Hydrologic and Carbon Services in the Western Ghats:
Response of Forests and Agro-ecosystems to Extreme Rainfall Events

- MoES-CWC Hydrology Team

ABSTRACT

This is an ongoing work, funded by the **Ministry of Earth Sciences and Natural Environment Research Council (UK) - Changing Water Cycle Program**—the project titled "Hydrologic and Carbon Services in the Western Ghats". It is a multi-institutional collaboration and includes researchers from **ATREE, FERAL, NCBS, University of Dundee and Lancaster University (UK)** working together. There are two components to the project - one deals with hydrology and the other deals with carbon. This poster presentation is an outline of the work being conducted with an update on what has been achieved so far under the hydrology component.

INTRODUCTION

- The tropical regions support a large fraction of the human population and subject to intense anthropogenic pressures, there is an urgent need to understand and predict the hydrological and carbon consequences of land-use and climate change in these dynamic landscapes.
- Recent studies on climate change impacts on rainfall in India show that the Western Ghats have faced an increase in the number of extreme rainfall events (ERE) in the past few decades.
- The Western Ghats, provide a unique location for a study of the likely effects of ERE on hydrologic services. These services refer to the regulatory role or "sponge effect" of forests in discharge during high rainfall as well as dry periods.[1] How such increased rainfall variability is likely to interact with smaller-scale processes such as deforestation and degradation to influence the provisioning of ecosystem services to humans in landscapes such as the Western Ghats remains unclear.

The project relies on intensive sampling in two catchments varying in land cover and land use. Data collected include hydraulic responses, carbon stocks and transport of sediment, carbon and nutrients from these catchments.

OBJECTIVES

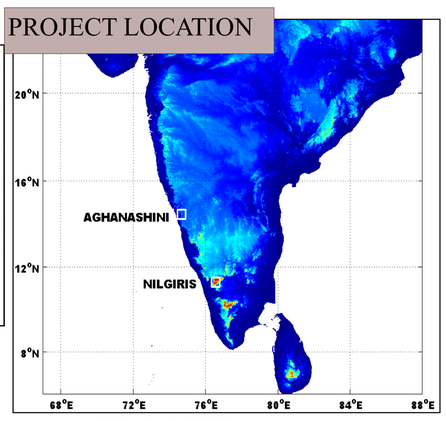
1. Understand the spatial and temporal dimensions of ERE in the Western Ghats (WG) and relation to spatial patterns of land-cover and land-use.
2. Determine the hydrologic and carbon dynamics consequences of existing land-cover and land-use including large scale forestation in the WG.
3. Assess the hydrologic and carbon vulnerability of ecosystems, natural, semi-natural and agro-ecosystems, to ERE at various spatial scales.
4. To prioritise sites in the WG for restoration under Green India Mission (GIM) and other watershed management programmes.

METHODOLOGY

		No. of instruments installed	
Instruments	**Parameters**	**Aghnashini**	**Nilgiris**
Tipping bucket rain gauges	Rainfall	26	29
Capacitance Water level recorders	Water level (stage)	10	13
Pygmy Velocity meters	Velocity	2	2
Flumes	Discharge	3	4
Weir	Discharge	1	1
iButtons	Temperature, Humidity	26	26
Automatic weather station	Temp.,Humidity, heat index, wind speed & direction, solar radiation and rainfall	1	1
Water Analysis	Temp., pH, EC, turbidity, DO, Salinity & TDS (in-field)	Analysis kit-1	Analysis kit-1
	Nitrate, phosphate & sediment	In lab	In lab
Tensiometer (Manual)	Soil Tension	Length of 15, 30, 45, 60, 90 & 120 cms each	Length of 15, 30, 45, 60, 90 & 120 cms each
Mini-disc Infiltrometer	Infiltration and Hydraulic Conductivity	1	1

- Discharge was measured using different techniques. Since the last season, **salt dilution techniques** were employed for measuring discharge. During very heavy flows, slug injection method is employed. Likewise, during very lean flows, when water in streams is not enough for the pygmy current meter to immerse, constant rate injection method of salt dilution technique to measure the discharge.

PROJECT LOCATION

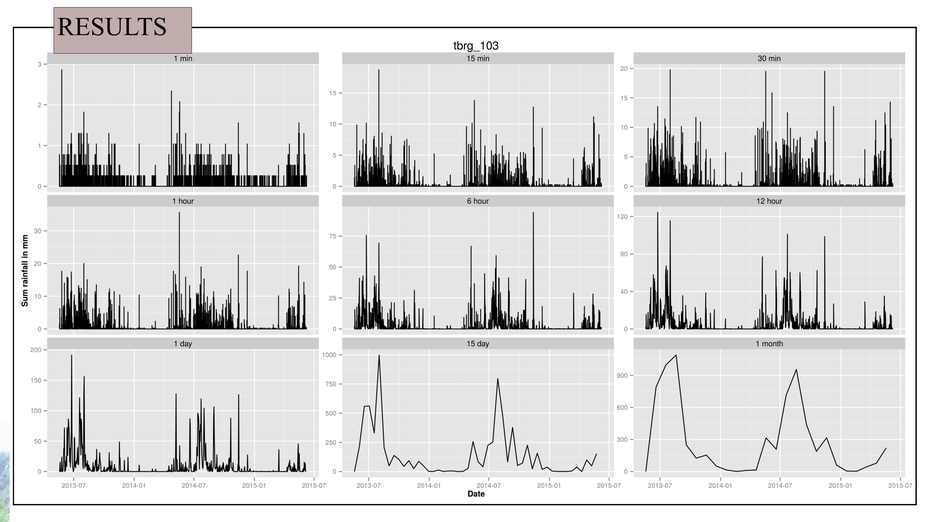


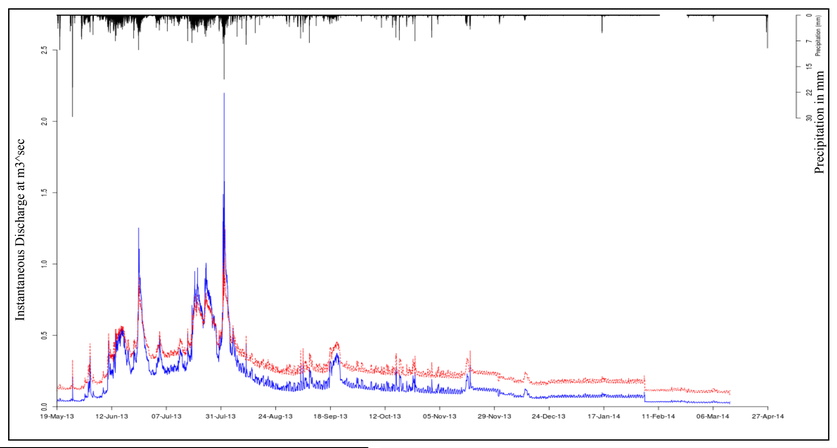
	Grassland	Wattle	Shola
Min.	0	0.5969	0.2236
1st Qu.	1.072	1.955	2.346
Median	2.356	3.705	3.479
Mean	2.975	4.759	6.135
3rd Qu.	3.997	7.286	6.392

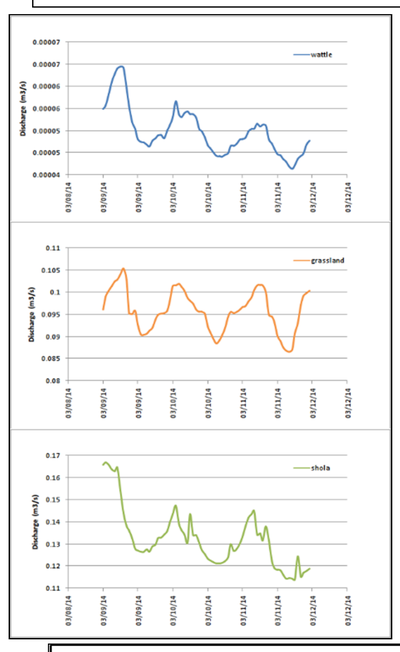
Table: Summary statistics for ET in mm per day

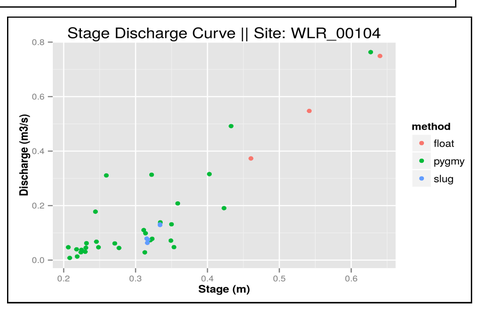
A Master's thesis was produced as a part of one of the objectives of the project. Results indicate how land cover can affect stream flows, and findings from this study provide valuable information to GIM and other afforestation programmes. Land use conversion from grasslands to wattle has potentially caused water loss due to evapotranspiration to the order of 65% during the dry period.

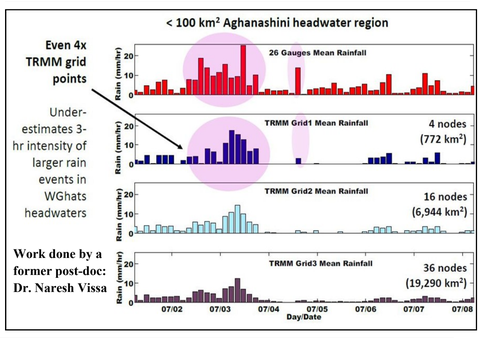
RESULTS

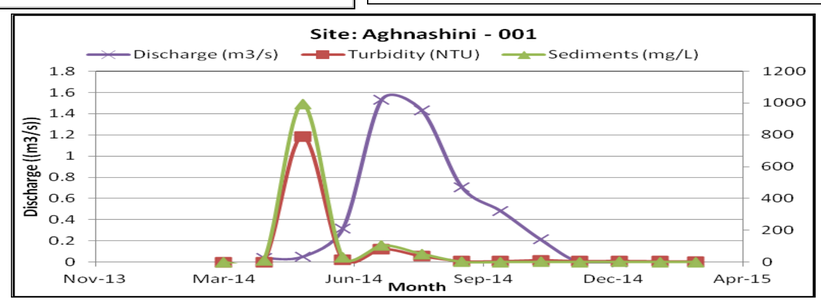












KEY– POINTS

- Analysis of rainfall extremes & rainfall-runoff response with respect of meteorological characteristics show contrasting monsoon rainfall totals with Aghnashini at 6457 mm and Nilgiris at 2807 mm.
- The data analysis for rain gauge and stream discharge has been completed till December 2014 and preparation for the next round of analysis is going on. Hydrographs have been generated for few of the basins.
- Initial analysis of sediment values against discharge show that Aghnashini being a supply limited system, the peak sediment flush occurred before the peak discharge event. In contrast, in Nilgiris which is an energy limited system, the peak for the sediment flush as well as the discharge coincided with each other.
- The recently published paper in the Journal of Climate Dynamics[2] talks about the increasing influence of the Indian Ocean Dipole (IOD) as compared to El Nino Southern Oscillation (ENSO) on the Indian Monsoons (IM) and consequently on ERE.
- Work linking response of extreme rainfall events with water quality dynamics, notably carbon & sediment is ongoing. We are also looking at total organic carbon analysis in water samples.

REFERENCES & PUBLICATIONS

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[3]Krishnaswamy. J., M. Bonell, B. Venkatesh, B. K. Purandara, K. N. Rakesh, S. Lele, M. C. Kiran, V. Reddy and S. Badiger. 2013. The groundwater recharge response and hydrologic services of tropical humid forest ecosystems to use and reforestation: support for the "infiltration-evapotranspiration trade-off hypothesis. *Journal of Hydrology* 498,191-209.

[4]Krishnaswamy, J., M. Bonell, B. Venkatesh, B. K. Purandara, S. Lele, M. C. Kiran, V. Reddy, S. Badiger, and K. N. Rakesh. 2012. The rain–runoff response of tropical humid forest ecosystems to use and reforestation in the Western Ghats of India. *Journal of Hydrology* 472–473 (November 23): 216–237.

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*Dr. Mike Bonell (deceased on July 2014) - was PI , NERC side. We are grateful for his guidance over the years and miss his presence and his input.