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Reliability Test of Mass Balance Model on Nitrogen Loads at The Rembangan River Jember

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Abstract - The Mass balance model of nitrogen load was based on the continuity and momentum equations. Running the model was inserted the variable input into mathematical models based on differential equations by the finite difference method. Aims this study was to calibration, and validation the model. The coefficient of average monthly runoff (Cb) was defined as the ratio between the peak intensity of rainfall runoff to monthly. In this study, the average runoff coefficient monthly (Cb) was used to calculate the monthly average discharge. Calibration of the runoff coefficient of the monthly average (Cb) was do to find the best value of the runoff coefficient as output the model that was similar to the discharge measurement results in the field. The type of water flow in the river Rembangan Jember could determine with calculated the value of the Reynolds number. From the calculation, the Reynolds number is equal to 1929,821. Thus, the value was smaller than 2000, it was means the type of stream Rembangan including laminar flow. The result of running model was value of the nitrate concentration was 0.6549 mg/liter with calibrate of the reaction coefficient (K) and obtained a value of -1759 x 10-6. The minus sign means that the speed of reaction that occurs in the river Rembangan in July 2010 at a point 2 to decrease or reduction in the value of the reaction rate of 9.88 x 10-5/sec. This shows that the speed of the reactions in the river Rembangan tended to decline and approach the value zero.

Keywords: reliability, mass balance, model, nitrogen

1. Introduction

The nitrogen mass balance model can applicable to predict the load of pollutant which contained in runoff water from fertilization activity in plantation area. Mass balance model was developed based on the continuity equation and the momentum equation [1], the input variables used in the process of running this model are: water density (ρ), velocity of water flow in the direction of the x axis (u), the flow velocity water in the direction of the y axis (v), the concentration of nitrate (c), the x-axis changes tehadap distance (Δx), changes in the distance to the axis y (Δy), the reaction coefficient (K), the speed of the earth's gravity (g), the area of coffee plantations, coffee plant populations, high water level (h), air pressure (Po), the runoff coefficient of the monthly average (Cb) rainfall intensity (I), and the elevation of the river length (L). One example of the input variables at one time running a model that is as is done at the point to two months in July 2010.

In the process of data input that will be used for the process of running the program is the first time the value of the reaction coefficient (K) and the correction coefficient (r) given any numerical value or zero for these parameters will be further calibrated to produce a match between the value of the calculation result model with the value of the results of measurements in the field. Once the process is complete, the data input process is then performed. Aims of this study was to determine the results of the calibration model applied to the Rembangan river Jember.

2. Methods

Inventory and identification of data

This study used primary data. The primary data were taken directly in the field. The water quality testing was conducted in the laboratory of Chemistry Department, Jember University and Laboratory of Environmental Control and Conservation Engineering, Department of Agricultural Technology, Faculty of Agricultural Technology, Jember University. Primary data taken were concentration data of N, velocity and discharge on the measurement of surface runoff.

Data Analysis

The data obtained were made to be data plot to identify trends and patterns that occurred on each type of data. Furthermore, the calibration of the runoff coefficient of the monthly average (Cb) and the calibration of the reaction coefficient (K) by using the trial and error method .

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3. Result and Discussion

Calibration Against Runoff Coefficient Monthly Average (Cb)

Before running model must determine type of river water flow. The type of water flow in the Rembangan river Jember could determine with calculated the value of the Reynolds number . From the calculation, the Reynolds number was equal to 1929,821 . Thus, the value was smaller than 2000 , it was means the type of stream Rembangan including laminar flow. The coefficient of average monthly runoff (Cb) is defined as the ratio between the peak runoff to monthly rainfall intensity. In this study, the runoff coefficient of the monthly average (Cb) was used to calculate the monthly average discharge. Calibration of the runoff coefficient of the monthly average (Cb), which aims to find the most runoff coefficient values as output model that was closer to measurement discharge. Control parameter used was the amount of discharge measurements in October 2010 (Figure 1) while the value of the runoff coefficient of the monthly average (Cb) obtained from the calibration runoff coefficient between discharge rate of model calculation results and the measurement discharge in the field in October 2010. (Table 1 and Figure 2).

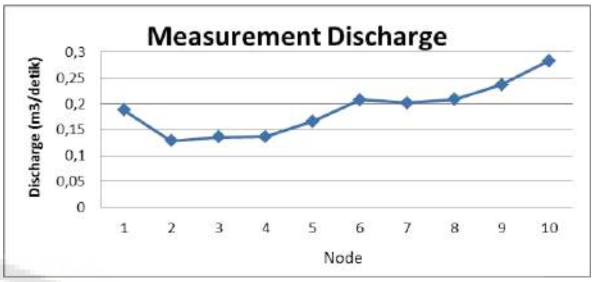

Figure 1. Measurements Discharge on Rembangan River Jember.

Based on the data in Table 1 and Figure 2 shows that the average monthly runoff coefficient (Cb) in October 2010 from point 2 to point 9 tends to fluctuate with the value of the average runoff coefficient of 0.1394. In Figure 2 it can be seen that the overall results of the calibration of the monthly average runoff coefficients (Cb) from point 2 to point 9 shows a similar pattern with the measurements discharge data that was increasing fluctuation in the downstream.

Table 1. Calibration of monthly average runoff coefficients (Cb)

Titik	Q ukur (m^3/dtk)	Intensitas CH rata-rata bulanan **Bulan Oktober** (mm/bulan)	Luas Area A (ha)	Volume rata-rata bulanan = 0.000003858 x I_b x A	Koefisien Limpasan rata-rata bulanan (C_b)
1	0.1881	318	1011	1.240339284	0.151652054
2	0.1285	318	1011	1.240339284	0.103600685
3	0.1364	318	1011	1.240339284	0.10996991
4	0.1371	318	1044	1.280825136	0.107040373
5	0.1662	318	1044	1.280825136	0.129760102
6	0.2084	318	1044	1.280825136	0.162707613
7	0.2021	318	1044	1.280825136	0.157788908
8	0.2084	318	1259	1.544596596	0.13492196
9	0.2371	318	1259	1.544596596	0.153502863
10	0.2834	318	1259	1.544596596	0.183478327
		Rata-rata:		1.347810818	0.13944228

Source: Results of Field Measurements and Calculations

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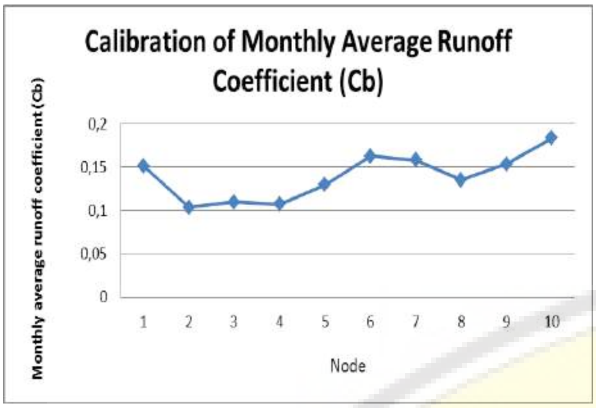

Figure 2. Calibration of Monthly Average Runoff Coefficient (Cb) on October 2010

The pattern of monthly average runoff coefficient (Cb) from point 1 to point 2 decreased, then from point 2 to point 3 there was further increase in the runoff coefficient of the monthly average (Cb) slightly down to the point 4 and started to increase again at the point 5. From point 5 to point of the monthly average 6 runoff coefficient (Cb) increased again and reached a peak further decreased at point 7 to point 8, and the monthly average runoff coefficient (Cb) increased back at point 9. From the above discharge pattern can be seen that the runoff coefficient of the monthly average (Cb) obtained ranged from 0.10 to 0:18 with an average value of 0.1394. This value represents the initial conditions of the rainy season with the amount of rainfall in October 2010 amounted to 318 mm / month that occurred during the 25 days of rain. The smaller the value of the monthly average runoff coefficient (Cb) shows the less rainfall runoff cause infiltration into the ground more and the greater of average monthly runoff coefficient (Cb) show more runoff to infiltrated into the ground. This was consistent with the statement of Suripin (2004) that the infiltration rate decreased in conditions of continuous rain [2]. This was because the soil has been saturated water so that rain water and the less water infiltrated rain water runoff becomes more.

Reaction Against calibration coefficient (K)

Calibration of the reaction coefficient was done by adjusting the concentration of nitrate in the field of measurement results with the results of calculations by the nitrate concentration in the model so that get a reaction coefficient (K). Nitrate concentration data in the field measurement results are presented in Figure 3.

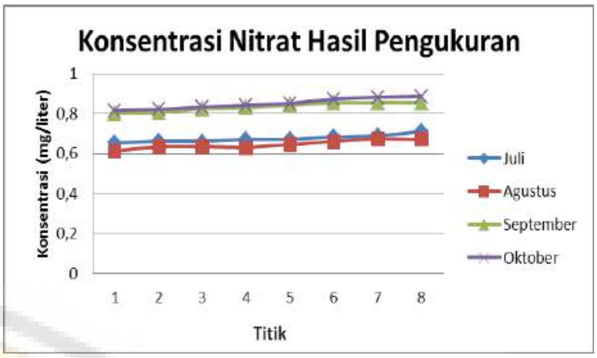

Figure 3 Measurement Nitrate Concentration

Figure 3 it can be seen that the nitrate concentrations occur in Rembangan river Jember in July 2010 to October 2010 Month pattern has increased from the upstream to the downstream. The concentration of nitrate in July 2010 and August 2010 have a value with an interval of about 0.6 mg / liter to 0.7 mg / liter and the concentration of nitrate was lower than in September 2010 and October 2010. July 2010 and August 2010 was the condition before fertilization so that the concentration of nitrate in river water has not been affected too much by the addition of nitrate compounds from the coffee plantation.
While the concentration of nitrate in September 2010 and October 2010 also has an interval value of about 0.8 mg / liter to approach the value of 0.9 mg / liter with nitrate concentration value greater than in July and August 2010 because it was the condition after fertilization in the land coffee plantations so that the concentration of nitrate in river water has been affected by the addition of nitrate compounds from the coffee plantation.

The results of the calibration coefficient (K) was presented in Figure 4 and Figure 5 below.

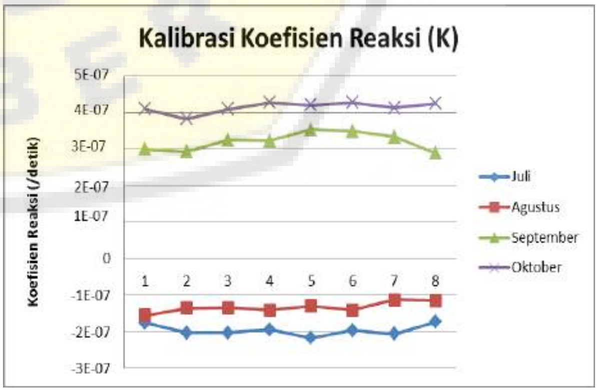

Figure 4. Fluctuation Calibration Results Reaction Coefficient (K) at each point of observation.

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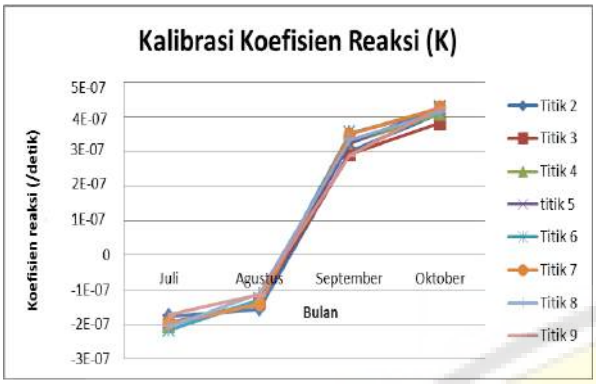

Figure 5. Fluctuations Calibration Results Reaction Coefficient (K) Every Month.

From the calibration process in Figure 4 Results calibration reaction coefficient (K) was the difference between the results of the calibration pattern reaction coefficient in the period July 2010 and 2010 with the results of the calibration Agusutus reaction coefficient in the period September 2010 and October 2010 in the period July 2010 and August 2010 showed the value of the reaction coefficient of -1.6395 x 10-6 / sec with a minus sign , which means a decrease or reduction in the rate of reaction on the Rembangan river because the month was the month that represents the dry season with rainfall fairly small. Meanwhile, in September 2010 and August showed a reaction coefficient of 3.6775 x 10-6 / sec , which means an increase in the reaction rate for the month is the rainy season and the addition of nitrogen into the water stream as a result of fertilization is done on Rembangan coffee plantations Renteng Jember so on to increase the amount of river water nitrate concentrations of compounds .

Table 2. Concentrations of Nitrate Model Calibration Results.

Node	Juli 2010		Agustus 2010		September 2010		Oktober 2010	
	Nitrate concen tration (mg/ltr)	Calibration of K	Nitrate concen tration (mg/ltr)	Calibration of K	Nitrate concen tration Nitrat (mg/ltr)	Calibration of K	Nitrate concen tration (mg/ltr)	Calibration of K
2	0.6549	-1.759×10^{-6}	0.612	-1.552×10^{-6}	0.8008	3.004×10^{-6}	0.814	4.097×10^{-6}
3	0.6635	-2.021×10^{-6}	0.6339	-1.353×10^{-6}	0.8045	2.931×10^{-6}	0.8201	3.830×10^{-6}
4	0.66	-2.024×10^{-6}	0.6339	-1.344×10^{-6}	0.8233	3.255×10^{-6}	0.8323	4.094×10^{-6}
5	0.6712	-1.933×10^{-6}	0.6311	-1.403×10^{-6}	0.8308	3.233×10^{-6}	0.8416	4.276×10^{-6}
6	0.6712	-2.164×10^{-6}	0.6448	-1.279×10^{-6}	0.8421	3.535×10^{-6}	0.8506	4.207×10^{-6}
7	0.6848	-1.956×10^{-6}	0.6612	-1.401×10^{-6}	0.8534	3.498×10^{-6}	0.872	4.270×10^{-6}
8	0.6902	-2.057×10^{-6}	0.6749	-1.121×10^{-6}	0.8534	3.336×10^{-6}	0.8811	4.134×10^{-6}
9	0.712	-1.726×10^{-6}	0.672	-1.138×10^{-6}	0.8534	2.887×10^{-6}	0.8841	4.250×10^{-6}
Average	0.676013	-1.955×10^{-6}	0.6455	-1.324×10^{-6}	0.832713	3.210×10^{-6}	0.84955	4.145×10^{-6}

Source : Results of Field Measurements and Model Calculations.

It can be concluded that the Rembangan river will decrease or reduction in the rate of reaction of nitrate compounds in the dry season with little rainfall and will increase the reaction rate or the addition of nitrate compounds in the conditions of the rainy season with rainfall greater.

4. Conclusion

Based on the above it can be concluded as follows :

1. The results of the calibration coefficients of the monthly average runoff (Cb) in October 2010 showed a similar pattern with the data flow graph that is increasing fluctuation in the value of coefficient of runoff downstream with an average of 0.1394.
2. The results of the calibration coefficient of reaction (K) was the difference between the results of the calibration pattern reaction coefficient in the period July 2010 and Agusutus 2010 with the results of the calibration coefficient of the reaction in the period September 2010 and October 2010 in the period July 2010 and August 2010 showed reaction coefficient of -1.6395 x 10-6 / sec with a minus sign , which means a decrease or reduction in the rate of reaction on the river Rembangan . Meanwhile, in September 2010 and August showed

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a reaction coefficient of 3.6775 x 10-6 / sec , which means an increase in the reaction rate .

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*) *the reference which is not cited in the text can be considered for further reading or bibliography*