Modelling hydrological impact of remotely sensed vegetation change

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Abstract: Vegetation cover over a catchment could be altered by a changing climate, bushfire or human interventions. This will result in changes of catchment hydrological response that may affect catchment water resources management. For developing adaptative water resources management strategies under a changing climate, it is essential to take into account hydrological responses to the dynamics of vegetation. In this study, we adapt an existing hydrological model (GR4J) by incorporating remotely sensed vegetation cover (represented by leaf area index) into the model, in an attempt to better reflect the relationship between catchment evapotranspiration and vegetation cover. The model is designed to be parsimonious and plausible for quantifying hydrological impacts of vegetation change.

The model has been tested in 122 catchments across the Murray Darling Basin (MDB), with remotely sensed leaf area index (LAI) from GIMMS3g and climate inputs from the SILO gridded dataset. Results show that the model performs reasonably well in most catchments (with NSE>0.5 for 95% of the catchments). The model performance is comparable to the original GR4J for most tested catchments but is notably better for 20% of the studied catchments (Figure 1a). The results indicate that remotely sensed LAI can help improve hydrological modelling, particularly by better reflecting the impact of vegetation dynamics on evapotranspiration. However, uncertainty exists in the remotely sensed LAI, which in some cases could affect model performance negatively.

Hydrological responses to vegetation change are then conducted via scenario modelling. In the modelling, vegetation cover scenarios represented by different levels of LAI (i.e., maximum, minimum, median, mean, 25th percentile, 75th percentile of seasonal LAI in the period 1981-2018) are considered. Results show that variations in vegetation cover could have substantial impacts on annual total runoff in many catchments (Figure 1b), with little impact on the low flow and high flow extremes.

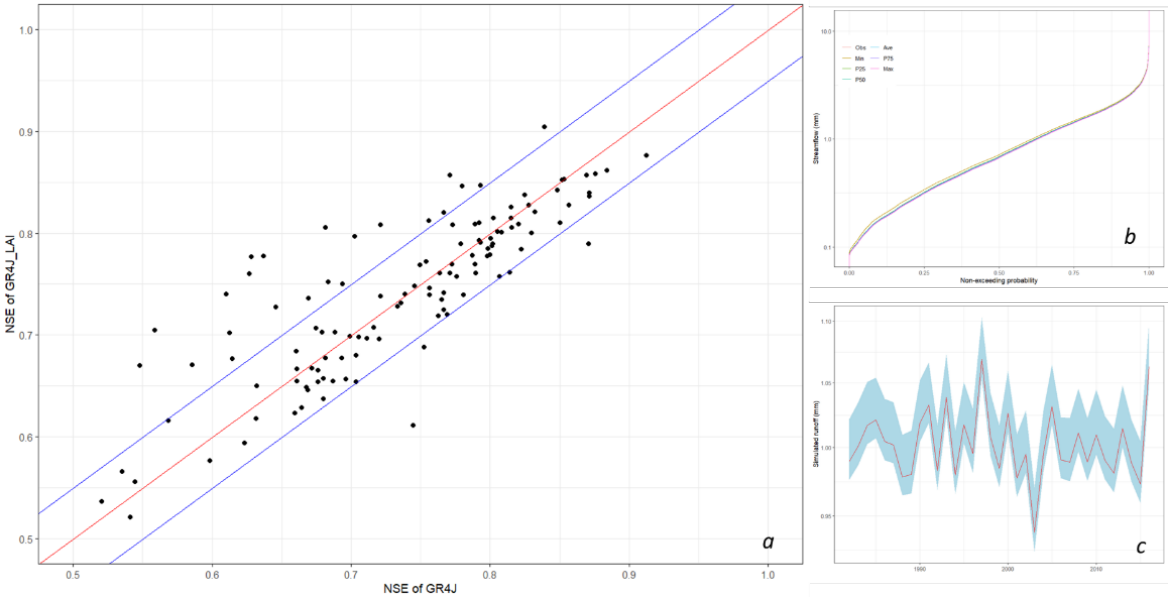

Figure 1. (a) Comparison of model performance in the 122 catchments (b) Difference in modelled flow duration curve under different vegetation cover scenarios for a selected catchment (c) Difference in modelled annual runoff different vegetation cover scenarios for a selected catchment.

Keywords: *Hydrological modelling, remote sensing, leaf area index, vegetation change, climate change, runoff*