Socio-Ecological Modelling of a Mediterranean Landscape

James D. A. Millington

PhD Abstract

Ecologists have increasingly come to recognise that landscapes are the historical outcome of multiple complex interactions between social and natural processes, and must therefore be considered together through inter- and trans-disciplinary research. A long history of occupation by humans, allied with high levels of biophysical heterogeneity and spatially dynamic ecological processes, generate the high levels of biodiversity that characterise the landscapes of the Mediterranean Basin (Blondel and Aronson 1999). The importance of human activity in Mediterranean landscapes suggests that future threats to their sustainability and biodiversity are more likely to come from technological and social changes than from climatic ones (Grove and Rackham 2001).

In general, over the last few decades forest cover in the northern Mediterranean Basin has increased; an ageing and diminishing rural population is regularly cited as the cause of reduced land-use intensity and increased abandonment of marginal agricultural lands. (e.g. MacDonald et al. 2000, Mazzoleni et al. 2004). Trends in the wider economy of the region, for example as the tertiary (service) sector grows, are also driving land use toward more recreational uses. As human pressures on the land are eased or altered, ecological succession and invasion promote the observed increases and changes in vegetation. The ever-present risk of forest fire, another highly spatially and temporally dynamic ecological process, is likely to be altered as vegetation pattern and abundance in the landscape changes. To meet the aims of initiatives such as the EU's Sixth Environment Action Programme, and to maintain both sustainable production and biodiversity in future Mediterranean landscapes, better understanding and projection of agricultural and other land use change is vital. At broad landscape scales, the impacts of land use and cover change is unclear because of uncertainties in the relationships between the spatial patterns of change, the processes causing that change, and the feedbacks between the two.

In such circumstances, when ecological knowledge is poor, when data is sparse, and when logistics constrain the scope of empirical experimental study (as are all the case at the landscape level in the Mediterranean Basin), statistical and computer simulation models are tools often used to attempt improve understanding. By definition, these models are simplified representations of the real

world. However, when modelling complex systems containing multiple interactive and adaptive components, these models may themselves reach high levels of complexity. In this case, analysing, interpreting and explaining both model dynamics and output becomes challenging. In turn, model validity and credibility may be quickly questioned and difficult to defend.

The research here asks the questions:

1) What might a complex, multi-use(r) Mediterranean landscape look like in the future as a result of changes in wider socio-economic trends?
2) How can socio-economic and ecological processes operating and interacting at different scales be modelled effectively?
3) How are local human activities best incorporated into spatially-explicit landscape simulation models that consider both natural resources and future socio-economic trends?
4) What are the best methods to interpret and validate simulation models that consider human activity?

The ability of empirical methods (i.e. multinomial logistic regression and hierarchical partitioning) to integrate both socio-economic and biophysical data is examined, and used as a preliminary investigation into the most important data variables and scales of change in the study area. A process-based simulation model is developed, taking a combined agent-based/cellular automata approach to directly consider;

1) human land management decision-making in a low-intensity Mediterranean agricultural landscape [agent-based module]
2) landscape vegetation dynamics, including seed dispersal and disturbance (human or wildfire) [cellular automata module]
3) the interaction between 1) and 2)

The model is run to examine scenarios of both socio-economic and climatic change for EU Special Protection Area number 56, 'Encinares del rio Alberche y Cofio', 40 km south-west of the city of Madrid in central Spain. The thesis then explores the practical and philosophical issues arising from the communication of the modelling results with local stakeholders, and the promise of participatory approaches to asses model output and improve model credibility. The potential of a narrative-approach to examine both the process of simulation model development and output is also discussed.

References

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