Bioenergy production and forest multifunctionality: a trade-off analysis based on multiscale spatial tool

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Abstract

Large scale environmental assessment needs of Decision Support Systems (DSS) able to consider several aspects in an unique framework analysis. The complexity of interaction between ecological, socio-economical and political aspects and a widespread lack of data availability lead to a difficult in bringing together legislation at national and supra-national level with local planning systems. Furthermore, in practice, only with small scale management interventions it is possible to reach a global sustainable development. This loop can be solved through flexible tools able to relate large scale environmental assessment with small scale DSS, useful for local decision makers.

One of the main environmental topics emerged in last years is the importance of renewable energies to realize strategic objectives in term of reduction of carbon dioxide emissions and integration of thermal and electric energy production. In particular, bioenergy from woody sources can lead to an improvement of agricultural land and forest stands in terms of employment and rural area conservation. However the exploitation of this kind of biofuel must take into consideration an in depth analysis of local energy demand/supply ratio, logistical, economical and social variables. In this way it is possible to implement sustainable agro-energy chain and to avoid an impoverishment of natural resources. In addition, the estimation of bioenergy impact on the multifunctionality of a particular environmental system, seems to get a strong importance (Stupak et al., 2010). For instance, in order to consider all above issues, the Directive 2009/28/EC on the promotion of the use of energy from renewable sources provided both a series of targets to be met by 2020 (e.g. the reduction in EU greenhouse gas emissions of at least 20% below 1990's levels) and the introduction of sustainability criteria in biofuel production.

In this framework the present research aims at creating a multiscale spatial model (called MULTIFORENERGIS) based on Geographic Information System (GIS) tools capable to estimate the potential production of bioenergy from forest residues. The model is carried out basing on the introduction of multifunctionality parameters (Verkerk et al., 2011). The forest functions considered in the model are: (i) timber production, (ii) soil and water protection, (iii) biodiversity and habitat conservation, (iv) touristic-recreational function and (v) fire risk assessment.

The structure of the model is based on sub-models that enable biomass production analysis from large scale to small scale. Large scale analysis is developed using forest yield data, protected areas localisation, geomorphological variables and fire risk maps. An increase of input data (socio-economics and logistics variables) is requested for small scale analysis. For this reason the spatial tool follows a rule that can be defined as a Scale-Complexity Inverse Proportion (S.C.I.P.): larger is the assessment area size and lesser is the model complexity and *viceversa*. S.C.I.P. approach permits to realize analysis from national or international level to local one, with different degree of details and differentiated by data availability. In this research, MULTIFORENERGIS model was tested from national (Italy) to provincial scale (Province of Trento in north-eastern Italian Alps). Results were aggregated into a S.W.O.T. analysis to highlight the main strengths and weaknesses, as well as the opportunities and threats deriving from the modelling of trade-off between bioenergy production and each forest functions. The models' results can provide an useful instrument to address the management interventions and to support the administrators in decision making process at local scale. Sensitivity analysis and model validation emphasize the possibility of using the model as Decision Support tool in environmental and forest planning. Finally, comparison between model results and real timber production data stressed the level of uncertainty in the evaluation.

References:

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