LEMSI – The Landscape Evolution Model Sensitivity Investigation

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Landscape Evolution Models have been developing through a combination of improvements in model efficiencies and computational power. This improvement has allowed simulations to take on more detail and complexities, pushing the modelling from the realm of pure exploration of major processes, into one of numerical prediction and real-world applications. However, unlike the tools other numerical modelling fields, Landscape Evolution Models have not yet undergone rigorous sensitivity analyses to highlight the main sources of model sensitivity and uncertainty.

The Landscape Evolution Model Sensitivity Investigation (LEMSI) is the first large, global analysis of parameter sensitivity within a Landscape Evolution Model. We applied the Morris Method to the CAESAR-Lisflood model, investigating sensitivities to 15 user-defined parameter values and the sensitivities of 14 model output measures, featuring 4,800 individual tests and using over 500,000 cpu hours. This was repeated over two different catchments over 30-year and 1000-year periods. The model showed some sensitivity to most parameters, with variation between the catchments and the timeframe. However, the model showed consistent sensitivity to the choice of sediment transport law throughout, highlighting this as the major source of uncertainty in Landscape Evolution Models.

Our results demonstrate the importance of considering parameter uncertainty in Landscape Evolution Modelling, especially if the model is to be used for prediction and/or real-world applications. The reliance on uncertain, deterministic sediment transport laws was shown to be the most important sensitivity in the model, and developing novel, probabilistic approaches could be a solution to this.