Securing the Conservation of biodiversity across Administrative Levels and spatial, temporal, and Ecological Scales

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SCALES seeks ways to better integrate the issue of scale into policy and decision-making and biodiversity management in the EU.
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SCALES briefs 5

Impact of policy and socioeconomic drivers on anthropogenic processes and pressures affecting biodiversity

Summary

The development of effective biodiversity conservation management plans and policies requires a sound understanding of the driving forces involved in shaping and altering biodiversity and structure and function of ecosystems. However, driving forces, especially anthropogenic ones, are defined and operate at multiple administrative levels, which do not always match ecological scales. Scale sensitivity varies considerably among drivers, which can be classified into five broad categories depending on the response of 'evenness' and 'intensity change' when moving across administrative levels. Indirect drivers tend to show low scale sensitivity, whereas direct drivers show high scale sensitivity, as they operate in a non-linear way across the administrative scale. Thus policies addressing direct drivers of change, in particular, need to take scale into consideration during their formulation. Moreover, such policies must have a strong spatial focus, which can be achieved either by encouraging local-regional policy making or by introducing high flexibility in (inter)national policies to accommodate increased differentiation at lower administrative levels.

Key words

Biodiversity loss, policy impact, socioeconomic impact, anthropogenic processes, drivers

Relevance to legislation

Birds Directive 79/409/EEC
Habitats Directive 92/43/EEC
Common Agricultural Policy (CAP)

Relevance to actual environmental problems

Biodiversity loss, climate change, land use change, landscape fragmentation

Description of the problem

The global decline in biodiversity has been significant and long-term. This loss has not been stemmed despite the 2010 targets (European Commission, 2010) and so the need for protection of biodiversity remains. Approaches to understanding the loss of biodiversity and preventing further declines have moved beyond the traditional single-site approach, which is now considered insufficient for a robust conservation strategy. The development of effective biodiversity conservation management plans and policies requires a sound understanding of the relevant actors and driving forces involved in shaping and altering ecosystems' structure and function.

The Millennium Ecosystem Assessment (MEA, 2005) defines drivers as "any natural or human induced factor that directly or indirectly causes a change in an ecosystem" and divides them into "Direct drivers", which have a

Figure 1. Land use intensification and fragmentation by technical infrastructure like, e.g. roads and high-voltage power lines are main drivers affecting biodiversity. Photo: Reinhard Klenke.

direct impact on biodiversity and "Indirect drivers" whose impacts are more diffuse (Nelson et al., 2006; Figure 2). The drivers are further divided into two categories:

Both the scale (e.g. spatial) and the level (e.g. administrative unit) at which drivers are generated affect their impacts on biodiversity. Drivers, especially the anthropogenic ones, operate at multiple spatial, temporal or administrative scales, which do not always match ecological scales.

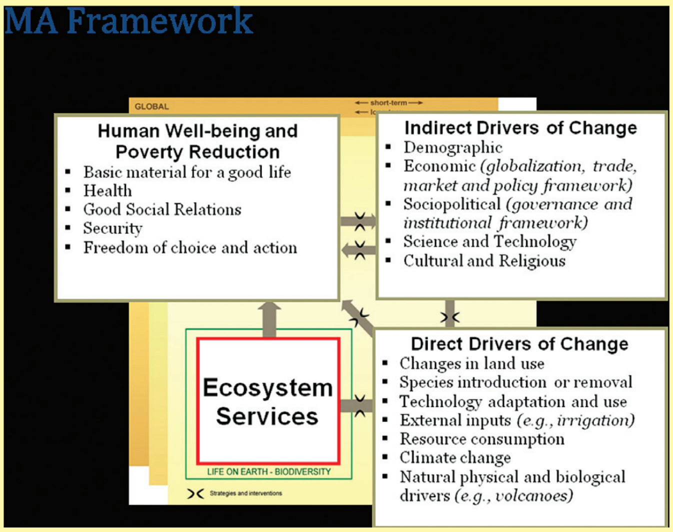

Figure 2. The MEA Framework linking indirect and direct drivers to human well-being.

Scale sensitivity varies considerably among drivers which can be classified into five broad categories of scale sensitivity depending on (i) how they change in intensity across administrative levels, and (ii) how even (i.e. homogeneous) they are (Table 1).

Generally speaking, indirect drivers tend to show low scale sensitivity for example, most of the indicators referring to economic sectors (with the exception of tourism) or to demographic factors show minimal changes as we move across administrative levels. In contrast, most of direct drivers show high scale sensitivity with characteristic examples being deforestation, agricultural conversion and wetland loss (Figure 3).

Evenness (measured using the Shannon's Evenness Index) is a measure of how similar the values of an indicator are for different regions within a larger unit. The Shannon's Evenness Index is constrained between zero and one and the closer evenness is to 1, the more the regions within a NUTs level are similar in terms of the values of the indicator. The term NUTS stand for "Nomenclature of territorial units for statistics" where NUTS 0 indicates countries, NUTS 1 major socio-economic regions, NUTS 2 basic regions and NUTS 3 small regions (see http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction). Change in intensity (I) was assessed by measuring the relative change in the median of an indicator at a given administrative level compared to NUTS level 0. Thus change in intensity can be equal to zero at NUTS level 0 and can either be positive or negative in other levels. Thus, intensity measures how low or high values of an indicator are over- or under-represented within regions from one NUTS level compared to NUTS level 0. A negative value of intensity stands for an over-representation of low values of the indicator whereas a positive one stands for an over-representation of high values

The maps produced form a short atlas of socio-anthropogenic drivers that allows the visualization of the spatial distribution of drivers at different scales, providing decision makers and stakeholders with an easy and a quick overview and appraisal of each driver's scale sensitivity (Table 1).

Recommendations

The presence of scale sensitivity has important implications for policy making. Policies addressing direct drivers of change (such as land conversion) need to be scale sensitive (i.e. take scale into consideration during the designing process) in order to better respond to scale differentiation that is observed across administrative

Table 1. Typology description moving from upper to lower administrative levels (i.e. NUTS 0 to NUTS 3).

Class	Scale sensitivity	Evenness	Change in Intensity	Drivers
1	Very low	Almost no change (0)	Almost no change (0)	most demographic and economic indirect drivers
2	Low	Slight increase (↑)	Almost no change (0)	drivers linked to land cover and farm structure
3	Moderate	Moderate increase (↑)	Moderate increase (↑)	drivers linked to urban areas
4	High	Moderate increase (↑)	Large decrease (↓)	direct drivers related to land conversion
5	Very High	Large increase (↑)	Large decrease (↓)	

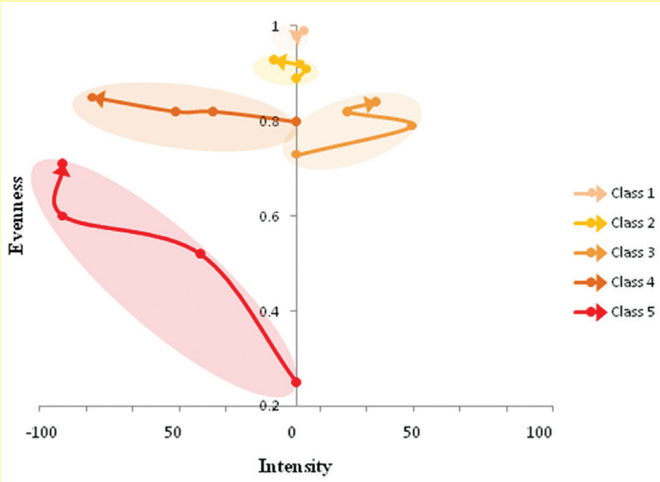

Figure 3. Contrasting scale sensitivity of different classes. For interpretation see Table 2.

levels. It is important that direct drivers are examined at least at the NUTS 3 level (i.e. local level) in order to capture more efficiently spatial variation and polarization effects. Thus, policies addressing direct drivers must have a strong local – regional focus which can be achieved either by encouraging local-regional policy making or by introducing high flexibility in national – international policies to accommodate increased differentiation and often polarization at lower administrative levels. Non-scale sensitive drivers may require non-scale sensitive policies on the contrary. The different types of non-linearities that drivers show across administrative levels may require different policy approaches to deal with their biodiversity implications. For example, spatially targeted economic instruments could possibly be more effective than non-targeted instruments when we deal with highly spatially differentiated drivers that show high intensity in few locations only.

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Sources

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Box 1

Example of Scale Sensitivity - Agricultural Conversion in Germany and Poland.

At NUTS level 0 (country level), both countries tend to show similar patterns in the share of surfaces affected by agricultural conversion. However, mapping similar data at NUTS level 1 reveals some strong regional contexts. Globally, Polish NUTS 1 regions have medium rates of conversion. In eastern Germany, NUTS 1 regions show a strong agricultural conversion caused by the economic changes after the fall of the Iron Curtain while regions from the western part have low rates of conversion. In this case, an observation of the conversion process at the country level can lead to a misinterpretation of the situation.

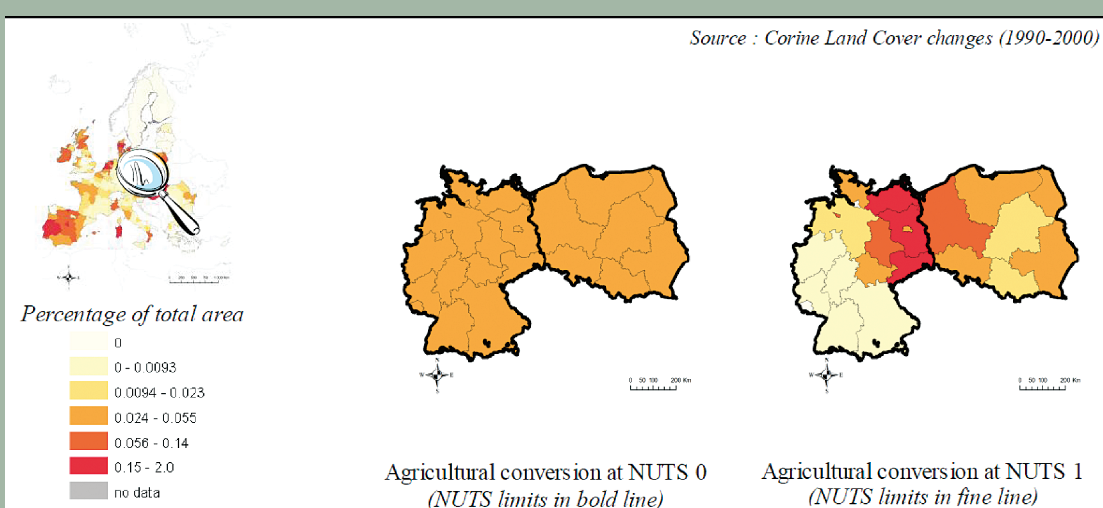

Figure 4. Agricultural conversion at NUTS 0 and NUTS 1 in Germany and Poland.

Table 2. Restricted list of socio-anthropogenic indicators for which analyses are available.

Driver	Indicator	Source of data
Afforestation	% of total area	CLC change 1990-2000
Age structure (x3)	% of population within each age class	Eurostat (decade 2000-2010)
Agricultural Conversion	% of total area	CLC change 1990-2000
Arable area	% of total area	CLC 2000
Deforestation	% of total area	CLC change 1990-2000
Employment in agriculture	% of total active population	Eurostat (decade 2000-2010)
Employment in industry	% of total active population	Eurostat (decade 2000-2010)
Employment in services	% of total active population	Eurostat (decade 2000-2010)
Farm size	Hectares	Eurostat (decade 2000-2010)
Farm standard gross margin	European Size Units / UAA	Eurostat (decade 2000-2010)
Farmers training level	% of farmers with full agricultural training	Eurostat (decade 2000-2010)
Forest Area	% of total area	CLC 2000
Grasslands area	% of total area	CLC 2000
Gross Domestic Product (GDP)	Purchasing Power Standard per inhabitant	Eurostat (decade 2000-2010)
Irrigation	% of Utilised Agricultural Area	Eurostat (decade 2000-2010)
Livestock density	Livestock units/ UAA	Eurostat (decade 2000-2010)
Mortality	Number of deaths per 1000 inhabitants	Eurostat (decade 2000-2010)
Permanent crops area	% of total area	CLC 2000
Population density	Number of inhabitants per km^2	Eurostat (decade 2000-2010)
Tourism	Number of beds in hotels per km^2	Eurostat (decade 2000-2010)
Unemployment	Unemployment rate	Eurostat (decade 2000-2010)
Urban area	% of total area	CLC 2000
Urbanization	% of total area	CLC change 1990-2000
Utilised Agricultural Area (UAA)	% of total area	Eurostat (decade 2000-2010)
Wetland Loss	% of total area	CLC change 1990-2000
Women in active population	% of total active population	Eurostat (decade 2000-2010)

Figure 5. Changes in environmental policy to mitigate climate change can cause unforeseen side effects like substantial land use changes as consequence of the EU Common Agricultural Policy incentive measures. Substantially increasing proportions of rape and maize fields for the production of bio fuel can lead to further loss of biodiversity and competition with food production. Photo: André Künzelmann.