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Erosion Potential to Determine Conservation Locations as an Effort to Handle Sediment in the Nangka Watershed

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ABSTRACT
The Nangka Watershed is located within the Lombok River Region in Indonesian. The area of Nangka Watershed is 32,87 km2. Erosion prediction uses the USLE (Universal Soil Loss Equation) method with the help of arcGis software. The results of the analysis show that the land area with a moderate erosion hazard rate of 2,44 km2 or 7,46% of the total area of the watershed, the land area with a severe erosion hazard level is 0,86 km2 or 3,56% of the total watershed area and land area with a very severe erosion hazard amounting to 2,27 km2 or 6,13% of the total watershed area. Sediment potential in the Nangka Watershed is 16.520,22 tons / year. To reduce the erosion hazard, conservation efforts were simulated by vegetative methods and mechanical methods by Strip Cropping building bench terraces, reforestation and building sediment control buildings. Efforts to reforest and build sediment control buildings are the right conservation to be applied in the Nangka Watershed.

Keywords - Nangka Watershed, USLE, Erosion Hazard Level, Sediment Potential, Conservation, Lombok Island

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I. INTRODUCTION

The Nangka Watershed is located within the Lombok River Region (WS) administratively included in the East Lombok Regency of West Nusa Tenggara Province. The Nangka Watershed or also by residents around it named Nangka has an area of 32 km2. Nangka watershed has quite high utility, namely utilization for agriculture, raw water, and ponds. Land use in the Nangka watershed consists of forests, rice fields, gardens, fields and settlements. River conditions have very steep morphology in the upstream and gentle slopes in the lower reaches. With the condition of the steep river morphology upstream, it can facilitate the transfer of erosion material to the downstream of the river so that it can infer changes in river morphology (Kustamar, 2013).

Changes in river morphology in the form of siltation, groove removal, and even loss of old river flow are also adverse effects of sediment. This will be very dangerous if not handled carefully and as quickly as possible. One of the things that can be done to suppress sediment hazards in the watershed is conservation. While the definition of conservation is an effort made to preserve nature. On the other hand, the definition of conservation is also understood as efforts to preserve the environment but still pay attention to the benefits that can be obtained at that time while maintaining the existence of every environmental component for future use.

Knowing the magnitude of erosion that occurs in an area is important, because besides being able to find out how much land is transported it can also be used as a way to find a solution to the problem. Erosion prediction can be done directly or indirectly through the erosion prediction model. Direct erosion prediction has many obstacles, one of which is the time needed to work long enough, so that an erosion prediction model is used. The erosion prediction model itself is quite diverse, one of them is the USLE (Universal Soil Loss Equation) method.

Along with the development of technology, a spatial database processing system is needed to accelerate, make it easier to detect the location while providing an overview of the location and results of the study in the form of jpeg. In the study of this paper using GIS (Geographic Information System). GIS (Geographic Information System) or in Indonesian language is better known as Geographic Information System is an information system used to manage and store geographic data or information.

GIS uses a database management system by utilizing computers to capture, store, receive, manage, analyze, and display spatial data, such as the location or shape of the earth's surface.

Based on the explanation above, it can be concluded that an erosion potential study is needed to determine the conservation location as an effort to handle sediment in the Nangka Watershed using the GIS (Geographic Information System) USLE method.

II. METHODOLOGY

Erosion is the erosion of top soil caused by water and wind. The level of erosion hazard is the level of threat of damage caused by erosion of a land. The erosion hazard level (TBE) is obtained by comparing the level of erosion in a unit of land with effective depth. The more shallow the soil solum means the less soil can erode, so the erosion hazard level in shallow depth of soil is already in the heavy category even though the soil is lost or eroded is not too large. This erosion hazard classification can give an idea, whether the level of erosion that occurs on a land or watershed is included in a level that is dangerous or not, so that it can be used as a guide in watershed management.

Table 1. Determination Criteria for Erosion Hazard Levels

Erosion class	Land loss	Erosion hazard level
1	<15 tons/ha/year	Very light erosion
2	15-60 tons/ha/year	Light erosion
3	60-180 tons/ha/year	Moderate erosion
4	180-280 tons/ha/year	Heavy erosion
5	>480 tons/ha/year	Very Heavy erosion

To find out the value of erosion by overlaying between Rain Erosion Index (R), Long factor and slope (LS), Erodibility Index (K), Factors of vegetation cover and crop management (C) and Soil conservation action (P). lets see Fig. 1.

INDENTATIONS AND EQUATIONS

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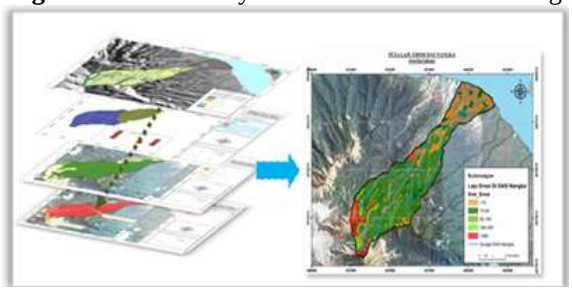
Figure 1. The Overlay Process of Factors Affecting



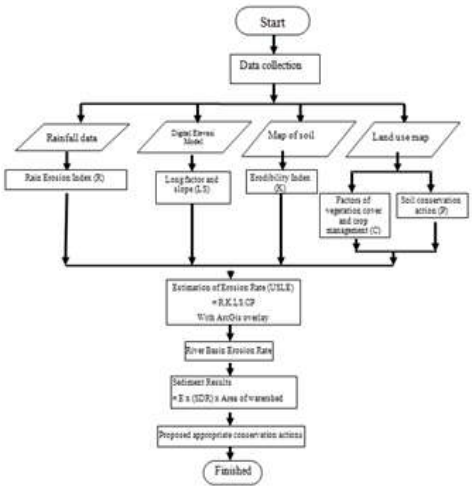


Figure 2. The flow chart in the preparation of this study

III. EROSION HAZARD LEVEL ANALYSIS

Estimation of erosion hazard levels in the watershed is determined by the level of erosion which is a factor of rain erosivity, soil erodibility, slope length and slope, land cover, and land replacement measures. Based on the results of the erosion calculation, it can be concluded that 10% of the area of the Nangka Watershed is identified with severe and very heavy erosion.

Table 2. Erosion Hazard Level in the Nangka Watershed

Erosion class	Land loss	Area (km^2)	Persentase	Explanation
I	<15	8,651	26%	Very light erosion
II	15-60	18,653	57%	Light erosion
III	60-180	2,439	7%	Moderate erosion
IV	180-480	0,860	3%	Heavy erosion
V	>480	2,267	7%	Very Heavy erosion
Total		**32,870**	**100%**	

Based on the results of the analysis of erosion rates all factors are directly proportional to the increase in erosion rate. But there are factors that have a large influence on the increase in erosion hazard values, namely LS factors and C factors. The rate of erosion will tend to be large if the value of C is large, the same is true for LS. This shows that the factor of land cover by plants and slope has a large role in reducing the rate of erosion that occurs. The flatter the land and the more tight the closure of the crown and soil surface, the less erosion rate will be. The rain erosion factor (R) has a smaller range of values than other factors. For LS factors that are high, it tends to be large in terms of erosion when compared to other factors. Look at Figure 4.13 and by comparing the determinants of erosion value from the figure it can be seen that the flat area (low LS) will tend to have a small erosion hazard and vice versa..

IV. POTENTIAL SEDIMENTS IN THE RIVER

Calculation of SDR values is strongly influenced by the shape of the earth and environmental factors. According to Boyce (1975) in (Parasdya, 2016) using equation 2.15 with the following results. It is known that the area of Nangka Watershed is 32.87 km2 or equal to 3,287 ha. SDR = 0,41 $A^{-0,3}$ = 0,41 x $3.287^{-0,3}$ = 3,6%.

Based on the analysis of sediment flowing into rivers in very lightly eroded sub-watersheds, the total sediment transport is 178.41 tons / year, for lightly eroded sub-watersheds it has a total sediment transport of 1,969.48 tons / year, eroded sub-watersheds are having total sediment transport 878.32 tons / year, heavily eroded sub-watersheds have a total sediment transport of 784.19 tons / year, and very heavily eroded sub-watersheds have total sediment transport of 12,709.81 tons / year. So the total sediment potential that occurs in the river of Nangka Watershed is 16,520.22 tons / year. The following are the results of sediment calculations.

Table 3. Results of Sediment Calculation in the Nangka Watershed

No.	Land loss (tons/ha/year)	Explanation	Sedimen (tons/year)
1	<15	Very light erosion	178,41
2	15-60	Light erosion	1.969,48
3	60-180	Moderate erosion	878,32
4	180-480	Heavy erosion	784,19
5	>480	Very Heavy erosion	12.709,81
Total			**16.520,22**

Efforts are being made to prevent erosion and repair soil damaged by erosion. Erosion that damages ordinary soil is also explained as chemical or biological soil changes. This happens as a result of excessive use, salinization, acidification, or other contamination. To reduce the rate of erosion in the Nangka watershed a conservation effort simulation was carried out, strip cropping, construction of a bench terrace, reforestation, construction of a sediment control building.

4.1. Strip Cropping

Strip cropping is part of the vegetative method conservation effort. strip cropping is a cropping system in which several types of plants are planted in strips that intersect on a plot of land at the same time and are arranged to cut slopes or according to contour lines. Usually the plants used are food crops or other seasonal crops interspersed with strips of plants that grow closely in the form of cover crops or green manure. From the simulation results of the implementation of strip planting in the Nangka watershed can reduce the severity of very heavy erosion by 0.77%. The level of effectiveness of the implementation of conservation efforts in this method is quite small because not all regions with severe erosion hazard levels can be planted with this method. The following is the recapitulation of the results of the erosion hazard level simulation with the Strip cropping conservation effort. Lets see fig.3 for erosion after there are conservation efforts with the strip cropping map.

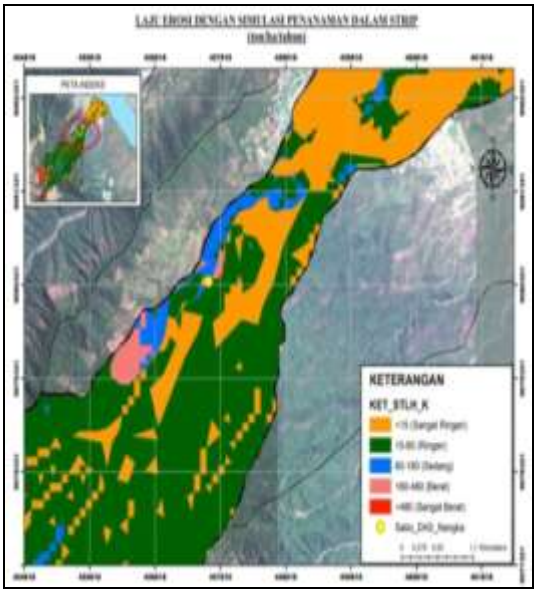


Figure 3. erosion after there are conservation efforts with the strip cropping map

Table 4. Comparison of Erosion Rate Before and After There are Planting Conservation Efforts in the Strip

No.	Erosion hazard level	Before There Are Conservation Efforts		After There Are Conservation Efforts			
		Area (km^2)	**Percentage**	**Area (km^2)**	**Percentage**	**Explanation**	
1	Very light erosion	8,651	26,32%	8,65	26,32%	Still	0,00%
2	Light erosion	18,653	56,75%	18,58	56,54%	Reduced	-0,21%
3	Moderate erosion	2,439	7,42%	2,45	7,46%	Increase	0,04%
4	Heavy erosion	0,860	2,62%	1,17	3,56%	Increase	0,94%
5	Very Heavy erosion	2,267	6,90%	2,01	6,13%	Reduced	-0,77%
Total		32,870	100,00%	32,870	100%		

4.2. Bench Terraces

The application of bench terraces in Indonesia has also been classified as old, although initially the application of this conservation technique focused on rice fields or more functioned as irrigated terraces. A bench terrace can also be continued with tree planting and other farming systems.

Conservation efforts with bench terraces consist of poor, medium and good quality. Based on the P factor index according to Arsyad the quality is having a conservation factor value (P) = 0.15. The area of the bench terrace effort is 0.82 km2 which is spread in various sub-sections of the Nangka Watershed.

The application in the field of bench terrace system conservation is quite effective in high slope areas so that it reduces rainwater runoff and can reduce soil erosion. Simulation of the application of bench terraces in the Nangka Watershed can reduce the severity of very severe erosion by 0.71%. The following is the recapitulation of simulation results after conservation efforts with medium quality bench terraces.

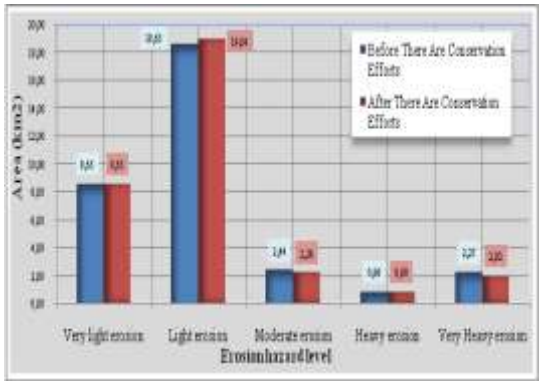


Figure 4. Chart of Changes in Erosion Hazard Levels After the Efforts to Conservation Bench Terrace

4.3. Reforestation

The area that is carried out by conservation efforts using conservation methods is an area that is not a community agricultural land. The area for simulating conservation efforts by reforestation is 5.23 km^2. The following Fig.5 shows the location for simulating conservation efforts by reforestation in the Nangka watershed, which is mostly located in the upper watershed.

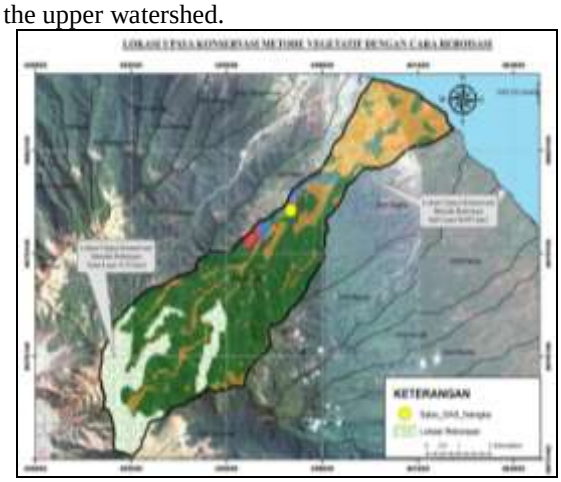


Figure 5. Locations for Simulation of Conservation Efforts by Reforestation

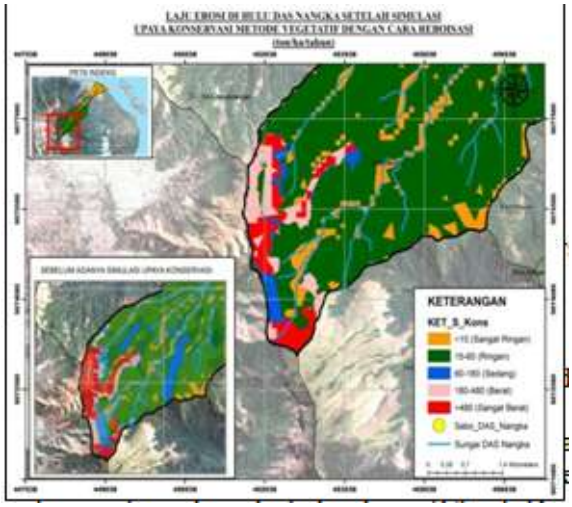


Figure 6. Erosion Rate in the Jackfruit Watershed After Conservation Efforts by Reforestation

4.3. Construction of Sediment Control Buildings (Check Dam)

Based on the distribution map of the Erosion Hazard Level of the Nangka Watershed it is planned to place sediment control structures (Check Dam) in three locations with severe and very heavy erosion hazard levels. The following is the location

of the planned placement of sediment control buildings.

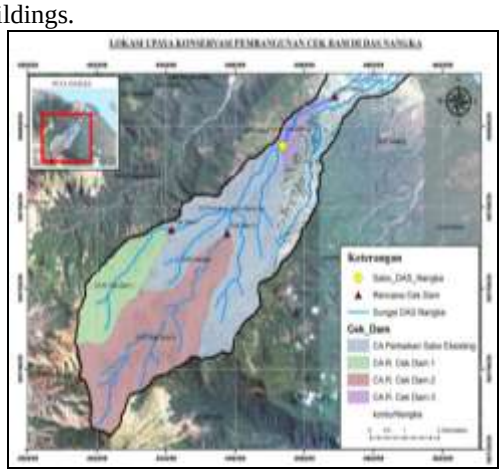


Figure 7. Plans for Placing Sediment Control Buildings

The following are the results of the recapitulation of potential sediment catches in each check and plan.

Table 5. Catch of Sediments in each Check Dam

Check Dam	**Area (km^2)**	**Percentage to Area**	**Sediment Retained (tons / year)**	**Percentage of sediment held up**
CA Sabo	9,64	29,33 %	1.380,04	8,35%
CA R. Cek Dam 1	3,61	10,97 %	3.438,27	20,81%
CA R. Cek Dam 2	8,64	26,29 %	10.590,34	64,11%
CA R. Cek Dam 3	0,84	2,54%	232,69	1,41%
Sub-Total	**22,72**	**69,13 %**	**14.261,31**	**86,33%**
Total-Nangka	**32,87**	**100,00 %**	**16.520,22**	

4.4 Konservasi Rekomendasi

Based on analysis, it can be determined that the most appropriate conservation effort is carried out by constructing a check dam building that is capable of holding sediment (can reduce sediment hazards) by 86.33%. Efforts to conserve mechanical methods with the construction of check dams and not improve land functions only reduce the level of danger of sediments so that it is recommended to be combined with conservation efforts of the vegetative method by reforestation.

VI. CONCLUSION

Based on the results and discussion, it can be concluded that:

a. The Nangka Watershed has a diverse erosion rate. Some regions have erosion rates smaller than 15 tons / ha / year with an area of 8.65 km2, have erosion rates ranging from 15 tons / ha / year to 60 tons / ha / year with an area of 18.65 km2, has erosion rates ranging from 60 tons / ha / year to 180 tons / ha / year with an area of 2.44 km2, has erosion rates ranging from 180 tons / ha / year to 480 tons / ha / year with a total area of 0 , 86 km2 and has an erosion rate greater than 480 tons / ha / year with an area of 2.27 km2 with a total area of 32.87 km2 of watershed.
b. The Nangka Watershed area has a very low erosion hazard rate of 26.32%, an area that has a low erosion hazard level of 56.54%, an area that has a moderate erosion hazard rate of 7.46%, an area that has a severe erosion hazard of 3.56 %, the area that has a very heavy erosion hazard level is 6.13%.
c. Sediment potential in the Nangka Watershed is 16,520.22 tons / year.
d. Decrease in erosion hazard level carried out by conservation efforts of the reforestation method amounted to 58.62% reduction in sediment in the river, using the Bench Terrace method of 6.31% reduction in sediment in the river, with the Strip Planting method of 3.61% reduction in sediment in the river, and with development sediment control buildings amounting to 86.33% of sediment retention in the river.
e. The right conservation effort is carried out in the Nangka watershed, namely by reforestation and building sediment control.

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