HydroServ NRP61

Setting up a spatially explicit land use decision model

A first step towards integrated water resource management

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Land use decision modelling

Land use changes are one of the most important alterations of the Earth system. In cultural landscapes, as they are frequently found in Switzerland, decisions of land managers are an important driver of land use changes. These decisions are modelled to elaborate a spatially explicit land use decision model.

Spatially explicit land use models using Bayesian Networks (BN) and models accounting for stakeholder preferences are rare. Yet, these models have two advantages compared to other land use modelling approaches: uncertainty inherent to decision-making and stakeholder knowledge can be accounted for in a spatially explicit manner.

Besides modelling land use changes, the model can be employed to test policy instruments regarding land use. This is a first step to elaborate management strategies for a specific catchment.

Connection between spatially explicit data and the Bayesian Network

Every value of a raster cell serves as input for the BN.

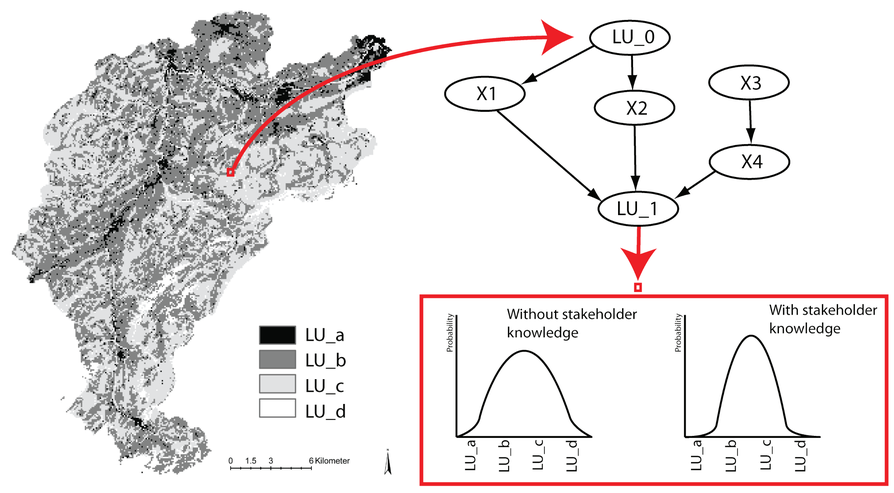
Land use categories:
extensive vs. intensive agriculture

coniferous vs. deciduous forest

built vs. unbuilt settlements

moorland

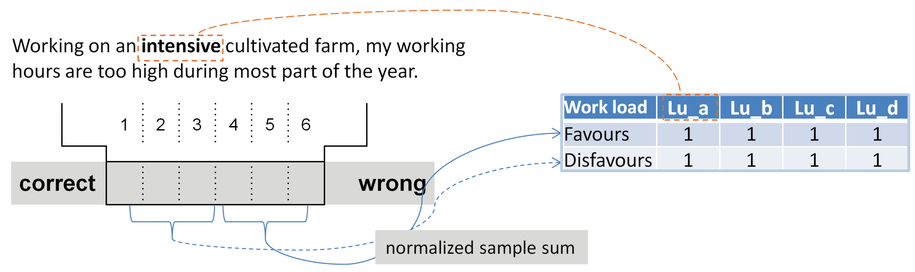
unproductive areas



Expert process and stakeholder survey

The **expert process** focuses on nodes, states, causal connections & prior probability distribution.

Update of probability distribution with a **questionnaire:**
Every root node of the BN is updated according to a related question in a questionnaire.



A five-step-procedure to set up a Bayesian Network-based land use decision model

1 Pre-phase

Problem overview	Define scope and context Delineate geographical area Define social and economic boundaries Define timescale

2 Expert based BN

Experts' identification	Identify and select experts Analyse expert interest, world perception Agree on expert's roles and responsibilites Collect variables (interviews, questionnaires)
Variable identification	Identify key indicators Identify potential actions/scenarios Identify data sources
Construct expert BN	Establish causal connections Define states of variables Fill in conditional probability tables Collect data from statistical surveys Rationalise network Check consistency and logic of the network Demonstration of the network (collect feedback) Parameter learning; structure learning (if data is available)
Spatially explicit model	Spatially explicit: software(s) and scripting

3 Stakeholder based BN

Stakeholders' identification	Identify and select stakeholders Collect data from stakeholders (questionnaire)
Stakeholder BN	Update network Add decision nodes if required

4 Validation

Sensitivity and validation analysis	Sensitivity analysis Quantitative validation of outcomes Feedback from stakeholders Incorporate findings and evaluate modelling approach

5 Implementation

Implementation	Scenario building Use of land use decision model: coupling, decision making Stakeholder meeting to discuss findings and further course of action

Research Questions

- Which are the most important drivers of land-use decision making in the Kleine Emme catchment?
- How can quantitative and qualitative knowledge be systematically integrated in the set up process of a BN land use decision model?
- Can the integration of stakeholder knowledge into a BN-based land use decision model improve land use decision modeling?

Expected Results

- Through integration of empirical stakeholder knowledge, an expert-based BN land use decision model can be improved for the specific case study. Therefore, the fulfilment of the model's potentials concerning the integration of quantitative and qualitative knowledge is achieved.
- Spatially explicit representation of land use patterns based on stakeholder preferences.

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