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Sedimentation Handling Model Of Sediment Reservoir On Darma Reservoir Das Cimanuk – Cisanggarung Kuningan Regency

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Abstract- Reservoir is a water reservoir in a watershed which is used to irrigate agricultural land, fisheries, water regulator (flood controller), watershed catchmentdams channeled by outlet (river) to the reservoir so as not to flow and stagnant in places beneath it and used for drinking water, as well as tourism. As one of the efforts to overcome the flood, it is necessary to revitalize the water structures as a shelter for rainfall runoff and sediment storage building.This research took a case study at Darma Reservoir. In this study, the analysis was performed using Hydrologic Engineering Center-River Analysis System (HEC-RAS). Based on the simulation results of the existing conditionflow, there is a water runoff at River Station (RS) 10 and RS 9. Hence, the design of sediment reservoir building is performed by using Homogeneous Dam as a prevention of overflowing in Darma Reservoir leading to Cisanggarung watershed. The calculation of water potential is based on Rainfall data, while irrigation water demand is calculated based on irrigation total area, water requirement standard for rice plant and crops, industrial water requirement standard based on BWRP Guidelines, Dit.Jen SDA, drinking water requirement standards based on Dinas Cipta Karya and the standard of fishery needs based onDirectorate of Irrigation. One benefit from the calculation of water discharge is for flood control. Measure to be able to control the overflow of river water so it is not too abundant at certain times that can cause flood is to know how much value of the water discharge. The conditions of water that remain in control can be profitable for the fishing business there. The calculation of the discharge can also indicate a response due to changes in bio-geophysical characteristics that occur in a watershed (by watershed management activities) or changes (seasonal or yearly fluctuations) of the local climate. It can later be useful for the subsequent management of the watershed in accordance to the law of natural balance (ecology) which ultimately creates environmental sustainability. The maintenance of watershed ecology is very beneficial to keep the fishery business running in this water body because the ecosystems in it live with supportingconditionfactors (Asdak 1995).

Keywords*:* Reservoir, DAS. Sedimentation, HEC- RAS

1. Preface

Reservoir is a water reservoir in a watershed which is used to irrigate agricultural land, fisheries, water regulator (flood controller), watershed catchment dams that are drained by outlet (river) to the reservoir so as not to flow and stagnant in places beneath it and used for drinking water, as well as tourism. The reservoir ecosystem cannot be separated from the influence of the river condition that inlet from a watershed. The Watershed (DAS) is an area of ecosystem unity which is bounded by water divide

topography in which there is a rainwater catchment system that enters the reservoir and exits through a single loose channel.

In essence, the natural phenomena in which we live, physically and socially will always have a causal and interconnection relationship (Bintarto, 1982: 12). Reservoir and watershed are unitary units that serve as water catchment areas. The ecosystemdamage that occurs in a watershed due to the use of land such as for agricultural land, shifting cultivation, and settlement by the community has an effect on the natural balance of the area. The damage results in the change of the extent of land use as a water buffer that will lead to accelerated erosion or soil erosion to the soil damage process.

Erosion disaster is an event of transport of land or parts of the land by natural media, especially water. The soil or parts of the soil from an eroded and transported watershed are then deposited to a lower place forming sedimentation in the reservoir. Sedimentation leads to river and reservoirsilting that will eventually cause flood and damage the reservoir function. The amount of sediment yield from erosion in the reservoir will produce morphology of the soil body that creates a new face shape of the reservoir.

The changes in sediment morphology in the reservoir have an influence on the value of the reservoir building. Sedimentation causes siltation which can reduce the function of the reservoir so it cannot be utilized optimally. It can also reduce the age of reservoirs designed when a reservoir construction project is planned. The data of sediment material entering the reservoir, especially the amount of sediment transported by the erosion transport from the watershed to the river and then into the reservoir, can generally be used to evaluate the amount of sediment yield and residual life estimate of the reservoir.

As one of the efforts to overcome the flood, it is necessary to revitalize the water structures as a place to collect water from rainfall and sediment storage. This research took a case study at Darma Reservoir. In this study, the analysis was performed using Hydrologic Engineering Center-River Analysis System (HEC-RAS). Based on the simulation result of the existing conditionflow, there is a runoff at River Station (RS) 10 and RS 9. Hence, the design of sediment reservoir building is done by using Homogeneous Dam as a prevention of overflowing in Darma Reservoir that flows to Cisanggarung watershed.

2. Problem Formulation

To examine a problem that has been established into the subject, it should be supported by knowledge and theoretical basics. The theoretical basics of this chapter are summaries of theories that support further analysis.

The problem formulation in Sedimentation Handling Study with Sediment Reservoir is:

1) Analyzing the potential of sediments in Darma Reservoir at this time
2) Determining the sedimentation reservoir method of Darma Reservoir
3) Creating the numerical model of Darma sedimentation reservoir usage

3. Research Purposes And Benefits

The objectives to be achieved in this research are to overcome the flood and sediment buildup and to revitalize water structures as a place to collect rainfall water and sediment storage in 2030. In this research, the analysis was done using Hydrologic Engineering Center-River Analysis System (HEC) -RACE). Based on the simulation result of existing conditionflow, there is a runoff in River Station (RS) 10 and RS 9.

Calculating water potential was based on Rainfall data, while irrigation water demand was calculated based on the irrigation total area. The water requirement standard

for rice plant and crops and industrial water requirement standard were based on BWRP Guidelines, Dit.Jen SDA. The drinking water need standard was based on Dinas Cipta Karya and the standard of fishery needs was based on the Directorate of Irrigation.

The benefit that can be taken from this research is expected to be used as one of the inputs for the policy holder in managing water resources especially in WS Cimanuk - Cisanggarung in anticipating the sediment in Jatigede Reservoir which can be said to be newly operated.

4. Scopes Of The Problem

This research has limitations of Darma Reservoir and Jati Gede Reservoir (DAS Cimanuk - Cisanggarung), processing of sediment data and available rainfall data to obtain sediment deposition potency in reservoir body and potency of Cimanuk - Cisanggarung river water.

5. Literature Review

Sedimentation can be defined as hauling, the suspension or precipitation of fragmental material by water. Sedimentation is the result of erosion, and has a big impact. In reservoirs, sediment deposition will reduce its effective volume. Most of the amount of sediment is flowed by rivers flowing into reservoirs, only a small portion of which comes from avalanches of reservoir cliffs or from landslides of cliffs by the surface runoff. (Soemarto, 1987).

The ultimate precipitation or sedimentation occurs in relatively flat foothills, rivers, and reservoirs. In the watershed, particles and nutrients dissolved in the flow of the surface will flow into the river and reservoir, resulting in siltation at the site. This condition, according to Soemarwoto (1978), will decrease the capacity of the river and reservoir to resulting in the danger of flood and excessive water fertilization or etrofication.

Sedimentation process according to Manan (1979) produces:

1. Solute materials, all organic and inorganic materials that are transported as a solution by running water.
2. Solid or bed-loaded materials, all crude materials from minerals and stones transported along the riverbed.
3. Total river transported materials or total stream load are all organic and inorganic materials transported through a measuring station in the form of suspension or bed load.

Erosion is a natural process that cannot or is difficult to remove completely or its zero erosion, especially for agricultural areas. The action that can still be done is to strive for erosion to occur below the maximum threshold (soil loss tolerance), i.e. the amount of erosion does not exceed the rate of soil formation. (Suripin, 2004).

The process of soil erosion caused by water includes three stages that occur under normal circumstances in the field, i.e. the splitting stage of chunks or soil aggregates into the form of small grains or soil particles. The second stage is transporting the small grains until smooth and the third stage is the deposition of the particles in a lower place or bottom of the river or reservoir. (Suripin, 2004).

Frevert, et al. (1950), defines soil erosion as a process of soil layers missing that is much faster than the process of soil loss in geological erosion events. It is caused by the changes in the soil or the cropscovering the soil. Based on the origin shape of the land affected by water erosion, erosion is divided into two kinds, namely sheet erosion and rill erosion which develops into gully erosion.

Topography or soil surface plays an important role in determining the flow velocity carrying the soil particles. The role of cover vegetation is to protect the soil from direct blow of rainwater and improve soil structure through the spread of its roots. Factor of human activity plays a very important role especially in erosion prevention efforts. (Suripin, 2004).

a. Sediment Transportation

The rate of sediment transport is the amount of sediment measured for a moment. If the debit does not change rapidly, a one-time sediment transport rate measurement is sufficient to determine the average rate in a single day. However, if the discharge changes rapidly and the sediment rate is high, some measurements are needed to determine the daily average rate more closely. (Soemarto, 1987).

Water-induced erosion is described by Fosterdan Meyer in his book titled *Soil Erosion and Sedimentation by Water, An Overview*. In this book it is explained that erosion occurs including the following processes:

1. Detachment of soil particles. The detachment is the result of the loads of rainfall points that hit the surface of the soil.
2. Transportation or soil particle washout.
3. Deposition of the particles that have been swept away.

Shen (1971) argues that sediment particles are transported by water flow with one or a combination of transport mechanisms consisting of:

1. Absorption (surface creep), i.e. the process of sediment particles rolling or shifting over the riverbed.
2. Saltation, which is the process of sedimentary particles jumping over the riverbed and sometimes stop and then jump again.
3. Suspension, i.e. the process of sediment particles which is supported by the surrounding fluid during the move so as not to come in contact with the riverbed.

According to Mardjikoen (1971), the amount of sediment transport (expressed in weight, mass, or volume of time union) can be determined from the net place transfer from the material which passes through a cross section for sufficient period of time. Factors that determine sediment transport are the properties of water flow, sedimentary properties, and their mutual effects.

The sediment loads transported through a cross-section of the river flow consist of wash load, suspended load, and bed load. Wash loadconsists of very fine particles and colloids, which settle very slowly, even in still water. This type of material is obtained from the bed material in very small amount, so the amount is very limited. Suspended loads and bed loads are sometimes grouped together and are called bed material loads, since they are formed by particles found in many bed materials. A suspended load is defined as a sediment that is never in the bed of the river channel (excluding the washload), during the flow conditions.

According to Mardjikoen (1971), to find the value of wash load, suspended load, and bed load, several formulas are used:

1. Meyer-Peter and Muller (1934), to calculate the bed load
2. Einstein (1950) has derived formulas to determine the bed load by reviewing the possibility of grain movement, equating the concentration to be the counting subject of suspended load
3. Frijlink O.B.E. (1952).

b. Land Erosion

Plate erosion from the soil depends on the rainfall properties, the resistance provided by the soil to the blow of raindrops, and also depends on the movement of the thin layer of water above the soil surface as the surface runoff.

According to Frevert in *Soil and Water Conservation Engineering*, soil erosion is related to accelerated erosion, because in this case, the soil erosion is defined as the process of soil layer losing which is faster than the removal/the loss of the soil parts due to the natural erosion process.

According to Soemarto (1987), factors that can affect soil erosion include:

1). Rain Erosivity, R

Erosivity is the nature of rainfall; low intensity rains rarely cause erosion, but heavy rainfall with short or long periods can lead to high surface runoff and land loss. Rainfall properties affecting erosivity is seen as the kinetic energy of rain grains that pound the surface of the soil.

2). Soil Erodibility, K

Erodibility is the inability of the soil to withstand rain grains. Fast eroded soil that can be pounded by raindrops has high erodibility. Erodibility can only be learned in the event of erosion. Erodibility of various soils can only be measured and compared if it is caused by rain.

3). Scouring speed

The speed of scour is the velocity that will move the ground when a thin plate flow moves over the ground. The speed depends on the surface slope, the amount of rainfall that cannot do the infiltration and the roughness of the soil surface.

c. Estimating the Functional Age of Reservoir

The end of the reservoir function is fully loaded by sediment. If the incoming air streams carry much sediment to the reservoir capacity, the useful life of the reservoir will be short. A small water supply reservoir in Salomon River near Osborne, Kansas, is fully loaded with sediment during the first year after the completion of its construction. Plan for reservoirs should take into consideration about the possibility of deposition rates to determine if the planned useful life of the reservoir is sufficient to ensure its development.

The knowledge of sedimentation rates in reservoirs is based on surveys to establish the rate of sediment buildup in reservoirs that have existed for years. The survey shows the specific gravity of the sediment that settle and the percentage of sediment deposited in the reservoir against the total number of its incoming. Those data are needed to interpret the data of river sediment loads in relation to the precipitation in the reservoir.

The percentage of sedimentary inlet flow retained inside the reservoir is a function of the ratio number between the reservoir capacity and the entire inrush. The completion of reservoirs entirely by sediments may take a long time, but the actual useful life of the reservoirs has ended when the storage capacity of sediments taken is big enough to prevent the reservoir from performing its functions.

The amount of sediment transport is very changing, ranging from zero during the dry season, to an incredible amount during the rainy season. Therefore, it needs some data of sediment for a year to know the amount of sedimentation that occurs. There are many factors that influence the amount of sedimentation, so the research is done on a very wide

field and complicatedanalysis. Several factors that influence the amount of sedimentation in the river drainage are:

1. The coverage of drainage area
2. The geological condition of the drainage area
3. Topographic conditions
4. Meteorological conditions
5. River hydraulics characteristic
6. Vegetation in the channeling area
7. Human activities
8. Human Characteristics

According to Asdak (1995), the technique of river flow dischargemeasuring direct in the field can basically be done through four categories, namely:

1. Measurement of river flow volume
2. Measurement of the discharge by measuring the flow velocity and determining the cross-sectional total area of the river.
3. Measurement of the discharge by using chemicals (dyes) flowed in the river stream.
4. Measurement of the discharge by making debit measuring buildings such as weir (slow water flow) or flume (fast water flow).

One of the benefits from the calculation of water discharge is for flood control. Measures to be able to control the overflow of river water so it is not too abundant at certain times that can cause flood is to know how much value of the discharge in a water. The conditions of waters that remain in control can be profitable for the fishing business there. The calculation of the discharge can also indicate a response due to changes in bio geophysical characteristics that occur in a watershed (by watershed management activities) or changes (seasonal or yearly fluctuations) of the local climate. It can later be useful for subsequent management of the watershed in accordance to the law of natural balance (ecology) which ultimately creates environmental sustainability. The maintenance of watershed ecology is very beneficial to keep running the fishery business in this water body because the ecosystems in it live with the condition factors that always support (Asdak 1995).

d. Legislation and Related Government Regulations.

Laws and Regulations related to the management of water resources in the River Basin, particularly in WS Cimanuk - Cisanggarung, are as follows:

1. The 1945 Constitution,
2. Law No.26 of 2007 on Spatial Planning,
3. Law No.33 of 2004 on Financial Equilibrium between Central and Regional Government,
4. Law No.32 of 2004 on Regional Government,
5. Law No.25 of 2004 on National Development Planning System,
6. Law No.7 of 2004 on Water Resources,
7. Law No.34 of 2000 on Amendment to Law No.18 of 1997 on Regional Tax and Levy,
8. Law no. 41 of 1999 on Forestry,
9. Law No.23 of 1997 on the Environment,
10. Law No. 5 of 1990 on the Conservation of Biological Natural Resources,
11. Law No.11 of 1967 on Basic Provisions of Mining,
12. Government Regulation no. 42 of 2008 on the Management of Water Resources,
13. Government Regulation No.26 of 2008 on National Spatial Planning,
14. Government Regulation No.20 of 2006 on Irrigation,

15. Government Regulation no. 16 of 2005 on the Development of Water Supply System,
16. Government Regulation no. 82 of 2001 on Water Quality Management & Water Pollution Control,
17. Government Regulation No.35 of 1991 on Rivers,
18. Government Regulation No.28 of 1986 on Forest Protection,
19. Government Regulation No.23 of 1982 on Swamp,
20. Government Regulation No. 6 of 1981 on Financing Contribution of Exploitation and Maintenance of Irrigation Infrastructure,
21. Presidential Decree No.32 of 1990 on the Management of Protected Areas,
22. Regulation of Minister of Public Works No.11A of 2006 on Criteria and Determination of River Region,
23. Regulation of the Minister of Public Works No.67/PRT/1993 on the Provincial Water Supply Committee,
24. Regulation of the Minister of Public Works No.63/PRT/1993 on River Border Line, River Benefit Area, River and Used River Control Area,
25. Regulation of the Minister of Public Works No.49/PRT/1990 on the Procedures and Requirements of Permit for the Use of Water and/or Water Resources,
26. Decree of the Minister of Public Works No.502/KPTS/M/2007 on the Establishment of Water Resources Management Coordination Team (TKPSDA) of Cimanuk River Region - Cisanggarung, Decree of the Minister of Public Works No.458/KPTS/1986 on Provision of River Security in Relation to Mining Materials Group C. classification

METHODOLOGY

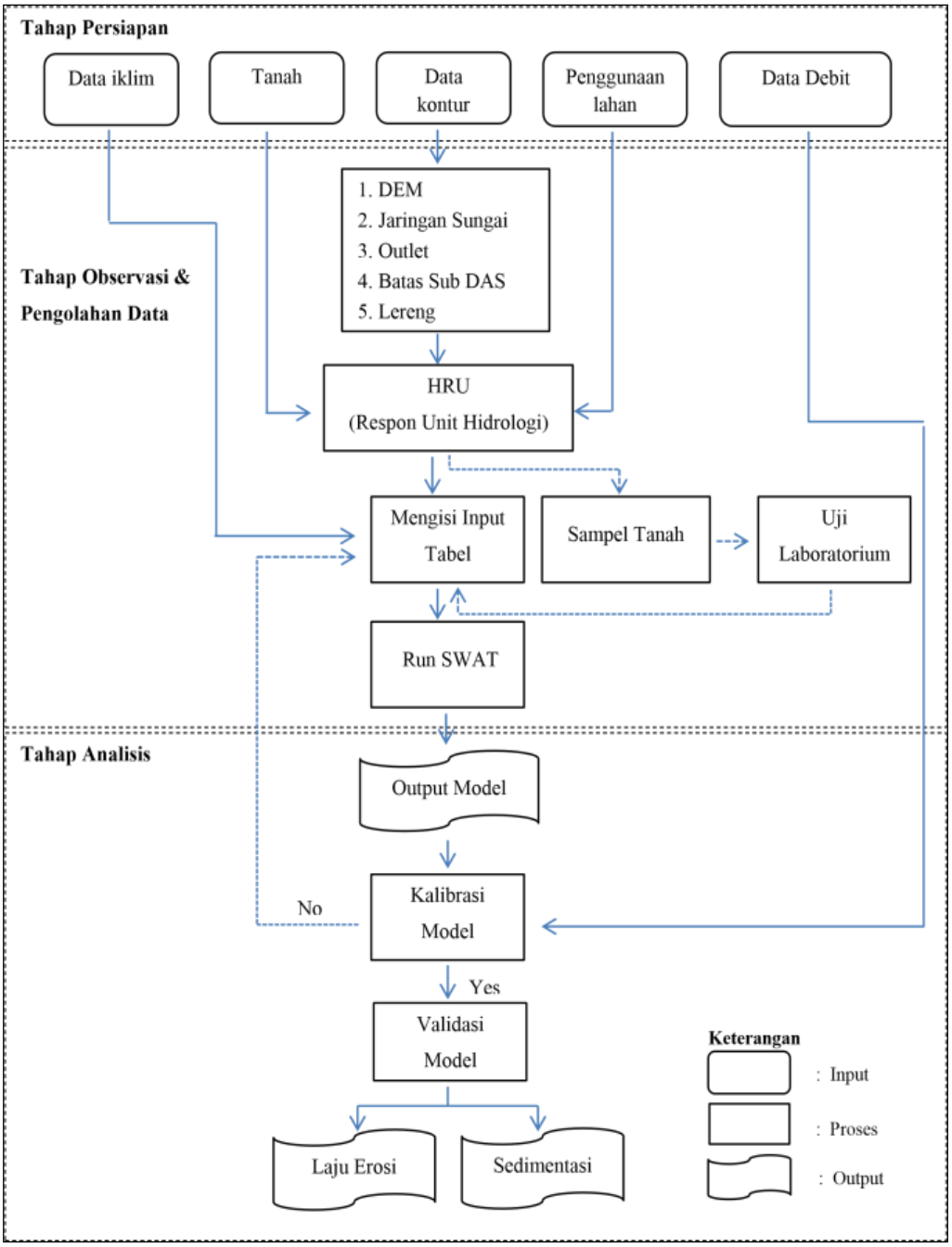

Figure 2.
Flow Chart of Research

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