

SUB CATCHMENT AREA DELINEATION BY POUR POINT IN BATU PAHAT DISTRICT

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ABSTRACT

Geographical Information System (GIS) has been recognized as a tool that could help in the study of natural resources and is able to prepare a plan to deal with the natural disaster. Reservoir and watershed area can be determined manually via topographic maps or simplified using digital elevation model (DEM) data. This article is described a procedure for manually delineating sub catchment and watershed of Batu Pahat area from DEM. By adding pour points element, the procedure is capable for terrain with flat level area and low DEM resolution at 20 meter interval.

Field of Research: Sub catchment, watershed, pour point, GIS

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1. Introduction

Batu Pahat is a district that synonymous with flood events that occurred each time coming monsoon season which usually will last at the end or beginning of the year. Besides influenced by heavy rain, the flood also was due to overflow of major rivers drain that makes the area around the river basin continues to flood or hold water. In Batu Pahat own, land development was in full swing and changing patterns of land use map to form drastically in the last ten years. Most of the status of agricultural land converted to oil palm type than rubber, coconut or pineapple. Status changes gradually with the production of crop in the country for high returns to livelihoods. Exploration rainfall within the catchment area into the new planting area or developed for other uses causes the catchment area declining in percentage.

To overcome the severe threats caused by the floods, the dangers of a comprehensive prevention strategy should be made, and cooperation between authorities should be provided especially to the Batu Pahat flood prone area. However, the priority areas where assistance should be provided have not operated in more detail. Hydrological map will provide very useful information when developing a proper and efficient strategy to overcome the flood disaster. Thus, in sequence with the process, Batu Pahat needs an appropriate bank data of hydrological database to improve the flood prevention and mitigation strategy.

2. Study Area

As previously stated, this study develops an approach to synthesize the relevant database in a spatial framework to evolve a flood hazard map of Batu Pahat. The purpose of catchment is to identify the areas within a development plan that are at risk of flooding base on factors that are relevant to flood risks. Policies are then outline to be applied to such areas to minimize and manage such risk in the Batu Pahat (see Figure 1). The major river basins of the Batu Pahat are the Sembrong river and the Bekok river which sources from Sembrong and Bekok dam. These two rivers as well as Simpang Kiri river and two dams are the distributaries of Batu Pahat river.

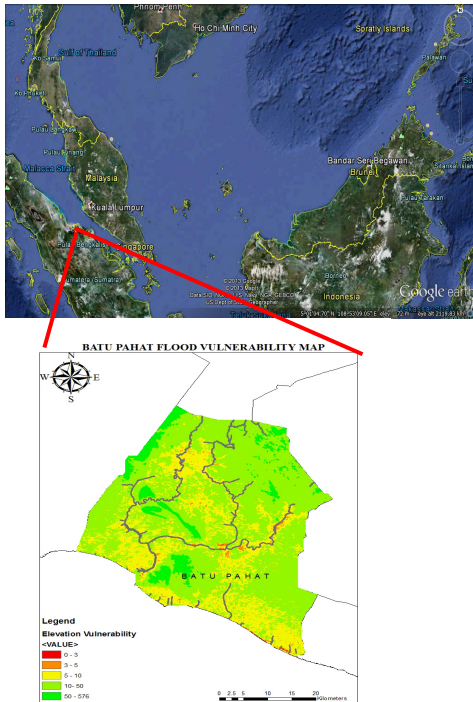


Figure 1: Batu Pahat district study area.

This study considered the Sembrong river catchment area due to its devastating effect when the Sembrong dam in neighboring Kluang district releases water into it. Batu Pahat district is located in the Johore state and bounded in the Malacca Strait in the west. The study area lies between latitudes 1°53' N and 1°59' N, and longitudes 103°07' W and 103°11' E. For this study, overall data are present as attribute and spatial data such as topographic DEM, stream network, district boundary, irrigation, land use and road network map within study area were used.

3. Catchment Area and Watershed

The determination of Catchments and watershed boundaries is necessary when generating a drainage system. Drainage demarcations are used in flood forecasting system, water quality projects, as well as public interest. Accurate model are essential comes from accurate drainage boundaries. Capability of ArcGIS in terms of determination catchment and watershed boundaries are most welcome as beneficial to researcher.

A catchment is defined as the land area that contributes runoff to a given stream line. Catchment characteristic derived directly from the geology, soils and land use (3). Raindrop falling on an edge catchment has a unique path to stream line and thus to being routed down through the stream network. In ArcGIS data model, the edge catchment represent by polygon features.

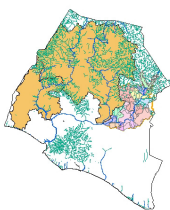


Figure 2: Sub-catchment boundaries

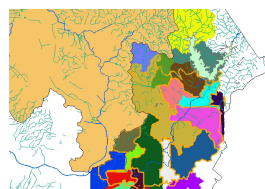


Figure 3: Each distinct color - Edge catchment

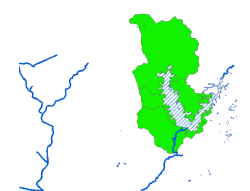


Figure 4: Dam shown in striking color- Water body

Digital Elevation Model

Preprocess steps is needed to be carried out as a vital step in extraction of delineation catchment and watersheds. Artificial spurious depressions will be generated during perform spatial interpolation. DEM are use for standard operation for delineating catchment areas. Terrain elevations for ground location are derived from standard topographic maps through the use of digitization methods. ArcInfo grid functions will easily process the grid to generate a DEM.

The next description explains the fundamental theory about the ArcInfo functions for watershed delineation. Derivation of watershed delineation are all from the basic that water flows downhill, and in so doing it will follow the path of with the steepest slope (largest gradient). In a DEM grid structure, there exist at most 8 cells adjacent to each individual grid cell. (Cells on the grid boundary will not be bounded on all sides). Accordingly, water in one cell travels in 1 out of at most 8 different directions in order to enter another cell. This concept is deemed the 8-direction pour point model.

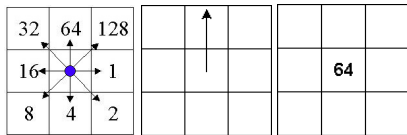


Figure 5: Direction of pour point model

Catchment Boundaries Set By Pour Point

In order to determine catchment and watershed area using ArcGis, some steps are required through processing steps. The following chart shows the process of extracting watershed and stream networks.

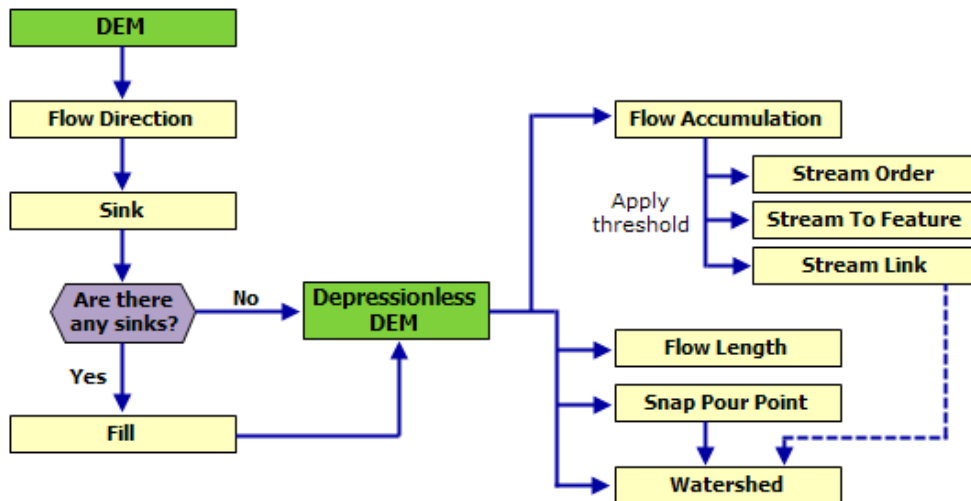


Figure 6: Hydrological watershed delineation flowchart

In the study area data set, the flow accumulation cells are set with accumulated flow greater than 10000 cells. The value is looks reasonable according to vector stream network.

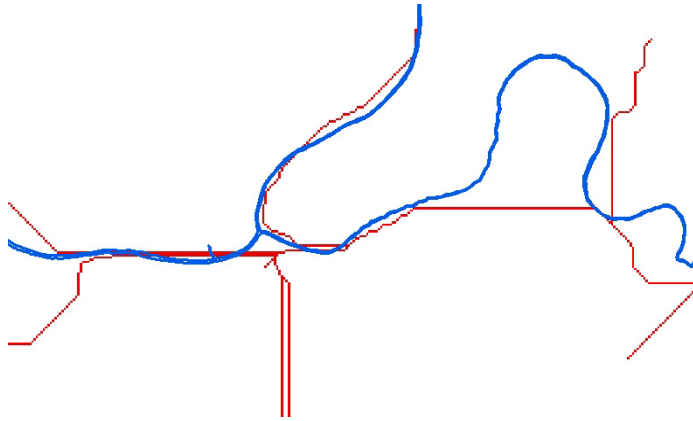


Figure 7: Flow accumulation (red line) stretch line up with river network (blue line).

The snap pour point in ArcGIS is used to ensure the selection of points of high accumulated flow when delineating catchment or watershed. When using Watershed tool, the snap pour point will search within a snap distance around the specific pour points for the cell of highest accumulated flow and move the pour point to that location. Pour point is selected by adding a new point layer to the ArcGIS project. These are typically points at the edge of downstream of major confluences. Points should be added that are as close the center of cells as possible.

The location of pour points is selected manually where drainage points are located at the each stream as shows as figure 8.

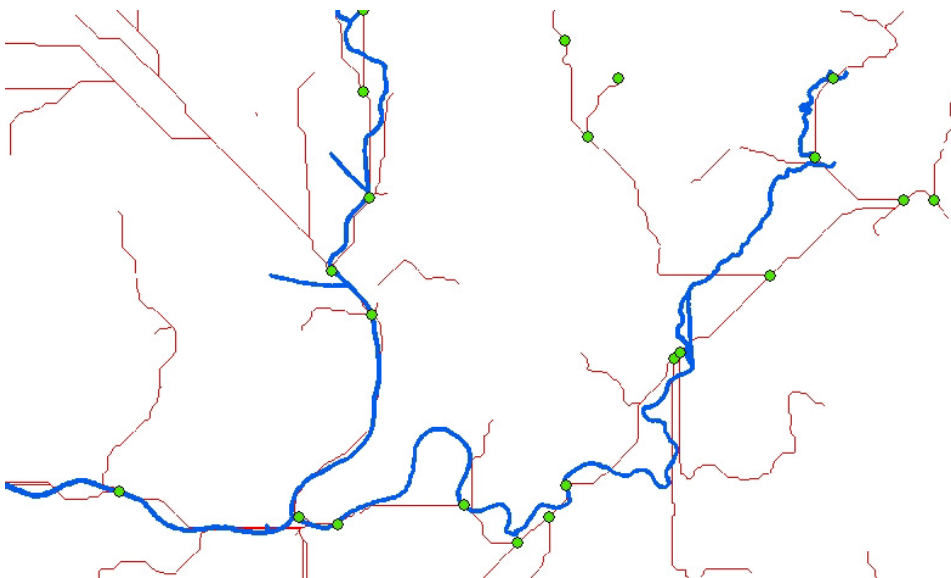


Figure 8: Pour point location in study area.

In result of flow direction result and pour point selection a catchment area is delineation. The catchment area creates a grid in which grid code indicating to which catchment the cell belongs.

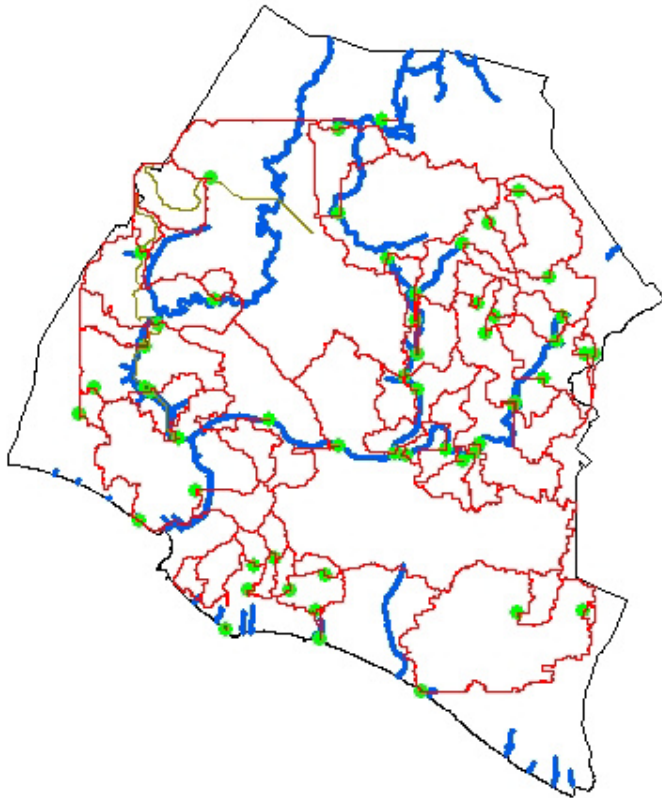


Figure 9: Main river and minor river subcatchments

4. Results and Discussion

After the batch subcatchment delineation successful generated, the total number is 50 subcatchments. Reducing the number through the size of area, we divided and merge the major sub catchment into 6. Table 1 shows the data breakdown.

Table 1: Area of calculated sub catchments

| Subcatchment | Subcatchment Area (km ²) |
|-------------------|--------------------------------------|
| Sg. Simpang Kiri | 131.04 |
| Sg. Simpang Kanan | 287.9 |
| Sg. Batu Pahat | 103.0 |
| Sg. Bekok | 340.0 |
| Sg. Sembrong | 251.9 |

As comparison, Batu Pahat's subcatchment area total calculated using pour point method compared to Syed Mohamad, Hooi & Binnie Sdn Bhd (SMHB) year 2000 has shown in table 2 below. Total catchment area of Sungai Batu Pahat catchment is 1944 km²

Table 2: Area of comparison calculated sub catchments

| Catchment | Area (km ²) Pour Point | Area (km ²) SMHB |
|--------------|------------------------------------|------------------------------|
| Sg. Bekok | 340.0 | 342 |
| Sg. Sembrong | 251.9 | 273 |

5. Summary

Referring to the recent developments, the quality of the main drainage in Batu Pahat catchment area has been enhanced. A source of data and database management technology has been used as far as possible to carry out flood management more effective and competitive. The conclusion that can be made is the GIS are the suitable and excellent tools that can help to combine information from various sources and it is really a helpful tool for decision making procedure.

References

- [1] Eric K.F., Digital Terrain Modelling in a GIS Environment. *Proceedings of The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Volume 37, (2008), pp. 1023-1029
- [2] Hazalilah, H., Johor; The Sinking State? Case Study: District of Muar and Batu Pahat, Introduction of FHM. *East and Southeast Asia Regional Seminar on Flood Hazard Mapping*, (2007)
- [3] Keokhumcheng, Y., Flood Hazard Assessment of the Eastern Region of Bangkok Floodplain, Thailand. *2nd International Conference on Biotechnology and Environment Management*, IPCBEE vol.42 (2012) © (2012) IACSIT Press, Singapore.
- [4] Mohd Sani., Application of Remote Sensing and Geographical Information System (GIS) for Reservoir Water Balance Analysis. *Proceedings of the Asian Conference on Remote Sensing*, (2010).
- [5] Mokhtar, A.R., Kemajuan dan Status Pelaksanaan Profile Julai 2011, *JPS Daerah Batu Pahat*. (2011)
- [6] Miller, S.N., GIS based Hydrologic Modeling: The Automated Geospatial Watershed Assessment Tool. *American Grant Writers' Association*, (2004).
- [7] Yee, L.W., The Social Economic Costs of Flood: A case of the Johor Floods During North-east Monsoon 2006/2007, *National Seminar on Socio-Economic Impacts of Extreme Weather and Climate Changes*.