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Calculation Analysis of Erosion Rates and Sedimentation Transport in the Liliba Watershed

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ABSTRACT

Erosion is the loss or erosion of land or parts of land from a place by water or wind. Erosion causes the loss of fertile soil layers good for plant growth and reduces the soil's ability to absorb and retain water. The Liliba watershed area in Kupang City includes Maulafa District, Oebobo District, and Kelapa Lima District. The Liliba River Watershed (DAS) is part of the development of the Noelmina River area, which flows into Oesapa Beach. The Liliba watershed has an area of 4,534 hectares with a central river length of 20,176.22 m. Using the USLE Method and SDR Transport Analysis, it was found that the erosion that occurred was 3.72 tonnes per year, and the amount of sediment transport that occurred was 2.73 tonnes per year.

Introduction

The biggest challenge in managing natural resources is to create and then maintain a balance between fulfilling the needs of human life and the sustainability of the use and existence of natural resources (Asdak, 2023). The primary natural resources, namely land and water, are renewable but easily damaged or degraded. Soil damage can occur by (1) loss of soil elements and organic material in the root area, (2) accumulation of salt in the root area, (3) saturation of the soil with water, and (4) erosion. This soil damage causes a reduction in the soil's ability to support plant growth (Anasiru, 2015).

According to (Neolaka et al., 2022), erosion is the loss or erosion of land or parts of land from a place by water or wind. Erosion causes the loss of fertile soil layers good for plant growth and reduces the soil's ability to absorb and retain water. A river basin (DAS) is a land area topographically limited by mountain ridges that collect and store rainwater. It becomes a water catchment area to channel it to the sea via the main river (Asdak, 2023). A water catchment area is an ecosystem whose main elements consist of natural resources, including land, water, and vegetation, as well as human resources as users of natural resources (Soetedjo, n.d.).

The Liliba river basin (DAS) is administratively located in 2 (two) administrative areas, namely Kupang City and Kupang Regency. The Liliba watershed area in Kupang Regency includes Nekamese District and Taebenu District. The Liliba watershed area in

Kupang City includes Maulafa District, Oebobo District, and Kelapa Lima District. The Liliba River Watershed (DAS) is part of the development of the Noelmina River area, which flows into Oesapa Beach (Seran, 2022). The Liliba watershed has an area of 4,534 hectares with a central river length of 20,176.22 m. The Liliba watershed serves the community's agricultural needs, flood control, and tourism activities (Kupang et al. Number 12 of 2011). Currently, there are many social activities along the banks of the Liliba River. This can be seen in many residential developments, even those on the river's edge. It can also be seen that a lot of rubbish is thrown into the river basin. This, of course, also influences the emergence of sedimentation in river basins (Sudira et al., 2013). This research aims to obtain initial data so that it can be compared again with analyses that will be carried out in the next 5 or 10 years. This research aims to determine the rate of erosion in the Liliba watershed using the Usle method.

Research Methods

The research was conducted in the Liliba River Watershed, Kupang City

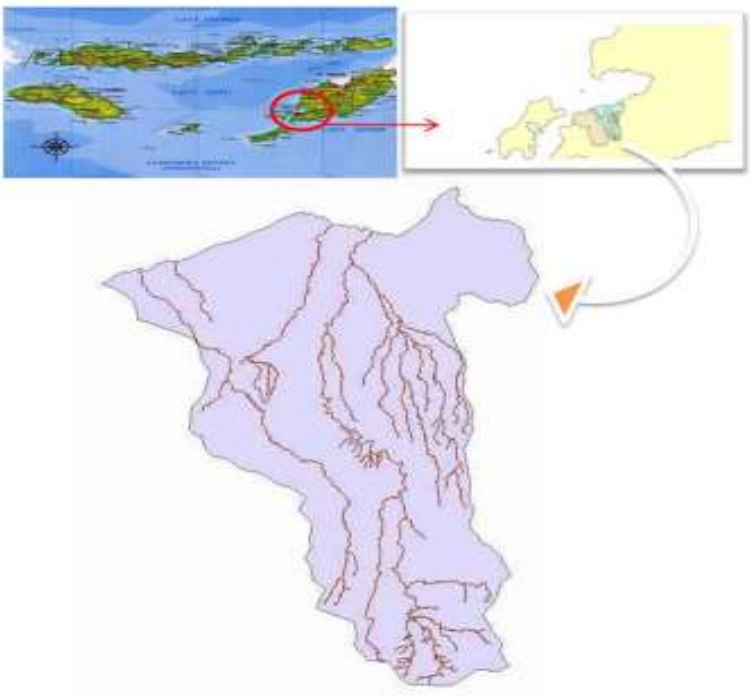

Figure 1
Location of the Liliba watershed

The first analysis is erosion analysis using the USLE method.

The research method used in erosion analysis is the USLE (Universal et al. Equation) method, which involves several essential steps. First, primary data on the study location, including soil type, topographic characteristics, rainfall patterns, and land use, were carefully collected. Furthermore, these parameters will be used to calculate erosion using the USLE formula. The next step is to apply the USLE formula, which includes soil erosion, slope, land cover, and land management factors. The data that has been collected will be processed and analysed using this method to produce an estimate of the level of soil erosion at the study location. Subsequent analysis will compare these results with existing erosion standards and identify the main factors contributing to soil erosion in the area (Sujatmoko & Hirvan, 2022). This approach is hoped to provide an in-depth understanding of the level of soil erosion and the factors that influence it, which can be used for more sustainable land management and environmental protection.

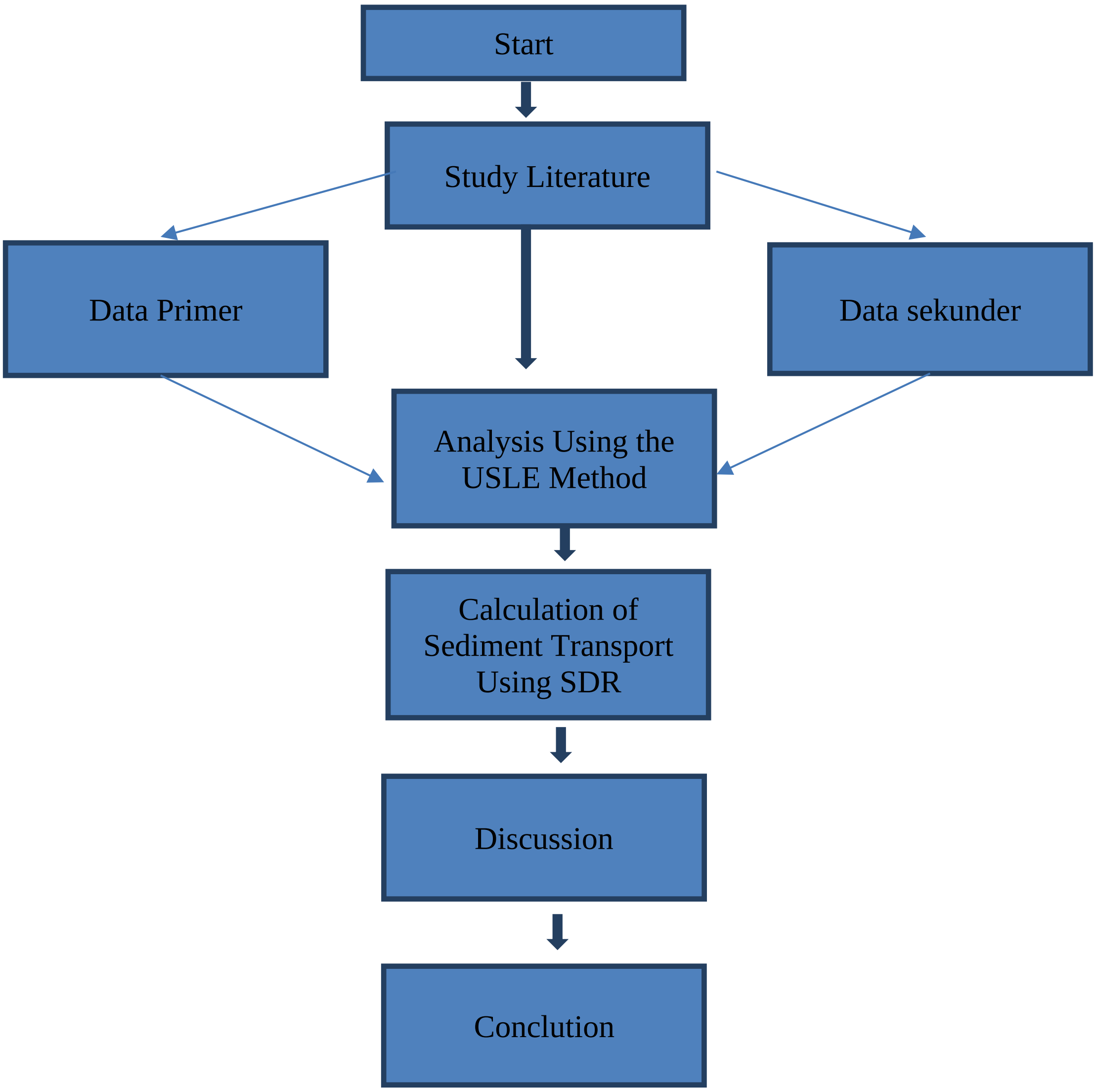

Figure 2 Research Flow Diagram

Results and Discussion

The Liliba watershed is in Kupang Regency (upstream) and Kupang City (middle and downstream). Taebenu sub-district, Kupang Regency on the east side, and two sub-districts in Kupang City, namely Maulafa sub-district and Oebobo sub-district. Meanwhile, the downstream part is the Kelapa Lima sub-district in Kupang City (Fathan, 2022). The dominant soil type in the Liliba watershed area is Alluvial, with an Erodibility Value (K) of 0.315 (Rizkia & Putri, 2019).

Erosion Analysis Using the USLE Method

When analysing rainfall data, erosion analysis was used to obtain the R-value. Rainfall calculations use Rain Data from El Tari Kupang Station.

Table 1

Rainfall Calculation for 1998 – 2008

Tahun	Jaruari	Februari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember
1998	564,00	306,00	139,00	117,00	11,00	3,00	28,00	-	-	70,00	312,00	273,00
1999	444,00	702,00	451,00	111,00	-	-	-	-	-	61,00	185,00	221,00
2000	**577**	**592**	**440**	**164**	**76**	**0**	**0**	**0**	**0**	**26**	**157**	**161**
2001	**365**	**322**	**139**	**19**	**0**	**49**	**19**	**0**	**0**	**30**	**192**	**274**
2002	**235**	**550**	**233**	**50**	**0**	**0**	**0**	**0**	**43**	**0**	**134**	**148**
2003	**314**	**714**	**316**	**28**	**0**	**21**	**0**	**0**	**0**	**56**	**107**	**666**
2004	**96**	**467**	**249**	**0**	**13**	**0**	**0**	**0**	**0**	**22**	**104**	**324**
2005	**253**	**229**	**198**	**35**	**0**	**1**	**0**	**0**	**0**	**23**	**92**	**300**
2006	**500**	**154**	**582**	**233**	**13**	**20**	**0**	**0**	**0**	**0**	**17**	**247**
2007	**305**	**328**	**415**	**124**	**0**	**27**	**0**	**0**	**0**	**0**	**91**	**205**
2008	**232**	**848**	**150**	**50**	**0**	**9**	**0**	**0**	**0**	**15**	**121**	**502**
Jumlah	3.885,00	5.212,00	3.312,00	931,00	113,00	130,00	47,00	-	43,00	303,00	1.512,00	3.321,00
Rata - ra	323,75	434,33	276,00	77,58	9,42	10,83	3,92	-	3,58	25,25	126,00	276,75
Jumlah Hujan Rata - rata dalam 10th												1.567,42

Based on the rainfall data above, the erosivity value that can be calculated is seen in Table 2.

Table 2

Erosivity values for the Liliba watershed

Tahun	Jaruari	Februari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember
CH	32,38	43,43	27,60	7,76	0,94	1,08	0,39	-	-	2,53	12,60	27,68
R	97,31	130,54	82,95	23,32	2,83	3,26	1,18	-	-	7,59	37,87	83,18
∑R												470,03
												47,00
											R =	415,41

Soil Erodibility Value (K) is obtained from secondary data collection through digital maps of the distribution of soil types in the Noemina watershed obtained from BWS NTT II. The soil type in the Liliba watershed area is an alluvial soil type with a soil erodibility (K) value of 0.315 (Upadani, 2017). The Liliba watershed area has a diverse topography using GIS tools. The average LS factor value obtained in the Liliba watershed can be seen in Table 3:

Table 3
Table of Slope Slope and S Factor Values in the Liliba Watershed

No	emiringan (%	Klasifikasi	Luas (Ha)	Persentase	Persentase
				%	Terhadap Luas
1	0 - 5	Datar	8,90	26,50	0,26
2	5 - 15	Landai	17,39	51,78	0,52
3	15 - 30	Agak Curam	6,66	19,83	0,20
4	30 - 45	Curam	0,63	1,88	0,02
5	> 45	Sangat Curam	0,01	0,02	0,00
				100,00	
Jumlah			33,58		1,00

Calculation of Slope Length (LS)
Slope length-slope factor:
LS = (L/22) z (0.006541S2 + 0.0456S + 0.065)
Is known:
Slope Length (L) = 20,167 m
z = 0.3
S = 0.24
So, LS = (20167/22)0.3 (0.006541(0.24)^2 + 0.0456(0.24) + 0.065)
LS = 0.18 m

Next, calculations are carried out to find the value of the Land Cover Factor (C) and Soil Conservation (P), which can be seen in Table 4 below:

Table 4
Determining the Average CP in the Liliba Watershed

Keterangan	Luas (HA)	Persentase (%)	% Thdp Luas	Nilai CP	CP xLuas
Badan Air	3,36	10,00	0,10	0,001	0,00
Belukar	8,40	25,00	0,25	0,3	2,52
Hutan Lahan Kering	1,34	4,00	0,04	0,1	0,13
Hutan Tanaman	6,72	20,00	0,20	0,05	0,34
Pemukiman	1,34	4,00	0,04	1	1,34
Persawahan	4,70	14,00	0,14	0,1	0,47
Tambak	2,69	8,00	0,08	0,001	0,00
Tanah Terbuka	5,04	15,00	0,15	0,1	0,50
	33,58	100,00	1,00		5,31
A Total	0,34	km2		Nilai CP	0,16

So the estimated amount of erosion per area (ha) is:
A = R x K
= 415.41 x 0.315 x 0.18 x 0.16 x 1
= 3.72 Tons/Ha/Year
So, the amount of sediment transported per year is

SDR : 0.5656 x Atot ^-0.11
:0.5656 x 33.58^-0.11
:0.64
So, the annual sediment transport obtained is:
Ae = Total Erosion per Year x SDR Value
= 3.72 x 0.64
= 2.73 Tons/Ha

Conclusion

From the research results, it is known that the average rainfall in ten years is 1567.42 mm, Rain Erosivity value (R) = 415.41, with the most dominant slope being 5-10% with a value of S = 0.24, the dominant soil type is alluvial with a value of K = 0.315. From the values above, it is known that the amount of erosion that occurs is 3.72 tons per year, and the amount of sediment transport that occurs is 2.73 tons per year.

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