Revisiting production and ecosystem services on the farm scale for evaluating land use alternatives

Themes:
2.2. Natural resources: management, use and conservation
2.3. Ecosystem services: debating, valuing, preserving and providing

Summary

Land is a scarce resource and should be used in such a way that the increasing global demand for food and feed can be fulfilled, ensuring sufficient levels of ecosystem services. Decision makers and other stakeholders are in need of appropriate diagnostic tools to estimate trade-offs and synergies associated with land allocation and land use intensity decisions. This often implies trade-offs between food and biomass production and other non-provisioning ecosystem services. This paper presents an approach using ecosystem services in evaluating land use strategies. The approach combines spatial and economic analyses to evaluate land use in a rural area under urban pressure. A preliminary application of this approach to a case farm demonstrates the relevance of this approach, and highlights current challenges. The results suggest that the optimal land use scenario in consideration of ecosystem services depends on the biophysical and spatial context as well as on the socio-economic context.

Extended abstract

Against a background of climate change and volatile energy markets, land is becoming a scarcer resource (Meyfroidt et al., 2013). Meanwhile, increasing population pressure leads to higher urbanization pressure which is accompanied by an additional demand for land for residential and recreational purposes (Zasada, 2011). This might increase insecurity in supply and prices of agri-food products. Outputs need to increase without further compromising environmental quality and other system services, which inevitably implies trade-offs.
From this perspective, maintaining certain levels of agricultural production or safeguarding the potential to domestically produce helps to buffer against shocks. The need for improving the capacity of agricultural systems to ensure ecosystem services has been thoroughly recognized. However, many of the services delivered by agricultural systems are non-marketable, so the market economy fails to provide sufficient incentives for delivering these services. A dominant production logic may push provisioning agricultural systems towards a state that is sub-optimal from a societal point of view because several non-provisioning services are not rewarded in the market. An integrative and spatially explicit approach to land allocation is highly needed, but it is largely missing (Bomans et al., 2010; Termorshuizen and Opdam, 2009). Meanwhile, the EU called its member states to assess and map the state of ES within their territory in the framework of the Biodiversity Strategy 2020. This development will provide opportunities to incorporate ecosystem services into decision making. Nonetheless, application of the ES concept to real-life land management decisions is a major challenge and there is a continuing need to evaluate the available tools against existing cases (Dale and Polasky, 2007).
This research aims to provide spatial planners with strategies for land use evaluation and decision making taking ecosystem services into account. Hereby, we define ‘Bioproductive land’ as the land providing ecosystem services through primary production processes. This includes (semi-) natural as well as agricultural ecosystems. The principal challenge is to simultaneously assess and maximize food and biomass production as well as the ES provided by bioproductive land (Balmford et al., 2012). Moving away from a predominantly ‘production-oriented’ and sectoral view on the landscape will aid policy makers and other stakeholders in recognizing opportunities and innovations within and across bioproductive land.

We focus on a case farm for extensive livestock production in Flanders. Here, livestock production combined with nature management and agro-tourism in an innovative agro-ecological production. Most of the land of the farm is located within a natural reserve. In an ongoing effort to counteract atmospheric nitrogen deposition (Stevens et al., 2011), semi-natural grassland management in Flanders

has to deplete nutrient stocks (Oelmann et al., 2009). Consequently, semi-natural grassland management typically produces biomass waste streams from mowing and haymaking. In general, grass from semi-natural grasslands is less suited for conventional livestock breeds, both in terms of digestion and nutritional intake. Therefore, ecological farms typically resort to more sturdy and self-reliant livestock breeds (Bedoin and Kristensen, 2013). The case farm's innovation lies in providing solutions for these waste streams through diversification and adaptation.
We created a spatially explicit dataset by mapping all parcels and associating data from a variety of sources, including the farm's registers. The present land use was mapped and forms the baseline land use alternative in the analysis. In addition, we formulated three potential land use alternatives for these parcels, each corresponding with a more intensive farming strategy. Each of these alternatives was compared to the baseline alternative in terms of delivery of a number of ecosystem services: crop & livestock, woody biomass, fine particle filtration, carbon sequestration in soil & biomass, nitrogen and phosphorous sequestration in soil, and cultural services. Monetary valuation was used to compare and aggregate the results, based on the methodology by Broekx et al., 2013.

The results allow us to compare how extensive livestock farming compares to a hypothesized conventional livestock farming in the same area. The analysis provides insights in how the on-farm diversification enables the farmer to internalize part of the positive externalities associated with this agro-ecological production model. Also, patterns of co-adaptation with natural management targets are revealed. A number of positive externalities remain however, and the question can be raised to what extent they can be internalized, and what the role of spatial planning is. This demonstrative case study suggests how extensive land use strategies may provide higher societal benefits (i.e. output of agro-ecosystem services) than intensive land use strategies in regions with both 'inferior' and high quality land and under high urbanization pressure. However, without biophysical constraints the intensive land use strategies might outperform extensive land use strategies.
Such aggregation of agro- and ecosystem services can be included in an analytical framework for maximizing the provision of services in a landscape. The local demand for ES can thus be addressed by a multitude of different farming models (Firbank et al., 2012). The analysis illustrates that the optimal land use strategy (land sharing versus sparing; extensive versus intensive) is likely to be context and scale-dependent and that the concept of ES can be very useful in designing optimal land policies.

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