Doing Hydrology Backwards: Retrieving Rainfall Distributions Using the Discrete Wavelet Transform

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- This research introduces model input data reduction using the Discrete Wavelet Transform to the hydrological sciences.
- Rainfall is retrieved using model inversion techniques.
- It is shown that simultaneous estimation of rainfall and model parameters improves model performance.

OVERVIEW

- Floods are devastating natural hazards. To provide accurate, precise and timely flood forecasts there is a need to understand the uncertainty associated with rainfall.
- Current methods to retrieve rainfall distributions from streamflow are unable to adequately invert hydrologic models.
- The retrieval of rainfall distributions from streamflow observations adds skill to current areal rainfall estimation methods and provides the ability to retrieve rainfall from poorly gauged catchments.
- It is shown that model parameter and rainfall distributions can be retrieved through multi-chain Markov chain Monte Carlo simulation with the $DREAM_{ZS}$ algorithm.
- The use of a likelihood function that considers both rainfall and streamflow error combined with the use of the DWT as a model data reduction technique allows the joint inference of hydrologic model parameters along with rainfall.

CATCHMENT SELECTION

The Warwick sub-catchment of the Condamine-Culgoa basin has been chosen for this study due to:

- Good availability of high quality data,
- History of significant & recent flooding,
- A significant and varied catchment response to a wide variety of weather events,
- Appropriateness for integration with remote sensing data;
- No flow regulation;
- A low degree of urbanisation.

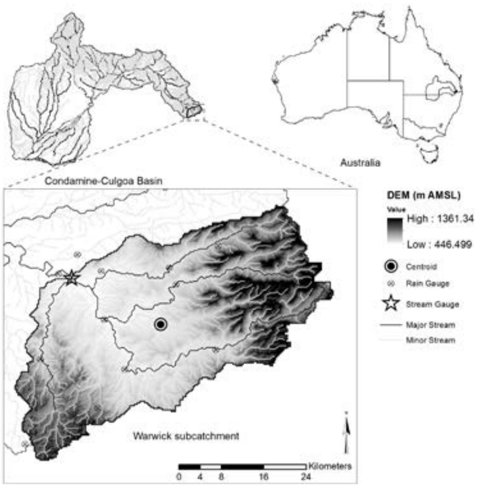

Figure 1. Location of study site.

RETRIEVAL OF RAINFALL

Input rainfall was retrieved by reducing rainfall dimensionality using the DWT before performing model inversion using the MCMC sampling algorithm $DREAM_{ZS}$.

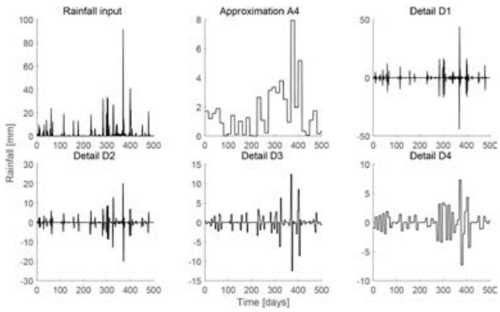

Figure 2. Reconstruction of rainfall record.

COMPARISON OF MODEL DATA REDUCTION TECHNIQUES

The ability to efficiently reduce the dimensionality of rainfall using the DWT and Discrete Cosine Transform (DCT) is compared in Figure 3.

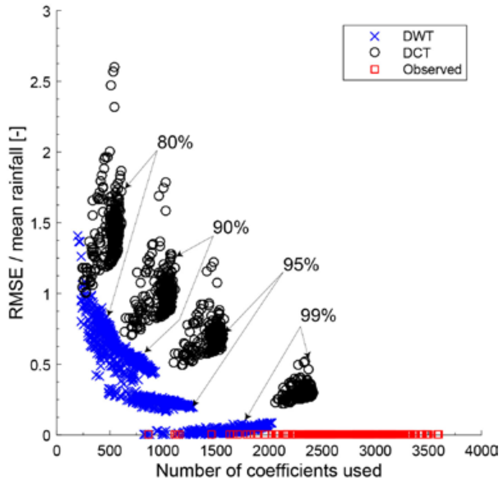

Figure 3. Difference between observed and reconstructed rainfall data record as function of the number of DWT (blue cross) and DCT (black circle) coefficients.

VALIDATION OF METHODOLOGY

The results in Figure 4 indicate that the simultaneous estimation of rainfall and model parameters yields superior streamflow simulations when compared to the retrieval of rainfall with a constant parameter set.

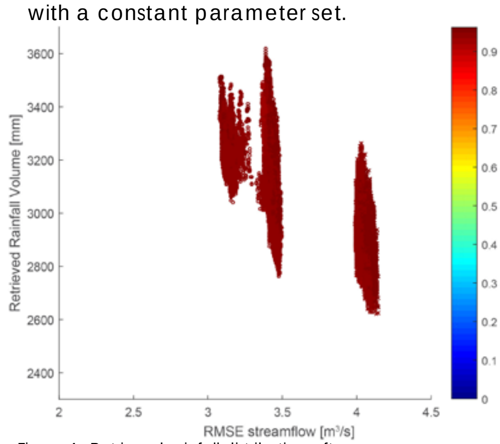

Figure 4. Retrieved rainfall distribution after the convergence criteria has been met for two case studies.