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Assessment of opportunities and challenges of renewable bioenergy technologies and their environmental impacts in relation to the energy transition in Germany

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Affordable, reliable, sustainable and modern energy for all, as listed in UN's SDG7, is a key component both for human well-being and for sustainable environmental development. The BMWi-funded project SustainableGas simulates different process chains for the substitution of natural gas by the use of renewable energies in the electricity and heat market. The project follows an interdisciplinary approach, taking into account economical and environmental feasibility as well as social acceptance; this presentation highlights the project results from the environmental perspective.

So far, detailed assessment of the costs of alternative gas technologies with a focus on GHG emissions reduction, regional process of energy transition and potential environmental (land-use) impacts has remained scarce. Although, such data constitute key input for decision-making, this study helps to bridge a substantial knowledge gap. Especially the use of renewable energies (for example biomass cultivation, construction of photovoltaic plants and wind farms) will increasingly conflict with the classical agrarian land use and ecosystems.

Competing land use systems are examined in order to secure central ecosystem services. Interdisciplinary scenarios of future energy systems are developed to map and quantify land use change and altered material flows between the hydrosphere, soil, plant and atmosphere on various scales (spatially explicit for selected river catchments, or county level for Germany). To fulfill this obligation, an Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) serves as the modeling tool. InVEST assesses ecosystem services (ES) that are affected by alternative bioenergy technologies in Bavaria and Germany. Spatially explicit model results include the ES water provisioning using the Water Yield model (WY), soil erosion and sedimentation described by the Sediment Delivery Ratio (SDR), nutrient fluxes (N, P) in response to changing land use and management are obtained through the Nutrient Delivery Ratio (NDR). Lastly, changes in habitat quality are evaluated by modeling the number of terrestrial species impacted or to be affected in the future if more energy plants are built.

The detailed model results are finally extrapolated to the county scale to provide a comprehensive image of environmental impacts caused by bioenergy expansion in Germany.

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