Hydrological and Suspended Sediment Concentration Study in a Small Rainforest Catchment (a Case Study in Nopu Catchment in Central Sulawesi, Indonesia)

Sance Lipu[1)], Gerhard Gerold[2)]

[1)] Department of Civil Engineering, Engineering Faculty, University of Tadulako Palu, Indonesia.

[2)] Department of Landscape Ecology, Geographical Institute, University of Goettingen, Germany.

Introduction:

Study on hydrological and suspended sediment concentration in a small rainforest catchment leads to understanding the effect of forest conversion to the characteristics of the flow and sediment concentration, in which forest conversion and clearing land lead to the higher overall runoff and SSC especially during the rain events. Purposes of the study are to envisage the effect of land use changing to the hydrological pattern and to quantify the suspended sediment concentration and total output in temporal and spatial basis. To achieve the study goals, a small catchment (2.45 km^2) at the border of Lore Lindu National Park (LLNP) has been selected (see figure 1 below).

Methodology:

In order to comprehend the effect of land use changing within the catchment, a combination of catchment and plot approach has been chosen by divided the catchment into three sections in respect to the land use pattern at each sections, and weirs have been constructed at each outlet of the sections. Numbers of hydrometric devices have been situated in the catchment, however, in this study we only focused at weir 2 and 3 represent slash and burn sub-catchment and the natural forest correspondingly. The data have been measured were water-level [m] (then converted to the flow rate [m3 sec-1] by using the stage-discharge rating curve) and the water turbidity [NTU] at the 10 minutes of time increment. For the suspended sediment sampling, an automatic water sampler (AWS) was placed at weir 2 since 2004 for collecting the suspended sediment especially during the rain events and additionally once a week for the normal flow. For supporting data of the rainfall, there were 5 gaingauges placed in the field with 10 minutes of data interval, among them, one situated in the automatic climate station.

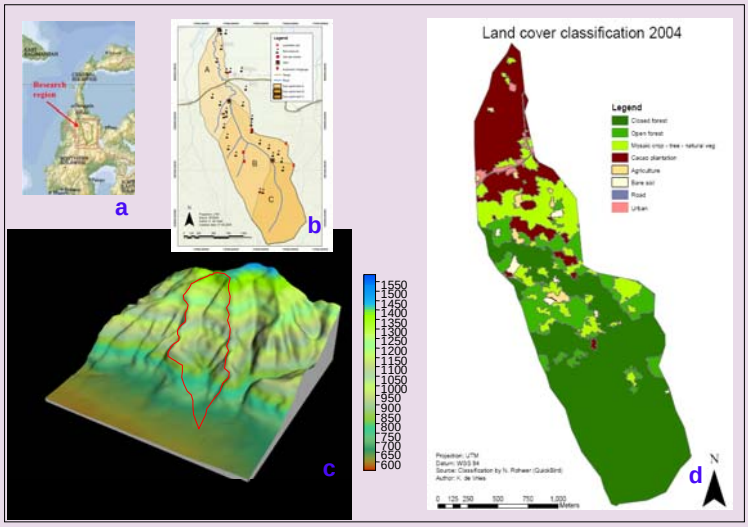

Figure 1. Study location at the rainforest margin of LLNP. Pictures: a). Entire research region of Storma Project in LLNP, b). Nopu catchment with climate-hydrological-soil measurement stations, c). 3 Dimension of the Nopu catchment and d). Land use classification of the Nopu catchment, 2004

Table 1. Total Suspended Sediment Output (in tha-1) at weir 2 and weir 3, 2002 and 2004

Year	Weir 2	Weir 3
2002	4.082	0.314
2004	1.608	0.043

Table 2. Correlation characteristics of some parameters

No.	Parameters	Regression	Correlation coefficient
1.	Discharge vs SSC		
	- Weir 2	Q [m3sec^{-1}] = 0.2647(SSC[gl^{-1}])+0.0768	r2 = 0.6431
	- Weir 3	Q [m3sec^{-1}] = 0.3657(SSC[gl^{-1}])+0.0171	r2 = 0.6059
2.	Discharge vs Turbidity (data in 2004)		
	- Weir 2	Q [m3sec^{-1}] = 0.001[NTU]+0.0789	r2 = 0.6441
	- Weir 3	Q [m3sec^{-1}] = 0.0007[NTU]+0.022	r2 = 0.7868
3.	SSC vs Turbidity		
	- Weir 2	SSC[gl^{-1}] = 0.1981 [NTU/100] + 0.1881	r2 = 0.5423
	- Weir 3	SSC[gl^{-1}] = 0.0893[NTU/100]^2 - 0.0473[NTU/100] + 0.0083	r2 = 0.7783

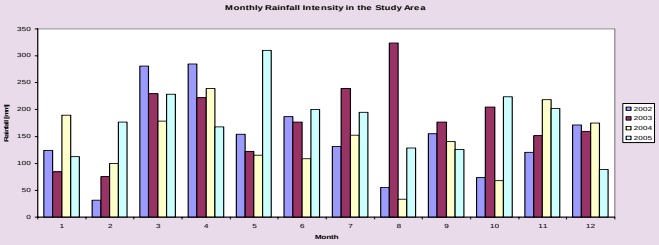

Figure 2. Monthly rainfall intensity in the study area. The data recorded since 2002 until 2005

Contact person: ***Sance Lipu,*** 1. Abt. Landschaftsökologie, Geographisches Institut, Georg-August-Universitaet Goettingen, GoldschmidtStr. 5, D-37077 Goettingen, tel.: +49 551 3919554, 2. Dept. Of Civil Engineering, Faculty of Engineering, University of Tadulako, Palu, Kampus bumi Tadulako Tondo, Palu 94118, Indonesia, tel.: +62 451 481 382, email: sancelipu@yahoo.com

Results:

Annual amount of the rainfall in the study area exhibits the typical of rainforest region with magnitude from 1.800mm until 2.200mm during measurement period in 2002 till 2005. Wet seasons are from March – June and the dry seasons are from August – November. Comparing the rain events that cause slight flood at weir 2 and 3, higher suspended load concentration [SSC] exist in weir 2 by 1.4 to 1.5 folds higher that in weir 3 generally. Despite lower amount of the rainfall in 2004 than in 2002, there was an increasing of total runoff of around 219 mm due to the forest conversion. Soil compaction processes, land-slope and fast growing of the *imperata*, agricultural practices and young secondary forest in the study area were the factors resulted on higher runoff but lower SSC of weir 2 and 3 in 2002 and 2004. During the flood event in 2004, the highest flow rate was 1.821 m^3 sec^{-1} [h = 0.529m] and turbidity was 962 NTU at weir 2, and 0.440 m3 sec-1 [h = 0.384m] with turbidity was 515.5 NTU. The ratio between suspended sediment output at weir 2 in 2002 was about 13-folds higher than one at weir 3, whilst in 2004 the ratio jumped to around 37 times. There is a strong correlation between discharge and turbidity particularly in weir 2 since the AWS is functioned at weir 2, but the hysteresis loop of the flood events (examples: events 24 and 26 February 2005) show that the inconsistency mainly due to the rainfall distribution within the catchment.

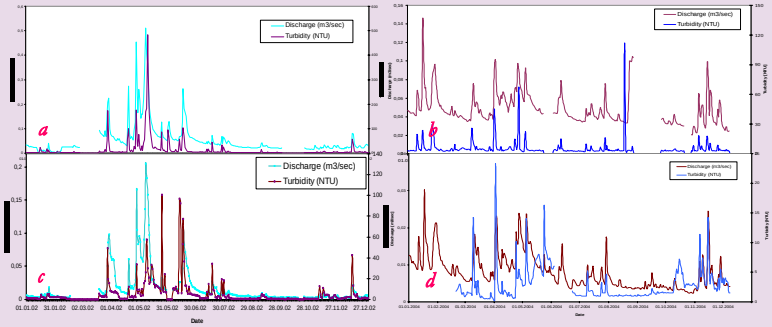

Figure 3. Graphs of daily mean discharge and turbidity at weir 2 and weir 3, year 2002 and 2004. Pictures: a). graph of Q and Turbidity at weir 2, 2002, b). graph of Q and Turbidity at weir 2, 2004, c). graph of Q and Turbidity at weir 3, 2002 and d). graph of Q and Turbidity at weir 3, 2004.

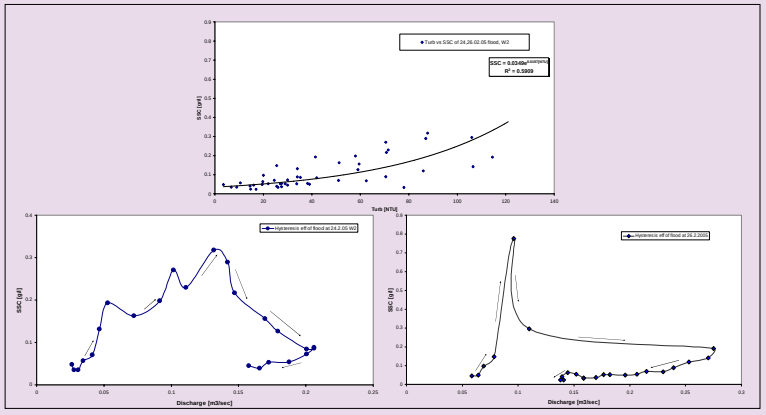

Figure 4. Relation between turbidity and SSC event 24 and 26 Feb 2005 at weir 2 with their hysteresis loop. Note that both of the graph shows the inconsistency in SSC and discharge relationship as indicated with an open loop.

Conclusion:

With a typical of rainforest region, the amount of annual rainfall in the study area vary between 1,800 mm until 2,300 mm with the wet months between March – June and dry months between August – November.

Forest conversion and land use change has an inherent impact on the hydrological and suspended sediment properties that result to higher overall annual runoff and the suspended sediment concentration in the study area.

In terms of total suspended sediment output, the diference in ampunt [t Ha-1] between weir 2 and 3 exhibited the great diference [app.37 folds] as an indicator of the impact of forest conversion.

Due to the forest conversion and land use changing, the SSC is higher in weir 2 by 1.4 to 1.5 times.

In comparison between weir 2 and 3, the ratio between the SS output was 13 times in 2002 and around 37 times in 2004 as a function of the sediment depletion during events.

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