Path dependent policyscapes: an agent-based modeling approach to the evaluation of policymixes for biodiversity conservation

David N. Barton[1], Christian Klassert[2], W.L. (Vic) Adamowicz[3],

[1]Norwegian Institute for Nature Research (NINA), Norway. david.barton@nina.no

[2] Helmholtz Centre for Environmental Research (UFZ), Germany. christian.klassert@ufz.de

[3] University of Alberta, Edmonton, Canada. vic.adamowicz@ualberta.ca

Teaser: Spatial locations of mixes of conservation instruments such as protected areas and PES have emerged over time as a result of heterogeneous landscape characteristics, policy targeting, and random shocks to landuse demand. The paper explores the potential of agent-based models(ABM) to simulate the emergent and path-dependent characteristics of the resulting policyscape over time.

Abstract:

A policyscape can be defined as the spatial configuration of a policy mix (Barton *et al.*, 2013). Spatial locations of mixes of conservation instruments such as protected areas and PES have emerged over time as a result of heterogeneous landscape characteristics, policy targeting, and random shocks to landuse demand (Barton and Adamowicz, 2013). The paper explores the potential of agent-based models (ABMs) to simulate the emergent and path-dependent characteristics of the resulting policyscape over time. Modeling spatially explicit emergent properties quickly becomes intractable in analytical optimization models. In contrast, ABMs have a comparative advantage in modeling local spatial interactions (Epstein, 2006). ABMs are models where individuals or agents are described as unique and autonomous entities that interact with each other and their environment locally (Railsback and Grimm, 2012).

In this paper we implement a simple ABM of the spatial allocation of two negative deforestation incentives (Figure 2) absolute protected areas (PA) and payments for protection of forest (PES). The paper explores the potential of the ABM to describe emergent and path-dependent spatial allocations of PA and PES locations. A number of modeling features are discussed using a simple ABM:

- extending a simple von Thunen land-rents model, where rents decline with distance to market (Randall and Castle, 1985), to also include rents' dependence on land use suitability (site index).
- implementing Pannell's (2008) public-private benefits framework for instrument allocation (Figure 2), as behavioural rules for a public agent allocating PAs, and a private agent adopting PES based on the ratio of public to private net benefits
- evaluating the targeting of policy instrument location to a random allocation of biodiversity and ecosystem services characteristics of forests (Figure 1), versus a landscape where land productivity (site index) is correlated with the presence of endemic species (biodiversity).
- using forest and cleared-land benefit functions to explore the effects of export demand shocks on forest clearing and demand contractions on forest regeneration.
- evaluating the spatial allocation of land-rents - with and without international import/export markets for timber and agriculture - by making the slope of forest and cleared-land benefit functions conditional on the total supply of forest cover and cleared land (Figure 3).

We conclude with a research agenda for 'agent-based policyscape analysis'.

References

Barton, D.N., Adamowicz, W.L.V., 2013. Path-dependent policyscapes: a theoretical approach to the evaluation of policymixes for biodiversity conservation. ESEE 2013 Conference : Ecological Economics and Institutional Dynamics. 10th biennal conference of the European Society for Ecological Economics., 18-21 Jun 2013 Lille (France).

Barton, D.N., Blumentrath, S., Rusch, G., 2013. Policyscape—A Spatially Explicit Evaluation of Voluntary Conservation in a Policy Mix for Biodiversity Conservation in Norway. Society & Natural Resources 26, 1185-1201.

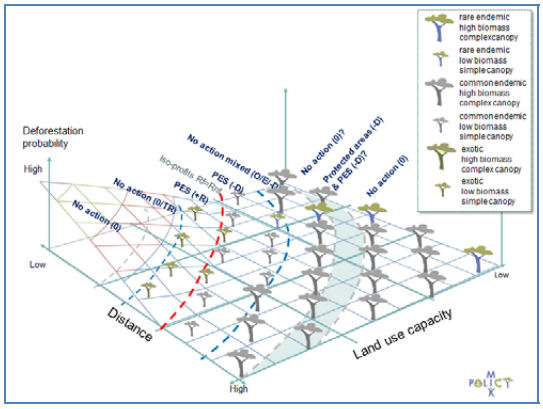
Epstein, J.M., 2006. Generative social science: studies in agent-based computational modeling. Princeton University Press, Princeton.

Pannell, D.J., 2008. Public benefits, private benefits, and policy mechanism choice for land-use change for environmental benefits. Land Economics 84, 225-240.

Railsback, S.F., Grimm, V., 2012. Agent-based and individual-based modeling : a practical introduction. Princeton University Press, Princeton.

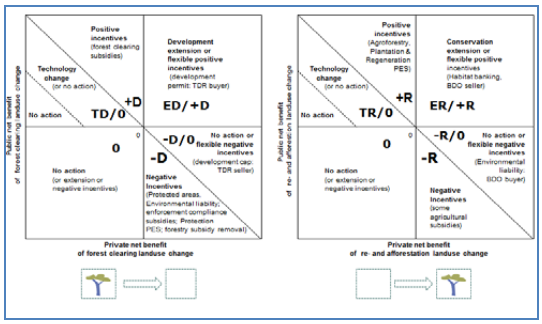
Randall, A., Castle, E.N., 1985. Chapter 13: Land Resources and Land Markets. In: Kneese, A.V., Sweeney, J.L. (Eds.), Handbook of Natural Resource and Energy Economics, Volume II, Amsterdam: North-Holland: 571-617 (584).

Figure 1. Conceptual forest landscape in regeneration forest transition stage 3-4 with predictions of positive and negative conservation incentives based on a revised public-private benefits framework



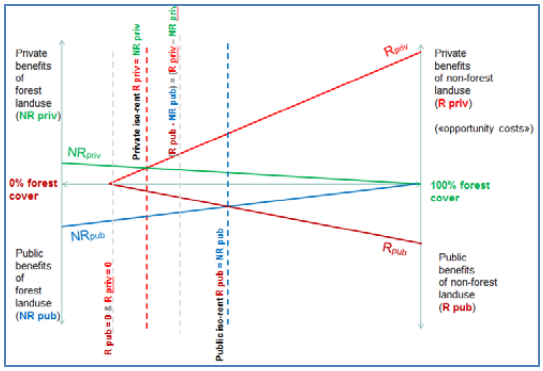
Source: Barton and Adamowicz (2013)

Figure 2. Conservation policy instruments depend on varying public-private benefits of landuse change at different forest transition stages.



Source: adapted from Pannell (2008)

Figure 3. Relative public-private net benefits to forestry and non-forest of landuse change sectors changes in different stages of the forest transition



Source: Barton and Adamowicz (2013)