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# A Study on Integrated Community Based Flood Mitigation with Remote Sensing Technique in Kota Bharu, Kelantan

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**Abstract.** This study is conducted to establish a community based flood management system that is integrated with remote sensing technique. To understand local knowledge, the demographic of the local society is obtained by using the survey approach. The local authorities are approached first to obtain information regarding the society in the study areas such as the population, the gender and the tabulation of settlement. The information about age, religion, ethnic, occupation, years of experience facing flood in the area, are recorded to understand more on how the local knowledge emerges. Then geographic data is obtained such as rainfall data, land use, land elevation, river discharge data. This information is used to establish a hydrological model of flood in the study area. Analysis were made from the survey approach to understand the pattern of society and how they react to floods while the analysis of geographic data is used to analyse the water extent and damage done by the flood. The final result of this research is to produce a flood mitigation method with a community based framework in the state of Kelantan. With the flood mitigation that involves the community's understanding towards flood also the techniques to forecast heavy rainfall and flood occurrence using remote sensing, it is hope that it could reduce the casualties and damage that might cause to the society and infrastructures in the study area.

## 1.0 Introduction

Flood recurrently damages physical infrastructures like houses, schools, sub-health post, road, culverts, marketing centers, gabion embankments, spurs, hand pumps, etc. Flood also damages the productive agriculture land, and livestock (ICHARM et al., 2008). These are important areas to mankind which could put a hold to their livelihood earnings. When flood occurs and these areas are affected, it damages the earning of the society for a certain period of time thus making work opportunity for the young generation reduced. This factor contributes to the migration of the youth from the rural areas to urban areas.

In recent years, several parts of Malaysia have been hit by severe flooding, known as the localised flash flood and the basin-wide floods on the major river systems. River basin areas which were

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severely affected are in Penang (Juru River Basin), Pahang (Pahang River Basin), Terengganu (Setiu River Basin) and Perak (Kinta River Basin). By their nature, floods are generated by the random coincidence of several meteorological factors but man's use of the river catchment also has an impact upon the severity and consequences of the events (Shafie, 2006).

In this country, there are two types of major floods that usually sets-in, they are the monsoon flood and the flash flood. The monsoon flood occur mainly from the northeast monsoon in the month of November to March with heavy rains to the east coast states, northern part of Sabah dan Southern part of Sarawak (Chan, 1995). In history, there were several times of severe flood experience by this country (Shafie, 2006).

Flood event Year	Place	Damage		
		(MR million at 1993 prices)	Deaths	Persons evacuated
1967	Kelantan River Basin	199.3	38	320,000
1967	Perak River Basin	154.5	0	280,000
1967	Terengganu River Basin	40.2	17	78,000
1971	Pahang River Basin	93.1	24	153,000
1971	Kuala Lumpur	84.7	24	NA
1979	Peninsular Malaysia	NA	7	23,898
1982	Peninsular Malaysia	NA	8	9,893
1983	Peninsular Malaysia	NA	14	60,807
1984	Batu Pahat River Basin	20.3	0	8,400
1986	Peninsular Malaysia	NA	0	40,698
1988	Peninsular Malaysia	NA	37	100,755
1988	Kelantan River Basin	33.0	19	36,800
1991	Peninsular Malaysia	NA	11	NA
1992	Peninsular Malaysia	NA	12	NA
1993	Peninsular Malaysia	NA <sup>a</sup>	22	17,000

Source: DID Malaysia and Malaysian National Security Council  
 NA = Not available  
<sup>a</sup> In the State of Kelantan, a total of 200 schools were closed during the 1993 flood resulting in 113,000 students missing school for a total of six to 11 days

Figure 1.0 Official flood loss estimate for selected floods in Malaysia (Shafie, 2006)

In the State of Kelantan, the bulk of population is concentrated in the Kelantan Delta (around Kota Bharu) and its fertile river valleys. Consequently, the majority of its settlements suffer from river flooding during the North-East monsoon season. It has been estimated that a major flood such as the 1967 flood would inundate almost 70.0 per cent of villages in Kelantan or affect nearly half of the State's population (Chan, 1995).

## 2.0 Local knowledge for flood forecasting

As have been introduced above, flood is a disaster that influences the livelihood of the society. The experience going through the disaster, adapting to the changes that occur drastically and trying to survive within the climate evolves to become an essential local knowledge for the people (Dekens, 2007). In assessing flood disaster, it is essential for local authorities to invite the public to participate and contribute to design a community-based flood mitigation plan (Motoyoshi, 2006). In the past, flood mitigation plans have failed to provide sufficient help due to the neglecting of local authorities towards the public perception (Hung et al., 2007; Bradford et al., 2012). With the public participating in the flood mitigation plan, it could enable a more cooperative approach between the public and the authorities thus could effect in reduce casualties and a more prepared situation to comprehend.

Julie Dekens also describe how local knowledge could evolve becoming into a disaster preparedness in figure 1:

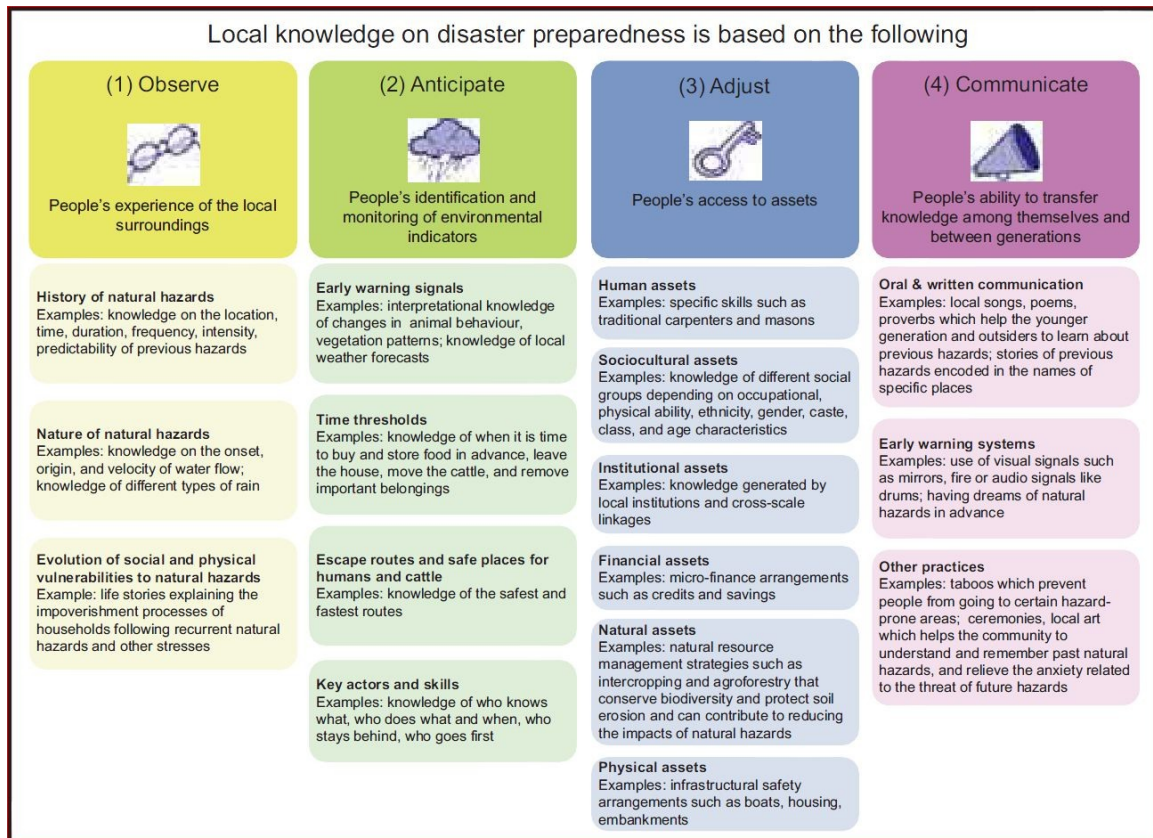


Figure 2: Four pillars of local knowledge in disaster preparedness (Dekens, 2007)

In 2004, UNEP conducted a study to understand the benefits of local knowledge towards the life of local people in four countries of Africa. The study showed that the rural community of Africa adapted actively with the environment surrounding them especially in major disasters such as droughts and flood. For example, in Lake Victoria, Africa, the Luo community had a large number of climate monitoring indicators which they learned from past generations as an early prediction for coming disasters which comprises from the behaviour of animals, birds, reptiles, amphibians, movement of insects, vegetation and trees, direction and strength of wind blowing, temperatures and celestial bodies (UNEP, 2008). The knowledge they obtain from their long observation and adaption made them resilient towards flood disasters and survived settling there for quite some time.

In Kenya, Africa, Nyakundi (2010) describe how the local communities depend more on the traditional knowledge compared to scientific knowledge when facing with flood disasters. It is with regard to the local flood warning system establish by the local authorities where not accurate in predicting the incoming of flood and the water extent reach, which the local community where more aware and knew from their daily observation and understanding of their own terrain and areas.

Most local community depend more on the local knowledge that they inherit because it is a part of their daily observation, experience, exposure from time to time which enables them to adapt to the climatic changes in order to survive. The local community are on the ground themselves, facing

disaster throughout their life and making improvements to adapt with changes that occur, thus making local knowledge a valuable information that must be considered to be part of flood mitigation plan in order to obtain a more comprehensive approach in mitigating flood. Local knowledge could become the 'ground source information' for flood mitigation plan.

### 3.0 Monitoring flood with remote sensing

As local knowledge plays a vital role in providing ground information about the community's perspective on flood, remote sensing as a scientific method through technology could provide information about flood extent, flood duration also risk areas.

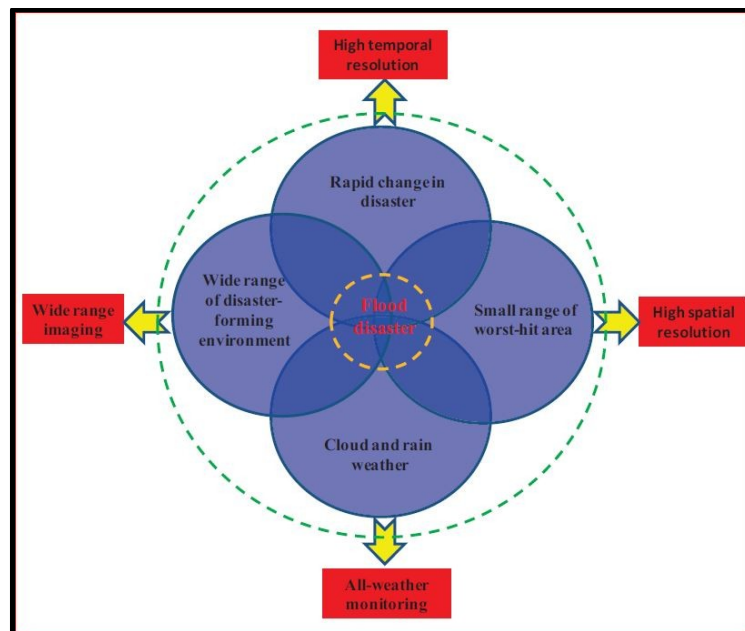


Figure 3 Characters of flood disaster and their monitoring requirements for remote sensing data (Zheng, 2012)

Remote sensing techniques can provide information due the flood characteristics (Zheng, 2012). To monitor large areas, the passive microwave data such as the Advance Microwave Scanning Radiometer for Earth Observation System (AMRS-E) data can be used. Where as, satellite data such Moderate Resolution Imaging Spectrometer (MODIS) which has high spatial and temporal resolution data, could be use to monitor flood in a scale of moderate areas. To monitor detail areas for detailed assesment, it is prefereable to combine the radar data which can penetrate clouds with optical image during non-flood period. An example of this process is the combination of Radar Satellite (RADARSAT) and LANDSAT Thematic Mapper (TM) (Zheng, 2012).

In flood monitoring, the process of establishing water extent is also important. Shin-xin et al., (2002) did a study in Dongting Lake, China and established a normal water extent by automatic extraction using the TM and the Advance Very High Resolution Radiometer (AVHRR) which is embarked on the Nationaol Oceanic and Atmospheric Adminitstration (NOAA) satellite. This water extent that has been extracted from the TM & NOAA/AVHRR data is used to create a "Normal Water Extent Database (NWED)" for flood monitoring in Lake Donting, China.

All in all, regardless of the usage for each satellite data, execpt for radar data, all satellite data could not be used the during the flood period due to heavy cloud cover (Zhou et al., 2000; Bach et al., 1999) which limits the visibility of areas hit by flood. Thus the best data to be used during flood is the radar data. It can also produce a better assesment with the fusion of TM data (Zheng, 2012). To gather

information about the flood duration and maximum extent, then the best data to be used is the MODIS data which also has a spatial resolution of 250 m.

#### **4.0 Applying Remote Sensing with Community Knowledge for Flood monitoring**

It is understood that remote sensing plays a vital role to produce an accurate flood extent map with its instantaneous and synoptic view (Zhou et al., 2000) thus it is a necessary tool for flood monitoring where as the local knowledge could provide with micro information about the surrounding terrains and also the ability of human attitude to encounter the flood with their experience and observations (Nyakundi, 2010).

In identifying the community knowledge, a survey must done where certain items were presented to the community. Motoyoshi (2006) considered survey items such as acceptance of general risks, consideration of the society, perception regarding the communities faith towards the local flood control techniques, self-responsibility, trust in administrative bodies and interest in or concern about flood disasters. Whereas Nyakundi (2010) listed a few items such as age, education level, socio-economic characteristics, perceptions of flood risk, perception of flood risks.

Information gathered from the local community will then be documented and be used to assist the flood mitigation plan. These information will serve as credible ground data and human data which will help during the mitigation of flood on the ground where the local authorities could communicate with the local community better.

#### **5.0 Conclusion**

In performing an effective flood mitigation plan, it is important to combine the remote sensing techniques and also the local knowledge. Nevertheless, combination from both sides of information could be perform through the analysis approach rather than technical approach. Analysis of how to handle the perception of the community during a disaster occurrence, providing the best routes of evacuation, flood extent can be predicted and early actions can be made, provide an alternative methods of prediction and contribute towards early warning system for the community. With all these in information considered, it is expected that during flood mitigation, the outcome when executing the flood mitigation plan is more effective, less casualties and less property damages because the community's information is included during the early process.

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