Paper 23
Effect of Change in Land Use on Surface Water Resource: Case Study in Badulu Oya Basin

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INTRODUCTION

Extreme hydrological events such as floods and droughts have significant environmental, social and economic consequences that cause considerable damages in urban as well as rural areas over the world. Severe flood, drought and landslide events experienced in last couple of years in Sri Lanka brought several concerned discussions on to the stage associated to, changed environment by human influence and related potential impacts on the rainfall and runoff processes.These impacts can be intensive in small catchments. It is obvious that, studies on discharge and it's relation with land use, on river catchment scale can assist to reduce existing and upcoming vulnerability on water related issues in the concerned area.

The main intention of this case study is to conduct the trend analysis for both rainfall and river discharge and monitor the relationship between river discharge and changing land use pattern in Badulu oya river basin, Sri Lanka. Currently 199,000 (2012) people live in the Badulu oya catchment area. Home gardens, forests, tea and paddy are the main identified land use patterns.Agriculture is the basic reinforcement to the economy of the area.

HIGHLIGHTS

- Mann-Kendall Trend analysis test was performed for both rainfall and river discharge.
- Rainfall has no considerable trend in the concerned time period although river discharge has a significant increasing trend.
- Corellation Coefficent analysis shows that river discharge has a strong positive relationship with incresing urban lands and a strong negative relationship with deforestation.
- Badulu oya discharge is predicted up to 2020, from the best fit regresson model.

METHODOLOGY

Daily rainfall data from Badulla and Bandarawela regional stations were obtained from Meteorological Department for the period from 1996 to 2012. Badulu oya river discharge data at the Thaldena gauging station was obtained from the Department of Irrigation for the same duration.The land use data in the Badulu oya river catchment were collected from Land Use Policy Planning Department.Trend analysis for both rainfall and river flow has been calculated using non-parametric Mann- Kendall test.Trend was calculated by considering a 95% significance level.

Land use data in the Badulu oya catchment were analyzed from 1982 to 2012.The evolution of the land use data in the concerned period is assumed to be linear for the analyzing purposes. Correlation Coefficient analysis was conducted to find the relationship between river flow and major changing land use types. Best fit regression model was used to predict the Badulu oya discharge upto 2020.

RESULTS

Generally Badulu oya experienced high flow in the months of September, October and November in the period of second inter monsoon (refer Figure:1). Most of flood events and landslide events have been occurred in this period. The Mann-Kendall test analysis emphasize that annual rainfall has no trend with time in the considered time period, but Badulu oya river discharge has a significant increasing trend (refer Table:1). Based on the outcome, it can be understood that increasing river flow scenario has no influence from rainfall.

Land cover changes analysis was carried out to assess the relationship with the increasing river flow discharge. For analysing purposes all lands principally occupied by agriculture which are home gardens, paddy, tea, rubber, chena and other crop lands were totalled as agricultural lands; dense and open forests, scrubs and grass lands were categorized as forest lands and built up areas, roads and railway lines were categorized as urban lands (refer table:2). The data indicates that the dominant land cover type in Badulu oya catchment is agricultural based lands in last two decades. The economy in the area mostly depends on agriculture. Moreover forests and urban lands are the majority land use types in the catchment. Correlation coefficient test was conducted by using forest lands and urban lands versus river discharge data. The correlation coefficient for forest lands and river discharge is -0.83. It expresses a strong negative relationship between forest lands and river discharge. Correlation coefficient for urban lands and river discharge data was +0.84, which means a strong positive linear relationship. The study indicates that the river discharge has been increased with related to increase in urban lands and decrease in forests, which is correlated with urban development.

The future predicted river flows using regression model highlighted that it is high time to consider sustainable development by adopting feasible approaches to decrease surface flow towards the decisions in a sustainable stage (refer Table:3).

CONCLUSION

Increasing river flow scenario has a strong relationship with changing land cover pattern. It emphasizes the significance for the necessity of improved catchment management for better utilization of natural resources in the area. Conserving natural areas such as forests, offering several potential planting areas in development sites, creating storm water pits, use of vegetated swales and wetlands and storm water retention methods are some sustainable and feasible approaches to mitigate the critical circumstances which could occur in near future with the increasing river discharges.

Multi-purpose dams across the river are a major possible intervention to reduce the river discharge and mitigate the flood risk.

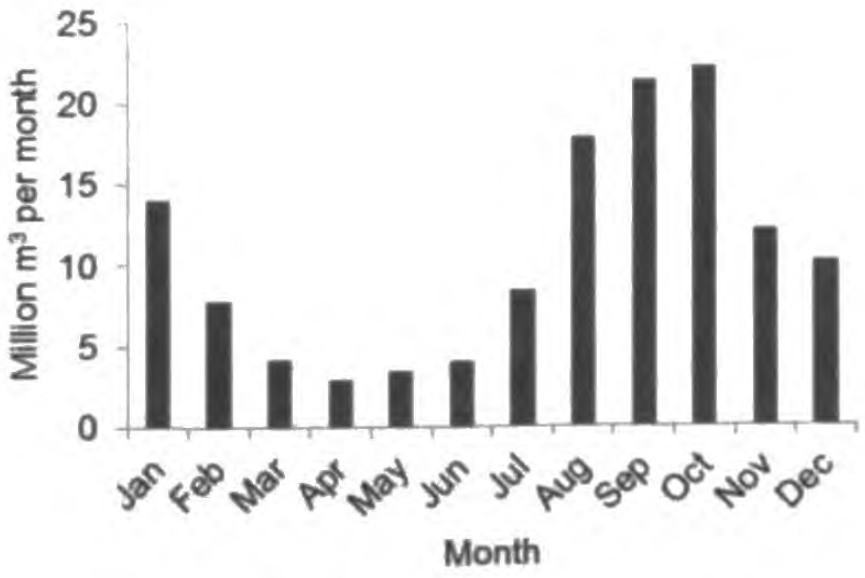

Figure 1: Monthly Average Flow

	Mann-Kendall Test		Regression equation
	Z value	Trend Significance	
Rainfall	1.93	No trend	-
River Flow	3.20	Significantly increasing	$y = -0.216x^2 + 14.546x + 10.899$

Table 1: Trend analysis for rainfall and river flow

Land use Type	Land use (km^2)			
	1982	% from the total catchment	2012	% from the total catchment
Agricultural Lands	301	72.53%	342	82.41%
Forest Lands	103	24.82%	50	12.05%
Urban Lands	9.5	2.29%	17	4.10%
Water Bodies	1.5	0.36%	4	0.96%
Rocks and Barren lands	-	-	2	0.48%
Total	415	100%	415	100%

Table 2: Land use types

Year	Predicted Flow (million m^3/year)
2015	190 to 240
2016	196 to 246
2017	201 to 251
2018	206 to 256
2019	211 to 260
2020	214 to 264

Table 3: River discharge predicted from 2015 to 2020