Study of Sediment Transport in Krueng Meureubo River of Padang Mancang Village Kaway XVI Sub District Aceh Barat District

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Abstract. This research was conducted to see the rate of sediment transport in the Krueng Meureubo watershed in Padang Mancang Village, Kaway XVI Subdistrict, West Aceh Regency, where in this village floods often occur due to overflowing of the river, which is predicted to occur due to river silting. The ability of the river to accommodate the flow at the time of flood discharge decreases due to silting caused by sedimentation of sediment grains originating from erosion of land in the watershed area. Soil erosion is caused by erosion of soil layers due to rain that occurs on land that is prone to erosion, such as open land, forests that have been damaged due to illegal logging and areas whose land functions are transferred. Method used to analyze the sediment transport rate in the Krueng Meureubo watershed is Yang's method, where the data to be analyzed is primary data in the form of direct measurement results in the field such as river cross-section data, flow velocity and bedload sampling using a sediment trap and suspended load in the river. The amount of sediment transport that occurred along the Meurebo River in Padang Mancang Village was 52.7634168 tons / year.

Keywords: Bed load, Krueng Meureubo watershed, sediment transport, Yang’s

1. Introduction
Siltation of the river is one of the causes of flooding that often occurs in several regions in Indonesia, the ability of the river to accommodate the flow when the flood discharge decreases due to silting, this usually occurs in the downstream river, so the people who bear the effects of this are the community which is downstream of the river. One of the reasons for river siltation is the large amount of sediment material transport into the river that originates from the erosion of land in the River Basin (DAS). Soil erosion or often called erosion is caused by erosion of soil layers due to rain that occurs on land that is prone to erosion, such as open land, forests that have been damaged due to illegal logging and areas whose land functions are transferred. Erosion that occurs continuously and into the river can cause build up in certain parts of the river and silting occurs. This shallowing causes the height and appearance of the river flow to be smaller than before. One indicator that can be seen in river bodies when erosion occurs upstream is that river water becomes turbid due to suspended sediment material. The description of the amount of the ratio of sediment transported in each sub-watershed is based on the value of the results of the erosion process deposited on the land or also into the river [1]. According to [2] there are 2 types of sediments found in rivers namely suspended sediments and bed sediments. Elevated sediment measurements can be done by taking river water samples through direct sampling methods (grab
samples; for homogeneous rivers) or depth integrated methods (depth integrated; for deep and non-
homogeneous rivers). This study was conducted to see the rate of sediment transport in the Krueng.

Meureubo watershed in Padang Mancang Village, Kaway XVI Subdistrict, West Aceh Regency, where in this village floods often occur due to overflowing of the river, which is allegedly caused by river silting. Normalization of the Krueng meurebo river located in Tumpok Ladang Village, Kaway XVI Subdistrict, West Aceh Regency, where this village is a village adjacent to Padang Mancang village which is also located along the Krueng Meureubo River. Based on the analysis states that the results of the normalization plan carried out is to expand and deepen the shape of the river crossing with a plan width of 116 m and river depth of 3.00 m. From the comparison between the discharge due to flooding with the existing river discharge that is Q flood <Q existing river so that the capacity of the river is able to accommodate the discharge due to rain so that such conditions can be said to be safe and not flooding. 

Padang Mancang Village, Kaway XVI District, West Aceh Regency is one of the villages that is vulnerable to flooding. This village is located in the Krueng Meureubo River Basin. Based on the results of surveys and interviews at the location, the floods that occur every year in the village are getting worse and result in river silting, siltation of the river that occurs due to sedimentation.

2. Research Method

2.1. Research Location
This research is located in Padang Mancang village, Padang Mancang Village is one of the villages located in Kaway XVI Sub district, Aceh Barat District. Geographically, Padang Mancang Village is located at position 04°01’0” Latitude and 96 ° 10’0” Longitude. Research location can be seen in figure 1.

![Figure 1. Research location.](image)

2.2. Primary Data
Primary data is taken in the form of bed load and suspended load samples, as many as 6 samples consisting of 3 samples from the right side of the river and 3 samples from the left side of the river. Mechanism of sediment uptake is carried out by means of sediment traps and direct retrieval for bed
load at the river banks whose depth allows it to be taken directly. Sediment trap tool can be seen in Figure 1.

![Sediment trap tool](image)

**Figure 2.** Sediment trap tool.

2.3. Secondary Data
Secondary data is data obtained from various sources or related institutions and is needed in completing this planning study. Secondary data in this plan include data:
1. Map of Krueng Meureubo watershed
2. Rainfall data from BMKG Cut Nyak Dhien Nagan Raya
3. Topographic map
4. Map of Krueng Meureubo river profile

2.4. Data Analysis Method
Data analysis is a data processing that is carried out to get the desired results. Analysis of the data in this study includes the analysis of the calculation of the amount of sedimentation. To analyze the amount of sedimentation from an area is the calculation of the method. The amount of sediment value is expressed as the volume or weight of the sediment per unit area per unit time. The unit commonly used to indicate the amount of sediment yield is tons/ha/year.

3. Result and Discussion
Krueng Meureubo river dimension Analysis results Padang Mancang village dimension data or river physical data is data on the existing condition of the river, including river length, river width, river depth and river area. This data was directly collected at the research location in the village of Padang Mancang. The results of dimensional analysis of the Krueng Meurebo River, Padang Mancang Village Kaway XVI District can be seen in Table 1.

| Number | Parameter      | Value     |
|--------|----------------|-----------|
| 1.     | Watershed      | 490.1255 km² |
| 2.     | Base Width     | 80.48 m   |
| 3.     | River Depth    | 4.65 m    |
| 4.     | Temperature    | 28°C      |
The results of river flow velocity measurements in Padang Mancang village were measured manually at the study site with an average speed value of 0.837 m/s. This data will also be used for gabion planning. For more details, measurements of river flow can be seen in Table 2.

| Velocity Measurement  | Distance (m) | Time (s) | Velocity (m/s) |
|-----------------------|--------------|----------|----------------|
| River Left Side       | 10           | 10       | 1              |
| Middle                | 10           | 12       | 0.833          |
| River Right Side      | 10           | 13       | 0.769          |
| Average               |              |          | 0.837          |

Sediment samples to be analysis in this calculation are six samples, where this sample consists of three samples from the right side of the river and three samples from the left side of the river. The size distribution of sediment grains can be seen in Table 3.

| Number | Percentage (%) | Diameter |
|--------|----------------|----------|
| 1      | 13.6346        | 9.500    |
| 2      | 13.0516        | 4.750    |
| 3      | 12.7375        | 2.00     |
| 4      | 12.2795        | 0.850    |
| 5      | 12.1322        | 0.425    |
| 6      | 12.0622        | 0.250    |
| 7      | 12.0529        | 0.075    |
| 8      | 12.0489        | PAN      |

The data in analyses total sediment transport using the Yang method is as follows.

Flow velocity \( (V) = 0.837 \text{ m/s} = 2.745 \text{ ft/s} \) \hspace{1cm} (1)

Temperature \( = 28^\circ \text{ C} = 9/5 \times 28 + 32^\circ = 82.4^\circ \text{ F} \) \hspace{1cm} (2)

Based on Yang's (1996), the kinematic velocity of water is determined in the Properties of water table. The analysis can be calculated as follows.

| Temperature (°F) | Kinematic velocity x \( (10^{-5}) \text{ ft}^2/\text{s} \) |
|-----------------|----------------------------------------------------------|
| 80              | 0.930                                                    |
| 90              | 0.826                                                    |

Because the available temperature data is 82.4° F, the kinematic velocity of water is calculated using the linear interpolation method.

\[
V = (0.930 + \frac{82.4-80}{90-80}) \times (0.930-0.826) \times 10^{-5} \\
= 9.0504 \times 10^{-6}\text{ft}^2/\text{s}.
\] \hspace{1cm} (3)

The grain form factor is taken in accordance with the analysis by [4] which is 0.7. Based on these form factors, the value of sediment fall velocity based on Yang's is 4 cm / s or equivalent to 0.13123 ft/s.

In addition to these data, other data used are as follows:
River Depth (D) = 4.65 m = 15.252 ft
Gravity (g) = 9.81 m/s² = 32.1846 ft²/s.
Slope (s) = 0.0002

Based on these data, shear velocity or shear speed (U *) can be calculated using the formula:

\[ U^* = \left( g \times D \times s \right)^{\frac{1}{2}} \]  

\[ = \left( 32,1846 \times 15,252 \times 0,002 \right)^{\frac{1}{2}} \]

\[ = 0,0981759 \text{ ft/s} \]

Reynolds number of shear velocity (U *), calculated using the equation below:

\[ Re = \frac{U^* \times d}{v} \]

\[ = \frac{0,0981759 \times 9,0504 \times 10^{-6}}{0,4101} \]

\[ = 44,4842 \]

For example the value 1.2 <Re <70, then the value of VCR / ω can be calculated using the formula:

\[ \frac{V_{cr}}{\omega} = \frac{2,5}{\log\left(\frac{U^* \times d}{v}\right)^{-0.06} + 0.66} \]

\[ \frac{2,5}{\log\left(0,0981759 \times 0,4101\right)^{-0.06} + 0.66} \]

\[ = 2,35709 \]

Analysis of the parameters of the concentration of equation as follows:

\[ \log\frac{wd}{v} = \log\left(\frac{1,64820 \times 0,4101}{9,0504 \times 10^{-6}}\right) \]

\[ = 2,873230 \]

\[ \log\frac{U^*}{w} = \log\left(\frac{0,0981759}{0,13123}\right) \]

\[ = -0,126028 \]

\[ \frac{VS}{W} = \frac{2,745 \times 0,0002}{0,13123} \]

\[ = 0,00418 \]

\[ \frac{Vcr \times S}{w} = \frac{2,5}{0,13123} \]

\[ = 19,050522 \]

\[ \log\left(\frac{VS}{W} - \frac{Vcr \times S}{w}\right) = \log 0,00418 -19,050522 \]

\[ = 1,2798 \]

To calculate the total sediment concentration, consider a relevant relationship between the following variables:

\[ \log Cts = 5,435 - 0,286 \log\frac{wd}{v} - 0,457 \log\frac{U^*}{w} \]

\[ = 5,435 - 0,286 \log 2,873230 -0,457 \log -0,126028 \]

\[ = 5,149 - 0,383192 - 0,8995 \]
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\[ (1,799-0.409 \cdot \log \frac{w_d}{v} - 0.314 \log \frac{\mu_s}{e_w}) \log \left( \frac{v}{w} \frac{v_s}{c_r} \right) \]  \hspace{1cm} (13)

\[ = 1,3899 - 0.408092 - 0.8995 - 0.1077 \]

\[ = 1,061116 \]

\[ G_w = v \times W \times D \times V \]  \hspace{1cm} (14)

\[ = 49,7244569 \]

\[ Q_t = Cts \times G_w \]  \hspace{1cm} (15)

\[ = 1,061116 \times 49,7244569 \]

\[ = 52,7634168 \text{ ton/year} \]

4. Conclusions

a. Sediment transport that occurs in the Krueng Meurebo River in Padang Mancang Village, West Aceh Regency is strongly influenced by the amount of rainfall that occurs and land conditions in the Krueng meureubo watershed, this causes particles to be transported into the river body through surface runoff.

b. This method is a method which is approached effectively used to predict the amount of sediment transport along the Krueng Meurebo River in Padang Mancang Village, West Aceh Regency, because in this method estimates the bed load transportation that occurs.

c. the amount of sediment transport that occurred along the Meurebo River in Padang Mancang Village was 52,7634168 tons / year, and it was spread over the river bodies, both the left and right sides of the river, but the shape of sediment particles on both sides of the river was very different, seen from the sample obtained, on the right side of the river the particles tend to be finer, this can be concluded that the particles eroded in this section are very much because the granules are very fine.

5. References

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