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Normalization of Way Solepay Watershed in Mamala Village, Central Maluku Regency

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***Keywords*— Normalization, rainfall, river discharge, sedimentation rate**

***Abstract*— Watershed is an area bounded by mountain ridges where rainwater that falls on the area will be accommodated by the mountain ridge and flowed through small rivers to the main river. The increase in population from year to year results in the need for land for shelter and clean water to be very important, thus requiring residents to tend to live on land located on hillside. The resulting impact on the surrounding environment is the reduction in green areas as water catchment areas in river basins, the threat of landslides and floods due to additional loads on the slopes. This study aims to overcome the accumulation of sedimentation which has resulted in water overflows along the Way Solepay watershed and to prevent sedimentation from occurring. The analysis method used in this research is rainfall analysis with the method of Log Percent III, Flood Planning Analysis, Watershed Erosion Analysis, and Sedimentation Analysis. The results of the analysis of this study show that there is a accumulation of sedimentation in the Way Solepay watershed on average every year of 3,599 m3 / day or 1,313,635 m3 / year and how to overcome this is by being transported regularly every year as much as 32,386 m³ / day or 11,954,078 m³ / yrs*

I. INTRODUCTION

Climate change is a global phenomenon, experiencing an increase as a result of human activities such as the use of fossil fuels and changes in land use. One of the changes that occur in the global climate is the increasing frequency and incidence of extreme climates such as storms, floods and droughts.

The development of the population on Ambon Island is increasing from year to year, so that the problem of settlement is the main problem of the government in overcoming the existence of natural disasters such as floods that occur in rivers and settlements. Settlement problems along the Way Solepay River Basin, Mamala Village. This must be considered by the local community and district government. From the results of observations at the research location, part of the Way Solepay watershed area has been damaged, water buffer land has been made into residential land which has resulted in flooding and landslides in the Way Solepay watershed area.

The limited handling of the Regency government and the awareness of the local community to expand the residential area in the Way Solepay watershed resulted in flooding and landslides that brought sedimentation which could cause water overflowing in the river.

The condition of the Way Solepay river in Mamala Village along the watershed has been added to the construction of a 325 meter long retaining wall and a 2 meter high retaining wall, a watershed area = 9100 meters and a watershed width = 12.5 meters.

The way to overcome the sedimentation problem that occurs in the Way Solepayriver is by periodically backfilling the Way Solepay watershed area. Therefore, the analysis of sedimentation transportation in the Way Solepay watershed needs special handling to overcome the water overflow that occurs in every rainy season on Ambon Island. Problems that occur in fact in the research area, the authors raise the title:

"Normalization of Way Solepay Watershed in Mamala Village, Central Maluku Regency".

II. LITERATURE REVIEW

2.1. General Purpose

Flood control is a relative term, because it is not economical to provide protection against the largest possible flood. Since the beginning of human civilization, floods are a natural occurrence that is well documented after describing a series of past floods. Hoye and Langbein (1955) concluded on a generally understood concept of flood control. Nature will let go of all the burdens it carries. Year-round floods cause immeasurable damage and terrible loss of life. Climatologists believe that the current flood rains are caused by a combination of metrological and hydrological conditions that will only occur once in a million years. Reservoir,

2.2. Hydrology

Meteorology is part of a broader hydrological science, which includes observing the occurrence of water in the atmosphere and water on the ground and below the earth's surface. one of the hydrological cycle presentations as shown below

Rain usually occurs in many forms and can change shape during the process. The form of rain in the form of falling water droplets can be classified as drizzle or rain. Drizzle consists of rain with a grain size of <0.5 mm. Larger raindrops are scattered on the air, droplets> 5 mm in diameter are generally unstable. Part of the rain will evaporate partially or completely before it reaches the ground surface. Rain on the ground can be captured by vegetation, infiltrating into the soil to evaporate or become surface runoff. Evaporation can come from the soil surface, free water surface, or from plant leaves through the process of transpiration. Some of the rain will move on the ground as runoff, some will enter the soil used by plants, can become a deep supply of groundwater,

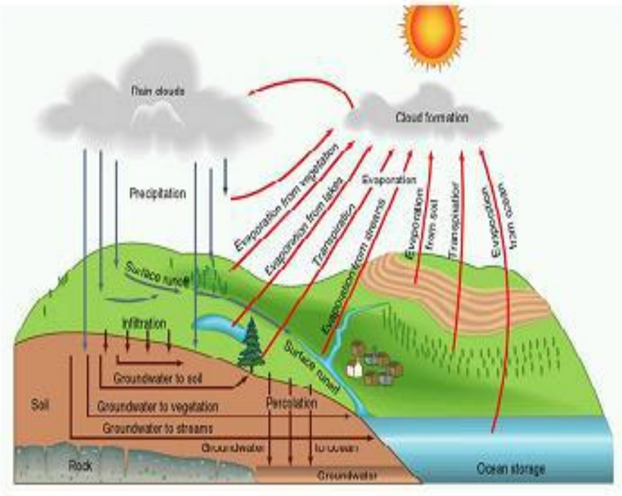

Fig.1: Hydrogen Cycle

(Source: Sandro Wellyanto Lubis 2009)

2.3. Surface Water Runoff

Runoff is the portion of rainfall that flows towards a channel, lake, river or sea as surface or underground flow. Runoff will only occur when the rate of rain exceeds the infiltration rate into the soil. Once the infiltration rate is met, water begins to fill in small or large creases in the soil surface. After the curve is filled, runoff begins. The water depth increases at the surface until it is sufficient to produce a runoff. So a rain in a short period of time may not produce runoff, while rain with the same incentive for a long time will produce runoff, in other words, rainwater that falls to the ground will flow to the ground if the soil infiltration capacity is less than the intensity of rain. The destructive force of water flowing on the ground is greater in proportion to the steeper and longer the slope. Plants that live above the ground will increase the ability of the soil to absorb water and reduce the destructive force of falling raindrops, the dispersion power and the carrying capacity of surface runoff. The rate and volume of runoff from an intermediate catchment area is updated by the distribution of rainfall in the area. The maximum runoff rate and volume play a role but heavy rainfall in a particular part of the catchment area can produce more runoff than moderate rainfall over the catchment. The amount of water that constitutes this layer is highly dependent on the amount of rainwater per unit time (intensity), soil condition (especially the slope), soil type, and the presence or absence of previous rain. Surface layers with a large number and speed often cause the removal or transport of land masses on a large scale as well. This is what is often termed a flood. Floods overflow and cause soil particles called sedimentation.

2.4. Soil Structure

Soil structure is defined as the mutually binding arrangement of soil particles (Soil Survey Staff, 1975).

The slope can be component as shown in the following table:

Table 2: Slope Classification

Symbols	Slope Class	Land Shape
L_O`	0 - 3	Flat
L_1	3 - 8	Slopes / waves
L_2	8 - 1	Slightly sloping / wavy
L_3	15 - 30	Sloping / hilly
L_4	30-45	Somewhat cheating
L_5	45 - 60	Steep
L_6	> 65	Very steep

(Source: Asdak, 2002)

The soil primarily functions as a nesting medium providing most of the way for water flow to move to the surface. The effectiveness of the soil as a means of removing water depends largely on the size and resistance of the channel in the soil. The physical properties of the soil change the infiltration capacity and how large the particles can be separated and transported. Soil properties that explain how easily soil particles can be eroded are their separation and transportability. The properties that renew erosion include soil structure, texture, organic matter, and chemical and biological properties of soil.

2.5. Vegetation and Land Use

Vegetation is one part of the land system that provides benefits for the survival of creatures, especially humans. The existence of vegetation varies from place to place, because it is influenced by different land conditions. Vegetation plays an important role in maintaining soil sustainability because it can inhibit surface runoff and erosion, including: (1) interception of rain by plant canopy; (2) reduce surface runoff and water-destroying force; (3) the influence of roots and biological activities related to vegetative activities and their effect on structural stability and soil porosity; and (4) transmiration which results in reduced groundwater content. Thick ground cover vegetation such as grass or jungle will eliminate the influence of rain and topography on erosion.

Land use according to Aryad (1989; 2007) can be interpreted as any form of human intervention (intervention) on land in order to meet their daily needs. Land use is a dynamic process. Therefore, information on land use relatively quickly becomes out-of-date when compared with geomorphological and soil geological information. Land use can be grouped into two major groups, namely agricultural land use and non-agricultural land use.

2.6. Erosion

Erosion is the event of removing or transporting material in the form of a solution or suspension from the original site by running water (runoff flow), erosion is the loss or erosion of soil or parts of land in a place that are transported by water, wind to other places (Arsyad, 1989). Erosion is an important problem. The damage experienced to the soil where erosion occurs takes the form of a deterioration of the physical and chemical properties of the soil such as loss of nutrients and organic matter, poor infiltration, the ability of the soil to retain water, reduced stability of the soil structure which ultimately leads to worsening plant growth. . (Arsyad, 1989).

The classification of the level of soil damage by erosion according to (Arsyad, 1989) is presented in table 2.

Table 2: Classification of Soil Damage and Erosion Levels

Symbol	Erosion Rate	Information
E0	No erosion	Fixed soil layer
e1	Light	Less than 25% of the top layer is lost
e2	Moderate	25-27% of topsoil is lost
e3	It's a bit heavy	More than 75% of the topsoil up
e4	Weight	More than 25% of that layer is gone
e5	Very heavy	Same with trench erosion

(Source: Ashad, 1989)

2.7. Land Erosion Factors

Factors that influence the amount of erosion in a watershed include:

- Rain Erosion
- Soil sensitivity to rain

- Drought and slope length and tillage factors are closely related to soil cover or vegetation
- Rain Erosion (REI)
  The amount of rain erosivity can be calculated based on the maximum rainfall data for each rainy day every month (from monthly rainfall data)
- Soil Erodibility (K)
  The soil erodibility factor is closely related to the condition and physical soil.
- Slope (LS)
  The slope factor can be calculated based on the empirical formula developed by Wischmeies, namely:
- For the slope (S) <20%, take:
  LS = Lo 0.5 x (0.0138 + 0.00965 S + 0.00138 S2) ... (1)
- For a slope (S)> 20%, is taken;
  LS0,6 1,4 .... (2)
  Where :
  Ls = slope factor
  Lo = Length of flow over the ground
  S = Slope
- Factors on Plant Types and Soil Processing (CP)
  This CP factor has a huge effect on sediment production and the amount of erosion in an area. The size of the CP value can be adjusted based on soil processing activities and by planting certain types of plants on the land
- Erosion Rate
  The estimated magnitude of the permissible erosion rate for a watershed is approached by the following formula (Achlil, 1982):
  A = 4 + 1,226 (10 D - K- 2) .... (3)
  Where :
  A = Permissible rate of erosion (tonnes / ha)
  K = soil erodibility factor
  D = depth of soil layer, (m)

Table 3: Classification of Erosion Hazards

Erosion rate tonnes / ha / year	Classification
0.0 - 12.5	Very small
12.5 - 17.5	Small
17.5 - 25.0	Medium
25.0 - 30.0	Weight
> 30.0	Very Heavy

(Source: Ashad, 1989)

2.8. Stream erosion

In the analysis of river channel erosion, the grain stability of the river bed and the volume of sediment transport will be reviewed.

In a gloomy river channel, in general, sediment transport, seen from the way it moves, can be divided into two, namely;

a. Suspended load where the sediment particles move floating in the water and carried along with the flow
b. Bed load, which moves the particles not far from the river bed and moves, shifts, rolls and jumps individually.

If there is a change in the river either artificially or naturally, the riverbed will change accordingly. Over time an adequate relationship will re-form between the hydraulic properties of the irrigation and the sediment that flows downward and eventually a stable channel will be formed.

Therefore, in making a review / planning of a river, the transverse reservoir must be selected not only based on the flood discharge but also taking into account the condition of the river repair work.

The stable condition of the channel means the condition where along the channel there is no streak and deposition. This means that the amount of sediment flowing in each cross section of the river must be kept stable.

2.9. Analysis of Rainfall Intensity` Bq1awsv bnm

To determine the intensity of rainfall, it is analyzed using the Log Pesen III method with the formula:

$$\sum \frac{\text{LogXi}}{n}$$

Where :

n = Return period in this case n = 10 years

Xi = Average daily rain during observation (mm)

2.10. Calculation of the Flood Plan

Design flood is a large discharge of annual flow caused by rain with a certain ulan period.
Flood plans are different from the largest floods. The largest flood can occur at any time, while the planned flood is expected to occur once for a certain period of time, to calculate the planned flood discharge the following methods can be used:

Flood discharge calculation using the Der Weduwen Method:

Formula: Q = α .β .qn. A .... (4)
Where :

Q = Discharge (m3 / s)
α = Flow coefficient (run off coefficient)
β = Reduction coefficient
qn = Maximum rain (mm)
A = Area of flow

1. The run off coefficient is the ratio between run off and rain:
   α = 1 - 4,1 / (β qn+ 7)... (5)

2. Concentration time (t)
   t = 0.25. L. A -0,126. I-0.26................................ (6)
   Where :
   t = Concentration time (hours)
   L = Length of river (km)
   I = Slope of 0.001
   A = Area of watershed (km2)

3. Reduction coefficient (β)
   This figure is used to get the average rainfall from the maximum rainfall.
   $\beta = \frac{120+\frac{t+1}{t+9}A}{120+A}$ .... (7)
   Where :
   β = Reduction coefficient
   t = Concentration time
   A = Area of the watershed

2.11. River Discharge Analysis

This analysis is carried out to determine the river discharge that occurs in the Way Solepay watershed using the following formula:

River water layer discharge (DLAS) uses the general equation DLSA (Chow), namely;

Q = V. A .... (8)

Where :

Q = River flow rate (m^3 / sec)
V = River water layer velocity (m / sec)
A = Wet cross-sectional area of river water layer (m3)

2.12. Analysis of Average Sediment Discharge

To calculate the annual average sediment discharge, the planned annual return discharge is used as follows:

Q = a * β * g * A .... (9)

Where :

Q = Return flood discharge (m^3 / sec)
A = Area of flow area (Km^2)
S = slope of the river bed
t = Concentric timebreast milk (hour)
β = Reduction coefficient
g = The calculated rain intensity (m^3/ km^2 / sec)

2.13. Sedimentation Rate

Sedimentation rate prediction is done using the equation:

Qs = Q. S .... (10)

Where :

QS = River water sediment discharge (gram / second)
Q = River flow rate (m^3 / sec)
Cs = Weight of filter paper (mg)
V = Sediment concentration (mg / liter)

2.14. Sedimentation Transport

Many methods for estimating the capacity for sediment loading have been developed, which are based on hydraulic shear rate, flow velocity and sediment properties.

V = P * Q .... (11)

Where :

V = volume of sedimentation (m^3)
P = length of river (m)
Q = amount of sedimentation (m^2)

The process of erosion between grooves is used in several computer models to estimate erosion, including CREAMS (Kniel, 1980).

III. METHODOLOGY

3.1. Location and Time

The location or object of this research analysis was taken based on the map of Ambon island, Central Maluku Regency, with the problem of sedimentation transportation planning that occurred in the Way Solepay River, Mamala Village in the last 10 years (2008 - 2017) of the rainfall data at the Ambon Pattimura Airport Meteorological Station.

Fig.2: Research Location

3.2. Writing Technique

In general, the analysis techniques of this research are as follows:

1. Data collection
2. Rainfall analysis using Log Percent III method
3. Planned Flood Analysis
4. Watershed Erosion Analysis
5. Sedimentation Analysis

3.3. Materials and Tools

The materials needed in carrying out this analysis are a permit and data, both in the form of analysis data and planning data from the object being analyzed, and so on. Meanwhile, the tools used are digital cameras, heavy equipment to support the implementation, meters and other supporting tools.

3.4. Analysis Variable

The analysis variables required in the analysis of sedimentation transport on the Way Solepay River are specified as follows:

1. Map of the Way Solepay River
2. Map of research locations

3.5. Data Collection Technique

In conducting sedimentation transport analysis, data collection steps are very important, all of which are a schematic or description of the analysis process being carried out. The data collection stages from the sedimentation transport analysis are as follows:

1. Preparation phase
2. Data collection stage
3. Problem formulation stage
4. Problem analysis stage
5. Implementation of activities

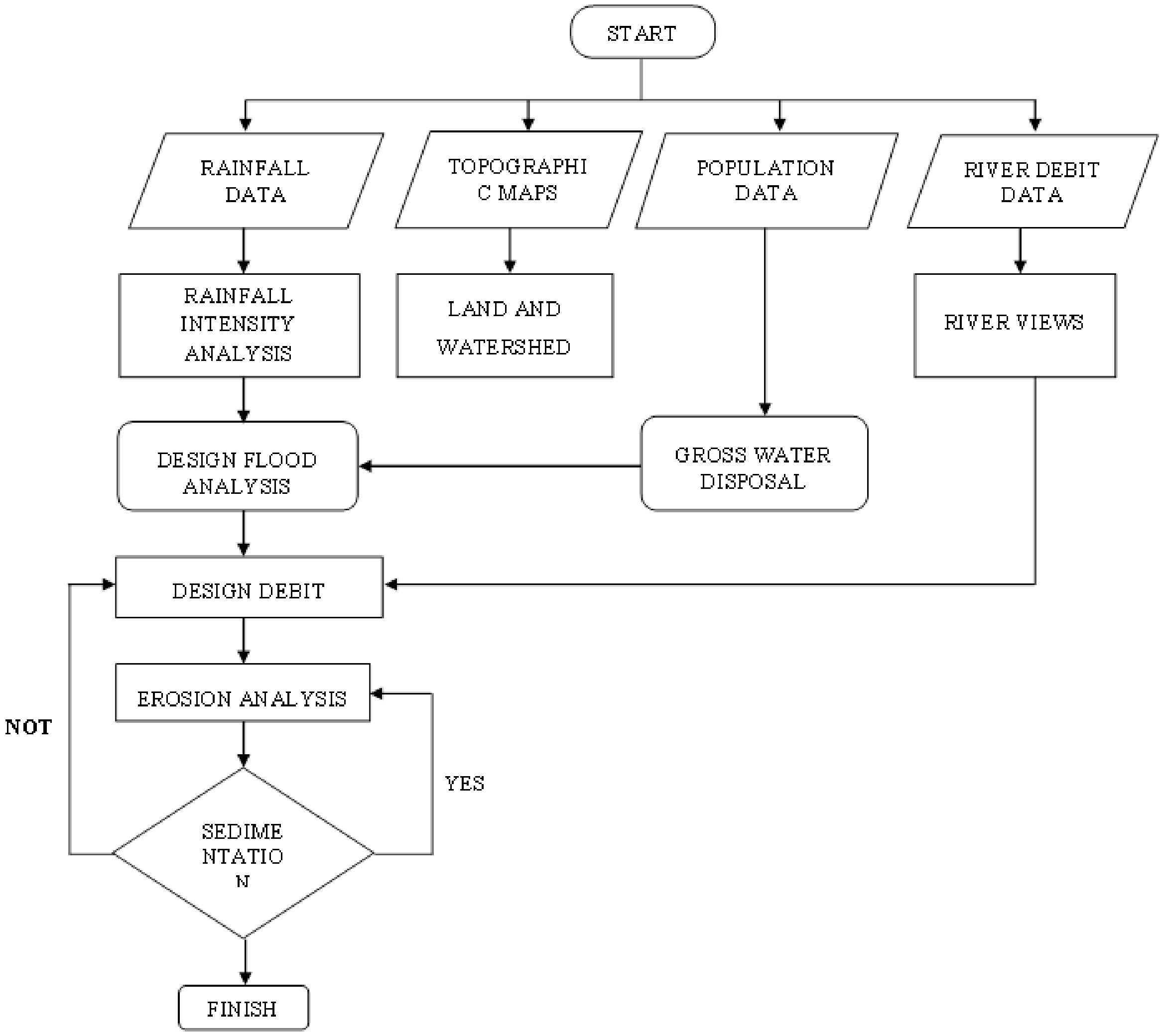

Fig.3: Flowchart Research

IV. ANALYSIS AND DISCUSSION

4.1. The Mechanism of Erosion

So erosion can occur at least with one step, namely dispersion by granules or runoff water. The erosion stages include:

1. Raindrops collide with the ground;
2. Splash the ground by raindrops with soil.
3. Destruction of a lump of soil by raindrops.
4. Transport of splashed particles / soil mass dispersed by runoff during rain.

To find out the relationship between erosion and hydrology, we must study the effects of land and vegetation management in upstream and downstream watersheds, including their effects on erosion, water quality, flooding and climate in the upstream and downstream areas. And the influencing factors in this calculation are rain erosivity, slope slope, soil sensitivity to erosion, and river length, and soil management factors which are closely related to land cover or vegetation.

4.2. Hydrological Data Analysis

To find out the amount of erosion that has occurred in the Way Solepay watershed, it is necessary to know the planned flood discharge that will be used to calculate the amount of erosion that occurs in the Way Solepay watershed.

The accuracy of the results of hydrological analysis to determine the magnitude of the planned flood depends on the amount of data available, the length of observation and the data used to analyze it.

The more data available and the length of time for the observation, the more accurate the results will be, as will the selection of the right method, because the formulas used are empirical formulas.

Rainfall data required is maximum daily rainfall data with a minimum number of observations in the last 10 years from 2008 - 2017. Rainfall data for this analysis is taken from the Pattimura - Ambon Meteorological Station.

4.3. Rainfall Calculation

Rainfall calculation analysis, selected the Pattimura Airport Meteorological Station Observation Post - Ambon.

Table 4: Maximum Daily Rainfall Data in Way Solepay Watershed 2008 - 2017

No.	Observation Year	Rainfall (mm)
1	2003	305.16
2	2004	372.17
3	2005	429.09
4	2006	261.31
5	2007	378.66
6	2008	405.25
7	2009	416.34
8	2010	397.05
9	2011	216.76
10	2012	323.00

(Source: Pattimura-Ambon Airport Meteorological Station)

a) Calculation of Algebraic Average Rainfall

$R = \frac{1}{n}\,(R^1 + R^2 + R \ldots\ldots R^n)$............................ (12)

Table 5: Rainfall Recapitulation

Year	*R*	*R - Rr*	*(R - Rr)²*	*(R - Rr)³*
2003	94.47	-184.35	-33984.92	-6265.12
2004	135.65	-143.17	-20497.64	-2934648.34
2005	237.82	-41	-1681	-68921
2006	262.05	-16.77	-281.23	-4716.27
2007	284.66	5.84	34.10	199.17
2008	476.31	197.49	39002.3	7356848.77
2009	167.32	-111.5	-12432.25	-1386195.87
2010	325.68	46.86	2195.84	102897.98
2011	384.17	105.35	11098.62	1169239.88
2012	420.09	141.27	19957,21	2819355.46
Σ	**2788.29**		**3411.03**	**7047794.66**

(Source: Analysis Results)

b) Calculation of Standard Deviation, Coefficient of Variation and Coefficient of Skewness

1. Σ Year (n) = 10
2. On average, Rr

$$\text{Rr} = \sum \frac{\text{Ri}}{\text{n}}$$

$$= \frac{2788{,}29}{10}$$

$$= 278{,}82$$

3. Standard Deviation, Std

$$\textbf{Std} = \sqrt{\sum_{i-1}^{n} \frac{(\mathbf{R} - \mathbf{Rr})^2}{\mathbf{n} - \mathbf{1}}}$$

$$= \sqrt{\frac{3411{,}03}{9}}$$

$$= 19{,}46$$

4. Coefficient of Variation, Cv

$$\textbf{Cv} = \frac{\textbf{Std}}{\textbf{Rr}}$$

$$= \frac{19{,}46}{278{,}82}$$

$$= 0{,}06$$

5. Skewness Coefficient, Cs

$$\textbf{Cs} = \frac{\mathbf{n} \sum(\mathbf{R} - \mathbf{r})^3}{(\mathbf{n} - \mathbf{1})(\mathbf{n} - \mathbf{2})(\mathbf{Std})^3}$$

$$= \frac{10\,x7047794{,}66}{(9)(8)(19{,}46)^3}$$

= 132.82

4.4. Calculation of the Flood Plan

Design flood is a large discharge of annual flow caused by rain with a certain ulan period.

Flood plans are different from the largest floods. The largest flood can occur at any time, while the planned flood is expected to occur once for a certain period of time, to calculate the planned flood discharge the Log Percent III method can be used:

- Planning flood discharge calculation:

  Formula: Q = α .β .qn. A

  Where :

  Q = Discharge (m^3 / s)

  α = Flow coefficient (run off coefficient)

  β = Reduction coefficient

  qn = Maximum rain (mm)

  A = Area of flow

1) Calculation of the length of rain (hours)

   t = 0.25. L. A -0,126. I-0.26

   Where :

   T = concentration time (hours)

   L = length of river (km)

   I = slope 0.01

   A = Area of watershed (km^2)

   t = 0.25. L. A -0,126. I-0.26

   = 0.25. 9.10. 0.0216 -0.126. 0.01 -0.26

= 12 hours

2) Redux Coefficient (β)
This figure is used to get the average rainfall from the maximum rainfall.

$$\beta = \frac{120 + \frac{t+1}{t+9}\ A}{120 + A}$$

Where :

β = Reduction coefficient
t = Concentration time (hours)
A = Area of watershed (km^2)

$$\beta = \frac{120+\frac{12+1}{12+9}0{,}0216}{120+0{,}0216} = 1.02$$

3) Calculation of rainfall area (m^3 / sec / km^2) with return period

$$qn = \frac{Rn}{240} + \frac{67{,}65}{t+1{,}45}$$

Where :

Rn = daily maximum rainfall (mm / day) with a return period of (n) years. = 278.8 mm / day
t = time (hours)

$$qn = = 6.2\ m^3 / s / km2\frac{278{,}8}{240} + \frac{67{,}65}{12+1{,}45}$$

4) The run off coefficient is the ratio between run off and rain:
α = 1 - 4,1 / (β qn+ 7)
Where :

B = reduction coefficient
qn = area of rainfall (m^3 / sec / km^2)

α = 1 - 4,1 / (1.02. 6.2+ 7)
= 0.7

5) Flood discharge calculation
Q = α .β .qn. A
Where :

Q = Discharge (m^3 / s)
A = flow coefficient = 0.7
B = reduction coefficient = 1.02
qn = Maximum rain (mm)
= 6.2 m^3 / s / km
A = Area of flow = 0.0216 km^2

Q = α .β .qn. A
= 0.7. 1.02. 6.2. 0.0216 = 0.0956 m^2 / sec

4.5. Slope (Ls)

As an example of calculating the slope of the slope, DAS Way was chosen Solepay

Known :

River length, L = 9.10 km
Watershed area = 0, 0216 km
Drainage Density, d = $\frac{L}{A}$
= 9, 10 / 0.0216 = 421.29 km^2

4.6. Calculation of potential and actual land erosion in the Way Solepay watershed

From the data it is known:

1. For land slopes of 0 - 3%,value of K = 0.120
2. For land slopes of 3 - 8%,value of K = 0.120
3. For land slopes of 8 - 15%,value of K = 0.260
4. For land slopes of 15 - 40%,value of K = 0.230
5. For land slopes>40%,value of K = 0.210

4.7. Calculation of Average Slope

(for average slope S = 4%)

D = 1, 35. d + 0, 26. S + 2, 80
= 1, 35. 421.29 + 0, 26. 4 + 2. 80
= 572,581

$$Lo = \frac{1}{2\ .\ D}$$

$$= \frac{1}{2\ .\ 572{,}581} = 285.79\ m$$

Ls = $Lo^{0.5}$ (0.0138 + 0.00965. S + 0.00138. S2)
= 285,790.5 (0.0138 + 0.00965.4 + 0.00138.42)
= 1.259

(for the average slope S = 11.50%)

D = 1, 35. d + 0, 26. S + 2, 80
= 1, 35. 421.29 + 0, 26. 11.50 + 2.80
= 574,531

$$Lo = \frac{1}{2\ .\ D}$$

$$= \frac{1}{2\ .\ 574{,}531} = 287{,}265\ m$$

Ls = $Lo^{0.5}$ (0.0138 + 0.00965. S + 0.00138. S2)
= 287.2650.5 (0.0138 + 0.00965.11.50 + 0.00138.11.502)
= 5,211%

(for average slope S = 20%)

D = 1, 35. d + 0, 26. S + 2, 80
= 1, 35. 421.29+ 0, 26. 20 + 2.80 = 576,741

$$Lo = \frac{1}{2\ .\ D}$$

$$= \frac{1}{2\ .576{,}741} = 288{,}370\ m$$

Ls =. = 14,283% $\left(\frac{Lo}{22{,}1}\right)^{0{,}6}\left(\frac{20}{9}\right)^{1{,}4}$

(for average slope S = 35%)

D = 1, 35. d + 0, 26. S + 2, 80

= 1, 35. 421.29 + 0, 26. 30 + 2.80 = 579,341

Lo = $\frac{1}{2\ .\ D}$

= $\frac{1}{2\ .579{,}341}$ = 289,670 m

Ls =. = 31,351% $\left(\frac{Lo}{22{,}1}\right)^{0{,}6}\left(\frac{35}{9}\right)^{1{,}4}$

(for average slope S = 40%)

D = 1, 35. d + 0, 26. S + 2, 80

= 1, 35. 421.29 + 0.26 .40 + 2.80 = 581,941

Lo = $\frac{1}{2\ .\ D}$

= $\frac{1}{2\ .\ 581{,}941}$ = 290,970 m

Ls =. = 37,898% $\left(\frac{Lo}{22{,}1}\right)^{0{,}6}\left(\frac{40}{9}\right)^{1{,}4}$

Thus:

1. For land slope 0 - 30%
   Formula: A = 4 + 1.226 (10 D - K- 2)
   A = 4 + 1.266 (10. 572,581 - 0.120 - 2)
   = 7250,191 tons / ha / year
2. For land slope 3 - 8%
   A = 4 + 1.266 (10. 574,531 - 0.120 - 2)
   = 7274,878 tonnes / ha / year
3. For land slope 8 - 15%
   A = 4 + 1.266 (10. 576,541 - 0.260 - 2)
   = 7300,147 tons / ha / year
4. For land slope 15 - 40%
   A = 4 + 1,266 (10,579,341 - 0,230 - 2)
   = 7335,633 tonnes / ha / year
5. For slopes> 40%
   A = 4 + 1.266 (10.581,941 - 0.210 - 2)
   = 7368,575 ton / ha / year

The average allowable erosion rate for the Way Solepay watershed area is:

So the formula that I derive is:

$$\overline{Ar} = \frac{1A + 2A + 3A + 4A + 5A}{5}$$

$$\overline{Ar} = \frac{7250{,}191 + 7274{,}878 + 7300{,}147 + 7335{,}633 + 7368{,}575}{5}$$

=7305,884 tons / ha / year

Table 6. Calculation of Slope Slope (Ls)

No.	Long River	Large DAS	Drainage Density (d)	Slope Land%	Slope is average	D	Lo (m)	Ls
	DAS WAY Solepay							
	9,10	0.0216	421.29	0 - 3	4.00	572,581	285.79	1,259
	9,10	0.0216	421.29	3 - 8	11.50	574,531	287,265	5,211
	9,10	0.0216	421.29	8 - 15	20.00	576,741	288,370	14,283
	9,10	0.0216	421.29	15 - 40	35.00	579,341	289,670	31,351
	9,10	0.0216	421.29	> 40	40.00	581,941	290,970	37,898

(Source: Analysis Results)

Table 7. Calculation of Erosion Rate

DAS name	Slope Land (%)	Thickness Humus (D)(M)	Erodibility (K)	Erosion Rate (A) Ton / ha / yr	A Average (Ton / Ha / Year)
Way Solepay	0 - 3	3.00	0.120	7250,191	7,305,884
	3 - 8	3.00	0.120	7274,878	
	8 - 15	3.00	0.260	7300,147	
	15 - 40	3.00	0.230	7335,633	
	> 40	3.00	0.210	7368,575	

(Source: Analysis Results)

The calculation of erosion can be seen in Table 7. Based on the calculation results, it can be seen that the erosion rate in the Way watershed Solepay, is classified as very heavy so it needs immediate handling.

4.8. Annual Average Sediment Discharge Calculation

To calculate the annual average sediment discharge, the planned annual return time discharge using the DER WIDUWEN method is as follows:

Q = α * β * q * A

Where :

A = Flow area (km^2) = 0.0216 km^2

t = Concentration time (hours) = 4.65 hours

β =The reduction coefficient = 1.26

q = The calculated rain intensity (m^3 / km^2 / sec) = 314,130 m3 / km^2 / second

α = Flow coefficient = 0.421

Thus, the annual average sediment discharge can be calculated as follows:

Q = 0.421 * 1.26 * 314,130 * 0.0216

= 3,559 m3 / day

Q year = 365 * 3,599 = 1,313,635 m^3 / year

4.9. Sedimentation Transport

River length = 9100 m

Lots of sedimentation = 3,599 m³ / day

= 1,313,635 m³ / yr

Sedimentation Transport (V) = P * Q

Sedimentation transport / day = 9100 m * 3.559 m³ / day

= 32,386m³ / hr

Sedimentation transport / yr = 9100 m * 1,313,635 m³ / yr

= 11,954,078 m³ / yr

V. CONCLUSIONS AND SUGGESTION

5.1. Conclusion

Based on the results of calculations and analysis, the following conclusions can be drawn:

5.1.1. The accumulation of sedimentation that occurs in the Way Solepay watershed is an average of 3,599 m^3 / day or 1,313,635 m^3 / year.

5.1.2. How to handle it sedimentation namely being transported out of the Way Solepay watershed regularly every year as many as32,386 m³ / day or 11,954,078 m³ / yr

5.2. Suggestion

This research has several suggestions as follows:

5.2.1. For the Mamala Village Government to be able to participate and work together to maintain environmental sustainability by replanting shade trees, providing formative counseling so that the community around the watershed realizes their responsibility to maintain and protect the existing forest from damage.

5.2.2. For people who live around the watershed, they must maintain and preserve a clean culture by not throwing garbage into the river.

REFERENCES

[1] Arsyad, 1989. S Soil and Water Conservation. Faculty of Agriculture, Agricultural Institute: Bogor

[2] Bennet, HH, 1939. Soil Conservation, Mc.Graw-Hill, New York.

[3] Choy Asdak, MSc, PhD, 2002. Hydrology and Watershed Management, Gajah Mada.
[4] Ministry of Public Works Standard SK SMI – 18– 1989 – F, 1989. Flood Discharge Calculation Method. LPMB Foundation: Bandung.
[5] Ministry of Public Works, Directorate of Irrigation I, 1986. Handbook of Irrigation Planning, Bandung: cv. GalangPersada.
[6] Hoye and Langbein (1955)
[7] Rahim.SE 2002. Soil Erosion Control in the Framework of Environmental Conservation, Bandung: Earth Literacy.
[8] Vanoni, V, A. 1975. Sedimentatioan Engineering, New York.