Mapping Watershed Boundaries and Potential of Rural Farming in the Batang Masumai Watershed

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Abstract. Watershed is one of the hydrological components that acts as an area that collects, stores and drains rainwater into lakes or seas through rivers. Determination of watershed boundaries has several purposes such as knowing the shape of a flow hydrograph to predict peak discharge, flood analysis, planning for water resources management, and can be used as a reference in conducting an inventory of potential natural and non-natural resources in an area. Watershed. The Batang Masumai watershed is a part of the Batanghari watershed. Mapping of watershed boundaries is carried out in several stages of activity, namely making work maps, surveying rivers in the field, and analyzing field data and secondary data for determining watershed boundaries using terrain analysis with ArcGIS software. This research was conducted from June to August 2022. Most of the Batang Masumai watershed covers Merangin Regency (99.89%) and a small portion (0.19%) is the area of Kerinci Regency. The Merangin Regency area which is included in the Masumai watershed boundary consists of 8 sub-districts and 55 villages and the Kerinci Regency which is included in the Batang Masumai watershed boundary is Tamiai Village (122.96 Ha). The Batang Masumai watershed is dominated by land use as primary forest (46%) and secondary forest (41%) with slope classes of 0–8% (39.13%) and 8–15% (48.19%). The Batang Masumai watershed is very potential for agricultural development because it is supported by the availability of water sourced from the river. Residents living in the area utilize their resources through agricultural activities with a rural farming system. The application of rural farming systems is applied to the use of paddy fields and plantations by applying terracing techniques. Rural farming systems are carried out using traditional concepts in their management, so as to minimize degradation in the watershed area.

Keywords: Batang Masumai Watershed · Mapping · Rural Agriculture

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1 Introduction

1.1 Background

Watershed is one of the hydrological components that acts as an area that collects, stores and drains rainwater into lakes or seas through rivers. Watershed is composed of land units and rivers, including their tributaries, so that a watershed can be composed of several sub-watersheds or sub-watersheds. Watershed area units are described in units called watershed boundaries. The determination of watershed boundaries has several purposes, such as knowing the shape of a flow hydrograph to predict peak discharge, being used in flood analysis and planning for water resources management, and can be used as a reference in conducting an inventory of potential natural resources and non-natural resources. Potential of natural resources in a watershed.

Watershed is a hydrological unit. Watershed collects water, distributes water through a canal system from upstream to downstream, and ends in a body of water in the form of a lake or sea. The watershed is also an ecosystem, where elements of organisms and the biophysical environment and chemical elements interact dynamically and there is a balance in them. The watershed is seen as a unified area where rainwater gathers into the river to become a river flow. Factors that influence the characteristics of the watershed are the morphometric factors and the biophysical aspects of the watershed. Watershed biophysics is a factor that will affect the output of the hydrological cycle in a watershed so that river flow is greatly influenced by the biophysical conditions of the watershed. Analysis of the biophysical conditions of the watershed includes analysis of soil types, land use, topographical conditions including slopes and contours, and river water quality [1].

Watershed damage is found in many areas in Indonesia, including in Jambi Province, caused by exploitative use of resources, such as illegal mining in the Batang Masumai watershed, Merangin Regency. Damage to the Batang Masumai watershed can be seen visually in the form of land degradation, degradation of water bodies, decreased water quality, and decreased hydrological function of the watershed. However, tackling degradation has not yet become a priority for the local government, even though the Batang Masumai watershed has strategic value, especially to support people's lives. The restoration of the Batang Masumai watershed must begin with the collection of a database of the biophysical condition of the watershed which indicates the level of watershed degradation. Watershed damage has an impact on people's lives, especially water sources and land.

The Batang Masumai watershed is a part of the Batanghari watershed. The Batang Masumai watershed is located in Merangin District, Jambi Province. The rural farming system carried out by the surrounding community still uses traditional concepts in its management, so as to minimize degradation in the watershed area. In connection with these conditions, it is necessary to map and trace the biophysical conditions of the watershed to see how much potential the application of rural agriculture has in order to optimize the planning of the Batang Masumai watershed area.

The purpose of this study was to determine the boundaries and extent of the Batang Masumai watershed and to identify the potential for implementing rural agriculture in the Batang Masumai watershed.

In many developing countries, people engaged in agriculture make up over half of their entire population and many of them remain in extreme poverty. In addition, the agricultural sector plays an important role in the national economy of developing countries. For these reasons, cooperation in agricultural and rural development is essential for developing countries to address key food security issues. The term conventional agriculture is used in the discursive construction of cases for alternative approaches to agriculture (ie alternatives to conventional agriculture) [2].

Development activities have disrupted the biophysical balance of the watershed [3]. Causing various problems such as erosion, sedimentation, flooding, drought, land degradation and others [4]. Various risks and losses that occur due to disruption of the biophysical balance of a watershed, the watershed needs to be managed in an integrated and sustainable manner.

Watershed management is very important because the better the watershed is maintained, the smaller the risk of disaster due to river overflow. Watershed management can be done if the information about the watershed is complete, but until now the information available is still lacking. This condition makes it difficult to collect data, so we need a system that can be used to process watershed data. The system to be used is the Geographic Information System for Watershed Mapping [5].

The watershed management model can be classified into two, namely the conventional management model and the sustainable watershed management model. Watershed management based on the concept of sustainable development is based on a balance between economic, social and environmental development. In watershed management, the term "one watershed, one plan, one system" is known, namely one river - one plan - one management system, namely an integrated watershed management system [6].

Geographic Information System is a special information system that manages data that has spatial information (spatial dimension). Geographic information system is a form of information system that presents information in graphical form using maps as an interface. GIS is composed of the concept of several layers (layers) and relationships. The function of geographic information systems is to improve the ability to analyze spatial information in an integrated manner for planning and decision making. Geographic information systems can provide information to decision makers for spatial database analysis and applications [8].

2 Method

This research was conducted in the Batang Masumai Watershed, Merangin Regency, Jambi Regency. This research was conducted from April to August 2022. The tools and materials used in this research were writing instruments, GPS (global positioning system), meters, digital cameras, GIS-based computers, and a digital map of Indonesia's Earth at a scale of 1:50,000..

The mapping of watershed boundaries and rural agricultural potential was carried out in the Batang Masumai watershed, Merangin Regency, Jambi Province. This activity is divided into several stages, viz:

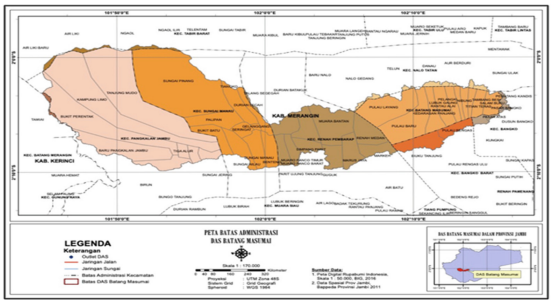

Fig. 1. Map of the Batang Masumai watershed boundaries

1. Preparatory activities. This activity includes a literature study related to the activities to be carried out, secondary data collection from reports, journals and data from related agencies as well as obtaining permits to carry out activities at the local government.
2. Mapping the Batang Masumai watershed boundaries. The mapping of watershed boundaries is carried out in several stages of activity, namely: preparation of work maps, river surveys in the field, and analysis of field data and secondary data for determining watershed boundaries using terrain analysis with ArcGIS software.
3. Conducting a field survey of the distribution of rural agricultural locations in the Batang Masumai watershed.
4. Field checking in the field for validation of the Batang Masumai Watershed Boundary Map.

3 Result and Discussion

3.1 Batang Masumai Watershed Boundaries

Mapping of watershed boundaries is one of the main parameters used as a boundary for determining land cover and watershed geomorphological conditions which include boundary mapping, environmental conditions, land cover, and watershed morphometry. The results of the mapping of the Batang Masumai watershed boundaries show that most of the Batang Masumai watershed includes the Merangin Regency (99.89%) and a small portion (0.19%) is the area of the Kerinci Regency (Fig. 1).

The Kerinci Regency area which is included in the Batang Masumai watershed boundary is Tamiai Village with an area of 122.96 Ha. The area of Merangin Regency which is included in the boundaries of the Masumai Watershed consists of 55 villages and 9 sub-districts, namely Bangko covering an area of 565.15 Ha, Sungai Manau covering an area of 16,917.29 Ha, Bangko Barat covering an area of 1,801.89 Ha, Nalo Tatan 706.98 Ha, Batang Masumai covering an area of 10,223.11 hectares, Renah Pembarap covering an area of 10,367.69 hectares, Pangkalan Jambu covering an area of 23,638.15 hectares and Tabir Barat covering an area of 507.89 hectares.

3.2 Land Use Mapping

There are 10 types of land use in the Batang Masumai watershed. Based on the distribution (Fig. 2), it is known that forest cover still dominates the Batang Masumai

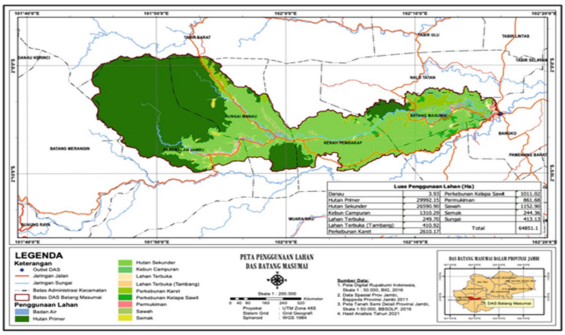

Fig. 2. Land Use Map

watershed. However, some parts of the watershed have been damaged due to Unlicensed Gold Mining activities.

The distribution of land use types in the Batang Masumai watershed consists of artificial lakes covering an area of 3.93 ha (0.01%), primary forest covering an area of 29,992.15 ha (46.44%), secondary forest covering an area of 26,590.90 ha (41.17%))), Mixed Garden area of 1,310.29 Ha (2.03%), Open Area of 249.70 Ha (0.39%), Open Area (Mining) of 410.90 Ha (0.64%), Rubber Plantation 2,610.17 Ha (4.04%), Oil Palm Plantations 1,011.02 Ha (1.57%), Residential areas 861.68 Ha (.1.33%), Rice fields covering 1,152.90 Ha (1, 79%), Shrubs covering an area of 244.36 Ha (0.38%) and Rivers covering an area of 413.13 Ha (0.64%). The land cover which is dominated by forest provides a lot of potential for the Masumai Watershed to carry out agriculture by implementing rural agriculture. Rural farming practices have also been implemented by local farmers who practice traditional farming and pay attention to the principles of soil and water conservation.

3.3 The Slope of the Batang Masumai Watershed

The land in the Batang Masumai watershed is more dominated by the 0–8% slope class covering an area of 25,279.47 Ha (39.13%) and 8–15% covering an area of 31,124.60 Ha (48.19%). Slope class can be seen in Table 1 and Fig. 3.

Table 1. Distribution of the Slopes of the Batang Masumai Watershed

Slope class	Hectare	%
0–8%	25.270,47	39,13
8–15%	31.124,60	48,19
15–25%	8.441,43	13,07
25–45%	14,63	0,02
Total	64.851,12	100

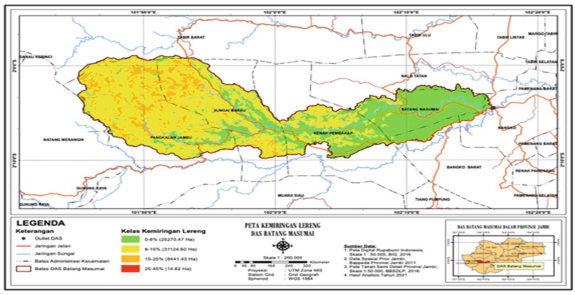

Fig. 3. Slope Map of the Batang Masumai Watershed

Based on the slope map it is known that areas with steep slopes are spread from upstream to downstream of the watershed (Fig. 3), but the area is only 14.64 ha or 0.02% of the total watershed area. The Batang Masumai watershed is very potential for agricultural development because the water source comes from the river [9].

States that the slope of the slope affects the rate of erosion that occurs in a land. Land with a steep slope has a greater gravitational influence than land with a rather steep slope (15–30%) or gentle slope (8–15%). The greater the slope of a watershed, the faster the water flow rate.

3.4 Watershed Morphometry and Identification of Rural Agricultural Potential in the Batang Masumai Watershed

Watershed morphometry is a quantitative measure of the natural characteristics of a watershed, namely the geomorphological aspect of an area. This characteristic is related to the process of the flow (drainage) of rainwater that falls in the watershed including the shape of the watershed, the area of the watershed, the density of the river (drainage), and the flow pattern [1].

Morfometri watershed Batang Masumai disajikan pada Table 2. Parameter morfometri yang diteliti adalah luas watershed, panjang watershed, lebar watershed di sekitar batas watershed, dan rasio kebulatan watershed untuk mengidentifikasi bentuk Watershed.

Table 2. Morphometry of the Batang Masumai Watershed

Parameter Morfometrik	Value	Unit
Large	64.851,10	Ha
Length	56,80	km
Wide	11,41	Km
Around the watershed	215,19	km
Roundness Ratio(Rc)	0,18	

Berdasarkan peta batas watershed (Gambar 1), diketahui luas Batang Masumai adalah 64.851,10 Ha dengan panjang 56,80 km, lebar 11,41 km dan batas watershed 215,19 km. Berdasarkan Regulation of the Directorate General of Watershed Management and Social Forestry No. P3/V-SET/2013 (2013) with the area of the watershed it is known that the Batang Masumai watershed is classified as a small watershed. Based on data on the area and circumference of the Batang Masumai watershed, it has an elongated shape with a roundness ratio of 0.18. The determination of the shape of the watershed is based on the ratio of the roundness of the watershed and the perimeter of the watershed.

The shape of the Batang Masumai watershed is categorized as an elongated watershed. The elongated shape of the watershed causes the peak discharge in the Batang Masumai watershed to come quickly and take a long time to decrease. An elongated watershed hydrograph will show a lower peak discharge with a longer recession time [9, 10]. Elongated watersheds or parallel or feather-like sub-watershed networks will have a lower hydrograph shape than watersheds that have a radial or circular sub-watershed network shape. The elongated shape of the watershed will have a longer peak time than the round watershed. Therefore, if there is a relatively large rainfall intensity, the chances of flooding in the Batang Masumai watershed tend to be smaller than in the round watershed.

Land use is dominated by Primary Forest covering an area of 29,992.15 ha (46.44%) Secondary Forest covering an area of 26,590.90 Ha (41.17%), The slope of which is dominated by a slope of 0–8% covering an area of 25,279.47 Ha (39 .13%) and 8–15% covering an area of 31,124.60 Ha (48.19%) of the total area of the watershed, and when viewed from the elongated shape of the watershed, the Batang Masumai watershed has very little potential for flooding if the intensity of rainfall is high. Judging from the land use, slope, and morphometry of the Batang Masumai Basin, the Batang Masumai Basin has great potential for the application of rural agriculture. Based on observations, the application of rural agriculture in the Batang Masumai area has also been carried out by local farmers, such as the application of terracing to rice fields and plantations.

4 Conclusion

From the research results it can be concluded that the mapping of the Batang Masumai watershed boundary is dominated by primary forest covering an area of 29,992.15 ha (46.44%) and secondary forest covering an area of 26,590.90 ha (41.17%). The slope is dominated by slopes of 0–8% covering 25,279.47 Ha (39.13%) and 8–15% covering 31,124.60 Ha (48.19%) of the total area of the watershed. The shape of the Batang Masumai watershed is an elongated watershed. Land use, slope, and morphometry of the Batang Masumai watershed show that the Batang Masumai watershed has potential for rural agriculture.

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