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Assessing the impact of land management changes on nutrient loads with the Reliability Ensemble Averaging (REA) method

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Nitrogen (N) has been identified as an essential element for life on Earth. In order to guarantee optimal crop growths, nitrogen and other limiting nutrients are often spread in excess over agricultural lands. Unfortunately, these intensive practices have altered the naturally balanced N cycle at a global scale. More locally, N leaching from cleared catchments significantly contributes to the nutrient balance in most of the estuaries of south-west Western Australia. In the specific case of the Swan-Canning estuary which drains the city of Perth, decision has been made to quickly reduce the contribution of upstream catchments to the nutrient balance in order to prevent unwanted algal blooms notably.

A large variety of hydro-biogeochemical models has been recently developed in order to describe and understand the water and nutrient balances at the catchment scale. These tools are useful to determine dominant processes as well as to assess the response of the studied systems to variations in either natural conditions or human pressure. However, models in general are always based on some assumptions and therefore it has been demonstrated that none of them could be perfectly reliable. Moreover, because of great structural differences between models, N predictions are highly uncertain. Still, most of the modelling efforts of land-use or management changes have only involved one model for which boundary conditions were changed.

For some years multi-model predictions have become a state-of-the-art option to consider structural uncertainties and increase the global reliability of predictions in atmospheric and hydrological modelling. Nevertheless, only few studies have considered using several models in a hydro-biogeochemical context.

In this ongoing study we propose to assess the impact of different land-management change scenarios on the total nitrogen (TN) exports from the Ellen Brook River located in Western Australia. This agricultural catchment significantly contributes to the nutrient balance of the highly disturbed Swan-Canning estuary. Therefore, the objective to quickly reduce TN exports by 50% via different systems has been decided. In order to identify preferential mitigation scenarios, we will use four catchment scale hydro-biogeochemical models: LASCAM, CHIMP, SWAT and HBV-N-D. Then, we will gather the different predicted responses to the different changes by using the Reliability Ensemble Averaging (REA) method. The REA method was primarily introduce to optimally merge the predictions of different global circulation models when applied with different global change scenarios from the IPCC. This helpful tool calculates the average and uncertainty range of an ensemble of prediction. A reliability criterion is firstly assessed for each model in a re-prediction exercise. During the actual prediction period (i.e. validation), a model convergence criterion is introduced. The surrounding philosophy is to minimise the contribution of the predictions that either poorly re-predict the current hydro-biogeochemical dynamics or provide very different responses than the other members to eventual changes.