Combination of Ecological and Hidraulical in River Management

by Nurlita Pertiwi

COMBINATION OF ECOLOGICAL AND HIDRAULICAL IN RIVER MANAGEMENT (CASE STUDY AT LAWO RIVER SOUTH SULAWESI)

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ABSTRACT: Ecohydraullic is a concept that combines ecological and hydraulical aspect in managing river environment. The ecological issues in this research is the vegetation grown in the river bank as flood retention, while hydraulical aspect refers to the flows of water in river bank to reduce flooding. The aims of the research were to obtain the diameter of vegetationin the river bank and the river management techniques that can reduce the velocity of flow. There are five stages in this study are hydrology analysis, hydraulics analysis, land use analysis, flooding analysis and ecohydraulic analysis. Hydrology analysis is used to obtain 50 annual flood discharge while the hydraulic analysis used to find the flood water level. Land use analysis to obtain the potential land use along the river and the flooding analysis describe the the risk of flooding in the riverbank. Ecohydraulic analysis is used to obtain the optimal width of the banks, the diameter of which is suitable for the management of vegetation along the river as well as the high floodwaters. The results of the analysis suggests that the diameter vegetation of riverbank between 10 cm and 20 cm and width of riverbanks are 100 meters - 150 meters. With the ecohydraulic concept, the river management techniques can reduce the water level along the river and the velocity of flow. Without banks arrangement, flood water level is more than 2.6 meters and the presence of structuring and vegetation in the banks the water level to 0.7 meters - 2.5 meters . The flow velocity can be reduced between 10 % - 76 % . Based on this research, it is known that the arrangement of riverbanks can provide benefits in flood control measures . This arrangement is the basis in determining the demarcation line of the river .

Keywords: Ecohydraullic, riverbank, flooding

INTRODUCTION

Most of rivers in Indonesia often suffer flooding or overflowing. Excessive water volume or amount of discharge water during the rainy season can cause flooding. Overflow of river water as a result of high rainfall will generate surface water. A small portion of rainwater percolate into the ground, while most of the flows on the surface of the ground and to get to the river. Floods are an inevitable function of the hydrologic cycle, and flood cycles were originally seen as blessings because they sustained riverine ecosystems and the floodplain economies dependent on them. (Tarlock, 2012)

The other side, flood with great discharge is considered as disaster. Flooding causes loss of material and sometimes caused of human deaths. Floods that inundated houses, fields of agriculture and other infrastructure can cause a much harm to the the public. Furthermore, floods lead economic losses of both personal and community. With these considerations, the government has to be able to manage the river and flood control.

A variety of well-established measures are used to mitigate floods. They can divided in two methods are structural and non structural. Structural methods such as storage reservoir, detention basins, levees and flood walls, channel modification, land treatment, emergency flood fighting, floodproofing, stormwater management. While non structural methods are flood forecasting, floodplain regulation, coastal zone management, evacuation, relocation, flood insurance, and land acquisition. (Changnon, et.al. 1983).

Flood plain is an area of land that is prone to flooding. In the dry season, this area is not inundated and can be used by humans as a rice field or plantation. While at large flow condition, this area inundated. Also, floodplain as referred to riparian. Specifically, Government of Indonesia regulate the floodplain in Government Regulation No. 38 of 2011 about River. The regulation adjust that borders the river as a buffer space between the river ecosystem and the mainland, so that the river functions and human activities are not mutually disturbed. Definition of riparian areas is a virtual line in left and right riverbed, while the riverbanks is the space between the edge of the riverbed and foot embankment located in the left and right of the riverbed. So, in Indonesia floodplain regulation covered the quality of riparian and riverbanks.

River morphology illustrates integration between abiotic characteristics (physical, hydrology, hydraulics, sediment, etc.) and biotic characteristics (biological or ecological) area which it passes. Factors that influence the morphology of the river not only abiotic and biotic factors but also human activities in the basin (socio anthropogenic).

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Influence of human intervention can result changes in river morphology faster than the natural influence abiotic and biotic.

Waryono (2008) illustrates the river morphology in figure 1.

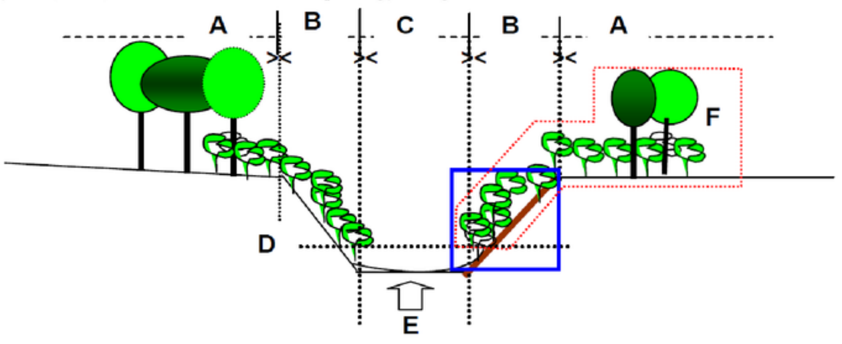


Figure 1. River Morfologi (Waryono, 2008)

River morphology includes not only the body but also the surrounding areas of the river. A is the area along the river which is a barrier between the river`body with the surrounding areas. Area B is a river edge that is limiting the flow area. Area C is water bodies and D shows the water level. The vegetation that grows on the banks of the river and also called riparian vegetation.

Ecohydrullic concept can be developed with eco-engineering approach or the utilization of ecological components to repair the physical structure of the river basin. Ecohydraullic intended to preserve the ecological components in the environment of the river in hydraulic engineering. Application of concept on the river as the protection of river bank erosion is the manufacture of riparian buffer strips or planting vegetation on the riverbanks. With the vegetation planted on the riverbank also cool river water creates a good environment for the growth of various types of aquatic animals. Theoretical foundation of eco-hydraulic engineering, namely vegetation with plant canopy will reduce the velocity of the water to the ground. By reducing the speed of the water in the river downstream flooding problems in the area can be reduced and the natural conditions of the river can be maintained. (Maryono,2005).

Based from the problems, the aims of the research were to obtain the diameter of vegetationin the river bank and the river management techniques that can reduce the velocity of flow.

MATERIAL AND METHODS

This research is located on the River Lawo Soppeng Regency which is part of the regional unit of Walanae River - Cenranae. Administratively the study area is located in South Sulawesi Province. The watershed area is 17 104,45 ha. There are five stages in this study are hydrology analysis, hydraulics analysis, land use analysis, flooding analysis and ecohydraulic analysis. Hydrology analysis is used to obtain 50 annual flood discharge while the hydraulic analysis used to find the flood water level. Land use analysis to obtain the potential land use along the river and the flooding analysis describe the the risk of flooding in the riverbank. Ecohydraulic analysis is used to obtain the optimal width of the banks, the diameter of which is suitable for the management of vegetation along the river as well as the high floodwaters.

RESULT AND DISCUSSION

Hydrology Analysis

Nakayashu hydrograph as result of this analysis in three locations for 50-year return period are presented in Figure 2.

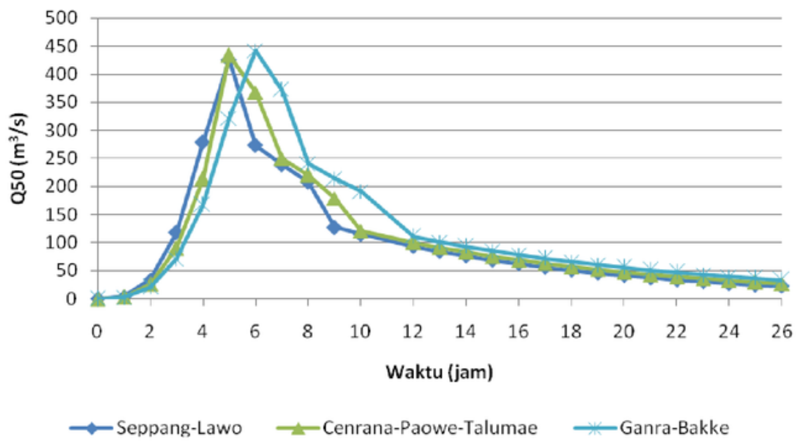


Figure 2. Hydrograph Nakayashu

Nakayashu hydrograph shows the time spent from the beginning of the rain until the flood peak is 4 hours at the local and regional Seppang-Lawo, Cenrana-Paowe-Talumae. Peak discharge in the first region is 425,432 m^3 / s. While the second area is 433,795 m^3/s. In the area Ganra-Bakke flood peak occurred with peak discharge of 441,692 m^3/s.

The analysis shows that downstream areas suffer greater peak discharge, this is due to the accumulation of river flow. The maximum discharge calculation results for the three regions as shown in Table 1.

Table 1. Maximum Discharge at Lawo River

Period (Year)	Qmax (m^3/s)		
	Seppang - Lawo	Cenrana-Paowe-Talumae	Ganra – Bakke
2	256.326	257.458	295.549
5	320.418	279.918	322.612
10	359.269	366.255	362.496
20	393.876	395.121	391.820
25	404.493	412.358	409.150
50	425.432	433.705	441.692

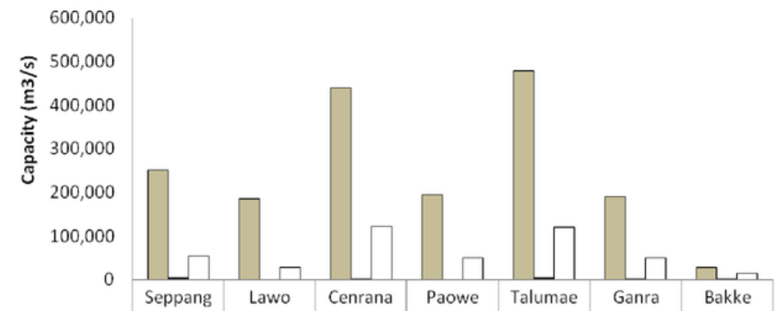
Hydraullic Analysis

The characteristics of the cross section in the river upstream, midstream and downstream varies greatly. (Table 2)

Table 2. Characteristics Of The Cross Section

Lokasi	Lebar dasar (meter)			Lebar Atas (meter)		
	Max	Min	Rata-rata	Max	Min	Rata-rata
Seppang	29.6	12.8	20.9	49.6	26.1	35.7
Lawo	31.2	6.6	17.9	49.1	14.4	30.2
Cenrana	48.0	10.3	28.0	58.2	31.0	41.4
Paowe	37.2	11.2	21.2	48.3	21.1	32.0
Talumae	44.0	5.9	24.1	52.0	13.2	33.3
Ganra	26.8	2.2	18.2	53.9	7.4	24.6
Bakke	16.0	11.2	13.7	53.9	30.3	36.0

Based on hydraulics analysis obtained by the variation of the capacity of the river as in Figure 3.



	Seppang	Lawo	Cenrana	Paowe	Talumae	Ganra	Bakke
Max	251,908	185,348	440,588	195,631	480,240	190,722	29,284
Min	4,426	1,894	3,831	1,078	4,512	2,238	2,659
Average	55,065	29,107	122,794	51,071	121,044	49,895	15,369

Figure 3. River Capasity

Land Use Analysis

Riverbanks is an area that receives the threat of flooding, but with its strategic location and the nearest water source, the banks used by the community. Conditions of land use on river banks along the river Lawo largely covered by paddy field. On the right side of the river, there is a paddy field as much as 43% were on the left side of the paddy field as much as 30%.

Flooding Analysis

Description of flood events at each location shows that Lawo River suffered major flooding, especially in areas downstream. The threat can not be reduced even with the efforts to normalize the river and constructing embankment partially. Analysis of flood load indicate the magnitude of the threat of flooding in Seppang, Lawo, Cenrana and Paowe is less than 2 meters, was Talumae suffered flooding threat greater than 2 meters.

Ecohydraullic Analysis.

Ecohydraullic analysis results that flood plains planted with trees in diameter 10 cm - 20 cm can reduce the threat of flooding. The width of the banks varies between 100 meters to 150 meters. The design width of riverbanks and vegetation diameter and can accommodate a minimum of 50 annual discharge plan can be seen in Table 3.

Table 3. Ecohydraullic Analysis In Lawo River

Location	Width of banks (meters)		Diameter of vegetation (cm)
	Left	Right	
Seppang	150	150	10
Lawo	150	150	10
Cenrana	150	0	10
Paowe	120	120	20
Talumae	100	100	10
Ganra	0	120	10
Bakke	150	150	10

Ecohydraullic analysis indicate that the inundation water at various points decrease significantly, so that flood damage can be reduced. Ecohydraullic is one of the efforts to reduce flood losses through made area immune to flooding (floodproofing) for certain property and processing floodplains (Linsley et al, 1996). Results of the analysis are presented in Table 4.

Table 4. Inundation Level Reduction In The River Due To The Concept Ecohydraullic

Location	Inundation high (meter)				. Inundation level reduction (meter)
	Without ecohydraullic		ecohydraullic		
	Left	Right	Left	Right	
Seppang	2.885	1.635	1.821	0,571	1.064
Lawo	3.975	2.895	1.456	0,376	2.519
Cenrana	2.626	0.000	1.689	0.000	0.937
Paowe	4.724	3.124	2.491	0.891	2.233
Talumae	3.595	3.505	1.901	1.811	1.694
Ganra	6.555	8.975	0.000	0.734	8.241
Bakke	11.251	10.971	2.221	1.941	9.030

Decreasing of inundation level is due to the magnification of the cross section of the river or riverbanks flooded areas. It is based on the theory that the width of the riverbanks causing an increase in the capacity of the river so that the water level happens to be lower. By vegetation planting in riverbanks, the flow of water can be retained on the banks so that the streamflow be lower. It means that ecohydraullic requires flood-resistant areas to minimize the threat of flooding in downstream areas.

Ecohydraullic analysis also verify that velocity of streamflow can be reduce. The velocity reduction at manu location varies between 10% to 76% . (Table 5)

Table 5. Reduction Of Streamflow Velocity

Location	Width of banks (meters)		Diameter of vegetation (cm)	V (m/s)		V reduction (%)
	Left	Right		Without ecohydraullic	ecohydraullic	
Seppang	150	150	10	2.344	0.897	62
Lawo	150	150	10	1.550	0.703	55
Cenrana	150	0	10	3.751	0.899	76
Paowe	120	120	20	1.901	0.845	56
Talumae	100	100	10	2.448	0.699	71
Ganra	0	120	10	1.707	1.542	10
Bakke	150	150	10	1.602	0.621	61

Decreasing water velocity by vegetation on the banks due to the increased interaction region (width of the banks) and the losses kinetic energy due to friction between the face . Its supported by Sadeghi et al. (2010) that the presence of vegetation on the riverbanks can cause differences in velocity water in water bodies and on the riverbanks. With the vegetation on the riverbanks, the velocity of water in the river banks is much smaller when compared to velocity the water in the river. With the vegetation, then there is momentum transfer lateral, shear forces and energy loss and increased flow resistance. Similarly, Sun et al. (2010) resulted that the vegetation on the riverbanks greatly affect the pattern of streamflow, decrease speed and increase friction between the flow and basic channels (increasing the value of the drag coefficient).

Ecohydraullic analysis that generate optimal width of the banks is also a base or reference in determining the border line of the river. It should be considered to enhance Government Regulation No. 38 of 2011 about the river. The policy regulate that border line of small river outside urban areas (without levee) at least 50 meters from the edge of the left and right of the riverbed along the river channel.

CONCLUSIONS

The diameter vegetation of riverbank between 10 cm and 20 cm and width of riverbanks are 100 meters - 150 meters. With the ecohydraulic concept, the river management techniques can reduce the water level along the river and the velocity of flow. Without banks arrangement, flood water level is more than 2.6 meters and the presence of structuring and vegetation in the banks the water level to 0.7 meters - 2.5 meters . The flow velocity can be reduced between 10 % - 76 % . Based on this research, it is known that the arrangement of riverbanks can provide benefits in flood control measures . This arrangement is the basis in determining the demarcation line of the river .

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