Landscape spatial modelling and scenario analysis of Mediterranean forest dynamics under climate change and anthropogenic disturbance conditions for adaptive management in protected areas

Spatial simulation models can be effectively used to build forest landscape modification scenarios providing inferences on the coupled effects of climate change and anthropogenic disturbance regimes on forest dynamics. Such inferences are of utmost importance for adaptive sustainable forest planning and required for biodiversity conservation. We illustrate this through a case study in a Mediterranean environment where semi-natural vegetation types, forests and grasslands, are cast within an agricultural matrix. We parallel the dynamics of these two broad vegetation categories over the next 150 years using a forest landscape dynamics simulator (LANDIS-II) under conditions of climate change, two alternative fire regimes (current-severe, and target-attenuated) and current forest management. Quantitative scenario analysis allowed to assess forest and grassland modifications in terms of spatial configuration, biomass density and relative woody species composition. Results indicate that a similar pattern of spatial changes in both categories is predicted to occur, whereas the attenuated fire regimes somewhat temper the qualitative vegetation changes. This seems to depend on the relatively stronger role of fire regime than that of forest management in shaping vegetation dynamics. The future site-scale management will most likely be based on the fixed-boundary protected area approach (resistance strategy to vegetation changes) aiming at the conservation of the ecosystem services now provided and valued for by semi-natural vegetation. In such a perspective, an alternative forest management might be appropriate to enhance the positive effects of the attenuated fire regime. In order to improve current spatially explicit modelling potentials of LANDIS-II, besides developments aimed at the incorporation of other vegetation types dynamic models (e.g., grasslands), the integration of modeling and monitoring by means of remote sensing technologies is advocated. This can be critical for protected areas adaptive management, providing early signals of environmental shifts within and outside protected areas.