Planning for sustainable energy landscapes using multicriteria decision analysis and GIS-based 3D landscape visualizations

Adrienne Grêt-Regamey and Ulrike Wissen Hayek

Serious challenges of climate change and the depletion of oil reserves increase the pressure on the development of renewable energy systems (RES). Planning and designing procedures for integrating these new structural elements into the landscape are missing. In order to design new energy landscapes securing both a high quality landscape supporting human wellbeing and meeting energy needs, planners and designers need to understand the spatial tradeoffs between ecological, aesthetical and socio-economic benefits of different sites for RES.

We developed a spatial decision support system taking into account the multifunctionality of the landscapes, the physical potential for RES and stakeholder's preferences to determine sites for new RES. Figure 1 illustrates the overall workflow for a quantitative and qualitative landscape impact assessment for new RES.

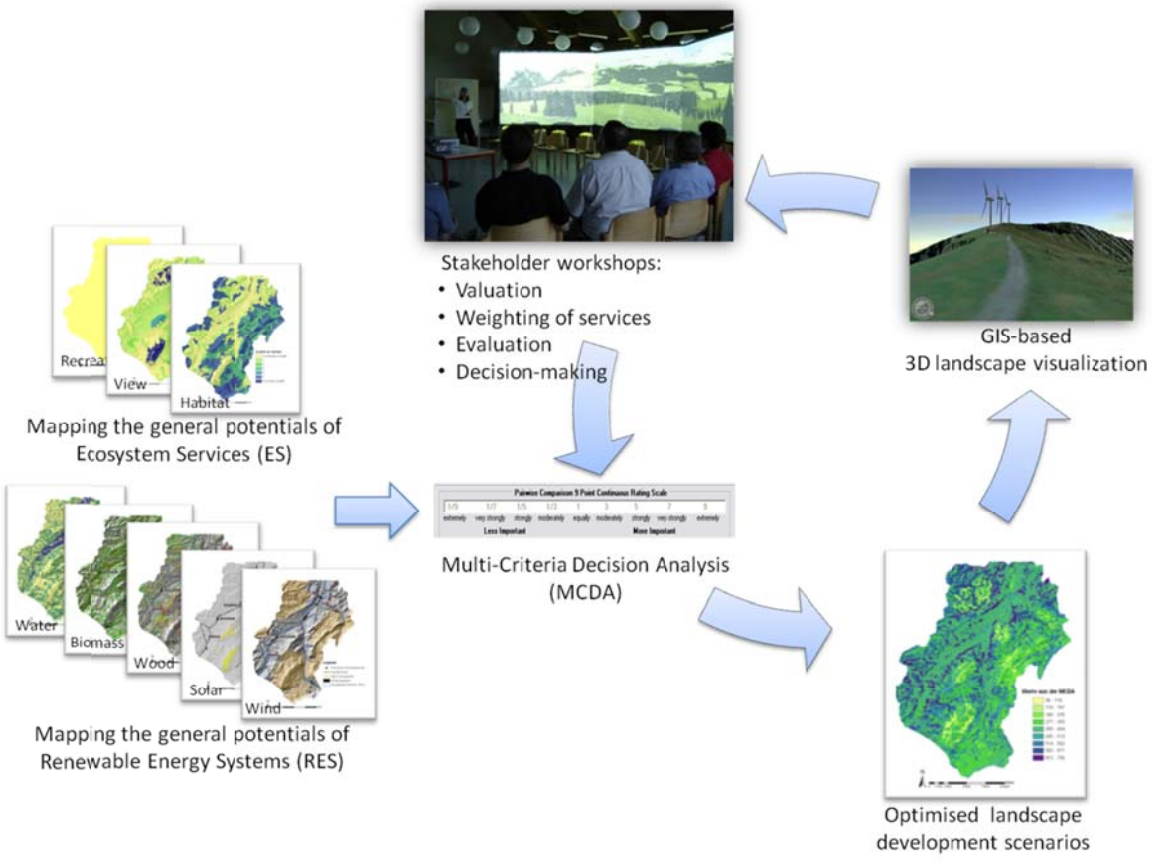

Fig. 1: Overview of the workflow for a landscape impact assessment of renewable energy systems.

In a first step, the suitability for RES and the potential for ecosystem and landscape services' provision are quantified in a GIS analysis. In a second step, possible tradeoffs between the different socio-economic, ecosystem and landscape services are determined in the spatially

explicit MCDA. Figures 2 and 3 show examples of resulting maps of the two steps for the case study area, the UNESCO Biosphere Reserve Entlebuch in Canton Lucerne (CH). Stakeholder knowledge and experiences can be integrated in both steps in order to reflect societal values and preferences for landscape development. Particularly, the GIS-based 3D landscape visualizations of the different energy landscape scenarios offer powerful possibilities to integrate stakeholder valuations into the decision-making process.

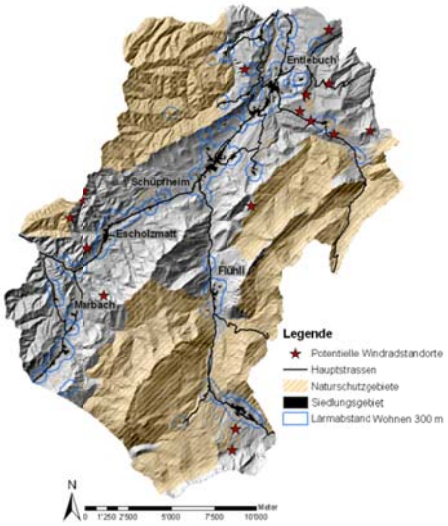

Fig. 2: Result of the GIS analysis of suitable locations of wind turbines according to technical and economic criteria such as energy output, wind speed, slope, access to the sites and legal regulations.

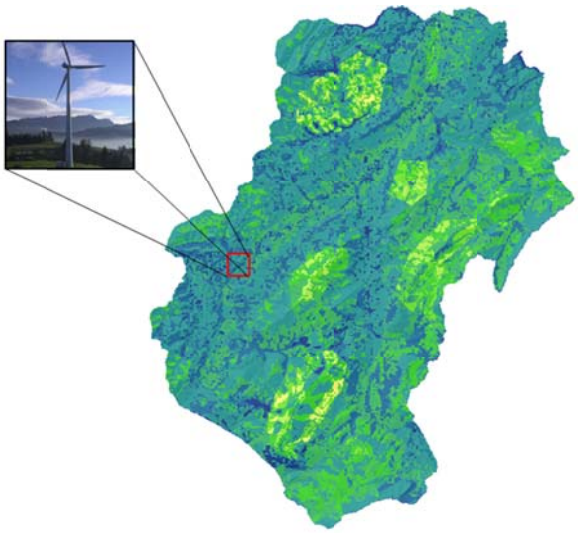

Fig. 3: Result of the MCDA aiming at highest renewable energy output for a mix of wind, solar, wood and biomass energy and lowest landscape impact considering the view of the landscape and habitat quality for protected species. The darker the blue, the better are the goals met. The 25m by 25m raster cell raster cell fulfilling the criteria best is a wind turbine site.

Using the capacity of GIS-based 3D landscape visualizations linked to quantitative indicators and spatially explicit site optimization models provides new powerful means for integrated and collaborative landscape impact assessments. Within a broader context, the implementation of the suggested framework will, on one hand, support exploiting the full potential of RES in a landscape. On the other hand, it will allow for a more comprehensive appreciation of landscape qualities. This will help overcome possible fear and prejudice opposite to the installation of these infrastructures, thus supporting the building of sustainable energy landscapes.