DELINEATION OF CATCHMENT BOUNDARY FOR FLOOD PRONE AREA: A CASE STUDY OF PEKAN TOWN AREA

OW YU ZEN [1], NOOR ASIAH MOHAMAD [1], IDRUS AHMAD [2]

[1] *Faculty of Engineering Technology. Universiti Malaysia Pahang, Pahang, Malaysia, noorasiah@ump.edu.my*

[2] *Department of Irrigation and Drainage Terengganu, Terengganu, Malaysia*

ABSTRACT

Pekan town is located in the downstream of Pahang River Basin. It is frequently hit by flood. The most recent major flood in Pekan town occurred from December 2007 to January 2008. Pekan Flood Mitigation Project was implemented by the government with the total protected area of 2,500 ha. Flood Wall were constructed along Pahang Riverside to protect the overflow of the river whereas flood bunds were constructed surrounding the Pekan town to protect the overflow of swamp water from the southern area into the town. While internal drain within the protected area is channeled to flow into the South China Sea via the main monsoon drain. The northwest of Pekan town which is located outside the protected area is still hit by flood. The major infrastructures in the northwest of Pekan town consist of hospital, mosque, local industry and residential area. The main causes of the flood in the northwest of Pekan town are due to the overflow of Pahang River and swamp surrounding the area. Flood mitigation measure should be carried out to protect the area. The objective of this research is to delineate the catchment boundary of the flood prone area in the northwest of Pekan Town as part of the flood mitigation study. This research is also aimed to identify the discharge point for the catchment area. Contour lines were extracted from ASTER DEM using ArcGIS and the existing drainage networks were identified based on topographic map. ASTER DEM was used as the best accessible data available for this study. The layout of current drainage networks was verified during the site visit. There were three major drainages in the study area namely Genuk River, West Drain and main drain along the road connecting Pekan town to Muadzam Shah. Based on the layout of current drainage network and contour, it is found that the study area can be divided into two polders (upstream and downstream) with the total area of 1,500 ha. The upstream polder lies on the upstream of Genuk River catchment which are generally flat and swampy. Runoff from the upstream catchment flow into three major drainages mentioned earlier before finally discharged into Pahang River via Genuk River. The downstream catchment lies on the downstream of Genuk River. Runoff from this catchment flow into Genuk River and the main drain before discharged into Pahang River. As noted earlier, the study area in the northwest of Pekan town can be divided into upstream and downstream catchment. Both catchments discharge runoff to Pahang River via Genuk River. Flood mitigation work should be planned considering the two polder areas identified in this study. Further work can be done to extract contour from higher resolution data to improve the result.

***Keywords*: Pekan Flood; Pahang River; Catchment Boundary.**

1. INTRODUCTION

The strategic geography location of Malaysia has set Malaysia free from natural disasters such as earthquake, volcanoes and typhoons. However, floods are most hazardous disaster which affecting most of the states in Peninsular Malaysia which affect 4.9 million people and inflict damage worth of several million every year in Malaysia (Mohit & Sellu, 2013). Flood occurrences seems to be getting more frequent in recent years, especially in some cities such as Kuala Lumpur, Penang and Kuching, where rapid urbanization is taking place (Ghani et. al., 2012). In the past decades, several types of flooding and causes of flooding in Malaysia were identified; they are extensive basin flood (riverbank overflow), inundation basin flood (backwater effect from tidal influence affecting lower reaches), inland flood (poor drainage from inland flood prone area) and urban flash flood (inadequate drainage and storage systems to cater for rapid urbanization (Abdullah, 2007). Various measures can be adopted to manage rainwater as part of the flood mitigation approach (N. A. A. Ghani, Mohamad, & Hui, 2006; Needhidasan & Nallanathel, 2013)

Several monsoon floods occurred in the last few decades in Pahang River basin. It had caused heavy damage to the community in Pahang. According to the records of past floods, Pahang River basin suffers from flood damage during January 1971 and the scale of January 1971 flood is over the 100-year ARI based on the hydrology probability analysis using the mean 8-day rainfall record (DID, 1974). Next, the flood incidents was followed by November 1988 December 2007, December 2014 (Ghani et. al., 2016). The most recent one happened on January 2017.

Pekan is one of the main towns located at the banks of the Pahang River. Pahang River Basin lies in the Malaysia Peninsular between latitude 2° 48'45" - 3° 40' 24"N and longitude 101° 16' 31" - 103° 29' 34"E (Tekolla, 2010). The total area of the basin is 27000km² and the length of the river is estimated to be 440km (Tan & Mokhtar, 2009) Sungai Pahang originates from Kuala Tembeling at the confluence of two equally large and long

rivers, about 304 km from the river mouth in the central north, the Sungai Jelai emerges from the Titiwangsa Range at the northwestern tip of the Sungai Pahang Basin, while the Sungai Tembeling originates from the Timur Range at the northeastern edge of the basin (Ghani, et. al., 2016). The upstream of the Pahang river basin is located at Jerantut, while Temerloh is the location where the midstream occurred and lastly downstream is located at Pekan whereas the river discharge into South China Sea (Elfithri et al., 2015; Yasuto et. al., 2004). (Figure 1)

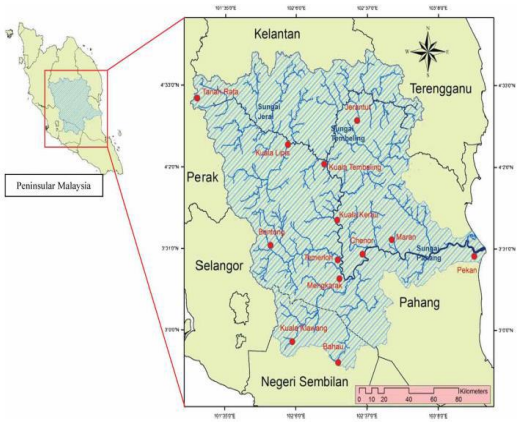

Figure 1: Pahang River Basin (Ghani et. al., 2012)

Pekan is the main district in Pahang River Basin whereas the place of downstream occurred. The geographical features and location of Pekan at the downstream of Pahang River Basin has caused Pekan to suffer both economic damages and physical destructions due to flood. Figure 2 shows the flood map in December 2007 and January 2008, it visualizes the areas affected by the major flood in Pekan such as Kuala Pahang, Ganchong and northwest area of Pekan Town.

Figure 2. Flood Map in December 2007 and January 2008. (Source: DID, 2014)

These issues had raised the concern from Department of Irrigation and Drainage Malaysia to come out with several flood mitigation measures in solving the flood issue in Pekan Town such as construction of bund, internal river drainage improvement, control structure and navigation tidal gate. Pekan Flood Mitigation Project was one of the most significant project which implemented by the government with the total protected area of 2,500 ha covering the town area (Department of Irrigation and Drainage, 2014). Flood walls were constructed along Pahang Riverside to protect the overflow of the river whereas flood bunds were constructed surrounding the Pekan town to protect the overflow of swamp water into the town. Meanwhile, internal drain within the protected area is channeled to flow into the South China Sea via the main monsoon drain. After the completion of flood mitigation project in 2007, the flood event in Pekan Town has been resolved. However, the unprotected area at the northwest of Pekan Town was still hit by major flood on year 2007. Heavy rainfall had caused the overflow of the Pahang River and swamp water flow into the northwest area of Pekan Town. This issue had been raised among the communities and the local government on solving the flood in unprotected area. Therefore, resolving the flood event in the northwest of Pekan Town had come to be one of the significant aim of conducting site study on flood prone area.

With the above background, this study intends to delineate the catchment boundary of the flood prone area in the northwest of Pekan Town as part of the flood mitigation study. This study is also carried out to identify the discharge point for the catchment area. Hence, both objectives of this study are aimed to produce primary sources for site studies purpose.

2. STUDY AREA

The northwest area of Pekan Town is the area covered in this study. (Figure 3) The study area is located outside the protected area of the flood bun and flood wall of Pekan Town. The major infrastructures of the study area consist of hospital, mosque, local industry and residential area. Besides, there are three major drainages in the study area namely Genuk River, West Drain and main drain along the road connecting Pekan town to Muadzam Shah. The main road at the study area is important because it connected Pekan Town to Muadzam Shah. Besides, swamp forest is covering the study area. During the flood event in 2007, most of the areas were flooded except Pekan Hospital and Mosque whereas these two places are built in a land-raise area. The main cause of the flood in the study area is due to the overflow of Pahang River and swamp surrounding the area. The residential area and local industry along the Pahang River was affected by flood during the flood event in 2007.

Figure 3. Layout of study area at Pekan Town

3. METHODOLOGY

3.1 Data Collection and Analysis

Firstly, ASTER Digital Elevation Model (DEM) was collected from internet sources. In order to generate a contour map from ASTER DEM obtained, the raster data was imported into ArcMap software for the production of contour lines. Existing drainage networks were obtained from topographic map and verified during the site visit. The result is overlaid with site inventory data to produce the study area layout. There were three major drainages in the study area namely Genuk River, West Drain and

main drain along the road connecting Pekan town to Muadzam Shah. (Figure 3)

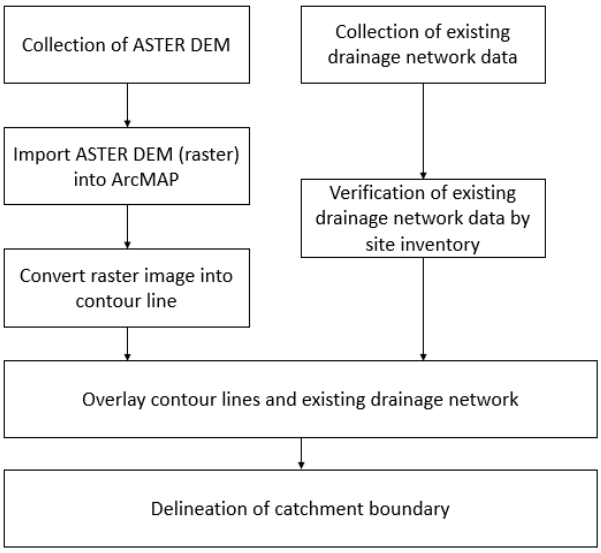

Figure 4. Method of generating contour lines from DEM

3.2 Delineation of catchment boundary

There are few major principles that required to be follow when generating the catchment boundary (Gribbin, 2013). According to Gribbin, the principles required to follow are listed as below:

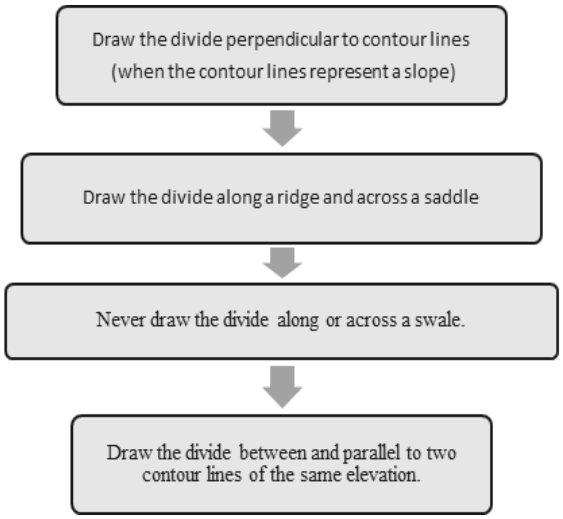

Figure 5. Principles of delineating catchment area

When all the divide lines are drawn, the line will be connected to each other for the formation of catchment area. After catchment area is delineated, the area of the catchment is measured and tabulated in hectare in English system. By overlaying the drainage network and the contour lines generated by ASTER DEM, discharge points are defined by taking the catchment boundaries as reference.

4. RESULT AND DISCUSSION

4.1 Contour Map

Contour map is generated from satellite data, ASTER DEM using ArcMap software. The generated contour map is shown as below.

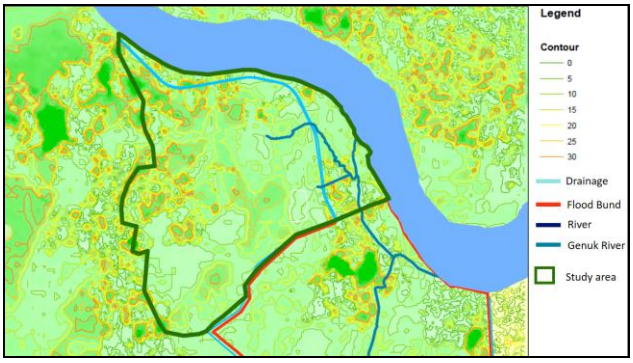

Figure 5: Contour Map of study area

The average elevation of the study area is in the range of 6m – 9m. From the contour map, the extent of study area is defined by using the same principles introduced in the methodology. Most of the area are coveried by swamp forest.

Table 1. Total area measurement

Catchment Area	Total area (ha)
Study Area	1,500 ha

4.2 Catchment Boundary

Based on the generated contour lines, the catchment boundary is identified by connecting all the divide lines according the principles stated in the methodology. By referring to the layout of current drainage network and contour, it is found that the study area can be divided into two polders (upstream and downstream) with the total area of 1,500 ha.

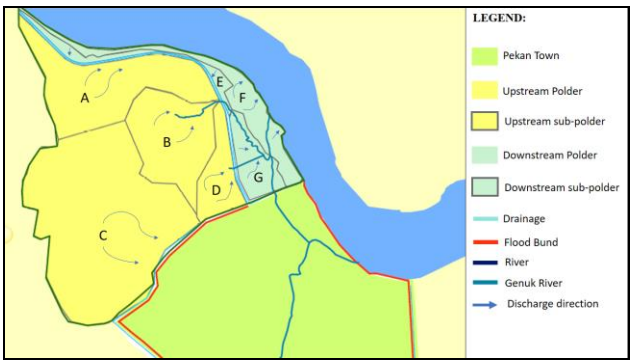

Figure 6. Sub-polders of study area are delineated for upstream polder and downstream polder

4.2.1 Upstream Polder

The upstream polder lies on the upstream of Genuk River catchment which are generally flat and swampy. Runoff from the upstream catchment flow into three major drainages mentioned earlier before finally discharged into Pahang River via Genuk River.

Upstream polder is approximately 1,205 ha with total four sub-polders identified in the upstream polder. Each area measurement of sub-polders is tabulated as below. It can

be noted that about half of the catchment area will discharge to Pahang River via the Genuk River.

Table 2. Total area measurement of upstream sub-polders

Sub-polders	Point of discharge	Area (ha)
A	Drainage along the road	294.3
B	Genuk River	220.0
C	West Drain	622.4
D	Genuk River	114.0
	Total	1,205.7

4.2.2 Downstream Polder

The downstream polder lies on the downstream of Genuk River. Runoff from this catchment flow into the main drain and Genuk River before discharged into Pahang River.

Downstream polder is approximately 300ha with total three sub-polders identified in the downstream polder. Each area measurement of sub-polders is tabulated as below.

Table 3. Total area measurement of downstream sub-polders

Sub-polders	Point of discharge	Area (ha)
E	Drainage along the road	62.2
F	Pahang River	125.0
G	Genuk River	117.5
	Total	304.7

5. CONCLUSIONS

Understanding the catchment and discharge points are significant in the planning of flood mitigation measures. ASTER DEM obtained in this study actually help in order to delineate the catchment boundary area and identify the point of discharge of sub-polders. There are two polders (upstream and downstream) identified using the generated contour map. Furthermore, there are total seven sub-polders have been delineated based on the elevation of the study area. Both polders discharge runoff to Pahang River via Genuk River. With the aid of the identified polders, flood mitigation work should able to be planned by considering the limitation of the geographical condition of the areas. Lastly, further work can be done to extract contour from higher resolution data to improve the result.

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