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Modeling Sustainable Bioenergy Feedstock Production in the Alps

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Sustainability of bioenergy is often indicated by the neutrality of emissions at the conversion site while the feedstock production site is assumed to be carbon neutral. Recent research shows that sustainability of bioenergy systems starts with feedstock management. Even if sustainable forest management is applied, different management types can impact ecosystem services substantially. This study examines different sustainable forest management systems together with an optimal planning of green-field bioenergy plants in the Alps. Two models - the biophysical global forest model (G4M) and a techno-economic engineering model for optimizing renewable energy systems (BeWhere) are implemented. G4M is applied in a forward looking manner in order to provide information on the forest under different management scenarios: (1) managing the forest for maximizing the carbon sequestration; or (2) managing the forest for maximizing the harvestable wood amount for bioenergy production. The results from the forest modelling are then picked up by the engineering model BeWhere, which optimizes the bioenergy production in terms of energy demand (power and heat demand by population) and supply (wood harvesting potentials), feedstock harvesting and transport costs, the location and capacity of the bioenergy plant as well as the energy distribution logistics with respect to heat and electricity (e.g. considering existing grids for electricity or district heating etc.). First results highlight the importance of considering ecosystem services under different scenarios and in a geographically explicit manner. While aiming at producing the same amount of bioenergy under both forest management scenarios, it turns out that in scenario (1) a substantially larger area (distributed across the Alps) will need to be used for producing (and harvesting) the necessary amount of feedstock than under scenario (2). This result clearly shows that scenario (2) has to be seen as an “intensification scenario” under which more biomass feedstock can be produced and harvested, so that less area would be affected by harvesting and other management activities. Intensification through optimal forest management can lead to a substantial reduction of the area necessary for bioenergy feedstock supply. This in turn means that the “spared” area and the associated ecosystem services can be designated for conservation or other uses. This insight provides support to policy and decision makers in considering the optimal “mix” or “co-existence” of different ecosystem services and economic demands from a modern landscape management approach.