Towards Multifunctionality of Landscapes – A Multi-Objective Land Use Optimization Framework for Exploring Interaction between Ecosystem Services and Biodiversity

Michael Strauch  
*Helmholtz Centre for Environmental Research-UFZ*

Anna Cord  
*Helmholtz Centre for Environmental Research-UFZ*

Andrea Kaim  
*Helmholtz Centre for Environmental Research-UFZ*

Carola Pätzold  
*Helmholtz Centre for Environmental Research-UFZ*

Christian Schweitzer  
*German Federal Environment Agency-UBA*

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See next page for additional authors

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Towards Multifunctionality of Landscapes – A Multi-Objective Land Use Optimization Framework for Exploring Interaction between Ecosystem Services and Biodiversity

Michael Strauch\textsuperscript{a}, Anna Cord\textsuperscript{a}, Andrea Kaim\textsuperscript{a}, Carola Pätzold\textsuperscript{a}, Christian Schweitzer\textsuperscript{b}, Ralf Seppelt\textsuperscript{a, c}, Martin Volk\textsuperscript{a, c}

\textsuperscript{a}Helmholtz Centre for Environmental Research-UFZ, Department Computational Landscape Ecology, German Federal Environment Agency-UBA, Martin-Luther-University Halle Wittenberg. Presenting author: martin.volk@ufz.de

Abstract: The sustainable appropriation of resources and the design of multifunctional landscapes requires the finding of solutions that minimize trade-offs between contrasting goals of land use, ecosystem services and biodiversity. Substantial progress has been made in the model-based quantification of land-use effects on ecosystem services and biodiversity over the past years, but finding ‘optimal’ land use patterns is still one of the challenges. Existing implementations of multi-objective land use optimization often have shortcomings or are not well designed for meeting multiple demands. For example, users may wish to include computationally extensive and complex process-based or statistical models to define their objective functions. Further, land use optimization has to consider user-defined constraints for the transformation rules between different land uses, to allow the exclusion of certain areas (e.g., patches) from the optimization and to include ways to limit the total area of each land use type based on minimum and maximum thresholds. Building upon recent advances of how to consider such spatial constraints, we present the framework CoMOLA (Constrained Multi-Objective Land Allocation). It is a freely available spatially-explicit optimization routine based on the NSGA-II genetic algorithm, which embraces multiple objectives and the mentioned user-defined constraints. Specifically, we have included a new variator to efficiently generate feasible solutions and a novel approach to test the feasibility of solutions. CoMOLA may be applied to address a wide range of different research questions and is aimed to facilitate interdisciplinary and comprehensive assessments of the performance (and limits) of a landscape based on multiple criteria such as environmental quality indicators, biodiversity indicators but also economic returns. The different options to constrain the spatial optimization in order to achieve more realistic results further ease the involvement of stakeholders in the study design and evaluation of the results. Related to presented framework, the role of modelling for evaluating sustainability and the multifunctionality of landscapes “in science and practice” are discussed in the presentation.

Keywords: Multifunctionality; Sustainability; Land Use Optimization; Ecosystem Services; Biodiversity; Modelling.