Geospatial Simulation Placement Of Sediment Retaining Buildings In The Mamasa River Basin

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Abstract: Sediment Review (BPS) uses erosion simulations using geospatial simulations. The amount of erosion was analyzed using a general version released by the soil (USLE) using ArcGIS software version 9.2. Sources of data and maps obtained from relevant agencies. A satellite imagery map for the Mamasa watershed area obtained on 28 July 2009 was obtained from LAPAN. Data input is initiated by digitizing analogue maps and satellite imagery maps, where georeferenced processes have previously been made to rectify maps so that they become digital maps. The resulting digital map consists of USLE thematic maps (erosivity maps, erodibility maps, long slope maps, and land cover maps). The USLE thematic map is then overlaid resulting in an erosion map. The amount of erosion was obtained from the calculation of USLE attribute data. Sediment rates are calculated using the NLS formula (Sediment Release Ratio). The location and number of BPS are based on sediment rate and distribution. The results showed that erosion rates with very high criteria occurred on farmland and plantations. While the highest sediment rate occurred in Leko-01, Merang and Malobo-Lalaki Sub Watersheds. As many as 26 BPS points are scattered in 16 Sub Watersheds in the upstream, middle, and downstream areas of the Mamasa watershed.

Keywords: erosivity, erodibility, rectification, thematic, Sediment Retaining Buildings

1. INTRODUCTION

The Mamasa watershed is geographically located at 119 ° 13 '-120 ° 21' BT and 2 ° 43 '-3 ° 46' LS. The Mamasa watershed area includes the administrative area of Mamasa Regency with an area of 83,352 ha (79%), the Pinrang Regency with an area of 21,160 ha (20%), and the Tana Toraja Regency with an area of 705 ha (1%). The total area of the Mamasa watershed ± 105,217 ha has S. Mamasa as the main river with a length of ± 117 km stretching from the north (Mamasa Regency) to the south (Pinrang Regency). S. Mamasa as a media to drain water is the critical and poor condition. This can be seen from the hydrograph indicator of river discharge, namely the ratio of the minimum river discharge that occurs in the dry season and the maximum discharge that occurs in the rainy season above 1:50. The standard size of river flow fluctuation is considered to be good if the minimum and maximum discharge ratios are below 1: 15. Another indicator for assessing the hydrological characteristics of flooding of a river is the measurement of water availability (specific discharge), especially in the dry season. The Mamasa River has a water availability of only 3.2 m3 / sec / km2 in the dry season, whereas in the rainy season, the availability of water is 6.6 m3 / sec / km2. The results of research on 10 major rivers in Indonesia show the specific value of river discharges in the dry season ranged from 4-10 m3 / sec / km2 and 10-80 m3 / sec / km2 in the rainy season[1]. The results of monitoring of the Mamasa watershed condition carried out by the Regional Environmental Impact Management Agency (Bapedalda) of South Sulawesi Province in 2002 showed that the forest area was only 39.57% of the area of the Mamasa watershed. The function of forests as water catchment areas in the Mamasa watershed is decreasing from year to year. Most of the forest land inside the protected area of the Mamasa River has been damaged and converted to agricultural cultivation. The amount of erosion that occurred in 1986 reached 60 tons/ha/ year with an area of erosion reaching 56%, whereas in 2002 erosion reached 784.8 tons/ha/ year. An increase in erosion of ± 300% in a period of 20 years. Land damage is a major cause of erosion and is a serious threat to the Mamasa watershed. As a result of continuous erosion, silting up along the river flows to the Bakaru reservoir, which is located downstream of the watershed. Silting problems have threatened the continuity of the service life of Bakaru Hydroelectric Power Plant so that it can disrupt regional electricity supply[2]. The sedimentation rate in 2006 of ± 800,000 m3 / year caused a decrease in the flow of water entering the Bakaru hydropower plant. The decrease in inflow caused the Bakaru hydropower production capacity to drop dramatically from a normal capacity of 126 MW to an average of only 20 MW.

In an effort to improve and restore the conditions of the Mamasa watershed, proper identification and mapping of the problem are needed. One of the efforts made through this research is how to identify the rate of erosion and sediment. The erosion and sediment rates were analyzed using the USLE Equation. The use of the USLE formula because it is commonly used and easily obtained by input data variables, and the results of the analysis can be improved when using the geospatial model. Geospatial simulation is an erosion calculation model using the Geographic Information System (GIS) application program. The role of GIS in the field of infrastructure and natural resources has made it easier to manage and store a database of a location or object so that mapping and analysis of problems can be carried out appropriately[3]. The use of GIS in this research is to identify and analyze the number and locations of Sediment Retaining Buildings appropriately. Besides that, the use of GIS for mapping land degradation or erosion prevention can provide information on land management and forms of conservation appropriately. One form of soil and water conservation in the Watershed is by implementing a Sediment Retaining Building that serves to accommodate a number of sediments so that it does not cause the overflow of sediment volume out of the river channel during floods. Sediment containment buildings can also control the rate of sediment downstream which can threaten and disrupt the functioning of infrastructure that is downstream.

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2 LITERATURE REVIEW

Erosion evaluation is an assessment of the possibility of the amount of erosion that will occur in an area. Assessment of the possibility of the amount of erosion that will occur is called a potential erosion or an assessment of the threat of the level of danger of erosion[4]. While the evaluation of the magnitude or level of erosion that has occurred in an area is called a measurement of total erosion. The erosion evaluation aims to find out which part of the land or area has the potential to experience erosion and the possibility of erosion threat that will occur. By using the results of predicted erosion which is the magnitude of the erosion threat generated by potential erosion on each land use, it can then be calculated the amount of total erosion that has occurred[5]. Total erosion is the accumulation of the magnitude of potential erosion multiplied by the unit area of each land. Sediment is the result of the erosion process. Sediment rate is the amount of soil and parts of land that are transported by water from an erosion site in a watershed and into a river or water bodies. SDR (Sediment Delivery Ratio) is a ratio of the amount of sediment transported into a body of water/river with the amount of erosion that occurs in the upper watershed. If the SDR value is close to one, it means that all the soil that has been eroded enters the river. Conversely, if the SDR value is close to zero, the erosion rate in the watershed is very small and indicates that the watershed is in a good category. Sediment yield depends on the amount of erosion that occurs in a watershed or sub-watershed and depends on the transport of eroded soil particles. Sediment production refers to the amount of sediment flowing through one observation point in a watershed/sub-watershed. The amount of sediment yield depends on the physical characteristics of a watershed/ sub-watershed and is expressed as the volume or weight of the sediment per unit catchment area per unit time. One of the Sediment Retaining Buildings commonly used in infrastructure, namely[6]: Sabo Dam. The function and use of Sediment Retaining Buildings are to hold, store and control large amounts of sediment so that sediment flowing downstream of the flow is much reduced so that it does not cause problems in the river channel downstream and localizes the spread of sediment so as not to damage the surrounding area. According to Munir, A., and N., Abdullah, (2006) Geographic Information Systems (GIS) are a collection of instruments in the form of collection, processing, storage, activation, transformation, distribution, and presentation of spatial data from a real phenomenon on the surface of the earth, which functions as data processing in mapping because it contains a database system (database) to explain data. Parts and components of GIS are described by Munir (2006), into five sub-system parts, namely: a. The hardware consists of computers with multimedia devices for data input purposes, for example, digitizer, CD-Room, mouse, scanner. b Software The software functions for the management of storing, analyzing, and displaying data. c. Human Resources Human resources are an integrated part of the GIS component. d. Database (database) is a set of several data files or tables that are stored with a particular structure so that they are interconnected among members of the data set for spatial data purposes. Database that works together with GIS: 1) Spatial data in the form of vector. Sourced from terrestrial surveys, the results of interpretations of aerial photographs, satellite imagery and other thematic maps. 2) Spatial data in the form of a raster is sourced from direct scanning of satellite recordings or aerial photographs. 3) attribute / tabular data sourced from statistical data, enumeration or other sources, in addition to spatial data information.

3 METHOD

The analytical method for estimating the rate of erosion and sediment uses the USLE equation with ArcGis software version 9.2. Map of the earth is used for the needs of input data boundaries, sub-watershed boundaries, rainfall, soil types. Topographic maps are used to calculate the length and slope of a slope. Image maps are used to determine the classification of land cover[7].

Map data input process

Data input begins with a 1: 50,000 scale map for the Mamasa and Pinrang districts, so that it becomes a digital data with raster data format (jpg).

Map merging process

Map merging is done if the area of the object of research is too large for one map scanning process so that a map is needed so that all boundaries of the area can be included in the merged map.

Geometry correction process

The resulting map geometry corrections, for example, rainfall maps are needed to equate the coordinates of the earth on the position with the coordinates on the map, in this case, the alos map image in 2009 which has been corrected which will be used as a reference to correct the map of the earth[8].

The process of digitizing the map

In general, the process of data input and digitization of maps, both analogue maps and satellite image maps.

4 RESULT

The level of erosion is calculated based on the factor value of each USLE variable. The level of potential erosion is divided into 4 classes of criteria namely: very high, high, medium, and low. The result of overlaying the USLE thematic map into the ArcGis version 9.2 application program, produced a total of 595 land units with a total erosion potential of 114,667 tons/ha/ year. The highest erosion potential occurred in uplands with a total erosion of 35,967 tons/ha/ year covering an area of 16,366 ha or equivalent to 15.56% of the total area of the Mamasa watershed. The magnitude of potential erosion that will occur based on erosion hazard criteria shows that the potential erosion value with very high criteria is found in 158 land units with an area of 35,776 ha or equivalent to 34.00% of the total area of the Mamasa watershed. The results of the analysis show the level of erosion hazard potential high level to very high reaching 48.74% of the total area of the Mamasa watershed. The amount of total erosion is the result of the accumulation of potential erosion from each area of the land unit. The results of the analysis show that land used for plantations and cultivation produces the highest total erosion value, namely 16,541,392 tons/ha/ year on land area of 51,882 ha and 6,733,517 tons / year on land area of 16,366 ha and, while forest land produces the lowest total erosion is 155,369 tons/ha/ year on an area of 25,660 ha. Data processing results for total erosion on each land use and the level of danger that can be caused. The results of the identification of the average surface soil loss in each land use show that land for plantations and cultivation / dry land has the highest rate of soil loss, which is 26 mm and 34 mm respectively. This proves that there has been a mismanagement and farming method carried out by residents who are in the Mamasa watershed area, so it is necessary to immediately take measures of land conservation and technical guidance in the form of counselling to farmers and land tenants. The level of erosion spread in each subdistrict area, it can be seen that the location of Tanduk Kalua and Balla Subdistricts located in the upper reaches of the Mamasa watershed, contributed the highest erosion to deposition of sediment deposition in bodies of water bodies leading to the Mamasa River. Map of sub-watershed area division is the result of digitization of a map of the earth scale of 1: 50,000. The sub-watershed area division is based on the hydrological characteristics of an area, which is determined based on the morphology of the watershed, climate type, topography, and slope as well as the characteristics of the soil and the type of land use. The division of the sub-watershed area in the Mamasa watershed is divided into 57 sub-watersheds. The results of an erosion map overlay with a sub-watershed map obtained a map of sediment distribution. Sedimentation rates in each sub-basin can be seen in table 24. The amount of sediment produced in the erosion production area is calculated based on the SDR approach, ie the magnitude of the potential erosion that occurs multiplied by the SDR coefficient, so that the amount of sediment yield in each sub-watershed is obtained.

5 DISCUSSION

As a basis for consideration for planning the location of the Sediment Retaining Building on the debris flow, including The basic slope along the river channel is determined based on a topographic map[9]. The upstream and downstream river bed slopes need to be known to calculate the planned river bed slope, the volume of sediment that can be retained and controlled by the Sediment Retaining Building. The river bed slope plan is the river bed slope which is expected to be formed after the Sediment Retaining Building has been completed and is filled with sediment deposits. The slope of the riverbed is closely related to the volume of sediment that can be accommodated. To determine the amount of sediment that can be held, collected and controlled. Sediment volume (Vs) obtained from the sediment calculation results is based on the SDR value approach for each watershed and total erosion. 1) Amount of sediment that can be retained. The amount of sediment held in the volume of sediment held at the bottom and on the river bank which is expected to drift downstream in the absence of a Sediment Retaining Building. 2) Amount of sediment that can be accommodated Amount of sediment that is accommodated is the volume of sediment that flows from the headwaters of the river and then accommodated by the Sediment Retaining Building. 3) The amount of sediment that can be controlled While the amount of sediment that can be controlled is the volume of sediment that can be controlled by the Sediment Retaining Building during major floods, the sediment carried will be temporarily held upstream of the building, and when the flood is small, the material will be washed away gradually[10]. BPS locations resulting from erosion simulations, sediment distribution, and field observations included: S. Bone, S. Kampinisan, S. Batangara, S. Sibenawa. The four tributaries are in the upper and middle sections of S. Mamasa. The names of the watershed sub and the location of the sediment containment building.

6 CONCLUSION

Results of analysis of erosion rates; The area of land that is potentially threatened by erosion with a very high category is found on an area of 35,776 Ha (34.00%). The threat of erosion with very high criteria is found in the agricultural land area of 16,366 hectares (15.55%). Total erosion with a very high category is found in agricultural land and plantations covering an area of 68,248 hectares (64.86%). The distribution of total erosion with a very high category is found in the Districts of Tanduk Kalua, Balla, Simbuang, and Messawa. The results of sediment analysis based on erosion simulations show: Sedimentation rates in the Mamasa watershed reached 1,563,842 tons/yr. Sediments with very criteria are found in Leko01 Sub-watershed with sediment rates reaching 134,826 tons/yr, Merang Sub-watershed with sediment rates reaching 119,157 tons/yr, and Malabo and Lalaki Sub-watersheds with sediment rates reaching 74,883 tons/ha. Sediment distribution according to sub-district area, the highest sedimentation rate was in the area of Tanduk Kalua Subdistrict with an area of 11,585 Ha (11.01%) and Messawa Sub-district area with a spread of 12,260 Ha (11.65%). The results of the analysis and identification of BPS show: The need for a BPS total of 26 points. The location and number of BPS proposed in the Leko01 and Merang Sub-watersheds are 3 units, Malobo and Lalaki, Balo03, Kumali, Talean04, Sanghua01, Tawalian01 2 units each. Sub Watershed Leko02, Solokan, Manta01, Sibentawa, Talean05, Leko03, Manta02, and Tawalian02 each with 1 unit.

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