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Metrics for Model Simplification in the Decision-Making Context

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Modern-day environmental decision-making is largely based on numerical models. It is widely accepted that outputs of these models should be accompanied by estimates of their uncertainties so that decision making can incorporate an analysis of risk. However, models are frequently far too complex to support uncertainty assessment. Instead their complexity promulgates numerical instability, drains modelling finances and time, and often detracts rather than enhances, even intuitive assessment of model output uncertainty. We explore the utility of using simpler models in common decision-making contexts. An obvious benefit of this strategy is the reduced cost of model construction, and therefore an ability to support decision-making at a greater number of sites. However the (often unrealized) benefits of complexity, namely the ability to quantify uncertainty, must not be surrendered if a simple model is used in place of a more complex one. Nor must predictive bias be incurred through use of a simple model. This bias can be an outcome of its design; depending on predictions required of the model, it can also be incurred through calibrating the model.

Analysis of optimal and suboptimal simplification has received only minor attention in the modelling literature. We apply existing theory to suggest suitable metrics for real-world model simplification where models are built to support decisions. These are then applied to a synthetic example that is typical of many New Zealand contexts wherein the financial imperatives of farming must be balanced against the need to sustain health of surface and subsurface water ways.