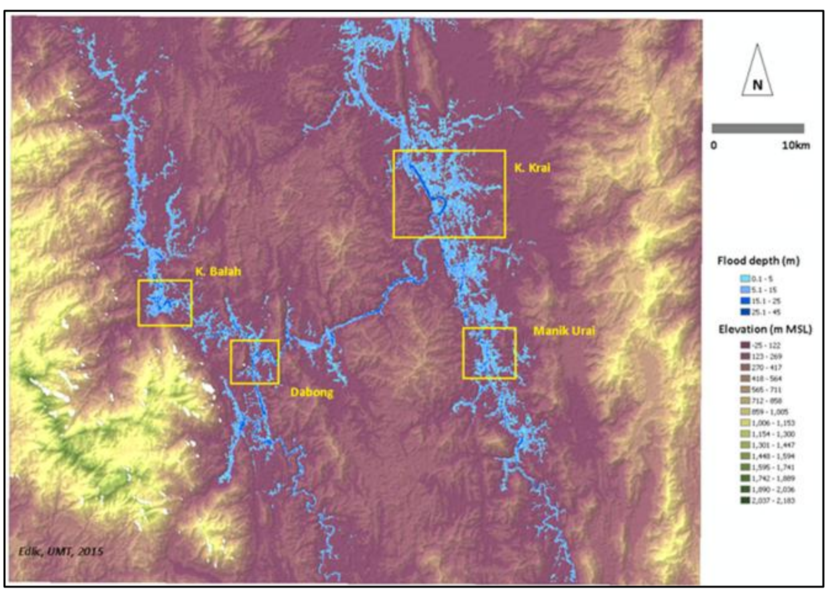

Figure 5: Flood extension inundation mapping on 26th December 2014 from remote sensing (Edlic Sathiamurthy, 2015)

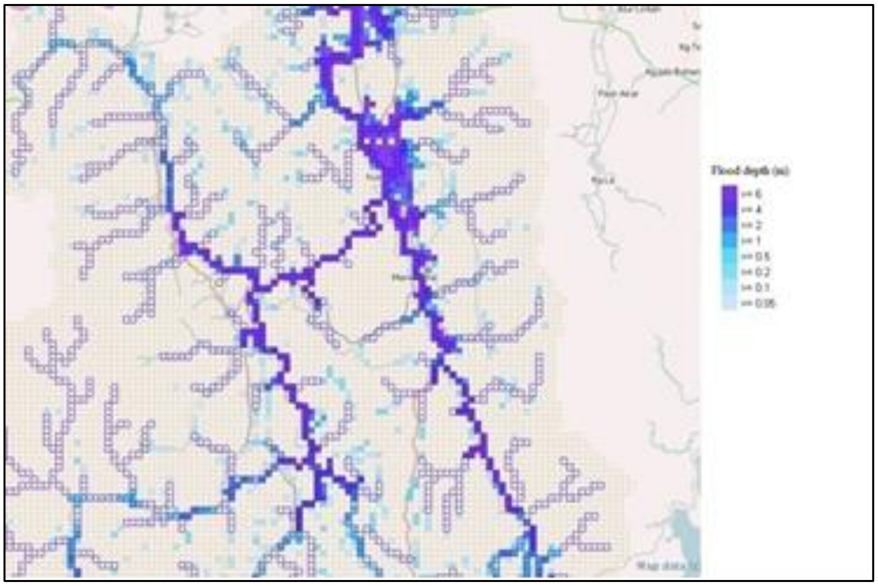

Figure 6: RRI simulation for maximum flood inundation for Kuala Kerai area

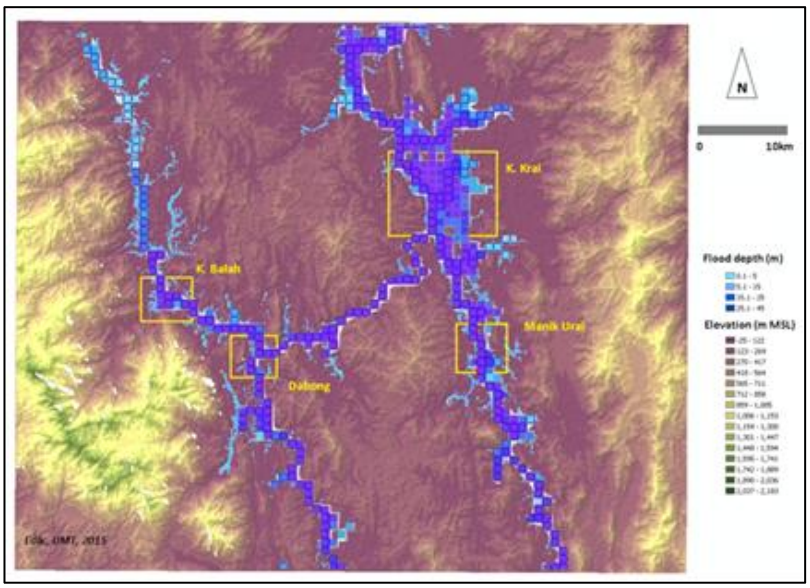

Figure 7: Comparison of inundation areas by superimposed observed (remote sensing) and RRI simulated flood inundation event in Kuala Kerai areas

The two peak discharges and inundations were occured as shown in Figure 8. Two peak discharges and inundations were occurred approximately on the 19th and 25th December 2014. The results are similar magnitude and timing with the flood report by DID. The second peak discharge and inundation height are higher than the first peaks. However, the peak observed hydrograph value was not recorded by the gauging station because all the equipment in the gauging station was swept away by the extreme flood.

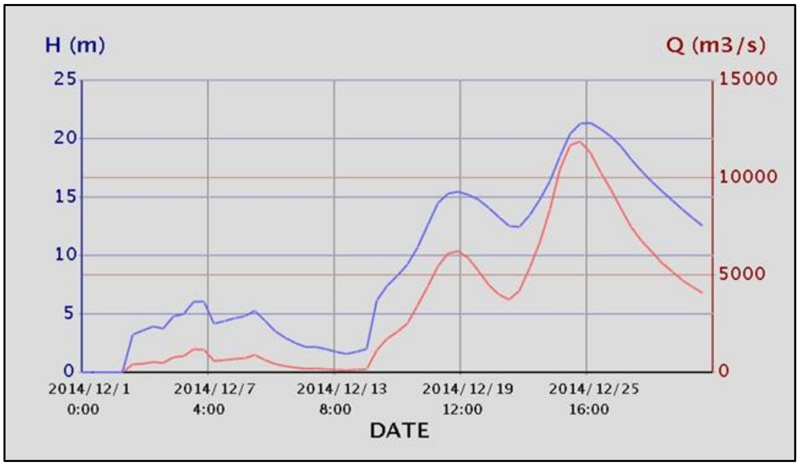

Figure 8: Water depth and discharge over time for Sungai Kelantan at Kuala KraiBrief the results and discussion

4.0 Conclusion

Kelantan suffered from extremely flood which occurred in December 2014. More than 19,544 people were affected by this flood disaster in the Kelantan River basin in Kelantan. This study, a 2 dimensional model was applied to simulate rainfall-runoff and inundation simultaneously. The main objective is to discuss whether or not the simulation model could provide useful information for the extreme flood phenomenon. The study is particularly focused on how well the simulated flood inundation areas agree with those in an inundation map prepared with satellite remote sensing.

The RRI simulation results and the remote sensing observed data showed good agreement in the extended maximum inundation flooded area along Sungai Kelantan particularly in Kuala Kerai areas. A local DID report confirmed severe flood damage in these areas. The analysis indicated that the model simulation may be capable of providing additional information to remote sensing. There is no doubt that model simulation involves large uncertainty. Therefore, we do not argue that such simulation alone can provide sufficient information for emergency response. Nevertheless, the model simulation performed here can provide additional information to help identify where flood damage may occur during emergency situation based on limited local information.

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MODELING FLOOD HYDROGRAPH IN SG. KELANTAN RIVER BASIN USING FUNCTIONAL CONCEPT

Project Information

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1.0 Introduction

In Malaysia, the phenomenon of extreme rainfall events particularly floods which are highly unpredictable, contributed to the lost of millions of ringgits and the worst cases, risk lives. Locally, the magnitude of recent floods seems to be increasing and occurs more frequently. To overcome the flood risks and having effective planning and management of water resources, river flows must be continuously measured. In practice, a river may have various shapes of flood hydrographs. The shape of a hydrograph varies in each river basin and each individual storm event. The objective of this study is to propose a new framework in hydrological application using the hydrographs as functional data.

Entire hydrograph as a curve with respect to time can be considered as a single observation within the functional context. There were some efforts to study the hydrograph as a function such as in the study of the design flood hydrograph (e.g. Yue et al. 2002) and in the flow duration curve study (e.g. Castellarian et al.2004). However, their studies are remaining limited. Recent study by Chebana et al. (2012) demonstrated the need to introduce a functional framework to study the whole hydrograph as a functional observation. Hence, a new statistical framework known as functional data analysis (FDA) is employed in this study by analysing the whole hydrograph as a functional observation.

The main input in this study is daily streamflow series from Sg. Kelantan River Basin which constitutes a hydrograph throughout the year. Entire hydrograph as a curve with respect to time can be considered as a single observation within the functional context. Functional descriptive statistics and functional principal component are the functional data analysis tools which are introduced in this study. It is concluded that the method of functional data analysis which treats the whole hydrograph as a function is more representative of the real phenomena and makes better use of available data.

2.0 Methodology

Suppose we have a data set such as $\mathbf{Y}_i = \left(y_i(t_1),...,y_i(t_T)\right)'$, $i=1,...,n$, $j=1,...,T$, with T=365 days, n is the number of years with n = 32, and $y_i\left(t_j\right)$ is the flow measured at the day t_j of the i-th year. The goal of FDA is to transform discrete observed data at discrete time intervals to smooth curves $x_i(t)$ as temporal functions through the basis function. A linear combination of basis function is used for representing the functions, given as

$$x_i(t) = \sum_{k=1}^{K} \beta_k \psi_k(t) \tag{1}$$

where β_k refers to the basis coefficient, ψ_k is the known basis function while K is the size of the maximum basis required. Spline basis is commonly used in FDA for those non periodic data. Since the flow data shows periodicity, the Fourier basis is employed in the analysis. Fourier basis is written in the form of sine and cosine functions. The coefficients of the expansion β_k are determined by minimizing a least square criterion. It is essential to choose the number of basis functions that can reflect the characteristics of data. If a large number of basis functions are used, a penalty term can be added to ensure the regularity of the smooth function.

In the context of FDA, smoothing location curves can be used to characterize a given river basin and for comparison or grouping a set of basins visually. Suppose that a sample composed of curves $x_i(t), i = 1, 2, ..., n$ .The sample mean and variance functions are defined as

$$\bar{x}(t) = \frac{1}{n}\sum_{i=1}^{n} x_i(t) \qquad \mathrm{var}(t) = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_i(t) - \bar{x}(t)\right)^2. \tag{2}$$

The covariance function summarizes the dependence structure between curve values at times *s* and *t*, respectively and can be written as

$$\mathrm{Cov}(s,t)\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i(s) - \bar{x}(s)\right)\left(x_i(t) - \bar{x}(t)\right). \tag{3}$$

The surface of covariance and the contour map are used to plot the variability of the data set.

On the other hand, the functional principal component analysis (FPCA) can be employed to find new functions that reveal the most important type of variation in the curve data. Based on the scores of two main FPCA, we could then classify the data into several clusters to examine the curve patterns. In order to explore, visualize and examine certain features such as outliers that might not be captured via summary statistics, three graphical methods are introduced. The first method refers as the rainbow plot is a simple plot of all the data with the only added feature being a color palette based on an ordering of the data. The bivariate bagplot is based on Tukey half-space depth function while the functional bagplot is a mapping of the bagplot of the first two robust principal component scores to the functional curves. The last method, the functional HDR boxplot is based on the bivariate HDR boxplot applied to the first two principal component scores. The bivariate HDR boxplot is constructed using a bivariate kernel density estimate. A detail review of these three methods can be found in (Hyndman and Shang 2010).

3.0 Results and Discussion

A functional hydrograph constitutes a year starting from 1 January through 31 December of the year. Using a suitable number of basis functions, the discrete flow data are converted to smooth curves. The smooth representation of flow data is done with a 365 day base period and selected *k* basis functions. Large values of *k* allow us to reach almost all the daily flow points including the peaks. However, it was found to be less smooth and the variance in the first few components cannot be captured. On the other hand, small values of *k* gave a bad quality of smoothing. Hence, it is recommended that to choose a number k which combines the quality of smoothing and a high percentage of explained variance by PCA analysis. Hence, the number *k* =183 is chosen based on the quality of smoothing and a high percentage of explained variance. Fig.1 shows all the smoothing curves for the studied period with 183 basis functions. It shows that these curves have several different shapes.

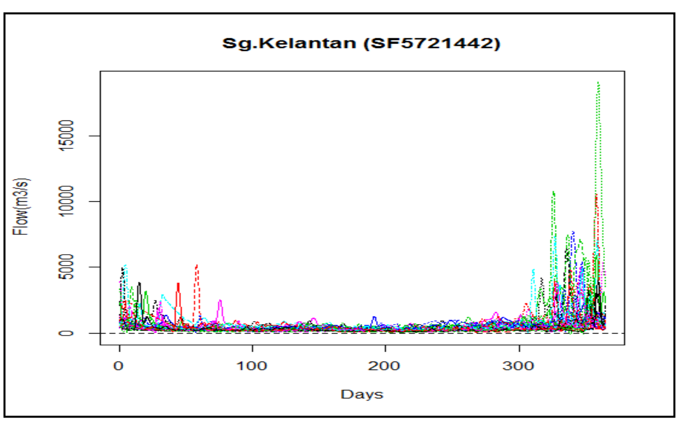

Figure 1: Smoothing curves of flow data with 183 basis functions.

For a certain flood event, they might be a case that there exist a multipeak of flood hydrograph in a given river basis. Compared to univariate and bivariate approaches, the functional consider the whole hydrograph as functional observation. Instead of several univariate or multivariate analysis, one analysis can be conducted for the whole data using FDA. Information on first and second derivative could also be obtained.

The smooth location curves showing the mean, median and modal curves are presented in Fig. 2. The maximum flow is normally observed in the middle of November up to early January which can be considered as the Northeast Monsoon flow. Due to the contribution of heavy rainfall during the Northeast Monsoon, it is often found that heavy floods occurred during this period. This kind of flood is exhibited by the median curve which is higher than the mean and the mode.

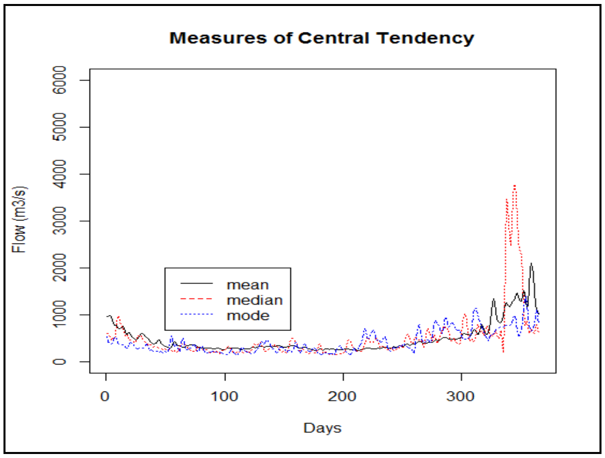

Figure 2: Fourier smoothing location curves.

Fig.3 shows the temporal bivariate variance-covariance surface and its corresponding contour map. As shown in the figure, the highest variability occurs at the end of the year and early January in which this period is also corresponds to the highest flow.

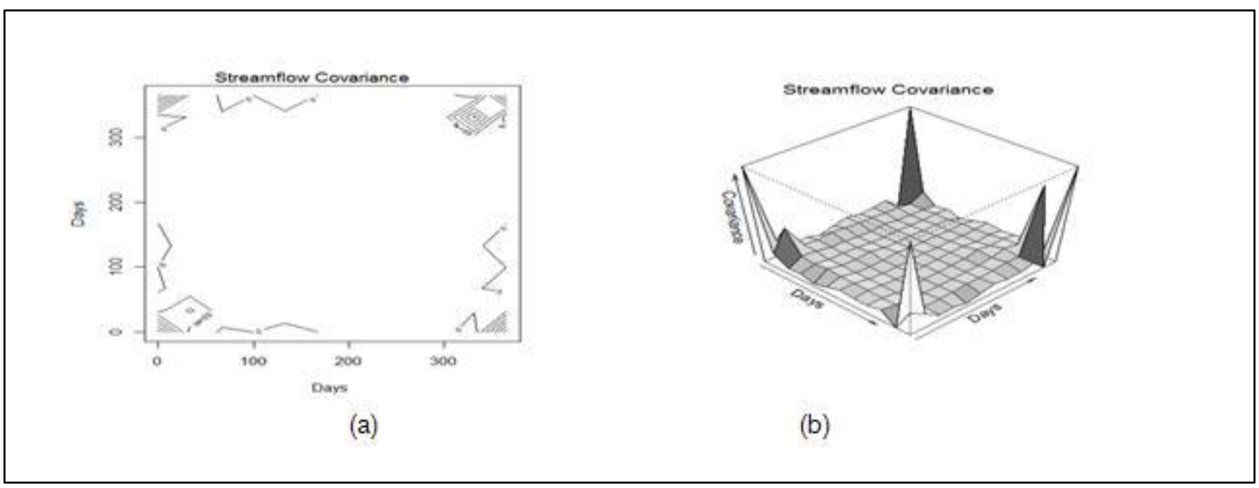

Figure 3: Estimated variance-covariance surface of the flow curves for years 1980 to 2014.

The most important type of variation in the curve data is explained by the functional PCA. The scores of the first two principal components were mapped onto Fig.4. Several clusters can be classified according to these scores. The curves for 2014, 1988 and 1993 may be considered having a unique cluster of their own while for certain curves, they are high possibilities that they can be grouped together. Based on these findings, it could be said that the shape of the hydrograph curves are different for a certain year based on the behaviour of the flow data. Hence, a classification of the hydrographs based on their shape is very important.

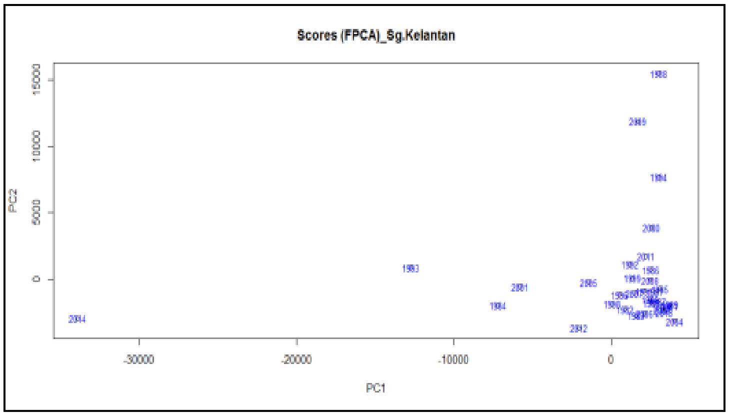

Figure 4: Mapping of the scores of the first two principal components.

In order to justify the above unusual years, the outliers' detection methods were employed. The functional HDR boxplot is a mapping of the bivariate HDR boxplot (Hyndman 1996) of the first two robust principal component scores to the functional curves. The functional HDR boxplot displays the modal curve, the inner and the outer regions. The inner region is defined as the region bounded by all curves corresponding to points inside the 50% bivariate HDR and usually 99% outer highest density region.

Fig. 5 displays the bivariate HDR and the associated functional HDR boxplots of the smooth flow curves for 99% of probability coverage. With the 99% coverage probability, the outliers detected in flow series are 1988 and 2014.

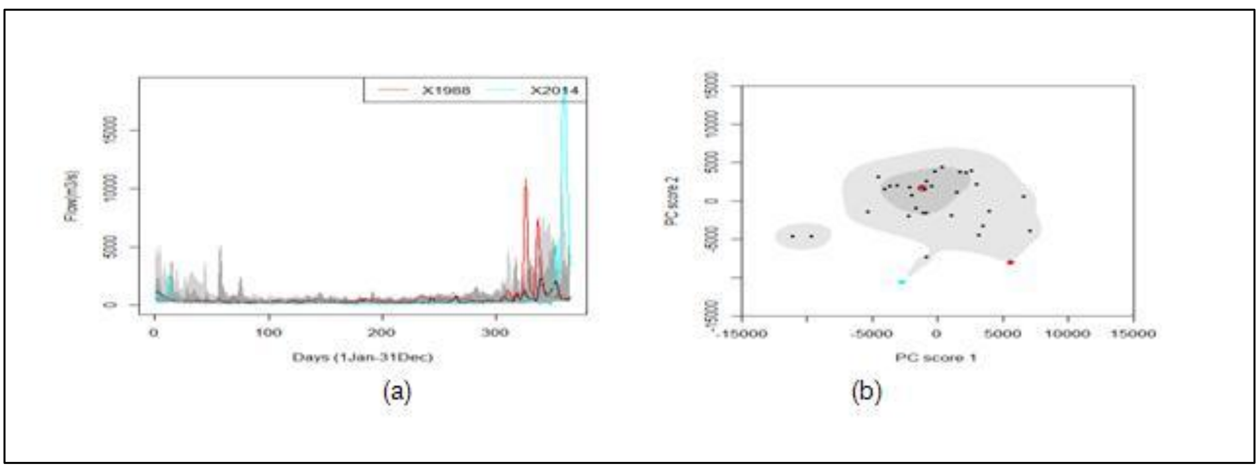

Figure 5: (a) Bivariate score HDR box-plot and the corresponding (b) functional HDR box-plots with 99% of probability coverage.

4.0 Conclusion

4.1 The location curves which represent the mean, median and modal curves are much better in providing more information, specifically in adding temporal aspects concerning the hydrological regime in the basin than classical statistical approach. Our findings indicate that the highest flow at Sg. Kelantan is observed between November and January. It is suggested that the flood which occurred during this period is exhibited by the median curve. The highest variability was again observed between November and January (northeast monsoon season) as shown by the bivariate (temporal) variance-covariance surfaces as well as the first two functional PCA.

4.2 It is found that FDA approaches gave an additional insight to the hydrological regime variability than the real value or matrix in the univariate and multivariate contexts. In addition, the visualization methods via functional bagplot and functional HDR boplot were used in this study to provide information that might not have been apparent using mathematical models and summary statistics. Based on 99% of probability coverage, 1988 and 2014 are considered as outliers since they lie outside the region.

4.3 The functional framework is more general and more flexible and can represent a large variety of hydrographs and able to make use the full information contained of the hydrograph.

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HYDRODYNAMIC SIMULATION OF KELANTAN RIVER BANKEROSION AND CHANNEL CHANGE DURING HEAVY FLOODS

Project Information

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1.0 Introduction
River bank erosion is a natural process that over time has resulted in the formation of the productive floodplains and alluvial terraces. Massive flood events like flooding in Kelantan, December 2014 can trigger dramatic and sudden changes in rivers and streams. However, land use and stream management can also trigger erosion responses. The responses can be complex, often resulting in accelerated rates of erosion and sometimes affecting stability for decades. The erosion process starts when raindrops dislodging soil particles and runoff water carries the dislodge particles to the river. Erosion by water has appears to be one of the chronic phenomenon whereby sediment budget involved estimating the sediment contributed from three main processes of erosion; hillslope erosion, gully erosion and bank erosion. The Department of Irrigation and Drainage (DID) reported that annual flooding of Sungai Kelantan is due to river's bank overflows, which occurs at least once a year. It becomes worst when associated with a northeast monsoon climate experiences from November to February, in which most of the areas in Kelantan hit by heavy rainfall from 17^{th} - 24^{th} December 2014. The 2014 Kelantan flood event was said as the worst flood after floods in 1984. In this study, the objectives are (1) to measure the stage-discharge, flow characteristics and flow resistance for inbank and overbank flows of Kelantan River and its tributaries, (2) to model the turbulence flow due to the secondary flow as a result of bed shearing stress leading to bank erosion, and (3) to map bank erosion for flood risk assessment.

2.0 Methodology
2.1 Phase 1: Determination of Hydraulics and sediment characteristics
This phase involves site investigation on flow parameters such as velocity, river cross-sections, water level, rainfall and soil types. Hydraulics and hydrology data can be obtained from the DID, whilst, for soil type characteristics were taken from the Minerals and Geoscience Department. Extreme rainfall data was gathered between the year 1990 and 2014, particularly rainfall from December to January. Similarly on stream flow data, which was taken directly form DID for the same monthly data.

2.2 Phase 2: Modelling of river bank erosion
The simulation combined a model of fluvial bank erosion with bank stability analyses to account for the influence of hydraulic erosion on mass failure processes, based on parameterized outputs from detailed in phase 1. The results were to identify two mechanisms that explain how most bank retreat usually occurs during flood peaks. This includes the investigation of maximum flow velocity during the flood that migrates away from the outer bank as flow discharge increases, reducing sidewall boundary shear stress. In this study, a three-dimensional flow-sediment model of the Kelantan River is developed using the EFDC (Environmental Fluid Dynamic Code) in order to study the changing riverbed. The model will be also calibrated and validated by daily measuring of the water surface elevation and using suspended sediment concentration data secured from flood data event between December 2013 and December 2014. Based on this model, the mobile sediment on the riverbed was simulated for the high water period of the Kelantan flood event 2014. The EFDC model's hydrodynamic component is based on three-dimensional hydrostatic equations formulated in curvilinear-orthogonal horizontal coordinates and a sigma vertical coordinate (Hamrick, 1992). Thus, in this application, the EFDC model was configured to

simulate time varying surface water elevation, velocity and cohesive and non-cohesive sediment transport.

2.3 Model Setup

EFDC is a general purpose modeling package for simulating three-dimensional flow, transport and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetland and coastal regions. The EFDC is an advanced public domain model developed by Dr. John Hamrick, hydrodynamic components which based on three-dimensional hydrostatic equations formulated in curvilinear-orthogonal horizontal coordinates and a sigma vertical coordinate. The model is calibrated and validated by daily measuring of the water surface elevation and using suspended sediment concentration data secured from flood data event in December 2014. Based on this model, the mobile sediment on the riverbed changes was simulated for the high water period of the Kelantan flood event 2014. The Digital Terrain Model (DTM) uses in the model was generated by combining different data sources, as follow,

1. Airborne LiDAR,
2. Interferometry Synthetic Aperture Radar (IfSAR) and
3. Shuttle Radar Topography Mission (SRTM).

All data was resampled and combined to produce a single DTM with a spatial resolution of 10 m. As for model's cross-sections, it divided into several reaches, which was 500 m interval. Meanwhile, for initial and boundary conditions setup, the domain was assigned the rainfall event from January 2014 to December 2014 data. The model's initial and boundary setup as follow,

1. Downstream boundary condition: Water level data at Kota Bahru (Guillemard Bridge station)
2. Upstream boundary conditions: Streamflow data at Lebir river (Tualang station) and Galas river (Dabong station).

3.0 Results and Discussion

3.1 Model verification

Figure 1 shows the observed data of maximum water stage at selected stations in Kelantan on 24th - 26th December 2014, whilst, in Figure 2 indicates the model verification of water stage at Kuala Krai station. The result of model's verification of water stage at Kuala Krai station gave a good agreement with observed data from the DID. Meanwhile, Figure 3 shows the eroded areas (red circles) due to maximum shear stress happened in a December flood event. A detailed of erosion model near Dabong have shown a critical bed shear stress happened near Kuala Krai at Lebir's river (a circle red), as shown in Figure 4. Therefore, the result of maximum shear stress predicted indicates the occurrence of high velocities leading to a river bank failure at Dabong and Kuala Krai. This can be seen in Figure 5, where the model has successfully predicted the high potential area of erosion happened during the peak flow. The result was then compared with the actual image taken from the google images; it showed that the massive erosion happened at the same location as the model predicted.

Bil	Sungai	Tempat	Aras Normal (M)	Aras Berjaga (M)	Aras Amaran (M)	Aras Bahaya (M)	Catatan Tertinggi	
							Tarikh & Waktu	Sukatan (M)
1	Sungai Galas	Dabong	28.00	32.00	35.00	38.00	24-12-2014 16:00	46.47
2	Sungai Lebir	Tualang	23.00	27.00	31.00	35.00	24-12-2014 06:00	42.17
3	Sungai Kelantan	Tangga Krai	17.00	20.00	22.50	25.00	25-12-2014 15:00	34.17
4	Sungai Kelantan	Jambatan Guillemard	10.00	12.00	14.00	16.00	26-12-2014 00:00	22.74
5	Sungai Kelantan	Tambatan DiRaja	1.00	3.00	4.00	5.00	26-12-2014 00:00	6.89

Figure 1: Maximum water stage recorded for selected stations in Kelantan (DID, 2014).

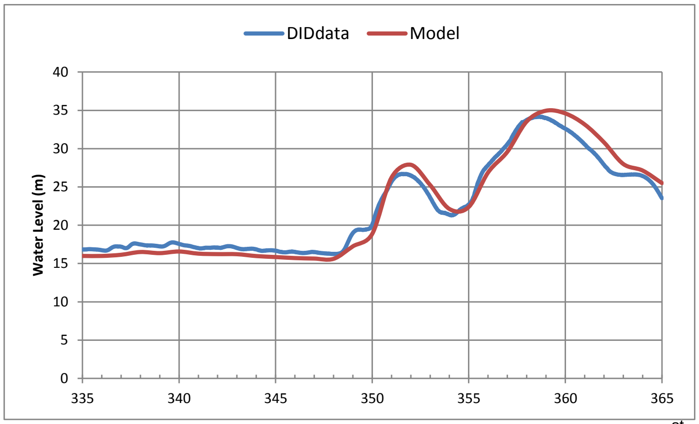

Figure 2: Model verification of water stage between observed and simulated data from 1st – 31st December 2014 at Kuala Krai station.

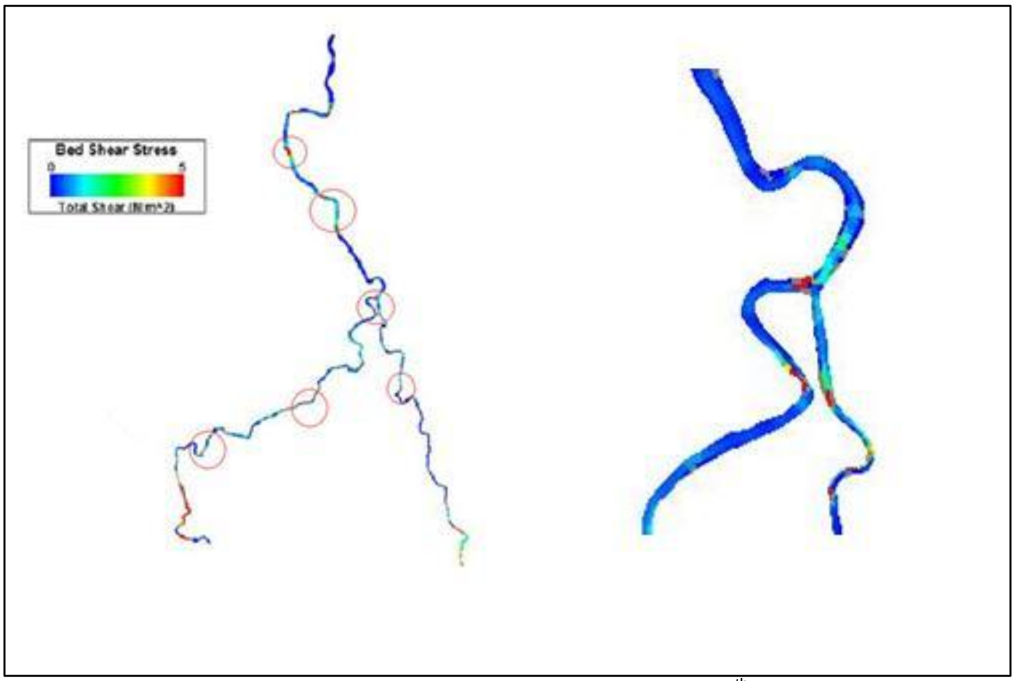

Figure 3: Simulated bottom shear stress of the riverbed on 26th December 2014.

(a) Before flood 2014 (b) After flood 2014

Figure 4: Google Earth Images; (a) before flood 2014, (b) eroded area after flood 2014.

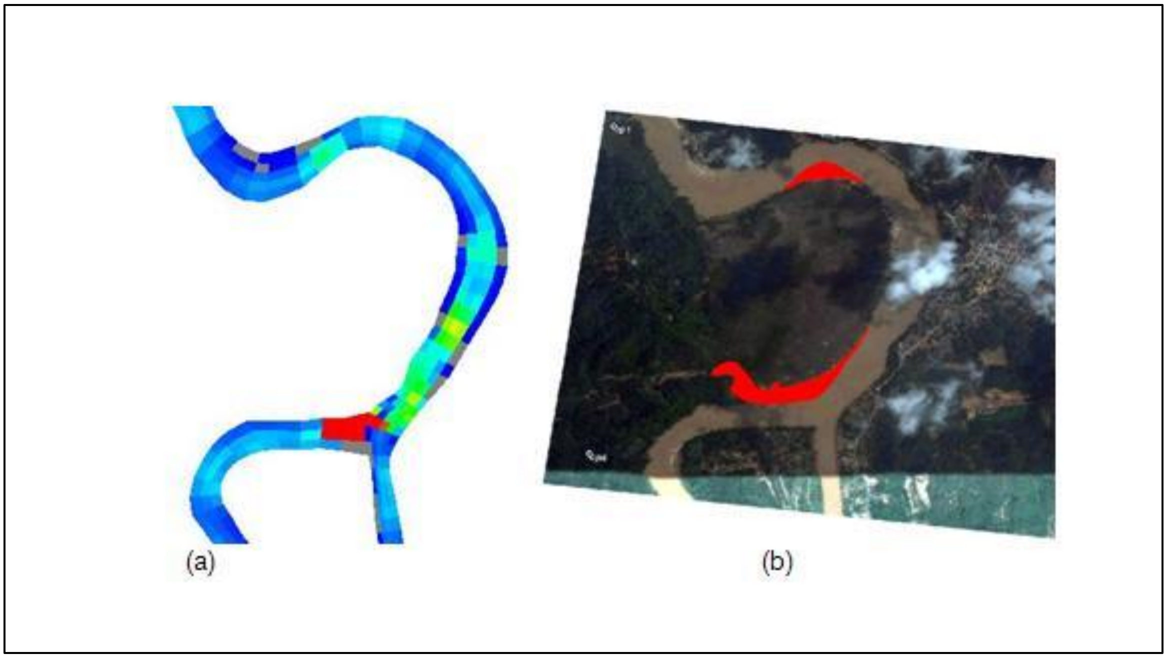

Figure 5: Model erosion against actual erosion; (a) simulated of maximum shear stress, (b) actual eroded area after December flood event.

4.0 Conclusion

The study can be concluded as follows:

4.1 Flood episode happened in Kelantan, in December 2014 has triggered dramatic and sudden changes in rivers and streams - due to extreme rainfall that creates rapid changes in flood velocities, leading to have potential of having river channel erosion.

4.2 The preliminary results of water column and bed shear stress indicate that the critical erosion was occurred at the river's banks near Kuala Krai and at the upstream at Lebir River, respectively.

4.3 As for velocities analysis, it has found that the velocities increase along the river of Sg. Kelantan. For example, the critical velocity was expected to occur at the junction between Lebir River and Galas River, near Kuala Krai. Thus, it marked as potential areas of river bank erosion.

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Lampiran 1

END OF REPORT

Project Title : **DETERMINATION OF FLOODPLAIN CHANGE AND ITS IMPACT ON FLOOD MODELLING USING MULTI-TEMPORAL DEM AND LAND USE/LAND COVER FROM INSAR/SAR TECHNIQUE**

A. Project Information

Start Date : 01/04/2015

End Date : 31/12/2015

Extension Date : 31/03/2016

Project Status : Completed

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B. Project Achievement

Project Progress : 100%

Research Output : (_2_), Conference Proceedings

Talent : RA (4_), PhD student (_0_), Master student (2_)

C. Expenditure

Budget Approved : RM 96000

Amount Spent : RM 95832.14

Balance : RM 167.86

% of Amount Spent : 99.83

Summary of Research Findings

Floods are one of the most severe natural disasters around the world which cause huge damage of property and loss of life every year. There are several causes for flooding (Merkuryeva et al., 2014) but the most common cause of flooding is the overflow of streams and rivers and abnormally high tides resulting from severe storms (Larry, 2011). The most significant natural disaster in Malaysia is floods that have been recorded since 1920s. Recently, the worst flood in decades was occurred from 25 December 2014 to 05 January 2015 that affected 200,000 people in several states in Malaysia such as Kelantan, Terengganu, Pahang, Perak, Sabah and Sarawak due to heavy monsoons rainfall which claimed the 21 lives and cost nearly million dollars of property. The natural disaster such as floods can't be stopped quickly but damage of property and loss of life can be reduced or minimized by the appropriate flood monitoring or modelling approach.

In floods modeling, two important parameters of floodplain are necessary; land use/land cover (LULC) and topography (Chen et al., 2009; Amini et al., 2011; Fox et al., 2012). Although several studies have pointed out that changes in LULC and topography have enormous impacts on the flood modelling, but unfortunately most of the studies related to flood modelling have ignored the importance of these two parameters probably due to the unavailability of appropriate LULC change information as well as Digital Elevation Model (DEM) resulting in uncertainties in flood modelling results. Therefore, this study is going to take an opportunity to examine the effects of these two parameters especially by generating DEMs from the multi-sensor SAR data. Considering the research goals, this study produced several outputs before going to develop flood model which includes i) updating the LUCL maps and generating new LULC maps based on several available data, ii) examining the existing DEM and exploring the possibility the use of existing DEM for the generation of flood model, iii) generation of DEM from the SAR data, iii) generating flood models using different types of LULC maps and DEM generated from the different sources. Although, the initial result is promising, however, it is important to mention that more investigation is required to validate the generated DEM as well as to generate multi-temporal DEM for this study area. Flood modeling results using LiDAR DEM indicates a successful determination of flooding extent and agrees with field data. Nevertheless, the quality of DEM needs to be improved and flood model using InSAR data needs to be investigated along with different types of LU/LC information in future endeavors since it was not possible to investigate all the aspect rigorously due to constraint, man-power and financial ability.

1.0 Introduction

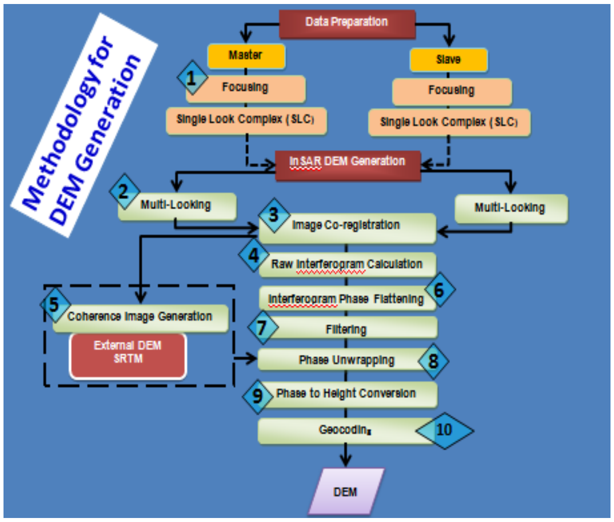
Floods are natural events that have always been an integral part of the history of earth. Flooding occurs i) along rivers, streams, and lakes, ii) in coastal areas, iii) on alluvial fans, iv) in ground-failure areas such as subsidence, v) in areas that flood due to surface runoff and locally inadequate drainage, and so on. Floods damages are usually reported as direct damages of property and loss of life but there are several indirect damages results from the adverse effects of flooding. Floods are no doubt a major hazard and the risks they pose are increasing due to shifts in meteorological forcing, population pressure, as well as anthropogenic change to riverine landscapes (Schumann et al., 2015). There are plenty of examples of flooding around the world indicated that severity and the intensity of flooding is increasing, and one of the recent examples is the 2014-2015 flooding in Malaysia from 15 December 2014 – 3 January 2015 which affected more than 200,000 people while 21 killed persons (AsiaOne, 2013).

Indeed, the necessity of monitoring and modelling of flood events is enormous for various reasons especially for the planning of flood mitigation and floods control is always a huge challenge for governments and local authorities (Chiang et al., 2010) because of the complexity of the processing and requirements of precise measurement of several parameters. In the developed world, dense river gauging networks, high quality channel survey data, as well as fine resolution ground elevation data over floodplains are available that allow long-term monitoring and modeling of flood events effectively. In the developing world, however, the situation is very different where river-gauging stations are often sparse and are only operated in very large basins, channel survey data hardly exist and if so, they are many restrictions to use or share this data (Merkuryeva et al., 2014). However, several hydraulic models are available for the modeling of flooding such as HEC-RAS, LISFLOOD-FP, TELEMAC-2D, and so on (Bates and De Roo, 2000) that required simple information. Moreover, in recent years, substantial efforts are being made to improve this complex situation of observing, mapping, and modeling flood processes, both in terms of flood model development and remote sensing, particularly satellite platforms (Merkuryeva et al., 2014).

Nevertheless, efforts have already been made for the modelling of flooding by the integration of hydraulic models and remote sensing data (Merkuryeva et al., 2014). The key purpose of all these flood modeling approaches is to accurately predict inundation extent and risk (Di Baldassarre et al., 2010; Pappenberger et al., 2007), however, most of the modeling technique at least requires few measurements such as soil, underlying geology, land use/land cover (LULC) of the watershed, channel topography, and initial and boundary conditions (Anmala et al., 2000, Sanyal et al., 2014). While geology, and soil types of watersheds generally remain the same, the initial condition and boundary condition can be estimated by interpolating the observations from available gauges, and by specifying the upstream and downstream ends of the system respectively. However, several human activities cause changes in LULC and to some extent topography in watersheds over time (van Dijk et al., 2011; Nagy et al., 2011), therefore, an up-to-date LULC as well as an accurate DEM are necessary but unfortunately this requirement is mostly ignored and in most of the cases, researchers use LULC and DEM from the secondary sources (such as SRTM and ASTER GDEM) without considering the effects of these two parameters on flood modeling approach. Therefore, this proposed study investigates the effect of DEM and LU/LC on flood modeling.

2.0 Methodology

In this study, two methodologies were developed: one for DEM generation and the other for flood modeling. Firstly, a DEM was generated for the study area using ALOS PALSAR data following the several steps (Figure 1) but main data processing steps include; i) multi-looking, ii) image co-registration, iii) raw interferogram calculation, iv) interferogram phase flattening, v) filtering, vi) phase unwrapping, vii) phase to height conversion, and viii) geocoding. Secondly, another methodology was also developed using 4-steps of main processing for doing flood modeling using LiDAR data (Figure 2).



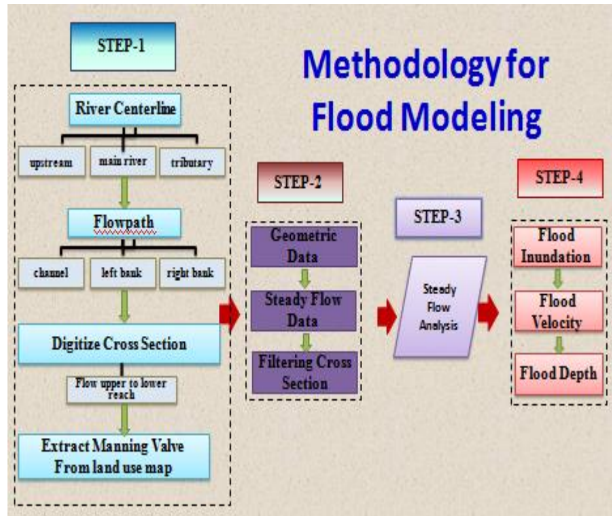


Figure 1 Overall Methodology for DEM generation

Figure 2 Overall Methodology for Flood Modeling

3.0 Results and Discussion

The results of DEM generation using ALOS PALSAR data are presented in Figure 3, 4 and 5 for flat view, shaded relief view and contour view of DEM respectively. However, the results of flood modeling are presented in Figure 6, 7 & 8. It is clear from the DEM results (Figure 3, 4, 5) that a DEM can be generated from the SAR data using InSAR technique effectively. Nevertheless, more investigation is needed to do the validation and to improve the accuracy of DEM using better processing software in order to make this DEM usable for flood modeling. On the other hand, it is obvious from the results of flood modeling (Figure 7 & 8) that modeling of flooding can be done appropriately if necessary data especially accurate DEM and LU/LC maps are available. This study found that flood depth using original LiDAR data was not well-delineated (Figure 7) due to some unwanted points/errors in the DEM. However, a better delineation of flood depth was found after correcting the original LiDAR data based on TIN (Figure 8).

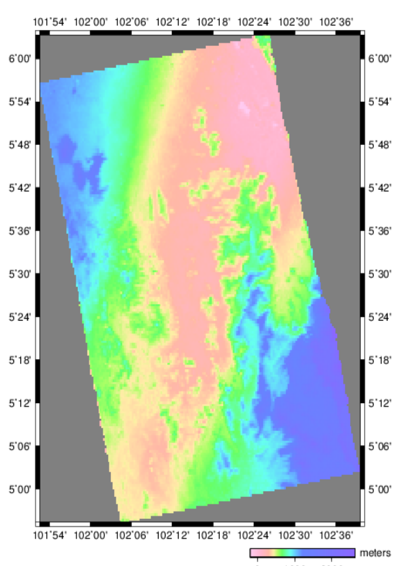


Figure 3: Flat view of PALSAR DEM

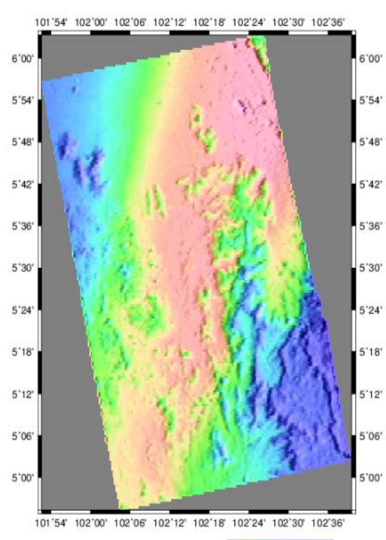


Figure 4: Shaded view of PALSAR DEM

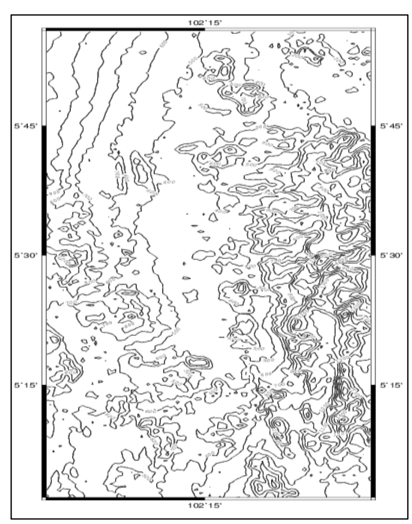


Figure 5: Contour view of PALSAR DEM

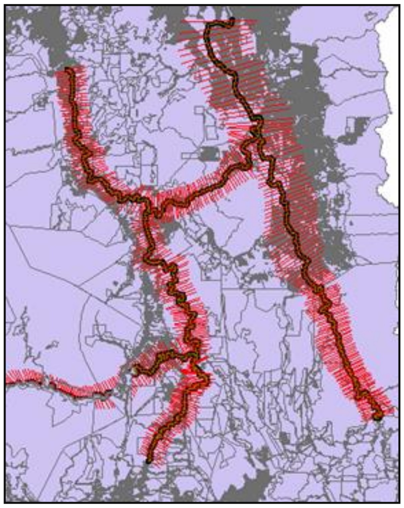


Figure 6: River cross-section with LU/LC maps

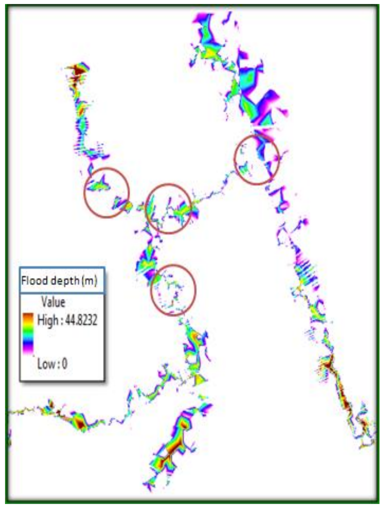


Figure 7: Flood depth using original LIDAR DEM

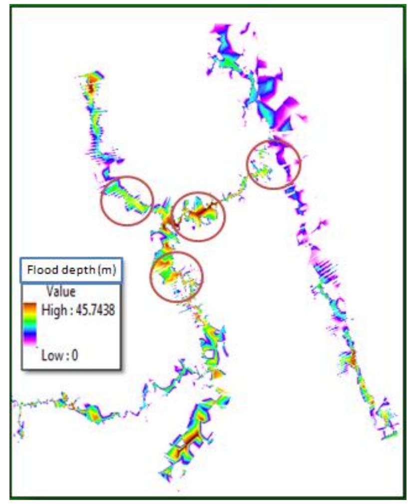


Figure 8: Flood depth using modified LIDAR DEM

4.0 Conclusion

- It is possible to detect flood depth and velocity accurately using accurate DEM and LU/LC data. However, getting an accurate DEM and LU/LC is not easy and needs lots of effort and time especially time series information.
- This study found that several factors are actually involved for creating the devastating flooding in Kelantan, however, major factor of this flooding is excessive rainfall within a short period. Other factors such as LU/LC change is important and need to investigate further as we were unable to detect the effect of this factor due to time limitation.
- **It is important to note that a simulation can be done in future using different levels of rainfall in different watershed in order to understand the relationship between rainfall and flooding depth. If this process is done successfully in future, then this information can be incorporated with the real time flood warning system.**
- This study tried to generate DEM from ALOS PALSAR data using InSAR technique. A promising result was obtained but further investigation is needed for the improvement of the PALSAR DEM using robust processing software and necessary field data.
- There are several limitations in this study especially constraint of time, man-power, financial ability to obtain good data to procure robust processing software. All these problems make this study difficult to complete but we have tried our best to finish this work successfully. Hope, all these difficulties make us more confident in future to do a better research.

References

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Chen, Y., Xu, Y., Yin, Y., (2009). Impacts of land use change scenarios on storm-runoff generation in Xitiaoxi basin, China, Quaternary International, 208, 121–128.

Fox, D.M., Witz, E., Blanc, V., Soulié, C., Penalver-Navarro, M., Dervieux, A., (2012). A case study of land cover change (1950–2003) and runoff in a Mediterranean catchment. Applied Geography, 32, 2, 810–821.

Larry W. M. (2011). Ground and Surface Water Hydrology, John Wiley and Sons, Inc.

Merkuryeva, G., Merkuryev, Y., Sokolov, B. V., Potryasaev, S., Zelentsov, V. A., Lektauers, A. (2014). Advanced river flood monitoring, modelling and forecasting, Journal of Computational Science, 10, 77-85.

Lampiran 2

END OF REPORT

(**maximum 5** pages of end report)

Project Title : SIGNIFICANCE OF SEASONAL RIVER MOUTH SANDBAR FORMATION TO FLOOD LEVELS IN THE KELANTAN RIVER BASIN

A. Project Information

Start Date	: 01/04/2015
End Date	: 31/12/2015
Extension Date	: 31/03/2016
Project Status	: Completed
Project Leader	: AHMAD KHAIRI BIN ABD WAHAB
I/C Number	: 611001-08-6487
University	: UNIVERSITI TEKNOLOGI MALAYSIA
Address	: PEJABAT TNC(P&I)
Contact number	: 012-7132300
Project Members	: MUSHAIRRY BIN MUSTAFFAR RADZUAN BIN SA'ARI ZULHILMI BIN ISMAIL FARIDAH BINTI JAFFAR SIDEK ILYA KHAIRANIS BINTI OTHMAN

B. Project Achievement

Project Progress	: 90%
Research Output	: Indexed Journal (-), Non-indexed Journal (-), Conference Proceedings (1), Book Chapter (__), Others (1)
Talent	: RA (1), PhD student (-), Master student (__)

C. Expenditure

Budget Approved	: RM 64,100.00
Amount Spent	: RM 39,432.43
Balance	: RM 24,667.57
% of Amount Spent	: 61.57%

Summary of Research Findings

1.0 Introduction

The mouth of Sg. Kelantan is subject to the persistent dynamic forces of the sea and seasonal river flows. The monsoon regimes, dominated by the North-east monsoon (between the months of November to March) bring strong winds and waves from the northeast direction while during the South-west monsoon (between May to September), a relatively calmer period prevails along the eastern coastlines of Peninsular Malaysia.

There are strong interdependency between these forces, which creates a state of dynamic equilibrium between the coastal processes of littoral and onshore-offshore sediment transport leading towards an evolution of the shorelines towards erosion, accretion and stability.

At river mouths, another important element that needs to be included is the river discharge that brings along its own load of inland sediment out to the sea. Thus, the mouth of any major river would be subject to an interaction between the various factors, which, inevitably, creates a pattern of sedimentation, erosion and mass movements around the river mouth area that is complex and seasonal. These are normally realized through as the formation of sand bars and offshore islands that partially blocks the river outflow, causing further sedimentation towards inland and may affect the efficiency of the river outflow especially during the months of heavy river discharges.

The research attempts to investigate the significance of this phenomenon on the outflow of Sg. Kelantan, especially during the monsoon season when the precipitation rates and the magnitudes of winds and waves from the sea are at their highest. This would be a major contributor towards increasing the flood levels and the inundation periods in the coastal areas.

A critical element of this research is the inclusion of seasonal sandbar migration obtained through field monitoring and model simulation of the flow hydrodynamics through the sandbar formations. An understanding of these two interlinked processes would lead to a better strategy of flood mitigation at the coastal plains and river mouth area.

2.0 Methodology

The flow hydrodynamics within the estuary and the general area of the surrounding waters around the Kelantan river mouth were simulated using the software package TELEMAC-2D (LNH-EDF, 2002). The TELEMAC system is a fully vectorised finite element software for the solution of the shallow water equations. The flow field is depth-averaged over a two-dimensional horizontal domain. The finite element formulation requires discretisation of the model domain into non-structured spatial meshes or triangular or quadrilateral elements in Cartesian or spherical coordinates. For any numerical modelling executions, the most important element is the availability of good quality data to set up the model domain and to calibrate and validate the dynamic processes being simulated. The mouth of Sungai Kelantan, also known as Muara Kuala Besar has a very dynamic morphological system. Past detailed hydrography and topography surveys are very crucial to understanding and quantifying the dynamics involved. However, for this site, such information are not readily available except for a 2009 survey conducted by the Marines Department Malaysia. Apart from the river and near shore processes, the research also investigated shoreline evolution of the nearby coastlines to further enhance the littoral sediment transport investigation. This was done by analysing Landsat 4-5 TM satellite images for the years

1990 to 2015 at 5-year intervals. The analyses were conducted using the Digital Shoreline Analysis System (DSAS), an extension of ArcGIS software, developed by the USGS.

Two sets of primary hydrographic data consisting of water level monitoring, sediment sampling, current measurements and river and nearshore hydrography surveys of Sungai Kelantan and Muara Kuala Besar were conducted by the project team from 30th May to 5th Jun 2015 and from 6th to 12th March 2016. These were used for the hydrodynamic modelling work and they are also can be made available through the *Pengurusan Data Tebatan Banjir 2015* data repository.

The coastal area survey covered an area with a rectangular size of 3.6km (alongshore) by 2.2km (offshore). River survey coverage was 13km inland to the Sultan Yahya Petra Bridge in Kota Bharu.

Secondary data were sourced from the Department of Drainage and Irrigation, JUPEM, Royal Malaysia Navy, MetMalaysia and Agensi Remote Sensing Malaysia. Additional survey records of Kuala Besar (2009) were also obtained courtesy of the Malaysia Marine Department.

3.0 Results and Discussion

Results of the modelling outputs were analysed in terms of flow capacity for the river, water level profiles, flow pattern and magnitudes, sediment transport and shoreline changes. The satellite images purchased through this project were used to obtain shoreline evolution and longshore sediment drift.

A notable profile change is from the 2010 and 2015 records, depicting pre- and post-2014 flood event as shown below (Figure 1) where transects close to discharge outlets record increased sedimentation after the flood event.

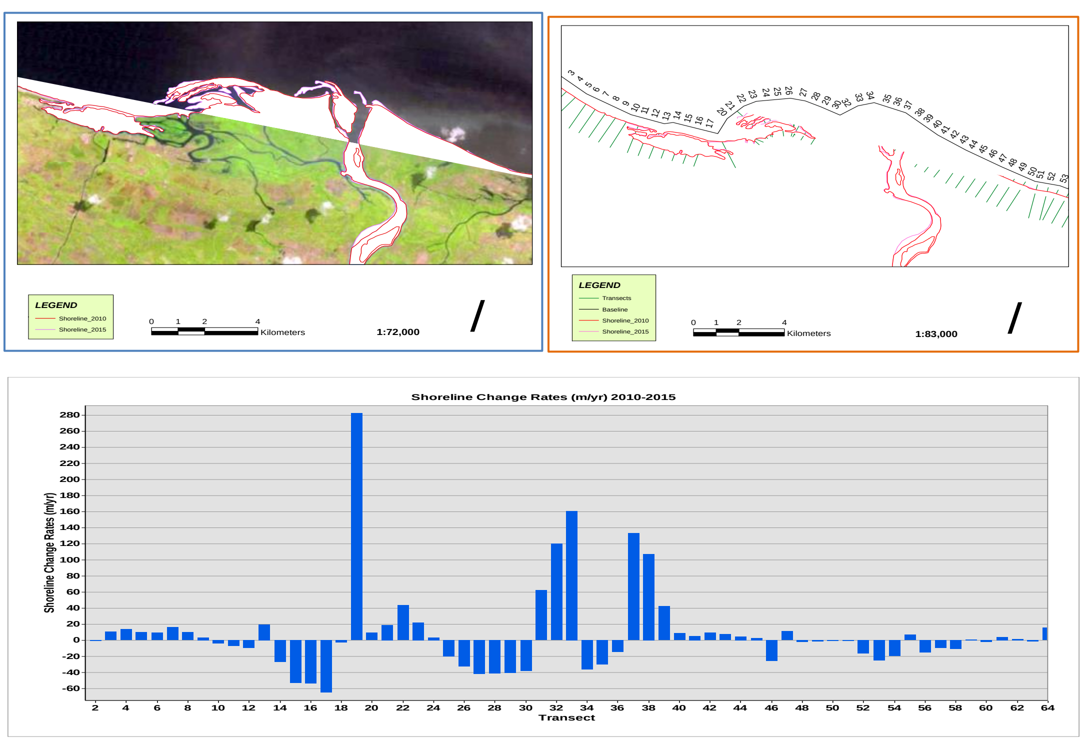

Figure 1: Shoreline evolution around Muara Kuala Besar from Landsat data for 2010-2015 period

Hydrodynamic modelling of 2015 and 2016 bathymetry were conducted using normal and flood discharges values. A flood discharge value of 900m^3/s were adapted for the simulation. The time variation of water levels at the Medan Ikan Bakar station reach are shown below in Figure 2. The blue line indicated measured level during normal condition and the red line are simulated flood levels with discharge of 900 m^3/s. Water level elevations along the river were charted up to the 13km mark from the river mouth. Figure 3 shows the variation along the river reach from Km-0 at the river mouth to Km-13 at Sultan Yahya Petra Bridge for the flood tidal phase. Comparison with other stages of the tide depicted similar patterns. Figure 4 shows the ebb and flood current vectors at Muara Kuala Besar.

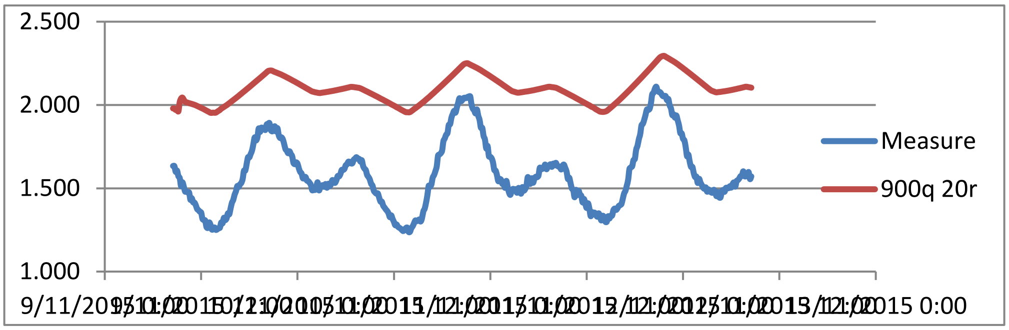

Figure 2: Comparison of flood and normal flow water levels at Medan Ikan Bakar Station

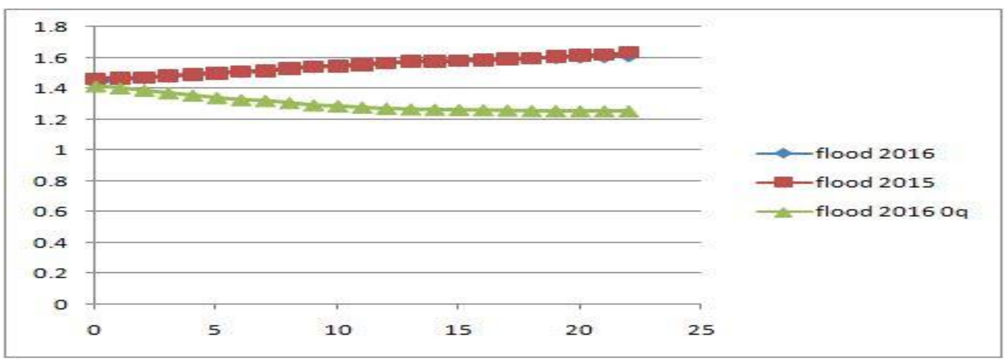

Figure 3: Comparison of flood and normal flow water levels along Sungai Kelantan from river mouth to the Sultan Yahya Petra Bridge during flood tidal phase.

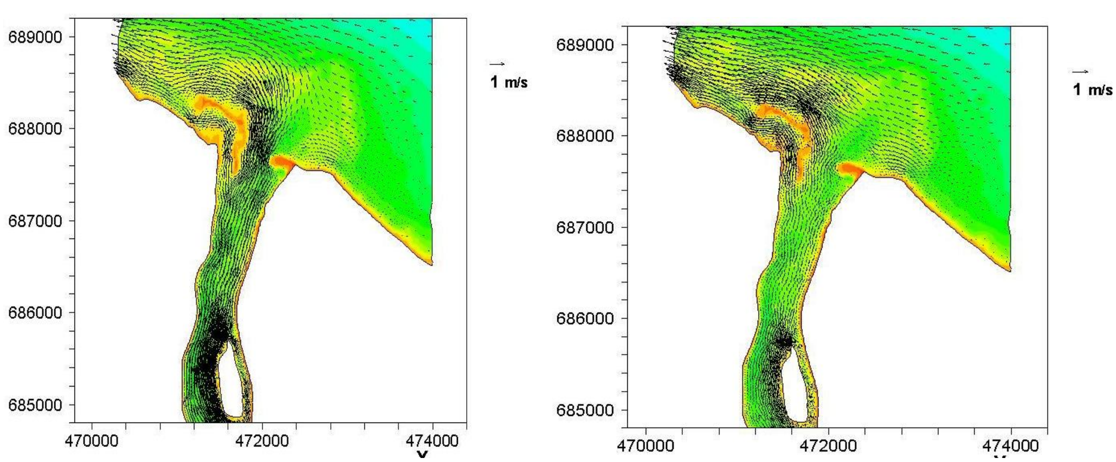

Figure 4: Ebb (left) and flood (right) current vectors around Muara Kuala Besar.

4.0 Conclusions

4.1 Two detailed hydrography surveys of Sg Kelantan (up to the Sultan Yahya Petra Bridge) and a 3.6 by 2.2km area of the river mouth were conducted in May-Jun 2015 and March 2016.

4.2 The shoreline evolution at 5 year intervals from 1990 to 2015 was conducted using DSAS.

4.3 The flood event accumulated vast quantities of sediment to the Sg Kelantan river mouth through its multiple discharge outlets and littoral sources. This was ascertained from the shoreline evolution analyses.

4.4 Simulation for flood flow using Telemac 2D indicated increase water levels and velocity during flood events.

4.5 Complete analyses involving quantitative determination of sandbar movements and refined current dan discharge values are being prepared and will be included in the upcoming publication.

References

1. J.K. Raj, Y. Ismail and W.H. Abdullah (2007), Past and present-day coastal changes between Kuala Sungai Besar and Kuala Besar, Kelantan Darul Naim, *Geological Society of Malaysia*, Bull. 53, pp.15-20.
2. DID (1994), *The National River Mouth Study in Malaysia (Vol. IV)*, report submitted to Drainage and Irrigation Department (DID) Malaysia by Japan International Cooperation Agency (JICA).
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Lampiran 3

BORANG FRGS BANJIR – P3(R)

KEMENTERIAN PENDIDIKAN MALAYSIA

FINAL REPORT
GERAN PENYELIDIKAN PENGURUSAN BENCANA BANJIR
Laporan Akhir Skim Geran Penyelidikan Fundamental (FRGS)
Tahun 2015

A

RESEARCH TITLE:
Urbanization and Industrialization: A Teaching Learning based Optimization Algorithm for Efficient Routing of the Emergency Flood Evacuation Process

YEAR:2015-2016

THEME CODE: 1.0 **SUBTHEME CODE:1.5**
(Please refer attachment)

Please Tick (√)

PHASE:	**01: Pre-Disaster**		**02: During Disaster**	√	**03: Post-Disaster**	
AREA:	**01: Preventive**		**02: Preparedness**	√	**03: Rescue anf Recovery**	
	04:Adaptation		**05: Mitigation**			

START DATE: 1 April 2015
END DATE: 31 May 2016

PROJECT LEADER: Prof Dr Kamal Zuhairi bin Zamli
I/C / PASSPORT NUMBER: 690620065069

PROJECT MEMBERS : 1. Dr Mazlina bt Majid
(including GRA/RA/RO) 2. Dr Parameswary a/p Sundara

PROJECT ACHIEVEMENT *(Prestasi Projek)*

B

ACHIEVEMENT PERCENTAGE			
Project progress according to milestones achieved up to this period	**0 - 50%**	**51 - 75%**	**76 - 100%**
Percentage (please state #%)			100%

RESEARCH OUTPUT		
Number of articles/ manuscripts/ books *(Please attach the First Page of Publication)*	***Indexed Journal***	***Non-Indexed Journal***
	1 SCOPUS (will be published in Advanced Science Letter)	1 Peer Reviewed
Conference Proceeding *(Please attach the First Page of Publication)*	***International***	***National***
	1 Workship	
Intellectual Property *(Please specify)*	2 copyrights - A Chaotic Teaching Learning based Optimization Algorithm for Optimizing Emergency Flood Evacuation Routing	

	- HHH: A Tabu Search Hyper-Heuristic Strategy for t-way Test Suite Generation -
Number and title of Policy Paper / SOP / Technology Solution *(Please specify)*	1. 2. 3.

HUMAN CAPITAL DEVELOPMENT					
Human Capital	**Number**				**Others** (please specify)
	On-going		**Graduated**		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	Undergraduate FYP finishes his study.
No. PHD STUDENT					
Student Fullname: IC / Passport No: Student ID:					
No. MASTER STUDENT					
Student Fullname: IC / Passport No: Student ID:					
No. RA/RO					
Student Fullname: Muhammad Hakim bin Abdul Halim IC / Passport No: 930826035017 Student ID:CB12049			1		
Total					

EXPENDITURE *(Perbelanjaan) as Borang K1(RMC)*

C

Budget Approved *(Peruntukan diluluskan)*	:	**RM 51,200**
Amount Spent *(Jumlah Perbelanjaan)*	:	**RM 36,006.47 (RM3000 is pending payment in VOT29K)**
Balance *(Baki)*	:	**RM 18,193.53**
Percentage of Amount Spent *(Peratusan Belanja)*	:	70.32%

ADDITIONAL RESEARCH ACTIVITIES THAT CONTRIBUTE TOWARDS DEVELOPING SOFT AND HARD SKILLS
(Aktiviti Penyelidikan Sampingan yang menyumbang kepada pembangunan kemahiran insaniah)

D

International

Activity	Date (Month, Year)	Organizer
(e.g : Course/ Seminar/ Symposium/ Conference/ Workshop/ Site Visit)		

National

Activity	Date (Month, Year)	Organizer

(e.g : Course/ Seminar/ Symposium/ Conference/ Workshop/ Site Visit) Presentation in Flood Workshop, Putrajaya		. KPM

E **PROBLEMS / CONSTRAINTS IF ANY** *(Masalah/ Kekangan sekiranya ada)*

We have succesfully implemented the strategy for efficient flood routing problem.. Some parts of the grants cannot be spend owing to the difficulty to get the MSc students.

F **RECOMMENDATION** (*Cadangan Penambahbaikan*)

G **RESEARCH ABSTRACT – Not More Than 200 Words** (*Abstrak Penyelidikan – Tidak Melebihi 200 patah perkataan*)

Flood evacuation process involves relocating residents from any life threatening sites to safe destination within the shortest route and with minimum possible time. There are potentially multiple dynamic constraints that need to be adhered to including limited transport vehicles and support personals, blocked roads as well as varying residents' requirements and population density. Addressing these aforementioned issues, this paper describes the software tool, called Banjero, for optimizing the emergency evacuation routing during the flood disaster. Banjero adopts the Teaching Learning Optimization Algorithm (TLBO) as the backbone to perform the searching of best route taking into account the dynamic constraints. Within TLBO, we have introduced two novel features, that is, the chaotic behaviour and elitism in order to improve the process of converging toward optimal solution. Our experience with the proposed work has been promising as we managed to demonstrate its effectiveness based on our simulation.

PROF. DR. KAMAL Z. ZAMLI
Professor
Faculty of Computer Systems & Software Engineering
Universiti Malaysia Pahang
Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang
Tel : 09-5492544 Fax : 09-549 2144

Date : *Tarikh* 24/5/2016	**Project Leader's Signature:** *Tandatangan Ketua Projek*

H	**COMMENTS, IF ANY/ ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC)** *(Komen, sekiranya ada/ Pengesahan oleh Pusat Pengurusan Penyelidikan)*

The project delivered all promised outcomes.

Name: *Nama:*
PROFESSOR DR. JOSE RAJAN
Dean of Research (Technology)
Department of Research & Innovation
Universiti Malaysia Pahang
Lebuhraya Tun Razak
26300 Gambang, Kuantan
Pahang Darul Makmur

Signature: *Tandatangan:*

Date: *Tarikh:* 01/06/2016.

END OF REPORT

(**maximum 5** pages of end report)

Porject Title : The potential of parameter estimation through regionalization for flood simulations in ungauged mesoscale catchments

A. Project Information

Start Date : 01/04/2015

End Date : 31/12/2015

Extension Date : 31/03/2016

Project Status : Completed

Project Leader : Dr. Chow Ming Fai

I/C Number : 831212-06-5365

University : Universiti Tenaga Nasional (UNITEN)

Address : Jalan IKRAM-UNITEN, 43000 Kajang, Selangor.

Contact number : +60389212256

Project Members : Assoc. Prof. Ir. Dr. Marlinda Abdul Malek

B. Project Achievement

Project Progress : 100%

Research Output :Indexed Journal(_1_), Non-indexed Journal (__), Conference Proceedings (_1_), Book Chapter (__),….

Talent : RA (__), PhD student (__), Master student (_1_)

C. Expenditure

Budget Approved : RM 50,500.00

Amount Spent : RM 49,443.00

Balance : RM 1057

% of Amount Spent : 97.9%

Summary of Research Findings

1.0 Introduction

Reliable estimates for the occurrence of flood event are important for planning measures which reduce or even prevent flood damage. Particularly on the mesoscale catchment (drainage area of roughly 10-1000 km2 in the present case), there is a great need for such estimates, as was e.g. shown in the aftermath of the 2014 serious flood event in Kelantan. Usually, flood with various recurrence intervals in catchments with long gauge records can be estimated by using extreme value statistics. However, the results for flood estimation are noticely influenced by many factors, such as the choices of theoretical extreme value distribution function, parameter estimation method and ignorance of processes governing individual flood events (Klemes, 2000). Other than that, short record or absent of local runoff data that used for calibrating model parameters would become the main challenge on flood estimation in ungauged catchments. For solving this problem, parameter regionalization method is widely used to estimate the parameters for calibrating the hydrological models (Fernandez, 2000; Szolgay et al. 2003; Hundecha, Y., and A. Bardossy, 2004; Lamb, 2000; Wagener and Wheather, 2006). In parameter regionalization, parameter values in ungauged catchments are normally extrapolated using calibrated values obtained from gauged catchments by applying different regionalization techniques. The successful of regional model calibration is mainly depends on the robustness of model parameters obtained from gauged catchments that are used in parameter estimation. The more robust parameters are contributing to the reduction of runoff simulation uncertainty when transposing them to ungauged catchments. Typically, the regression models are used to relate the model parameters with catchment attributes and climatic characteristics to determine the regionalized parameter values (Jarboe, 1974; Karlinger, 1988; Merz, 2004). Other commonly used methods are including global average (Merz and Bloschl, 2004; Kokkonen et al. 2003); average based on expected similarities in watershed hydrologic responses (Schmidt et al. 2000) and kriging (Vogel, 2006).

2.0 Methodology

Study Site

Kelantan River is divided into the Galas and Lebir Rivers near Kuala Krai, about 100 km from the river mouth. The Galas River is formed by the junction of the Nenggiri and Pergau Rivers.

The Kelantan River system flows northward passing through such major towns as Kuala Krai, Tanah Merah, Pasir Mas and Kota Bharu, before finally discharging into the South China Sea. The basin has an annual rainfall of about 2,500 mm much of which occurs during the North-East Monsoon between mid-October and mid- January. The mean flow of the Kelantan River measured at Guillemard Bridge is 557.5 m3/s.

Integrated Flood Analysis System (IFAS)

IFAS is a deterministic model which developed by ICHARM (International Center for Water Hazard and Risk Management) of Japan for flood modeling on river basin. The aim of IFAS is to create flood forecasting for river basins with insufficient hydrological data. The Public Works Research Institute Distributed Hydrological Model (PDHM) is employed in IFAS as its runoff simulation model. The structure of PDHM is consists of surface tank model, subsurface tank model, aquifer tank model and river tank model. The IFAS software is capable to import satellite-based rainfall data such as GSMaP and 3B42RT for insufficient ground observation river basin.

Regionalization methods

Regionalisation 1: Global average-based parameter regionalization

The global average parameters were determined by computing the mean of each of the parameters from selected gauged catchments as listed in Table 1. The parameter value will be reset to the maximum value of range if any mean value exceeding the reasonable range for the parameter. These parameter values were then inserted into their respective model input files for the tested river basin. The IFAS model was then run using the global average parameter values and the corresponding stream hydrographs were obtained.

Regionalisation 2: Regression

In the Regression approach, model parameters are related directly to selected catchment attributes. For each of the m model parameters (parami), a linear regression model containing n attributes (attribj) is set up:

$$param = a_i + \sum_{j=1}^{n} (b_{i.j} \,.\, attrib_j)$$

A specific regression model is built for each tuned-able parameter, containing the several attributes which show highest correlation with the respective parameter. The resulting parameter set for the ungauged catchment was then checked for plausibility: Values which exceed or fall short of the range of parameter values realized in calibration are set to the respective threshold. This avoids unreasonable parameter values in catchments with exceptional conditions.

Regionalisation 3: Nearest Neighbours

The Nearest Neighbour approach consists in finding a calibrated donor catchment which is as similar as possible to the ungauged target basin. All tuneable model parameters are then transferred from the donor to the target as a complete, unchanged set.

Model efficiency

The model performance is evaluated by using the Nash-Sutcliffe coefficient (NS) for peak flow, runoff volume and wave shape. The NS coefficient (as show in equation 1) is a measure of model efficiency that compares the simulated results to the corresponding measured results:

$$NS = 1 - \left(\frac{\sum_{i=1}^{n}(Q_i - Q_i')^2}{\sum_{i=1}^{n}(Q_i - \bar{Q})^2}\right) \qquad (1)$$

Where Qi is the measured value (stream discharge), Qi' is the simulated value, Q¯is the average measured value, and n is the number of data points.

3.0 Results and Discussion

Performance analysis of parameter regionalization methods

The calibrated IFAS parameter values are obtained from gauged catchments in Dungun catchment (Terengganu), Upper Indus basin (Pakistan), Kabul river basin (Pakistan), Cagayan river basin (Philippines) and Solo river basin (Indonesia). The global average values for each parameter in IFAS model were calculated and summarized in Table 3. Slightly difference was observed for surface roughness coefficient with a percentage of different of 21.4%. However, global average values for vertical hydraulic conductivity, maximum water height, rapid intermediate flow regulation coefficient and runoff coefficient of unconfined aquifer are exhibiting higher magnitude of different with percentage of 200%, 60%, -40% and 104%, respectively. The global average parameter values in Table 3 were inserted into the IFAS model for simulating the historical flood event (December 2016 – January 2017) in Kelantan river basin. The simulation performance was evaluated using Nash-Sutcliffe coefficient for parameters obtained using global averaging method. The model performance statistics were then compared to default and calibrated models for the Kelantan River basin for the period December 2006 – Jan 2007. Generally, the model performance was not comparable to calibrated model when global average parameters were used. For the flood event during period December 2006 – January 2007, the NS value obtained from global averaging was 0.4 compared to 0.8 obtained through calibration. The IFAS model performance statistics for parameters obtained using regression based method was also shown in Table 4. The NS values range between 0.68 and 0.73 which are considered as good. In general, the model performance obtained using regression-based parameters was comparable to that obtained through calibration. The regression-based method for parameter estimation for IFAS simulation is consistently outperformed the default model outputs in the tested flood event.

Table 1. Comparison of model performance statistics

		Nash-Sutcliffe Coefficient			
Time period	**Items**	**Default**	**Calibration**	**Global average**	**Regression**
Dec. 2006 – Jan 2007	Peak flow	0.45	0.80	0.40	0.70
	Runoff volume	0.50	0.77	0.56	0.68
	Wave shape	0.60	0.74	0.60	0.73

4.0 Conclusion

This study had evaluated the two parameter regionalization methods: global average and regression-based as a means of obtaining IFAS model parameters for use in ungauged catchments.

- The model performance results obtained using regression-based parameters was comparable to that obtained through calibration. The Nash-Sutcliffe efficiencies for predicting the peak flow using global averaged and regression-based parameters are 0.40 and 0.70, respectively.
- The result of regression-based technique is comparable with value of 0.80 obtained through calibration. In general, the results suggest that it is possible to estimate the IFAS parameter using regression-based techniques.

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