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Ecosystem Management in the Lamasi Watershed by Integrating Regional Spatial of South Sulawesi Province

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Abstract - *Flooding and sedimentation in the downstream area will be closely related to the ecological system in the upstream region that is not functioning correctly. This fact also shows the importance of unified natural resource systems and environmental policies in watersheds. The misalignment of natural resources and environmental management systems and policies that occur in the upstream, middle, and downstream areas of a watershed will cause an imbalance in the overall water management system in the relevant watershed. The Lamasi Watershed is one of the watersheds that need to be studied for its Watershed Ecosystem Management. This study aims to analyze the condition of improving the management of the Lamasi Watershed. This research was conducted in the Lamasi watershed located in Luwu Regency and North Toraja Regency. The analytical method uses Spatial Analysis to determine the condition of the watershed area. The results showed that the condition of the Lamasi watershed area with critical land in the watershed area consisted of medium critical, critical, and very critical with an area of 32.154 Ha or 67.37%. It is necessary to reforestation and reforestation activities in the Lamasi watershed. The activities are a reforestation area of 36.06% or 17,212 hectares and reforestation/enrichment activities of 26.51% or 12,653 hectares. Construction of technical civil buildings in the form of soil and water conservation buildings is dominated by the manufacture of Gully Plugs / Gulud Terrace / Bench Terrace according to watershed conditions) mostly with slopes above 30% and prone to flooding.*

Keyword*: Ecosystem Management, Lamasi Watershed, Watershed Internalization*

1. Introduction

Watershed management is a human effort in regulating the reciprocal relationship between natural resources and humans in the watershed and all its activities, in order to realize the sustainability and harmony of ecosystems and the increasing use of natural resources for humans in a sustainable manner. Furthermore [1], an ecosystem is an ecological system consisting of components that integrate into each other to form a unity. The main components of watersheds include vegetation, land and water, where water acts as a binder of interrelationships and dependencies between the main components of watersheds/ sub watersheds.

Biophysical problems are basically a consequence of watershed disruption closely related to human activities that can change the land use in watersheds. Changes in land use in the upstream watershed area through natural resource exploitation activities in the form of forests, as well as in the central area of watersheds through the development of settlements or other agricultural businesses without considering environmental aspects. The expansion and increase of critical lands is a picture of the use of land that is not in accordance with its designation and land carrying capacity, and without being accompanied by efforts to implement adequate soil and water conservation practices. In the last ten years the potential of watersheds throughout Indonesia including in South Sulawesi has decreased. With the declining condition of watersheds characterized by the occurrence of floods and landslides in the rainy season and drought in the dry season. One of the causes of the decline in watershed quality is the result of interaction between climate factors (especially rainfall), geomorphological conditions (geology, soil and topography) and especially human activities that cause a decrease in the quality (degradation) of forest resources and land in the form of critical land.

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Watershed ecosystems in upstream areas that are forest areas and play an important role in maintaining the continuity of hydrological processes, preventing erosion and sedimentation. Forest resource exploitation activities and land use changes in upstream areas that do not pay attention to environmental aspects will damage the watershed ecosystem. Damage to forests and land in watershed units in various regions continues to occur even though there is a tendency to increase. With the increasing rate of forest destruction reaching 1.6 million ha / year far exceeds the ability to do rehabilitation which is only about 900,000 - 1.2 million ha / year. This condition can occur as a result of the level of community participation in watershed management is still low category, many projects whose success rates are difficult to maintain, policies between governments and other stakeholders (stakeholders) and not in line (conflict of interest), and community intervention in forest land use and watershed intensifies. [2]. Lamasi Watershed (WATERSHED) that has experienced deforestation according to the results of the study [3]. Various watershed problems outlined above also occur in the Lamasi watershed, so it is necessary to manage watersheds that integrate spatial planning of South Sulawesi Province that can optimize the ecological and economic functions of the long watershed area.

II. Research

A. Research objectives

1. Describe the conditions and problems faced in improving management in the Lamasi Watershed.
2. Formulating the Management of Lamasi Watershed integrated with the Spatial Plan of South Sulawesi Province.

B. Research methods

1. Research site.

This research was conducted in the Area of River Basin (DAS) Lamasi, which administratively consists of Luwu Regency, which is the largest area that crosses 6 Subdistricts, North Luwu Regency and North Toraja Regency that feel the benefits are more dominant in the luwu district.

2. Data sources.

Quantitative data is data related to the condition of the Lamasi Watershed, and Secondary data is data obtained from various second sources of information, especially from various relevant agencies at the provincial and district/city levels. In Luwu Regency, such as bureau / central office statistics, forest office, Bappeda, Environment Office, Jeneberang Saddang River Basin Management Center, Forest Area Stabilization Center, as well as various publications of study results relevant to this research both at the regional, national, and international levels.

3. Data analysis

The method of data analysis used to determine the condition of watersheds is to analyze spatial data obtained from relevant agencies that have to do with ecosystem management and the management of watersheds in general. Data was obtained by using ArcGIS 10.5 application.

III. Results and discussion

A. General conditions of watersheds

1. Location and area of WATERSHED area.

Geographically Lamasi watershed is located at 119^0 49' 38,982" - 120^0 15' 55,8072" East Longitude (BT) and 2^0 39' 20,412" - 2^0 56' 50,0784" South Latitude. The total area of Lamasi watershed is about 47,726 ha located in three administrative areas, namely Luwu Regency covering 36,304 ha (76%), North Luwu Regency covering 7,227 ha (15%), and TanaToraja Regency of 4,195 ha (9%) with a length of 72 km from upstream to downstream, where upstream covers TanaToraja and North Luwu regency while the middle and downstream are all Luwu Regency.

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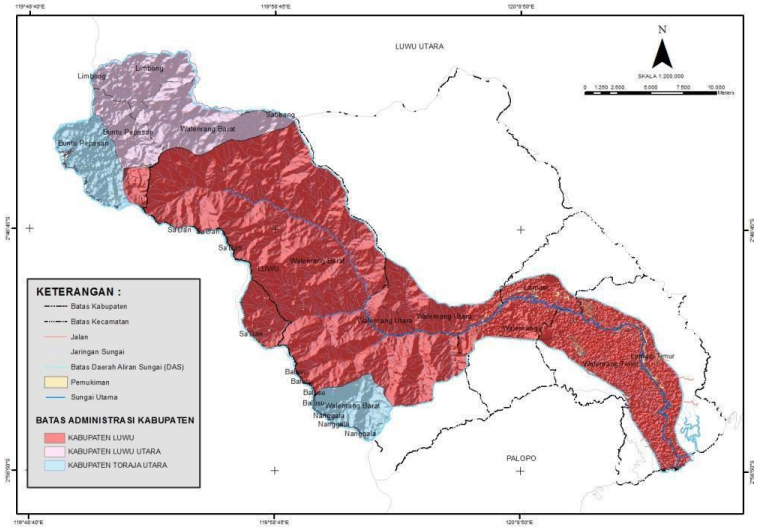

Figure 1.Lamasi WATERSHED Map

2. Forest area of lamasi watershed area.

The results of spatial analysis of the Lamasi Watershed area in the dominance of Other Use Areas (APL) with the status of the Region based on the map of Forest Areas of Forest Areas of South Sulawesi Province (Attachment to the Decree of the Minister of Forestry environment and forestry[4]. With the following details:

Table. 1 Functions of Forest Areas

No.	Area function	Broad (Ha)	Presentation (%)	Information
1	Protected Area (HL)	19.506	40,87	
2	Other Uses Area (APL)	28.220	59,14	
	Quantity :	**47.726**	**100**	

3. Morphological condition of lamasi watershed.

Prediction of peak discharge in relief can be approached in addition to the extent of the watershed with the help of the watershed form. If it is assumed that the intensity of rain, the area and topography of the watershed of two watersheds are the same but the shape of the watershed is different (e.g. long and round) then the flow characteristics can be relieved. The shape of the long watershed will have a longer beak than the round watershed shape; While the discharge of the round watershed is larger than the long watershed shape. For watersheds, the shape of the flow is elongated. As details of the morphology of the Lamasi watershed can be seen in the following table:

Table 2. Morphology of Lamasi Watershed

No.	DAS Name	Morphology DAS	Broad (Ha)	Presentation (%)	Information
1	Lamasi	Upstream	9.3551	19.60	
2		Middle	29.3062	61.40	
3		Downstream	9.0650	18.99	
	Quantity :		**47.726**	**100**	

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4. DAS topography.

The average elevation and altitude variation in a watershed are important factors that affect temperature and rain patterns, especially in areas with mountainous topography.The topographical conditions in the Lamasi watershed region vary greatly from flat to very steep, with slope classes from 0% to >40%. More data can be seen in the Data Table shows that approximately 80% of the entire Lamasi watershed is very steep (slope>40%). The slope is spread in Balusu, BuntuPepasan, Rongkong, Walenrang, Walenrang Barat, Walenrang Utara, and a small part in East Walenrang, and is included in the classification that must be protected or much-needed prudence in its management. Based on the function of the forest, the area should be classified into a protected zone [5] .

Table 3.Topographic conditions (slope class) of lamasi watershed area.

No	Slope (%)	Classification	Broad (ha)	Presentation %
1	0 – 8	Flat	8.091	16,953
2	8 – 15	Ramps	822	1.722
3	15 – 25	A bit steep	198	0.415
4	25 – 40	Steep	2	0.004
5	> 40	Very steep	38.613	80.906
	Quantity :		**47.726**	**100,000**

Source: Topographic Map Analysis Results

5. Suitability of space pattern.

Space pattern is the distribution of urban area space allocation activities that include the allocation of space that serves to protect and cultivate the intended until the end of the validity of the city Spatial Plan (RTRW) which provides an overview of the use of city area space for up to 20 (twenty) years to come. A city protected area is a protected area that is ecologically an ecosystem located in the city area, a protected area that provides protection to its subordinate areas located in the city area, for other protected areas that based on the provisions of the management laws and regulations are the authority of the city / district government.While the urban cultivation area is an area in the city area that is defined with the main function to be cultivated on the basis of the condition and potential of existing natural resources, as well as human resources, and artificial resources.The results of the analysis for the Lamasi Watershed area are as follows:

Table 4. Conformity of Lamasi Watershed Pattern

No.	Regional Functions	Broad (Ha)	Presentation (%)	Information
1	Protected Area	20,648	42.16	
2	Cultivation Area	27,078	57.83	
	Quantity :	**47,726**	**100**	

6. RTRW space pattern of lamasi watershed.

The city spatial plan (RTRW) is a spatial plan that is general to the city area which is the description of the provincial RTRW, and which contains the objectives, policies, strategies of structuring the city area space, the plan of the city area space structure, the city area space pattern plan, the determination of the city's strategic area, the direction of the utilization of city area space, and the provisions of control of the utilization of city area space. (Regulation of the Minister of Public Works No. 17/PRT/M/2009 on Guidelines for The Preparation of Urban Spatial Plans.) [6].The Regional Spatial Plan (RTRW) of South Sulawesi Province has been outlined in the Regional Regulation of South Sulawesi Province [7].

Based on the results of the analysis by overlaying a map of the Lamasi Watershed (WATERSH) and the Spatial Plan Map of South Sulawesi Province obtained the following conditions:

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Table 5. Spatial Plan of Lamasi Watershed

No.	Space Pattern	Broad (Ha)	Presentation (%)	Information
1	Body Of Water	0.2261	0.47	
2	Phishing Area	0.4268	0.89	
3	People's Plantation Area	6.6662	13.97	
4	Local Protection Area	0.7280	1.53	
5	Residential Areas	0.5853	1.23	
6	Mining and Energy Area	0.3840	0.80	
7	Agricultural Area	14.7193	30.84	
8	Disaster Prone Areas	4.3853	9.19	
9	Areas That Provide Protection to Their Subordinate Areas	19.6050	41.08	
	Quantity :	**47.726**	**100**	

7. Cover of land flow area (DAS) lamasi.

The occurrence of changes in Land Cover in a Watershed will affect the hydrological characteristics of the watershed [8]. Based on secondary data obtained from the JeneberangSaddang Watershed Management Center in 2018 for watershed area land cover can be classified as in the following table:

Table 6. Land cover conditions of lamasi watershed

No.	Types of land closures	Broad (Ha)	Presentation (%)	Information
1	Swamp Shrub	0.0700	0.01	
2	Primary dryland forest	7.7763	16.29	
3	Secondary dryland forest	13.2929	27.85	
4	Secondary Mangrove Forest	0.1382	0.29	
5	Settlement	0.4858	1.02	
6	Dryland farming	1.6460	3.45	
7	Mixed dryland farming	2.9485	6.18	
8	Savanna/meadow	0.5729	1.20	
9	Paddy	4.0452	8.48	
10	Shrubs	16.1019	33.74	
11	Pond	0.5815	1.22	
12	Open Ground	0.0295	0.06	
13	Body of water	0.1000	0.21	
	Quantity :	**47.726**	**100**	

8. Critical land.

Critical land is land that because of the non-appropriate use of land with its ability has experienced or in the process of physical, chemical and biological damage, which ultimately endangers the function of hydrology, orology, agricultural production, settlement and socioeconomic life. Critical Land Data review results in 2018 on the Lamasi watershed consists of five critical land critical, somewhat critical, critical, critical potential, very and not critical. Based on the data shows that the area of critical and somewhat critical land in the Lamasi watershed is 32,154 ha or 67.37% of the overall area of the Lamasi watershed, this shows that the condition of vegetation cover in the Lamasi watershed is not good and needs to be rehabilitated and is one of the

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watersheds in South Sulawesi Province that needs to be restored as stated in the South Sulawesi Provincial Regulations. Watershed Management, [9].

Table 7. Critical land condition of lamasi watershed

No.	Land Criticism	Broad (Ha)	Presentation (%)	Information
1	Somewhat Critical	23.423	49.08	
2	Critical	8.1660	17.11	
3	Critical Potential	6.534	13.69	
4	Very critical	565	1.18	
5	Not Critical	9.038	18.94	
	Quantity :	**47.726**	**100**	

9. Flood runoff.

The potential for catastrophic flooding in Indonesia is very large judging from the topographic conditions of lowlands, basins and most of its territory is the ocean. Rainfall in upstream areas can cause flooding in downstream areas [10]. Natural disasters in the form of floods that often occur every year in the Lamasi watershed area and remember the rice fields that exist in the downstream based on data prone to runoff flood in the Lamasi watershed in 2018 there are 3 categories of runoff flood classes namely Extreme, Normal, and High, where runoff with the most maleminant extreme category is 28.6260 Ha or 59.71%.

Table 8. Runoff Flood Levels

No.	Runoff flood level	Broad (Ha)	Presentation (%)	Information
1	Extrem	28.6260	59,71	
2	Usual	5.538	11,55	
3	Tall	13.780	28,74	
	Quantity :	**47,726**	**100**	

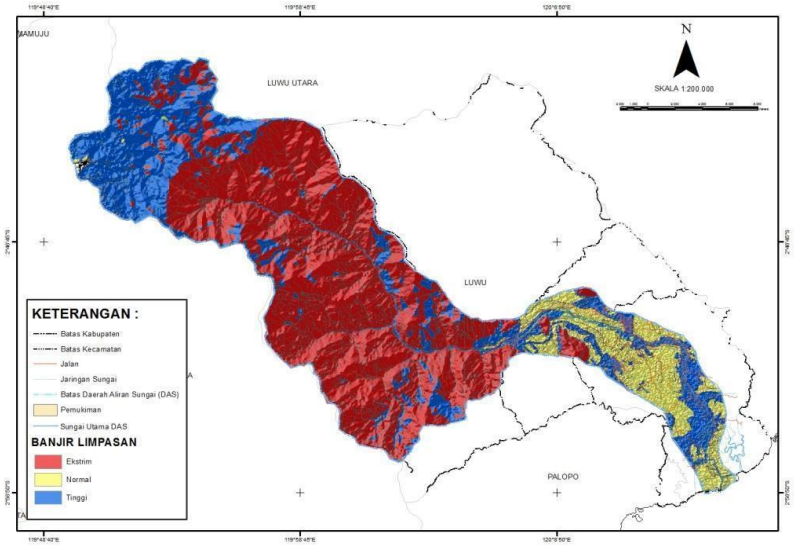

Figure 2: Flood Map of Runoff in Lamasi Watershed

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10. Impact Assessment erosion.

According to Arsyad [11], erosion is the event of the transfer or capture of soil or parts of the soil from one place to another by natural media. The process of soil erosion includes two processes, namely the process of destruction of soil particles and the process of transporting soil particles that have been destroyed [12]. Basically, erosion that most often occurs with the largest sediment yield is erosion on the surface (sheet erosion) when compared to some other types of erosion, namely groove erosion (rill erosion), trench erosion (gully erosion) and river cliff erosion (stream bank erosion) [13]. For the area of the Lamasi watershed the results of spatial analysis can be seen in the following table:

Table 9. Classification of erosion hazards in lamasi watershed area

No.	**Size of Erosion/Ha/Ton/Year**	**Broad (Ha)**	**PresentationI (%)**	**Information**
1	< 15	7,200.19	15.08	Very Light
2	15 – 60	6,323.95	13.25	Light
3	60- 180	19,385.04	40.62	Keep
4	180- 480	5,762.55	12.07	Heavy
5	>480	9,054.27	18.97	Very Heavy
	Quantity :	**47,726**	**100**	

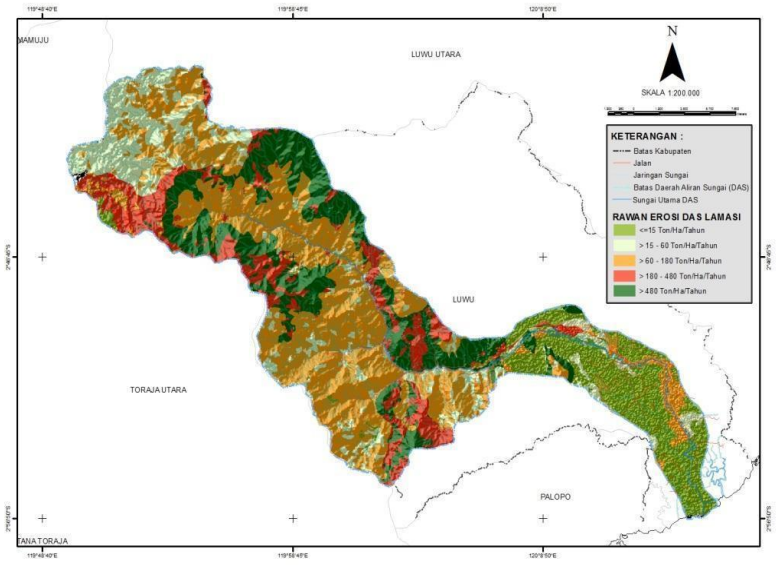

Figure 3. Impact Assessment Erosi Map of Lamasi Watershed

11. Internalization of the management direction of the lamasi watershed ecosystem

In internalizing after knowing the characteristics of the next watershed is to integrate the results of the analysis by overlaying the map that has been analyzed before [14] with the following stages:

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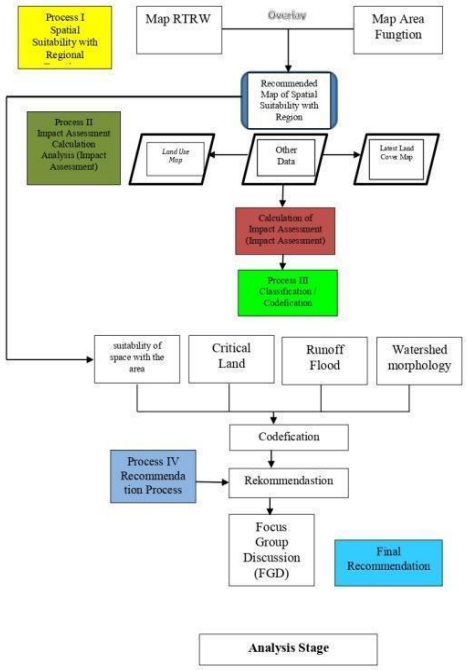

Figure 4. Internalization Stage

The results of internalization of ecosystem management of watershed areas are as follows: Recommendations management direction vegetative by conducting Greening Plants and Reforestation / Enrichment to areas that are considered prone to erosion and have flood-prone with the following results:

Table 10. Recommendations for management directives with rehabilitation programs vegetative forests and land

No.	Types of Vegetative Activities	(Ha)	Presentasi (%)	Ket
1	Greening/Agroforestry/Plantation/People's Forest	17,212	36.06	
2	Reforestation/Enrichment/Agroforestry	12,653	26.51	
3	Non	17,861	37.42	
	Quantity :	**47,726**	**100**	

Recommendation of Management Directive by making technical civilian buildings in the form of Land and Water conservation buildings guided by [15]with the following internalization results:

Table 11 Recommendations management directive by making technical civil buildings in the form of conservation buildings land and water with the results of internalization

No.	Types of Conservation Buildings	Broad (Ha)	Presentation (%)	Information
1	DPN/Gulud Terrace/Individual Terrace/Bench Terrace	13.430	28.14	
2	Gully Plug/Gulud Terrace/Individual Terrace	25.009	52.40	

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3	Infiltration Wells/Biopores/Dpi/Water Management Infrastructure Genagan (Reservoir,/Embung/Drainage Flood Way, etc.	3.950	8.28	
4	Non	5.337	11.18	
	Quantity :	**47,726**	**100**	

IV. Conclusion

1. The condition of the Lamasi Watershed area needs attention; this can be seen from the critical land condition of the watershed area consisting of a rather kriti, critical, and very critical area of 32,154 ha or 67.37% of the total watershed area.
2. Internalization results show that the Lamasi Watershed area needs to be greened and reforestation activities so that the ecosystem as a buffer to avoid flooding and erosion, can return to function as before; internalization results show for greening activities 36.06% or 17,212 ha from the watershed area and reforestation/enrichment activities 26.51 % or 12,653 Ha.
3. Recommendations management direction for the construction of technical civil buildings in the form of land and water conservation buildings dominated by the manufacture of Gully Plug / TerasGulud / TerasBangku in accordance with the conditions of the Watershed area is mostly with slopes above 30% and prone to flooding.
4. With this, Internalization can know the direction of ecosystem management activities that can be done through forest and land rehabilitation programs implemented by the Watershed Management Center.

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