DE1 (Märkische Schweiz, Germany): Land-cover based assessment of landscape capacity to provide ecosystem services

Objective

The main objective of this ad-hoc study was to assess the potential supply of landscape services in the case study area Märkische Schweiz (Germany), using the assessment matrix proposed by Burkhard et al. (2009). The approach is qualitative and based on Corine Land Cover (CLC) data (EEA, 2007). The study focussed on the possibility to integrate information in the assessment matrix that is available on specific landscape elements and features which are not taken into account in the CLC classes but which are extremely relevant to the supply of a number of landscape services. The study focussed on provisioning and supporting services.

Methodology

The assessment matrix is based upon different land cover types' capacities to provide individual services and adopt the following scale:

Table 1. Assessment scale.

0	**no relevant capacity**
1	low relevant capacity
2	relevant capacity
3	medium relevant capacity
4	high relevant capacity
5	very high relevant capacity

The individual services are grouped in four categories (Burkhard et al., 2009): (i) ecological integrity (i.e. supporting services), (ii) provisioning services, (iii) regulating services, and (iv) cultural services. In correspondence of each cell of a 100 m regular grid encompassing the CSA, the sum resulting from the scores of each individual service was calculated. In order to provide a better representation of the actual landscape and land use in the CSA the rough spatial resolution of CLC and its thematic generalization need to be integrated with the available information from different sources. In the case study area these are represented by area, linear and point landscape elements (Fig. 1). These elements are present, alone or in combination, in about 20.5% of the CLC cells and need to be accounted for when assessing landscapes' capacity to provide ecosystem services based on land cover, with a focus on provisioning and supporting services. Linear elements, summing up to about 640 ha, refer to the following biotopes according to the Biotopkartierung Brandenburg (*Landesamt für Umwelt, Gesundheit und Verbraucherschutz*, 2011):

Table 2. Biotope types.

Biotope type	No. of Subtypes
Water courses	30
Water bodies	11
Anthropogenic soil sites with pioneer ruderal vegetation	3
Marshes and swamps	2
Grass and perennial herbs	19
Deciduous shrubs, copses, alleys, rows of trees and groups of trees	37
Marsh and swamp forests	1
Built-up areas, transportation facilities	9

The areal landscape elements, summing up to a total of about 2,085 ha (96% of which represented by water bodies of different types), refer to the following typologies: (i) inland dunes, (ii) tree rows, (iii) single trees, (iv) wetlands and marshes, (v) group of trees, (vi) field margins, (vii) rock and stone areas, (viii) hedgerows, (ix) stonewalls, and (x) lakes and ponds. The presence of one or more of these elements within the CLC cells was accounted for in the implementation of the assessment approach, allowing for a more detailed and closer to reality evaluation of landscape capacities to provide ecosystem services.

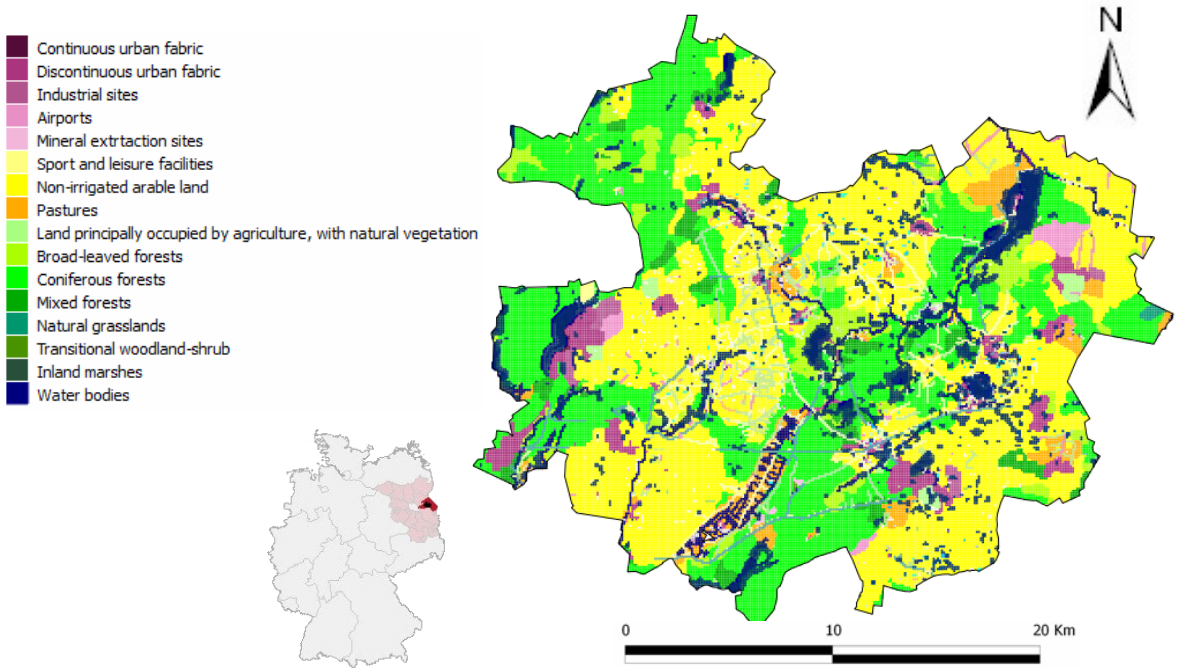

Figure 1. Corine Land Cover (EEA 2007, 100 m grid) and landscape elements in the CSA Märkische Schweiz.

Adopting the assessment matrix, it is possible to define a scale of service provision for each landscape element and calculate a weighted sum for each CLC cell based on the extent of the element, in the case of areal elements, or using a proper weighting factor in the case of linear elements. In the case of supporting and provisioning services, the assessment procedure has been applied in two steps, first considering separately linear and areal elements and then by combining the two. As a third step, the differences between the reference CLC assessment and the landscape elements integrated assessment have been calculated in terms of aggregated services and for the single underpinning services.

Results

The following figures illustrate the spatial distribution of aggregated ecosystem services considering landscape linear and areal elements (Fig. 2) and the spatial distribution of the differences between the reference CLC assessment and the landscape elements integrated assessments (Fig.3).

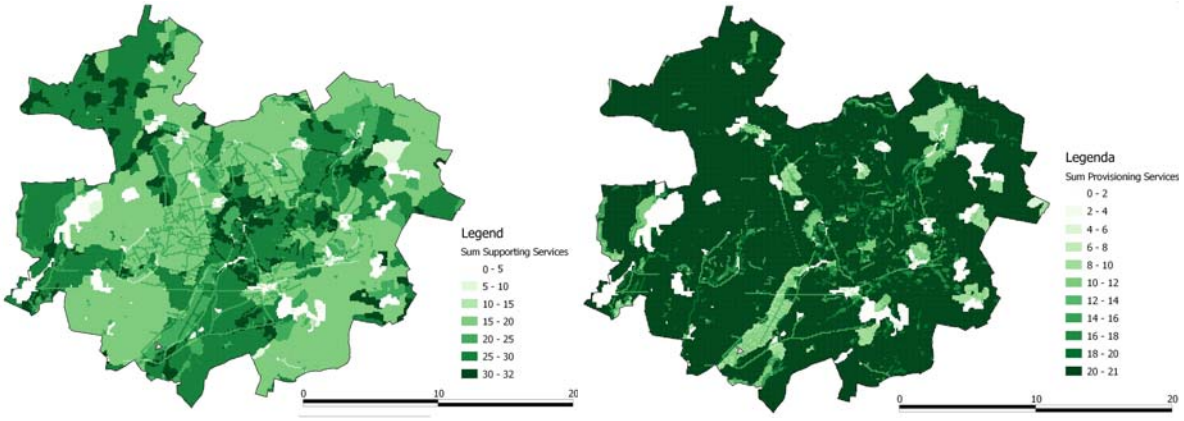

Figure 2. Spatial distribution of aggregated ecosystem services considering landscape linear and areal elements: left) supporting services; right) provisioning services.

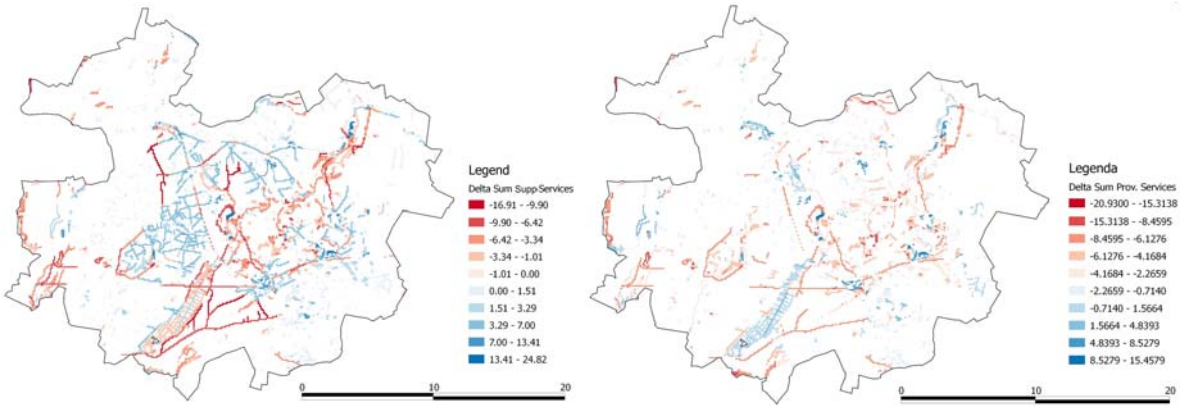

Figure 3. Spatial distribution of the differences between the reference CLC assessment and the landscape elements integrated assessment: left) supporting services; right) provisioning services.

Considering the whole case study area, accounting for landscape elements results in an overall lower capacity to provide both supporting and provisioning services. In the first case the difference in the average sum of scores is not statistically significant (p<0.05), while it is so for the second group of landscape services. In the case of supporting services the lower capacity is mostly due to its reduction in the services provided by forests, with a global average difference equal to -0.7, and to a lower extent to the reduction of services provided by grasslands, with a global average difference equal to -0.5. These reductions in potential service provision are partially counterbalanced by their increase in arable land (+.0.4). In the case of provision services, again, accounting for landscape elements results in an average overall reduction of service supply potential is observed and in this case the difference in the average sum of scores is statistically significant (p<0.05). The relative changes in the scores for the single services and for the total score considering only the locations where landscape elements are present are shown in Tables 3 and 4.

Table 3. Supporting services: relative change in potential service provision considering landscape elements.

Supporting services	Arable	Grassland	Forest
Abiotic Heterogeneity	2%	23%	4%
Biodiversity	28%	29%	-7%
Biotic Waterflows	-1%	-22%	-32%
Metabolic efficiency	65%	-12%	-9%
Energy capture	0%	-11%	-15%
Reduction of Nutrient Loss	8%	18%	-19%
SOM storage capacity	27%	-13%	-17%
Total	11%	-5%	-15%

Table 4. Provisioning services: relative change in potential service provision considering landscape elements.

Provisioning services	Arable	Grassland	Forest
Crops	-29%	nd	nd
Livestock	-26%	-31%	nd
Fodder	-25%	-29%	-17%
Wild foods	60%	377%	-9%
Timber	18%	607%	-21%
Wood fuel	18%	607%	-21%
Energy biomass	-17%	0%	99%
Biochemicals/Medicine	-11%	607%	-21%
Fresh waters	56%	317%	45%
Total	-17%	8%	-22%

Links connecting agents and causal connections through which landscape can potentially affect rural economies and societies

Landscape elements represent a key feature of the agricultural landscape in the CSA significantly affecting the delivery of relevant services for regional competitiveness and population welfare. From the results of our study it appears that the integration of landscape elements in the assessment matrix of landscape service provision is a necessary step to get a realistic picture of the CSA as it is characterised by a high degree of heterogeneity within the different land use classes. The use of Corine Land Cover alone would not result in an accurate assessment especially at a local scale, as its coarse resolution would ignore the relevant contribution of the many landscape elements which characterise the CSA in delivering landscape services.

Lesson learned & Policy Recommendations

The quantification of services actual delivery would require specific site specific measurements of specific indicators for each service. In absence of such direct surveys, the maintenance and periodic update of accessible spatially explicit public inventory of landscape elements is a crucial resource not only to explicitly assess the potential delivery of ecosystem services at local scale, which is the mandatory prerequisite for any policy implementation, but also to detect temporal dynamics i.e. actual changes in landscape elements occurrence in the fields following the implementation of landscape management measures (e.g. CAP measures) or changes in the intensity of agricultural practices.

Reference

Ungaro, F., Zasada, I., Piorr, A. (2014). Mapping landscape services, spatial synergies and trade-offs. A case study using variogram models and geostatistical simulations in an agrarian landscape in North-East Germany. *Ecological Indicators* 46, 367-378.

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