



**KTH Architecture and
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ENVIRONMENTAL MODELLING: LEARNING FROM UNCERTAINTY

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ABSTRACT

Environmental models are important tools; however uncertainty is pervasive in the modeling process. Current research has shown that understanding and representing these uncertainties is critical when decisions are expected to be made from the modeling results. One critical question has become: how focused should uncertainty intervals be with consideration of characteristics of uncertain input data, model equation representations, and output observations? This thesis delves into this issue with applied research in four independent studies. These studies developed a diverse array of simply-structured process models (catchment hydrology, soil carbon dynamics, wetland P cycling, stream rating); employed field data observations with wide ranging characteristics (e.g., spatial variability, suspected systematic error); and explored several variations of probabilistic and non-probabilistic uncertainty schemes for model calibrations. A key focus has been on how the design of various schemes impacted the resulting uncertainty intervals, and more importantly the ability to justify conclusions. In general, some uncertainty in uncertainty (u^2) resulted in all studies, in various degrees. Subjectivity was intrinsic in the non-probabilistic results. One study illustrated that such subjectivity could be partly mitigated using a “limits of acceptability” scheme with posterior validation of errors. u^2 was also a factor from probabilistic calibration algorithms, as residual errors were not wholly stochastic. Overall however, u^2 was not a deterrent to drawing conclusions from each study. One insight on the value of data for modeling was that there can be substantial redundant information in some hydrological time series. Several process insights resulted: there can be substantial fractions of relatively inert soil carbon in agricultural systems; the lowest achievable outflow phosphorus concentration in an engineered wetland seemed partly controlled by rapid turnover and decomposition of the specific vegetation in that system. Additionally, consideration of uncertainties in a stage-discharge rating model enabled more confident detection of change in long-term river flow patterns.

Keywords: Models, data, error, uncertainty, hydrology, soil carbon, wetlands, phosphorus

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