A multi-scale approach for analysing landscape service dynamics

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Landscapes are continuously changing and therefore the provision of landscape goods and services is subject to permanent change. The presence of landscape functions and their supply of services are affected by landscape properties like social and biophysical properties and patterns. Changes in these properties can therefore result in a change in the provision of landscape services. Understanding, monitoring and exploring landscape function dynamics is not a straightforward task. Landscape functions cannot be directly observed and monitored by standard techniques, like used in land cover observation, which makes the use of models inevitable. Most of the current landscape-dynamics models are based on land cover and use data. However, as landscape functions are driven by both local and contextual factors, of which land cover or land use are only one aspect, these modelling approaches cannot be used. For example, landscape functions may drastically change without any change in land cover and vice versa. Additionally, landscapes are often multifunctional, meaning that at a single location more than one landscape service is being provided. Current landscape models assign one land use to a specific location (e.g. arable agriculture), not taking into account the multifunctional potential a site.

We propose an innovative modelling approach that allows analysing the multi-scale dynamics in landscape service supply as a result of a changing landscape and societal demand. Drawing on the insights from land use system and ecosystem modelling efforts, we explicitly address in this modelling approach (i) the multifunctional character of the landscape, (ii) the different spatial levels at which interactions between landscape service supply, demand and land management occur and, (iii) the trade-offs in service supply levels as a result of land management actions. In our research we focus on the exploration of possible spatial and temporal dynamics of landscape functions. Therefore our approach does not aim at finding an optimal configuration of landscape functions to maximize service supply for a region.

The proposed modelling approach is a first step to better identify, map and quantify dynamic patterns of multiple landscape functions and their service supply. So far, land use models could capture decision making, feedbacks and spatial and temporal dynamics, while ecosystem–based spatial models addressed complex processes relating to multiple service supply. We combined both approaches by explicitly addressing the interactions and feedbacks between landscape service supply, demand, and land management actions of the multifunctional landscape. The proposed modelling framework could be an example of new innovative landscape modelling approaches, which include multiple uses of the land, and which have a potential for quantitative assessments of ecosystem services provisioning for policy discussions on landscape management.

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