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The Determination of River Order Classification with ArcGIS Application

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ABSTRACT

River is a natural or artificial water channel or container in the form of a water drainage network and the water in it, starting from the upstream to the estuary, where based on this understanding the river has a discharge and size dimensions. Based on the discharge and size dimensions, rivers can be used for human needs and a place for the development of aquatic life so that it can affect the ecosystem and must be protected and not be disturbed. However, not all rivers can be used for human needs and a place of life. This study will discuss the types of rivers and the classification of stream orders based on the laws and regulations in Indonesia. Therefore, decision can be made whether the rivers that located in densely populated areas and areas of economic facilities can be modified in form and location according to human needs or must be maintained based on the original nature shape.

INTRODUCTION

Watershed is a land area located on the right and left of the river that follows the pattern of river flow from upstream to downstream, and it also functions as a rain catchment area where all rainwater that falls in the watershed area will flow to fill the river. (Saidi et al., 2018; Sobatnu et al., 2017). The watershed is an integral part of the river and its tributaries and becomes the habitat of living things that are closely related to their environment (Centeno, 2012; Hakim et al., 2019).

The types of rivers are divided into several types, such as: 1) Types of rivers based on the direction of flow; and 2) Types of rivers based on their geological structure. Types of rivers based on the direction of flow are divided into several types (Figure 1), such as: 1) Consequent rivers, its flow direction is in accordance with the slope; 2) Subsequent rivers, it flows perpendicular to the consequent river; 3) Obsequent river, which is a sub-sequence tributary which has direction opposite to the consequent river; 4) Resequent river, which is a sub-sequence tributary that flows parallel to the consequent river; and 5) Insequent rivers, which flow direction is irregular and not bound by the slopes of the plains. Meanwhile, the river types based on their geological structure are divided into several types, such as: 1) Superposed

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River, which is a river that has a transverse position and has a flow direction according to or following its geological structure; and 2) Antecedent rivers, which is rivers that maintain the direction of the water flow even though there is a transverse geological structure he stream is the rank of the branching arrangement of the river channel which consists of the main river and its tributaries (Murtiono, 2001; Nurfaika, 2015). Stream orders are classified through several methods, such as the Strahler, Shreve, Horton, and Scheidegger method (Nurfaika, 2015; Pattiselanno, 2017). The Strahler method is the most commonly used method and is integrated with Geographic Information System (GIS) applications (Denaswidhi, 2020; Nurfaika, 2015; Pattiselanno, 2017; Stenger-Kovács et al., 2014).

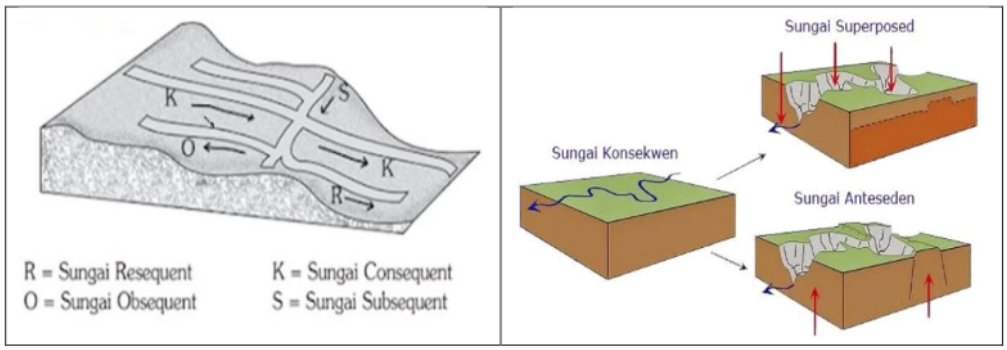


Figure 1. Types of Rivers Based on the Direction of Flow and Geological Structure

Based on the Strahler method, tributaries that are in the upstream position are classified into first order (order 1). Furthermore, the meeting of the same branch is classified into second order (order 2), and the meeting of the different order will not change the stream order. This continues until the river branches meet at the main river with the order of the largest order as shown in the figure below. (Ningkeula, 2016; Nurfaika, 2015).

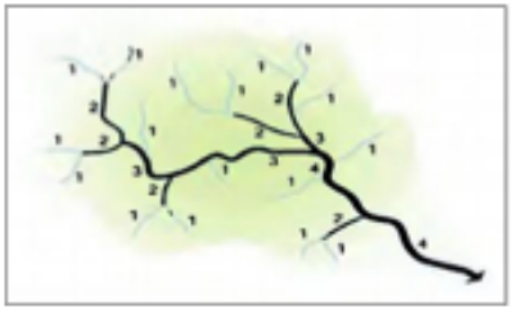


Figure 2. Determination of stream with Strahler Method (Purwanto, 2013)

Watershed is the most vulnerable area according to the negative impact resulted from settlement development activities that follow the pattern of river flow (Hakki, 2015), as well as other economic activities that do not pay attention to environmental aspects (Ningkeula, 2016). This can lead to a decrease in watershed potential in some areas characterized by flooding, landslides, erosion, sedimentation and drought (UU No. 41; 1999). Therefore, it is necessary to manage the watershed according to the watershed

classification determined based on the area of the watershed. Peraturan Direktorat Jendral Bina Pengelolaan DAS dan Perhutanan Sosial (2013) divide the watershed into 5 types, as can be seen in the table below.

Tabel 1. Watershed Classification Based on Watershed Area

No.	Area of Watershed (Ha)	Classification of Watershed
1.	> 1.500.000	Very Large
2.	500.000-1.500.000	Large
3.	100.000-500.000	Medium
4.	10.000-100.000	Small
5.	<10.000	Very Small

METHODOLOGY

Research Time and Location

This research was conducted by paying attention to the watershed in the Kebur Village area, West Merapi District, Lahat Regency, South Sumatra Province as shown in Figure 3. The area that becomes the research center is divided into 3 regions, which is Region A, Region B, and Region C. Overall there are 6 (six) tributaries in the three research areas.

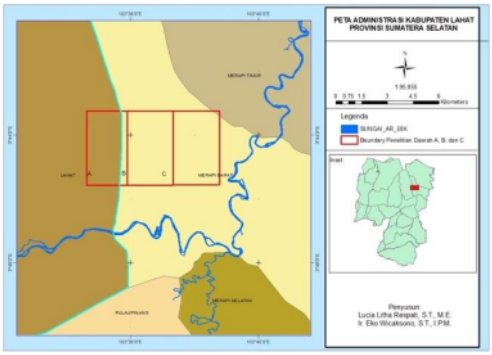


Figure 3. The Administration Map of Lahat Regency

Data Collection

This research was conducted in several stages, such as preparation, data collection, data analysis, and research writing. At the preparatory stage, the author develops a framework of thought. At the data collection stage, the authors collect secondary data and data entry. In the data analysis stage, the authors process the secondary DEM data into a river flow map at the research location, and analyze the method of classification of river orders. At the research writing stage, the author summarizes the results of the analysis from ArcGIS 10.2 software and displays a map visualization for later discussion regarding environmental impacts.

The data collected includes:
1. Watershed area and watershed classification
2. Stream order

Data Processing and Data Analysis

Watershed modelling and river order classification were carried out with ArcGIS 10.2 software. The data used was DEM (digital elevation model) which accessed from the DEMNAS website. This website managed by the government, which is tanahair.indonesia.go.id.

RESULT

Watershed Area and Watershed Classification

The calculation of the watershed area was obtained from the calculation in the attribute table of the defined research area boundaries. Watershed modelling was done by processing Basin data by using software ArcGIS 10.2 as shown in Figure 4. The area of the watershed in Regions A, B and C can be explained from the table below. Research area A has a watershed area of 1,001 Ha. Meanwhile, the area of the watershed in Region B was 1,138 Ha and in Region C was 1,138 Ha.

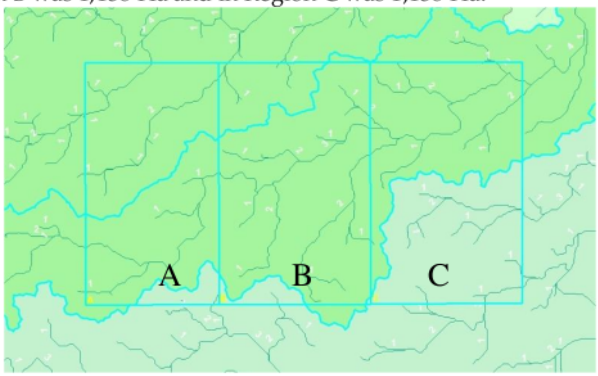


Figure 4. River Basin Modelling

Table 2. Watershed area of Region A, Region B and Region C

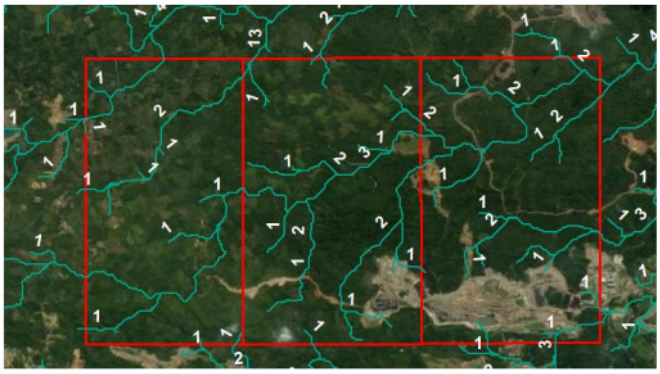
Boundary Penelitian Daerah A, B, dan C

	FID	Shape *	Id	Luas
▸	0	Polygon	1	10,012,036.3299
	1	Polygon	2	11,375,499.6772
	2	Polygon	3	11,381,882.2373

Based on the calculation of the watershed area that has been obtained, the classification of the watershed based on the area size in Region A, Region B and Region C was classified as a Very Small. The classification was made due to the watershed area in those three regions were less than 10,000 Ha.

Stream Order

From the results of monitoring in research areas A, B, and C, there were 6 (six) tributaries that classified as upstream rivers. Region A has 3 (three) tributaries with classification of stream order 1 and 2. Region B had 2 (two) tributaries with classification of stream order 1, and 2. While Region C, there were 3 (three) tributaries with classification of stream order rivers 1 and 2.



A B C

Figure 5. Stream Order in Region A, Region B and Region C

CONCLUSION

Based on the results of research conducted in Regions A, B, and C, it can be concluded as follows:

1. The area of the watershed in area A was 1,001 Ha, so classified as Very Small Watershed. The watershed area in Region B was 1,138 Ha, so classified as Very Small Watershed. Meanwhile Region C also had watershed area of 1,138 Ha, therefore classified as Very Small Watershed.
2. The stream order in the research area was divided into stream orders 1 (one) and 2 (two). In Region A, there were 3 (three) tributaries that classified as stream orders 1 and 2. In Region B, there were 2 (two) tributaries that classified as stream orders 1 and 2. And in Region C, there were 3 (three) tributaries that classified as stream orders 1 and 2.

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