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Communicating Uncertainty in Spatial Decision Support Systems - a Case Study of Bioenergy-Crop Potentials in Mozambique

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Spatial Decision Support Systems (SDSSs) are interactive, computer-based systems designed to support policy making. Important components of SDSSs are models that can be used to assess the impact of possible decisions. These models usually simulate complex spatio-temporal phenomena, with input variables and parameters that are often hard to measure. The resulting model uncertainty is however rarely communicated to the user of the SDSS, mostly because the user prefers clear and unambiguous results, or because of limitations of the used software regarding uncertainty analysis. Current SDSSs thus yield clear, but therefore sometimes deceptively precise outputs. Yet, calculation and communication of the uncertainty and its distribution in space and time makes the model more transparent and the output more informative, which gives policy makers a better basis for decision making. So, there is a strong need to include uncertainty in SDSSs. This requires modelling tools to calculate uncertainty and tools to visualise indicators of uncertainty that can be understood by users of an SDSS, having mostly limited knowledge of spatial statistics. Until recently however, most software packages were monolithic, i.e. either dedicated to model development, or to uncertainty analysis, or to visualization, where most visualisation tools do not support visualisation of stochastic spatio-temporal data. This hampers easy implementation in an SDSS as multiple toolboxes need to be linked. The PCRaster Python framework provides an important step towards a solution of this issue. It comprises both a spatio-temporal modelling framework and a Monte Carlo analysis framework as a Python class. These classes include methods to write the simulation results and uncertainty analysis to disk as stochastic maps, which can be visualized with the Aguila software, included in the PCRaster Python distribution package. This research shows how a modeller can use the PCRaster Python framework to construct an SDSS that integrates simulation, uncertainty analysis and visualization. This is illustrated by the implementation of a land use change model of Mozambique. The aim of this already fully operational model is to evaluate where bioenergy crops can be cultivated without endangering food production now and in the near future when population and food intake per capita and thus food arable land and pasture areas will increase. Population growth predictions and future change in food intake patterns are highly uncertain, so this uncertainty needs to be taken into account in the SDSS. It is shown that due to the capabilities of the PCRaster Python modelling framework the integration of modelling and uncertainty analysis can be accomplished without too much additional work on the modeller's side. Also, the outputs can be visualized and interpreted by users without specialist knowledge of statistics. This is considered a major step forward in the exposure of uncertainty in SDSSs.