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The December 2014 flood in Kelantan: A post-event perspective

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INTRODUCTION

The "Science to Action" (S2A) initiative was inspired by the Honourable Prime Minister Dato' Sri Mohd Najib Tun Haji Abdul Razak in 2013 to make science relevant for governance, industry and community well-being. A prominent S2A initiative is the partnership between Malaysian Industry-Government Group for High Technology (MIGHT) and the British Council to promote collaboration between Malaysia and the United Kingdom in science, technology and innovation through the establishment of the Newton-Ungku Omar Fund. The Newton-Ungku Omar Fund is a five-year programme launched in 2014 jointly funded by the Governments of UK and Malaysia to address issues on "Climate Change and Sustainability" through innovative capacity building anchored in science.

The Geological Society of Malaysia supported by the Institute of Geology Malaysia, Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), University Malaya's Geology Department and other parties is helming the flagship on Geoscience to Action for Disaster Risk Reduction (G2A4DRR). Funding has been secured from the Newton-Ungku Omar Fund via SEADPRI-UKM to mobilise coordinated measures underpinned by science to address the risks of climate related multi-hazards, in conjunction with partners from the UK. In the context of geoscience, the focus is on capacity building and professional development to build the nation's resilience to climate induced disasters and natural hazards.

In conjunction with the Geological Society's 2015 National Geoscience Conference hosted by the Universiti Malaysia Kelantan, the Department of Minerals and Geoscience Malaysia and Perbadanan Menteri Besar Kelantan, a field visit was organised to get an overview of the impacts of flooding in Kelantan in late 2014. About 20 participants from various institutions joined the visit to get an overview of affected areas in Kuala Krai and Dabong in Kelantan. This report provides a brief account of floods in Kelantan, features some physical impacts of the 2014 flood as observed eight months after the event and highlights the potential for geoscience inputs to improve the situation.

FLOODS IN KELANTAN

Due to the geographical location adjacent to the coast of South China Sea and the expansion of settlements on plain topography, a majority of the population in Kelantan are highly exposed to floods, especially during the northeast monsoon seasons occurring from November to March. Floods have been recorded in the state every year over the past decade (Figure 1). Small floods are frequent, occurring every 2-3 years on average while large floods are generally less frequent.

The December 2014 flood in Kelantan was unprecedented and the largest recorded flooding event in the century. The flood was preceded by more than a week of continuous rains, with intense raining period from 14th to 19th December 2014 with rivers exceeded the danger level by 17th December. This was an extreme

event of increased discharge that resulted from a short-term imbalance between the input and output of water discharge in the channel. As the discharge increased due to intense and prolonged rain, the massive water volume surged into the tributaries of Galas River and Lebir River and thence into the bottleneck of the main Kelantan River, causing water to overspill the banks in the surroundings of Dabong, Gua Musang, Manik Urai and Kuala Krai. The situation was exacerbated by tidal impact from the coast.

In the past, locals residing on the floodplains or low-lying areas in Kelantan are generally accustomed to recurrent floods and have traditionally adapted to the phenomena through appropriate dwelling architecture and practices. As the rate of development escalated settlements expanded in the floodplains. The advancement of the technology contributed to change the flood adaptation approach over time. In an attempt to protect the built-up areas, various structural measures were taken including the construction of levees and development of more efficient drainage systems, thus resulting in less frequent floods in the economically important areas. These measures contributed to a deceptive sense of security and overdevelopment in areas adjacent to the major rivers. Recent development saw the cessation of stilted and elevated houses and other practices that are more adaptable to floods. This may have been a contributing factor to the severe impact experienced during the flood event in 2014.

During the flood, large parts of Kelantan were inundated, causing the relocation of as much as 151,072 residents on 29 December 2014 (Bernama, 2014) and 10 deaths (e-banjir, 2014). In Kuala Krai, hundreds of the flood victims residing in the low floodplains fled to nearby mountains and were trapped there for several days. The estimated losses is about 2.8 billion ringgit. The actual losses are higher considering loss of economic productivity, compensation to victims, reconstruction, among others.

PHYSICAL IMPACTS

The physical impacts of some of the highly affected areas in Kelantan i.e. Kuala Krai and Dabong could still be discerned eight months after the flooding event. The area is drained by three main rivers namely the Kelantan, Galas and Lebir Rivers. The Galas and Lebir Rivers are the main tributaries to the Kelantan River, converging in Kuala Krai.

At Pengkalan Krai Jetty in Kuala Krai town, located along Kelantan River, flood remnants indicate that water levels were as high as 15 m (Figure 2). Flood remains hanging high on the tree branches serve as indicators of the water level (Figure 3). Vegetation damage can be observed along the Kelantan River due to flood erosion and a significant extension of point bars was also observed due to intense sedimentation (Figure 4). The alluvial sediment covering Kelantan River basin is highly erodible and was subject to intense erosion during the flood. This contributed to the large amount of sediment deposition along the river as the flood waters receded. The topography along the river has changed significantly due to this process.

At Kampung Tualang Bridge overlooking the Dabong train station, the flood level was at the height of a four-storey school building (Figure 5). It was reported that during the onset of the flood, residents had to abandon the building, which served as a shelter and take temporary refuge on a nearby bridge of higher elevation. The Galas is a tributary of the Kelantan River with high flow that meanders through Kuala Krai and Gua Musang. The river was expanded after the flood with significant erosion of the river bank and damage to vegetation (Figure 6). Land clearing has been identified as one of the factors that contributed to the unprecedented degree of erosion and sedimentation. Land clearing was observed on the hillslope upstream next to the Galas River, while an extended point bar was formed from sediments deposited during the recent flood (Figure 7). Sedimentation with thickness of about 1.2 m was observed along the bank consisting of coarse

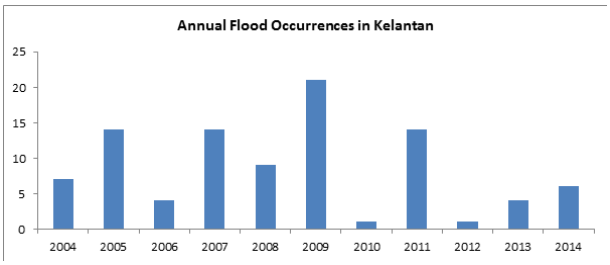

Figure 1: Flood occurrences in Kelantan over the past decade (2003-2014) [Source: Department of Irrigation and Drainage].

Figure 2: Flood level at Pengkalan Krai, along the Kelantan River.

Figure 3: Flood debris on tree branches (circle) in Pengkalan Krai, along the Kelantan River.

grained sand to gravel (Figure 8). The headwater stream, the uppermost tributary stream in the Galas River network is located at Gunung Stong (Figure 9). Headwater streams trap floodwaters, recharge groundwater supply, remove pollution, provide fish and wildlife habitat and sustain the health downstream of the river. It is important to prevent deforestation and irresponsible mining in this area as it may alter the headwater streams, affecting the ecological condition and health of the Galas River network.

In addition to direct impacts such as loss of life and damage property and infrastructure, flood disasters typically instigate cascading effects to humans and the environment. Such cascading effects include health problems related to sanitation and significant loss of income to local communities, among others. Floods also often lead to surface and groundwater contamination and environmental pollution related to waste management problems. A thorough understanding of the nature of these problems is important in order to take appropriate actions to address the issues and to promote well-being of humans and the environment through sustainable land use and development.

POTENTIAL FOR GEOSCIENCE

In 2015, the Government of Malaysia allocated RM20 million in research grants for flood-related research to be conducted by local universities in order to improve flood condition in the country. A total of 189 research projects have been approved for local universities covering a range of topics in various fields including Natural Sciences and National Heritage, Technology and Engineering, Art and Applied Arts, Clinical and Health Sciences, Pure Science, Applied Science, Social Sciences, and Information and Communication Technology. The research projects aim to support the five phases of the Disaster Management Cycle adopted by the Government i.e. prevention, mitigation, preparedness, response and recovery. There is great potential for geoscience to play a critical role in all five-phases drawing on existing fields such as engineering and environmental geology.

Fundamental factors in the severity of a flood event include extremely high rainfall and drainage basin morphology. However, human factors may to a greater or lesser degree influence the process, often exacerbating

Figure 4: Extended point-bars along the Kelantan River at Pengkalan Krai.

Figure 5: Flood level at Dabong train station.

Figure 6: Erosion and damage to vegetation along Galas River at Dabong.

Figure 7: Land clearing (A) and sedimentation (B) along Galas River at Dabong.

Figure 8: Sedimentation with a thickness of 1.2 m along Galas River at Dabong.

Figure 9: Headwater stream at Gunung Stong in Dabong.

the impacts. Inadequate understanding of the nature of the setting often lead to unapprised decisions of land uses on river and flood plains. In this context, geoscience can contribute to flood hazard assessments based on subsurface information and unveil the setting of historical floodplains. Geoscience can also facilitate integrated approaches and multi-hazard assessments to delineate areas that are susceptible to floods, landslides and other emerging hazards in the advent of climate change. Such approaches will contribute to enhance landuse decion-making and early warning to protect people and their livelihoods.

The December 2014 floods is a reminder that there is much to be done in building the nation's resilience toward disasters. New approaches and best practices have to be investigated, tested and adapted where suitable. There is need for multi-disciplinary teams to be formed to pilot novel and robust approaches. The Geological Society of Malaysia, SEADPRI-UKM and other partners are addressing this issue through the flagship on Geoscience to Action for Disaster Risk Reduction (G2A4DRR). A multi-disciplinary initiative to develop and enhance capacity in multi-hazard assessment at the local level level is being designed to be implemented over the next few years. The initiative will be anchored to the Science to Action" (S2A) initiative to support the newly formed National Disaster Management Agency.

CONCLUDING REMARKS

Flood events and other hazards associated with extreme weather is expected to become more imminent in the advent of climatic change. Even though Malaysia is familiar with annual flood events during the monsoon seasons, there is still a lot of room for improvement to effectively confront severe flooding that can result in state-wide disasters. Improved understanding of flood conditions at the local level is vital in order to be more prepared in a changing climate. It is also necessary to address knowledge gaps related to flooding and other climate driven hazards particularly at the local level. Geoscience has a significant role to play in this regard. The Geological Society of Malaysia, SEADPRI-UKM and other partners are meeting this challenge through the flagship on Geoscience to Action for Disaster Risk Reduction (G2A4DRR).

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