Prediction of sediments discharge in watershed with two tank models

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Abstract. Uncontrolled erosion would cause considerable damages, such as soil fertility decline, water structures damage and reservoirs sedimentation. As the data for the sedimentation rate are limited, several models have been developed to predict the surface erosion and the rate of sedimentation. However, the availability of sufficient, diverse and extensive data is needed for the implementation of the models, both for the model calibration and the verification. The result of the analysis shows that both of the Water Tank Models that represent the erosion-sedimentation rate process, in which Water Tank 1 being the three-tank cascade system and Water Tank 2 being two-tank cascade system, are not optimum. This can be observed from the values of volume error (VE), relative error (RE), root-mean-square error (RMSE) and correlation coefficient (R) that show the effect of 1.5 hours of rain period in the sedimentation rate. The field condition shows considerable sedimentation, on the other hand, the models’ simulations show decreasing sedimentation rates. The optimum model’s parameters for Water Tank 1 and Water Tank 2 are 924.51%-1049.26% for the relative error, 50.81% - 121.42% for the volume error, 0.9 for the correlation coefficient and 6703.59-17,297.85 for the root-mean-square error. The parameters and constant’s values of the models are different relative to the drainage basins’ condition.

1. Introduction
Water resource problems in Indonesia are originated by several causes, but the most prominent one is the environmental degradation as a result of deforestation in the watershed, thus resulting in its decreasing ability to store water. This irresponsible deforestation had first resulted in 58 critical watersheds in Indonesia [1], the number then increased to 62 critical watersheds [2], and currently, there are 108 watersheds (DAS) in critical condition [3]. The criteria used to determine whether the watersheds are in critical conditions are the low percentage of land cover, high annual erosion rate, the ratio of maximum and minimum river discharge rate, and excessive mud deposit (sediment load). The indicators of critical watersheds provide the averments that the environmental system supporting the hydrological cycle has been damaged, e.g. reduced forest area surrounding the river basins and higher levels of erosion and sedimentation, resulting in floods, landslides, and soil fertility decrease.

Uncontrolled erosion would cause considerable damages, such as soil fertility decline, water structures damage and reservoirs sedimentation [4]. Estimating the rate of sedimentation is difficult due to the variability of the data. Moreover, despite the variability, as the mechanism of erosion to sedimentation rate is quite complex, the availability of the data is limited. The analysis of sedimentation rate is usually carried out by measuring the sediment rating curve which requires sufficient data covering various range of small to large sedimentation rate which need extra time, cost and energy. Therefore,
for estimating or predicting the erosion, sedimentation rate at the watershed is needed for dam and reservoir planning, soil conservation design, land usage planning, water quality management and effective control strategies to reduce the risk of water runoff, and for protection against erosion.

A number of models and approaches for predicting the erosion and sedimentation rate have been developed, such as the WEPP model [5], the KINEROS model [6], the ANSWERS model [7], the AGNPS model [8,9] and the SWAT model [10,11]. Those models have included the erosion analysis and sedimentation rate in the area of rivers that are caused by rainfall and water runoff [12]. Applying the Time-Area method for predicting sediment deposit adjusted with time [13-15] with lumped sediment runoff models analyzing sediment flow covering areas of steep land and in rivers around the watersheds.

The flow of sediment in the river is mainly caused by erosion that occurs in the rivers’ areas [16]. Erosion and sediment displacements are included in the hydrological process that occurs in the watersheds [17]. The erosion - sediment discharge at the in the watershed occurs in steep land and in the channels or rivers.

Starting with the occurrence of rain, the process of sediment discharge in steep land is affected by rain and surface runoff; the process would result in sediment deposit in the steep land, and the process of sedimentation rate in the channel or river in which the sediment is originated from steep land, erosion and riverbanks. The process would result in sedimentary reservoir in a river or channel. Therefore, the concept of reservoir models will represent the prediction of sedimentation rate in the watershed. One of these models is the water tank model.

Based on the portrayals of the existing models, a hydrological model in the form of a tank model can be developed to predict sediment flow in the watershed that can represent the process of erosion and sedimentation in the watershed. Several models for sediment flow analyses are the rain-flow model which incorporate sediment elements with lumped methods based on existing distributions, but this model has not been applied, thus just acceptable in theory.

2. Related works

Optimization is an activity to get results repeatedly and influence each other. The best results that will be obtained are minimal or maximum values. If there is no function of several variables, it can be used as a result to provide conditions that provide minimum results or maximum results [18], as in Figure I.

![Figure 1. Minimum and maximum results.](image-url)

In recent years, there have been several types of variations of global optimization methods applied in automatic tank model calibration, Cooper et al [19] applying the Shuffle Complex Evolution (SCE) method, simulated annealing (SA) method and Genetic Algorithm (GA) for parameter optimization of tank models in the arrangement of two tanks, [20] applied the Shuffle Complex Evolution (SCE) method and Powell multistart for calibration of tank models in Taiwan, then Setiawan et al [21] and Setiawan [22], verifying with the Marquardt algorithm that showed efficiency and effectiveness in determining
the parameter optimization of the tank model for two watersheds in Japan and in Indonesia, and Kuok et al [23] apply global optimization methods (GOMs) namely the Shuffle Complex Evolution (SCE) method, the Particle Swarm Optimization (PSO) method and Genetic Algorithm (GA) for calibration and parameter optimization of tank models. From the above statement, there is no general agreement among researchers which method is most suitable for calibrating the tank model. Therefore, in this study parameter optimization of the tank model was carried out to predict sediment discharge in the watershed using the Genetic Algorithm (GA) method with Matlab.

3. Research method
The step in the research method for tank model development to predict sediment discharge in the watershed is data collection and processing. Data collection includes secondary data such as watersheds maps (DAS), land use maps, rainfall station maps. Then the primary data or observation data in the Kreo watershed include observation and measurement of rainfall data, data on elevated sediment discharge, discharge data with a period of time must be the same and carried out at the alleged post or river flow observation station (SPAS). Furthermore, data processing includes data recording, analysis and interpretation of result.

3.1. Data processing analysis
Data processing analysis in this research will be an analysis of the results of primary data measurement in the form of rain data, debit data, sediment discharge data and analysis of sample data testing in the laboratory.

Rain data is measured and recorded using the help of a telemetry device, automatic rainfall raingauge (ARR) rain gauge which is connected to a computer via the internet, so that rain data is read directly on the computer.

The discharge data begins with measuring the water level based on the automatic water level tool known as Automatic Water Level Recorder (AWLR). Once known the water level is measured by the wet cross-sectional area of the river. Then measured the velocity of the river current with the Current meter then it can be calculated by multiplying the cross-sectional area with the current velocity, as in Equation (1).

\[ Q = A \times V \]  

Where \( Q \) is the discharge (m\(^3\)/sec), \( A \) is the wet cross-sectional area (m\(^2\)), and \( V \) is the current velocity (m/sec). While the sediment discharge data, in this study the method of measuring the elevated sediment discharge using the Equal Discharge Increment (EDI) method, in which a cross section is divided into several sub-sections, where each sub-section must have the same discharge. Then the sediment measurement in this way is carried out in the middle of each sub-section [24]. The basic equation for sediment rate (elevated sediment discharge) uses Equations (2) and (3).

\[ Q_s = 0.0864 \times C \times Q_w \]  
\[ C = aQ_w^b \]  

Where, \( Q_s \) is daily sediment discharge (ton/day), \( C \) is the concentration of elevated sediment (mg/liter), \( Q_w \) is discharge (m\(^3\)/sec), \( a \) and \( b \) are constants obtained from regression.

The potential discharge of serious errors that arise in the use of curved sediment rate to calculate sediment load is the use of average daily debit data, especially if the average daily debit is used from the average of three measurements (06.00 am, 12:00 noon and 17.00 pm). This is due to heavy rain occurring at midnight night, so that the peak of the floods that occur will occur at night [24]. Meanwhile, according to Simons and references number [24-26], the equations of sediment transport can be classified in the basic form as in Equation (4).
Qs = A (B - Bc) D \hspace{1cm} (4)

Where, Qs is a sediment discharge, A is a parameter that relates to flow and sediment characteristics, B is a parameter that can be either Q discharge, average flow velocity \( u \), slope of \( Sw \) water level, slope of \( Sf \) energy, slope of \( So \) river base, shear stress \( \tau \), current strength \( \tau u \), \( uS \) unit current strength etc., Bc is a critical condition parameter associated with B in the initial movement (incipient motion), D is a parameter related to flow and sediment characteristics.

Sediment concentration from a river section is a comparison between sediment discharge and river flow discharge [27]. This value can be formulated as in Equation (5).

\[ Q_s = C \times Q \] \hspace{1cm} (5)

Where, Qs is a sediment discharge, C is the sediment concentration, Q is the flow discharge. For the measurement of this EDI method Equation (5) can be changed to Equation (6), by entering Equation (7).

\[ Q_s = \sum_{i}^{n} C_i q_i \Delta x_i \] \hspace{1cm} (6)

if \( Q = \sum_{i}^{n} q_i \Delta x_i \) \hspace{1cm} (7)

Then the average concentration is as in Equation (8).

\[ \bar{C}_i = \frac{\sum_{i}^{n} C_i q_i \Delta x_i}{\sum_{i}^{n} q_i \Delta x_i} \] \hspace{1cm} (8)

Where, \( \bar{C}_i \) is the average concentration of sediment on a river section, \( C_i \) is the concentration of sediment in the sub-section to i, \( \Delta x_i \) is the width of the sub-section of the river to i, \( q_i \) is the debit per width of the sub-section and n is the number of vertical measurements. Because in the way of EDI qi value, \( q_2 = ... ... = q_n = Q / n \) then Equation 8 can be changed to Equation (9) or (10).

\[ \bar{C} = \frac{Q}{n} \sum_{i}^{n} C_i \] \hspace{1cm} (9)

\[ \bar{C} = \frac{\sum_{i}^{n} C_i}{n} \] \hspace{1cm} (10)

Equation (10) is the average sediment concentration in the measured river section. Analysis of testing sample data in the laboratory is an analysis of the weight of the sediment and can be done as follows:

Samples in the form of water and soil erosion particles, which have been included in the bottle are labeled: sequence number and location and date of occurrence, first drained ± 24 hours so that the soil particles settle, after which the water is disposed of. Soil particles and residual water are then put into porcelain dishes that are known to be of weight and are labeled accordingly (date and number). At this stage, recording is done: the cup code number, the date of the rain event, the serial number, and the weight of the cup used. From a sample the weight of the cup used was used, as in Equation (11).

\[ Wm =... ... \text{ gram} \] \hspace{1cm} (11)
Then the cup and its contents are put in the oven at 110ºC for ± 24 hours, so the soil becomes dry (absolute). After that the cup containing dry soil (eroded soil) is removed from the oven, drained ± 15 minutes after it is put into the desiccator and after the cold is weighed. From a sample, the weight of the Wm plate, and weight (plate + eroded soil) was recorded in grams, as in Equation (12).

\[ W(m + s) = \ldots \text{grm} \]  
(12)

\[ W(m + s) = \text{weight (cup + eroded soil)} \ldots \text{gram} \]

Then Ws can state the weight of dry soil or eroded soil per sample per location per rain event, the amount can be calculated: \( Ws = [W(m + s) - Wm] \) gram for 500 CC water volume. Then the amount of eroded soil per location of rain events, can be calculated as in Equation (13).

\[ Wtot = (\frac{Vtot}{500}) \times Ws = \ldots \text{gram} \]  
(13)

3.2. Model accuracy test criteria

The model compiled to simulate processes in nature is a model that must be able to approach the actual process. In this connection, whatever the form of the model, whatever approach is used, the output of a model must be able to approach the process that actually occurs in nature. However, it is almost impossible for the natural processes that occur to be matched correctly.

Therefore, there will always be a deviation between the measured output (observed) and the calculated output (simulated) described in Figure 2. To see the extent of the results of the optimization approach to the model parameter values in the Sub-watershed, the calibration count output by means of optimization needs compared to the results obtained in a measured way.

The accuracy of the model depends on three factors: the accuracy of input data, the effectiveness of parameter assessment and errors in the model itself [28]. Testing the accuracy of the model can be done by testing the measured data and simulation results data. The model is said to be careful if there is a high correlation between measured data and simulation results data and has the smallest possible value deviation.

In this study used correlation coefficient (R), volume error (VE), mean relative error (RE) and the least squares average error (RMSE) as a test model accuracy criterion, and calculated in the auxiliary program. Limitation of criteria for the accuracy of the test model in this study is VE < 5%, -10% < RE < -10%, R > 0.7 and RMSE close to 0 (zero).

![Figure 2. Model calibration scheme.](image)
The correlation coefficient (R) is the price that shows the magnitude of the attachment between the measured value and the simulation value. If the price of R is worth 1, then it can be said that the correlation between the two is very close, but if R is zero then the two values are said to have no relationship at all. The correlation coefficient is formulated as in Equation (14) [29].

\[
R = \sqrt{\frac{Dt^2 - D^2}{Dt^2}}
\]  
\[Dt^2 = \sum_{i=1}^{N} (Sed_{obs}^i - \bar{Sed})^2\]
\[D^2 = \sum_{i=1}^{N} (Sed_{obs}^i - Sed_{sim}^i)^2\]

Where, Sed_{sim}^i is simulation sedimen debit in the i (ton / day) period, Sed_{obs}^i is the measured sediment discharge in the i (ton / day) period, N is the amount of data.

Volume error (volume error, VE) is a value that shows the difference in the volume of simulation results and measured during the simulation period. If the VE value is very small, it means that the total volume of the simulation value and measured is almost the same. Conversely, if VE is very large, there is a deviation from the simulation results and is measured. Volume errors are formulated as in Equation (15) [30].

\[
VE = 100 \left( \frac{\sum_{i=1}^{N} Sed_{obs}^i - \sum_{i=1}^{N} Sed_{sim}^i}{\sum_{i=1}^{N} Sed_{obs}^i} \right)
\]

Where, VE is the difference in the volume of sediment concentration, Sed_{sim}^i is simulation sedimen debit in the i (ton / day) period, Sed_{obs}^i is the measured sediment discharge in the i (ton / day) period, N is the amount of data.

Relative mean error (Relative Error, RE) serves to determine the mean relative deviation of simulated sediment discharge to measured sediment discharge. The advantage of using RE is the ease of checking simulation results, because if the value is close to zero it means that the deviation of simulated sediment discharge to measured sediment discharge is very small. The relative mean error is formulated as in Equation (16) [31].

\[
RE = \frac{1}{N} \sum_{i=1}^{N} \frac{|Sed_{sim}^i - Sed_{obs}^i|}{Sed_{obs}^i}
\]

Where, RE is a relative error, Sed_{sim}^i is simulation sedimen debit in the i (ton / day) period, Sed_{obs}^i is the measured sediment discharge in the i (ton / day) period, N is the amount of data.

The average root of the squared error (Root Mean Squared Error, RMSE) is a measure of the difference between the simulated sediment discharge value and the measured sediment discharge value. The RMSE is formulated as in Equation (17) [29].

\[
RMSE = \sqrt{\frac{\left( \sum_{i=1}^{N} (Sed_{sim}^i - Sed_{obs}^i)^2 \right)}{N}}
\]
Whereas, the RMSE is the root of the average number of squared errors, $\text{Sed}^{\text{sim}}_i$ is simulation sediment debit in the $i$ (ton / day) period, $\text{Sed}^{\text{obs}}_i$ is the measured sediment discharge in the $i$ (ton / day) period, $N$ is the amount of data.

### 3.3. Sensitivity analysis

Sensitivity analysis on the tank model for predicting sediment discharge is intended to determine the parameters that most influence the model output, which will be used as a guide to predicting sediment discharge in the watershed and to find the most sensitive parameters for sediment discharge, it is necessary to do by adding and subtracting the value of each parameter by 10%, then running, then see the output of the model.

To get the sensitivity index ($S$), a formula is used as in Equation (18).

$$ S = \left[ \frac{P_{10} - M_{10}}{\text{Baseline}} \right] $$

Where, $S$ is the sensitivity index with % unit, $P_{10}$ is the simulation result by making 10% addition, $M_{10}$ is the simulation result by making a 10% reduction, BASELINE is the initial (basic) simulation result. Each sensitivity index ($S$) occurs, then compared with the value of the largest sensitivity index and then the results are made in percent form. To test the sensitivity of the tank model for prediction of sediment discharge is applied to the Kreo River Basin.

### 4. Results and analysis

#### 4.1. Development of a tank model with hypothetic data

The results of the analysis of tank model development with hypothetical sediment discharge data which includes hypothetical data of 1 hydrograph, hypothetical 2 hydrograph data, hypothetical delay 1 data, hypothetical delay 2 data and ideal hypothetical data, indicate that the tank model program can work well. This is indicated by the value of sediment discharge resulting from the tank model simulation and the model accuracy value (model performance) of the 2 proposed tank models (Model Tank 1 in Figure 3, Model Tank 2 in Figure 4).

**Figure 3.** Configuration or model structure of tank 1.
4.2. Development of tank models with observation data

The results of the research on the development of tank models for the prediction of sediment discharge in the watershed using observation data in the Kreo Sub-watershed in 4 (four) rain events on 4 (four) days, namely on 6, 10, 26 and 28 January 2014, for 2 (two) The proposed tank model (Model Tank 1 and Tank Model 2), shows that the Tank Model 1 and Tank 2 model are not good enough to apply this based on the results of the model accuracy criteria which are the relative error value (RE), the volume error (VE) value (Table I), correlation coefficient value (R) and root mean square error (RMSE) value (Table II).

| Rain Date | RE Tank Model 1 | RE Tank Model 2 | VE Tank Model 1 | VE Tank Model 2 |
|-----------|----------------|----------------|----------------|----------------|
| 06/01/2014 | 413.63         | 277.67         | 119.73         | 57.08          |
| 10/01/2014 | 154.41         | 300.64         | 62.63          | 203.70         |
| 26/01/2014 | 433.74         | 375.67         | 165.54         | 129.69         |
| 28/01/2014 | 799.42         | 624.85         | 51.65          | 21.55          |

| Rain Date | RE Tank Model 1 | RE Tank Model 2 | VE Tank Model 1 | VE Tank Model 2 |
|-----------|----------------|----------------|----------------|----------------|
| 06/01/2014 | 0.52           | 0.52           | 275.4          | 183.11         |
| 10/01/2014 | 0.65           | 0.65           | 742.6          | 1851.7         |
| 26/01/2014 | 0.89           | 0.89           | 81.71          | 63.64          |
| 28/01/2014 | 0.83           | 0.83           | 1223.5         | 1006.3         |

Figure 4. Configuration or model structure of tank 2.
The results of the tank model analysis on January 6 and 26, 2014, for the Tank Model 1 and Tank Model 2 of the sediment hydrograph graph on the rising limb, the simulation sediment discharge value was greater (above) than the measured sediment discharge value, this was bulk rain tends to be high, of course the amount of surface flow increases so that the output value of sediment discharge in the tank model becomes larger and the recession limb value of the simulated sediment discharge is smaller (below) than the measured sediment discharge value, this is due to rainfall tends to decrease flow the surface also decreases so that the output value of sediment discharge in the tank model becomes small, and the condition of the field of rainfall decreases, the value of sediment discharge decreases but tends to remain high, while the peak value of simulated sediment discharge tends to be lower than the measured sediment discharge value. The simulation results of sediment discharge value of Tank Model 1 and 2 do not approach the measured sediment discharge value, see Figure 5.

Figure 5. Comparison of sediment discharge observation and simulation of tank models in the Kreo sub-watershed on January 6, 2014.

In the Tank Model 1 and Tank Model 2 the simulation results show the tendency of the results of simulation sediment discharge values to be higher than the value of measured sediment discharge, the possibility of accumulation of sediment discharge values from these tanks. However, the results of the tank model have a wide range of differences. The deviation of the sediment discharge value from the simulation results on observations is likely caused by several things including:

- The synchronization factor when measuring the initial occurrence of rain and measuring sediment discharge (sediment concentration), at least must be precise, which usually uses concentration time, and the process of measuring sediment discharge (sediment concentration) and careful and correct sampling is very difficult so it is likely to contain element of error.
- Activities of humans and / or livestock on land or in rivers, cause high enough sediment even though rain is not so heavy (normal rain).
- Data length, if the data used for calibration is too short or is less likely to affect the model output.
- The tank model is a lumped model, using a single value on input parameters without spatial variability and producing a single output and assuming steady state hydraulic conditions

However, the series of observable sediment discharge values and simulated sediment discharge have a pretty good resemblance.

4.3. Development of other data input tank models

4.3.1. Lesti river sub-watershed, East Java. The results of the analysis of the tank model development for the prediction of sediment discharge in the Lesti River sub-watershed, with the time series rainfall data on October 3-6, 2003 and applying 2 tank models, shows that the Tank Model 1 and Tank Model 2 are not good enough, to apply this based on the results of the model accuracy criteria are the RE value, VE value, R value and RMSE value (Table III).
Table 3. Accuracy criteria of 2 tank models and lumped method for prediction of sediment discharge in the Lesti river sub watershed for RE, VE, R and RMSE.

| Research Criteria | Lumped Method (Apip) | Distributed Method (Apip) | Tank Model 1 | Tank Model 2 |
|-------------------|----------------------|---------------------------|--------------|--------------|
| RE                | 231.73               | 214.41                    | 1049.26      | 924.90       |
| VE                | 6.06                 | 3.28                      | 98.18        | 50.81        |
| R                 | 0.90                 | 0.80                      | 0.90         | 0.90         |
| RMSE              | 3179.23              | 3545.76                   | 12371.71     | 6703.59      |

For all 2 tank models the value of $R = 0.8$, quite well this has similar shape, only the value of sediment discharge has a difference range can be seen in Figure 6, while 2 other tank models have a large enough VE value away from the requirements between 50.81-98.18. But the RE and RMSE values are still quite large.

Lumped Method by references number [32-35] is an analysis of the Lumped method physically based on a distribution model (distributed model) for the prediction of sediment flow on the scale of the Watershed. In a physical-based analysis based on a distribution model for sediment flow, the watershed is divided into segments or grids, and in its analysis segment or grid uses 12 parameters, including the depth of capillary soil layer ($d_m$); depth of capillary soil layer + depth of non-capillary soil layer ($d_a$); hydraulic conductivity of non-capillary (ka) soil layer; non-linear exponent constant for capillary ($\beta$) soil layer; roughness coefficient of manning ($n$); median grain size ($D_{50}$); off ground capability ($k$); release and settling efficiency ($\alpha$); sediment density ($\rho_s$); water density ($\rho_w$); gravity ($g$) and kinematic viscosity of water ($\nu$). Furthermore, with a lumped procedure estimation method, the estimated sediment flow can be determined.

The results of the analysis of the tank model development for the prediction of sediment discharge in the Lesti River Sub-watershed, with rainfall data of 2 hours on September 19, 2005 and applying 2 tank models, Tank 1 and Model Tank 2, are not good enough to apply this based on the accuracy criteria the model is the RE value, VE value, R value and RMSE value (Table V).

For all 2 tank models the value of $R = 0.9$, quite well this has similar shape, only the value of sediment discharge has a difference range can be seen in Figure 6. RE, VE and RMSE values for Tank Model 1 and Tank Model 2 tend to be large, because the simulation value of sediment discharge is greater than the value of measured sediment discharge, to start from rising limb, peak and falling limb, because the upper hole parameter factor of the tank for the lowest tank has a sensitivity between $11-18\%$, quite influential against simulation results.

Table 4. Tank Model Accuracy Criteria, Lumped Method, Distributed Method for Prediction of Sediment Discharge in the Lesti River Sub watershed with 2 hours of Rain Data for RE, VE, R and RMSE.

| Research Criteria | Lumped Method (Apip) | Tank Model 1 | Tank Model 2 |
|-------------------|----------------------|--------------|--------------|
| RE                | 441,85               | 168,27       | 212,91       |
| VE                | 117,53               | 58,59        | 73,29        |
| R                 | 0.60                 | 0.80         | 0.80         |
| RMSE              | 2260,94              | 2036,33      | 2191,57      |
Figure 6. Sediment discharge simulation results 2 tank models with 2-hour rainfall data in the Lesti river sub-watershed.

5. Conclusion

In this study the tank model was developed with its parameters for predicting sediment discharge in the watershed, using observation data input data, other watershed data in the form of rainfall data, and sediment discharge data, this can be summarized as follows:

- By representing the erosion-sediment process, the tank model developed for the prediction of sediment discharge in the Watershed is the Tank 1 Model with 3 (three) cascade series tanks and Model Tank 2 with 2 (two) cascade tanks.
- The optimum arrangement or configuration of the tank model gives a predictive result of sediment discharge in the watershed that is not good is the Model Tank 1 and the Tank Model 2. This is applied in the Kreo Sub-watershed, the Lesti River Sub-watershed in East Java. This can be seen from the accuracy of the model, namely the value of the volume error (VE), the relative error value (RE), the mean least squares error value (RMSE) and the correlation coefficient value (R), the Kreo Sub-watershed, Table I and Table II: Sub-watersheds Lesti River, Table III, that conditions in the field of sediment discharge process still occur with the value of sediment discharge is quite large, even though the rain stops or decreases, but the simulation results of the value of sediment discharge decreases. Optimal model parameters on Model Tank 1 and 2 tank models have RE values between 924.51% - 1049.26%, VE values between 50.81% - 121.42%, value $R = 0.9$ and values RMSE between 6703.59 - 17,297.85. The values of the parameters and the constant of the tank model in the River Flow area have different values according to the conditions of the Watershed reviewed.

It should be noted about the distribution of rain according to the time and distribution of rain (space function) actually, which is related to the regional average rainfall analysis as input data in the tank model modeling program for the prediction of sediment discharge in the watershed. Timeliness for measurement and data retrieval must be the same and the length of data taken, especially rainfall data, and data on suspension sediment discharge and discharge data at the watershed location reviewed. Further research is needed in the development of a tank model to predict sediment discharge, if there is a change in land use in the watershed. Further research is needed, the development of a tank model for predicting sediment discharge in the watershed monitoring system with a couple of information technology.

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