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Humus and humility in ecosystem model design

Ed Rowe
(ecro@ceh.ac.uk)

Prediction is central to science. Empirical scientists couch their predictions as hypotheses and tend to deal with simple models such as regressions, but are modellers as much as are those who combine mechanistic hypotheses into more complex models. There are two main challenges for both groups: to strive for accurate predictions, and to ensure that the work is relevant to wider society. There is a role for blue-sky research, but the multiple environmental changes that characterise the 21st century place an onus on ecosystem scientists to develop tools for understanding environmental change and planning responses. Authors such as Funtowicz and Ravetz (1990) have argued that this situation represents "post-normal" science and that scientists should see themselves more humbly as actors within a societal process rather than as arbiters of truth.

Modellers aim for generality, e.g. to accurately simulate the responses of a variety of ecosystems to several different environmental drivers. More accurate predictions can usually be achieved by including more explanatory factors or mechanisms in a model, even though this often results in a less efficient, less parsimonious model. This drives models towards ever-increasing complexity, and many models grow until they are effectively unusable beyond their development team. An alternative way forward is to focus on developing component models. Technologies for integrating dynamic models emphasise the removal of the model engine (algorithms) from code which handles time-stepping and the user interface. Developing components also requires some humility on the part of modellers, since collaboration will be needed to represent the whole system, and also because the idea that a simple component can or should represent the entire understanding of a scientific discipline is often difficult to accept.

Policy-makers and land managers typically have questions different to those posed by scientists working within a specialism, and models that are developed in collaboration with stakeholders are much more likely to be used (Sterk et al., 2012). Rather than trying to re-frame the question to suit the model, modellers need the humility to accept that the model is inappropriate and should develop the capacity to model the question.

In this study these issues are explored using the MADOC model (Rowe et al., 2014) as an example. MADOC was developed by integrating existing models of humus development, acid-base exchange, and organic matter dissolution to answer a particular policy question: how do acidifying pollutants affect pH in humic soils? Including the negative feedback whereby an increase in pH reduces the solubility of organic acids improved the predictive accuracy for pH and dissolved organic carbon flux in the peats and organomineral soils that are widespread in upland Britain. The model has been used to generate the UK response to data requests under the UN Convention on Long-Range Transboundary Air Pollution.

References:
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