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Spatial organisation in hydrological model structure for New Zealand catchments

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Hydrologists increasingly agree that a single hydrological model structure is unlikely to be suitable for all catchments: instead, models should be selected according to characteristics of the catchment. Our challenge is to determine how to select the most appropriate model structure. This complex question requires that we use observed data to infer dominant runoff generation processes, and translate this process knowledge into model structure choices. We can then ask questions such as: over what scales do recommended model structures change? How much data is needed to select model structure? How can we generalise model structure choices to catchments where data is scarce?

In this presentation we address these questions, using the New Zealand landscape as our 'virtual laboratory'. New Zealand is an excellent location to test hypotheses relating to model structure, due to its rich diversity of hydrological landscapes. Landscape types range from temperate rainforest with steep, bedrock gorges, through rolling pasture, to alluvial plains with braided rivers. Our method is to apply diagnostic signatures, which use a range of hydrological data types, to target specific aspects of model structure choice. We bring together results from national hydrometric networks, and in-depth studies in experimental catchments, to explore organisation, similarity and diversity in recommended model structures across the New Zealand landscape.

To identify model structures which are consistent with measured data, we use a range of diagnostic signatures tailored to the data types available. At the national scale, networks of rain and flow gauges are used to investigate runoff ratio, recession characteristics and threshold responses to precipitation and soil moisture. At the experimental Mahurangi catchments, dense networks of 13 rain, 27 flow and 36 soil moisture gauges within a 50 km^2 area enable us to evaluate small-scale patterns and diversities of model structure. In contrast, the experimental Waipara catchment in the Eastern foothills of the NZ alps provides networks of 20 soil moisture sensors and 10 shallow groundwater wells within a 1 km^2 catchment, as well as deep groundwater wells and 5 nested flow gauges. This data enables us to test for additional aspects of model design related to groundwater response.

We relate the local responses and diagnostic signatures to the wider, national-scale patterns. We consider whether local and national model recommendations are compatible, and how model structure patterns and diversity change with scale. Finally, we consider how uncertainty in measured data sources in NZ has the potential to affect diagnostics and hypothesis testing for model structure.