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THE DIVERSITY OF THE EUROPEAN LANDSCAPES AS A COMMON PLANNING GOAL

Introduction

LANDSCAPE DIVERSITY IS IMPORTANT

Landscape diversity is a core concept that appears in most recent reports on landscape assessment, protection and planning. This article examines first why landscape diversity is considered so important in these policy documents, in particular the ones referring to European landscape planning. It will become clear that the concept diversity needs more precise definition in order to avoid confusion and to make it operational in landscape planning. We will compare different definitions and their significance for landscape planning and management. This will be applied on the European situation using the most recent landscape typology made by the European Landscape Character Assessment Initiative (ELCAI) and a series of thematic maps concerning cultural themes, which are significant for the landscape. Difficulties in combining natural and cultural themes for assessing landscape diversity will be discussed and used to formulate suggestions for setting more clearly planning goals related to landscape diversity.

DIVERSITY IN RECENT POLICY DOCUMENTS

The Dobříš Assessment of Europe's environment (Stanners and Bourdeau 1995) triggered new thinking, new research and new policy initiatives concerning the landscapes in Europe. It led to the initiative of the Council of Europe to develop the European landscape convention, which was opened for signature in 2000 and entered into force on March, 1st, 2004.

Chapter 8 of the Dobříš Assessment is devoted to the situation and condition of the landscapes in the European Union. The introduction of the chapter starts with following statement:

"The richness and diversity of rural landscapes in Europe is a distinctive feature of the continent. There is probably nowhere else where the signs of human interaction with nature in landscape are so varied, contrasting and localised. Despite the immense scale of socio-economic changes that have accompanied this century's wave of industrialisation and urbanisation in many parts of Europe, much of this diversity remains, giving distinctive character to countries, regions and local areas."

(Stanners and Bourdeau, 1995).

It stresses for the first time the importance of landscape diversity and links landscape character to cultural identity. Indirectly it expresses also the fear that loss of this landscape diversity and character may lead to a loss of Europe's cultural identity. Consequently, it implicitly sets the policy and landscape planning goals as preservation and enhancement of this existing landscape diversity. Also, the concern for the landscape is seen as a key for success of the policy efforts in other environmental issues:

"Europe's landscapes are immensely diverse and rich in natural and cultural values. A series of factors are bringing pressures to bear on these landscapes causing changes that are both subtle and dramatic, and many of which are occurring at great speed. Often the changes being invoked are unintentional consequences of other activities where the roles and values of landscapes are not taken fully into consideration. This is resulting in a general replacement of natural and regional diversity by artificial diversity or homogeneity, and in some cases is accompanied by more specific environmental degradation. In the past, the approach to conservation has been species- or site-specific. Now, however, the fragility of whole landscapes is an issue. Approaches to halt the loss of biodiversity and cultural identity in Europe's landscapes can be successful only if they encompass the economic viability of rural communities. An understanding of the important links that exist between cultural landscapes and the people who live within them is essential for promoting both environmentally sensitive changes and social-economic integration. This in turn requires a framework of national and international support which recognises that there is a European interest in the future of Europe's landscapes and rural communities."

(Stanners and Bourdeau, 1995).

The Council of Europe opened the Landscape Convention for signature on 20 October 2000 and it entered into force on March 1st, 2004 after ten member states ratified the text. It is now signed by 29 and ratified by 19 of the 46 member states (Council of Europe, August, 2005), covering a larger territory than the actual European Union. Although the Council of Europe made already many recommendations concerning nature and landscape protection since the 1970s, the explanatory report of the European Landscape Convention refers explicitly to the Dobříš Assessment as one of the origins of this convention:

"Chapter 8 deals with landscapes, and in its conclusions it expresses the hope that the Council of Europe will take the lead in drawing up a European convention on rural landscapes."

(Council of Europe, 2000).

It took five years to finalize the text of the European Landscape Convention. Its preparation implicated a broad concerted effort involving the Committee of Ministers of the Council of Europe, the Chamber of Local Authorities and Chamber of Regions, and hearings for private and public national and regional scientific bodies, non-governmental organisations and international organisations and regional authorities. The draft text was examined by the Committee for the activities of the Council of Europe in the field of biological and landscape diversity (CO-DBP) and the Cultural Heritage Committee (CC-PAT), which contributed to the integration of the interests of the conservation of biodiversity and cultural heritage. The text also refers to UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage, the Convention for the Protection of the Architectural Heritage of Europe, the Convention on the Conservation of European Wildlife and Natural Habitats, the European Convention for the Protection of the Archaeological Heritage. Consequently a broad and comprehensive definition of landscape was proposed:

"Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." (European Landscape Convention, article 1).

Although this definition is 'for the purpose of the Convention' only, it is the first formal definition of landscape that is broadly accepted in Europe and subject to legal implementation. The definition is very general and easily acceptable by different interest groups. Its originality however resides in making no distinction any more between different types of landscapes to be managed and protected, as explicitly stated in the scope of the Convention:

"... this Convention applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas. It includes land, inland water and marine areas. It concerns landscapes that might be considered outstanding as well as everyday or degraded landscapes." (European Landscape Convention, Article 2).

This implies not only landscape protection, but even more landscape planning and management with the involvement of all. It also implies a reorientation and broadening of the scope of landscape research. Landscape policy as defined in the European Landscape Convention consists of general principles, strategies and guidelines for the protection, management and planning of landscapes. Landscape protection should aim to conserve and maintain

the characteristic features of a landscape, which have heritage value. Public authorities and the public should both be actively involved in the formulation of "landscape quality objectives" in the perspective of sustainable development. Landscape planning is seen very broad and aims to enhance restore or create landscapes, and landscape management should deal with the difficult task to guide and harmonise the inevitable ongoing changes in society with the natural and cultural landscape values (Council of Europe, 2000). It should be noted also that key concepts used in the European Landscape Convention are diversity, landscape character and identity.

WHAT DIVERSITY?

The meaning of the term diversity and heterogeneity, which are often used as synonyms, differ from their use in common language and in landscape ecology. In common language diversity and heterogeneity are very similar. Diversity comes from the Latin *diversus*, and emerges c.1340. Since c.1700 it is restricted to the meaning "different in character or quality." Heterogeneous stems from the Greek *heterogenes*, meaning *heteros* "different" and *genos* "kind, gender, race stock". Both terms are clearly related to character and identity.

In landscape ecology diversity and heterogeneity got more formal definitions related to the landscape metrics to calculate them and their meaning differs. Heterogeneity and diversity are related concepts (Farina, 1998), but not similar. The significance of landscape heterogeneity lies in the way it affects the reciprocal effects between spatial pattern and ecological processes (Risser, 1999). Heterogeneity is seen as an indicator of biodiversity. It is a characteristic of the spatial structure of the landscape and "on which biological diversity can develop" (Farina, 1998, p. 85). Forman (1995) defines heterogeneity as "an uneven, non-random distribution of objects" (p.4). Heterogeneity is formed by a combined action of three mechanisms: (i) the variation of the substrate which creates the vegetation patchiness, (ii) natural disturbance, and (iii) human activity (Forman, 1995). He distinguishes between two types of heterogeneity: (1) gradients, which define spatial heterogeneity without crisp borders, and (2) mosaics, which are formed by patches with crisp borders (Forman, 1995). Farina (1989) distinguishes between spatial, temporal and functional heterogeneity. Forman and Godron (1986) also distinguish between microheterogeneity and macroheterogeneity, depending on the grain and scale of observation. Heterogeneity depends on the nature of landscape patches and the scale the landscape is observed and varies in time (Burel and Baudry, 2003; McGarigal and Marks 1995). There is also an increasing demand to use numerical indicators and landscape metrics in the evaluation policy and planning efforts (Parris, 2004; Dramstad and Sogge, 2003; Botequilha Leitao and Ahern, 2002; Onate et al., 2000; Martinez-Falero and Gonzalez-Alonso, 1995).

Many numerical measures have been defined to express landscape heterogeneity (Forman, 1995; McGarigal and Marks, 1995) and many are correlated (Li and Reynolds, 1994). McGarigal and Marks (1995) define richness as the number of different patch types and diversity is a composite measure of richness and evenness and can be computed in a variety of forms, of which the Shannon-Weaver entropy is very common. They consider patch size distribution and patch density as the simplest measures representing the spatial character of a patch. Most landscape metrics either directly incorporate patch size information or are affected by patch size. Patch density is simply the number of patches per unit area and can be used as an indicator for landscape heterogeneity. As landscape metrics are frequently correlated, Botequilha Leitao and Ahern (2002) proposed a core set of landscape metrics for sustainable landscape planning. Patch richness and patch density are proposed as landscape composition metrics. Increase of patch richness indicates an increase of diversity and heterogeneity, and patch density indicates fragmentation. A standardized measure is the Relative Richness, which Turner (1989) defines to be calculated in a raster map as $R = N/N_{max} * 100$, where N = number of different classes present in the kernel and N_{max} = maximum number of classes in entire image. Antrop and Snacken (1999) used transect sampling for determining landscape diversity and heterogeneity, expressed as the Shannon entropy, for three different components of the landscape separately: land use, scenery and morphology.

Methods and materials

DATA SOURCES FOR LANDSCAPE DIVERSITY ASSESSMENT

The diversity of the European landscapes is represented in a series of typology and thematic maps. The first attempt for mapping a systematic landscape typology at the European scale was made by Meeus (1995) for the first assessment of Europe's environment by the European Environmental Agency (EEA), the Dobříš Assessment in 1995 (Stanners and Bourdeau, 1995). It is based on much generalised holistic and generic landscape types mapped at a small scale and few different types occur within countries to differentiate between landscape types and units that are useful for planning purposes. For the main types a general description of the landscape is given, illustrated with sketches of the landscape (Meeus, 1995; Meeus et al., 1990). This criticism leads to a new typology made by Vervloet, mainly based upon the main physical characteristics such as elevation and landform (Wascher, 2000). The landscape units are however not described in detail. Jongman and Bunce (2000) proposed a European Landscape zonation based upon climate and topography. The Environmental Zones of Europe are derived from the Environmental Stratification of Europe (Metzger et al.,

2005; Jongman et al., 2005; Múcher et al. 2003) and online available in the cultural landscape database Cultbase (<http://pan.cultland.org/cultbase/>).

The most recent version of a European landscape typology was realised by the European Landscape Character Assessment (ELCAI) (Múcher et al., 2003). The second version, LANMAP2, is the Pan-European Landscape map and extends Europe up to the Ural Mountains and includes Turkey, Scandinavia and the Baltic countries, Spitsbergen and Nova Zembla, but no Canaries. The map is based upon four themes: climate, a digital elevation model, parent material and land use. The climatic regions show fifteen categories based on the Environmental Classification of Europe (Metzger et al. 2005) and the biogeographic classification of EEA. The digital elevation model used is the global USGS GTOPO30 showing 17 classes. The parent material is derived from the FAO-UNESCO Soil Map and the European Soil Database and shows sixteen categories: river alluvium, marine alluvium, glaciofluvial deposits, calcareous rocks, soft clayey materials, hard clayey materials, sand, sandstone, soft loam, siltstone, detrital formations, crystalline rocks and migmatites, volcanic rocks, other rocks, organic materials and unclassified (urban areas, ice and water). Land use is derived from the CORINE data base, PELCOM and GLC2000 and 10 categories are used: artificial surfaces, arable land, permanent crops, pastures, heterogeneous agricultural areas, forest, scrubs and herbaceous vegetation, open spaces with little or no vegetation, wetlands and water bodies.

The different thematic maps are combined as 'spectral' bands to form a composite image that is successively analysed with object-oriented image classification software (eCognition) for segmenting the image into landscape units with unique combinations between the composing themes. Cluster analysis is used to define landscape types and spatial landscape units.

The results are 375 types and 14080 units

All themes refer to natural components of the landscape. In this series land cover is considered as a cultural component as well as a natural one. Maps giving a coherent and overall coverage of cultural themes for the whole of Europe are rare. Very often they describe different types of a theme using local examples and a very generalized overview (Lebeau, 1972). One of the rare series is compiled in the book *Europe's Cultural Area* first published by Jordan in 1973 covering Western Europe (Jordan, 1973) and later extended to the whole of Europe (Jordan-Bychkov and Bychkova-Jordan, 2002). These such as language, religion, rural architecture, rural building materials, farming types etc. are represented in much generalised thematic maps compiled from a wide variety of more local and regional sources. Many of the themes are outdated or reflect traditional characteristics of rural landscapes. New recent development such as urbanisation and fragmentation by transport infrastructure are not included.

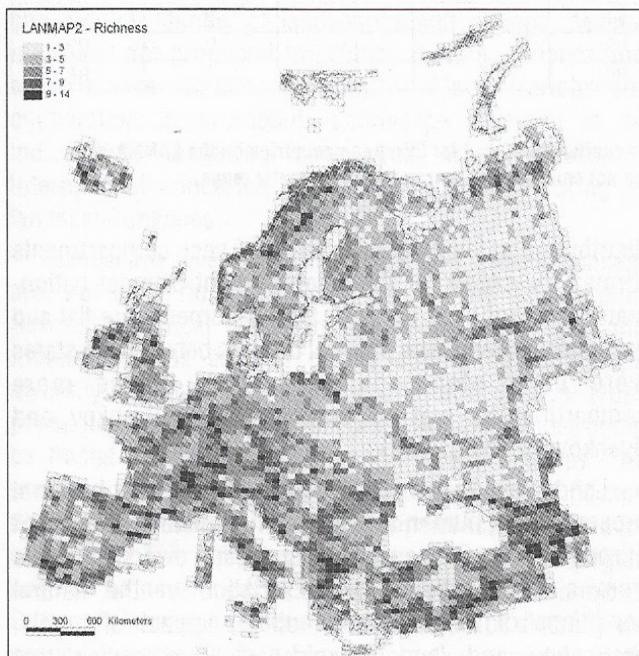
Following themes were selected for further analysis:

- Forms or rural settlement (17 categories)
- Traditional rural building materials (8 categories)
- Tradition rural house and farmstead types (5 categories).

These were selected because they are used often in the typology of rural landscapes and maps were available for a large part of Europe. The composite map of these three cultural themes resulted in 167 types and 2021 units.

ASSESSING DIVERSITY AND HETEROGENEITY OF EUROPEAN LANDSCAPES

All maps were digitised and transformed to fit the Albers conical equal area projection and scale used by the ELCAI LANMAP2. The selected cultural themes were combined by GIS-overlay into a composite map. A geographical grid with mesh size of 0.5' was used as an overlay to sample the categories in the different thematic maps. Two indices of landscape diversity were calculated for each grid cell: richness and patch density. These were represented in choropleth maps with five classes. This was done separately for the LANMAP2 (fig. 1 and 2) and the composite map of cultural themes (fig. 3 and 4). Patch richness (PR) was expressed as the number of different landscape types or map categories per 0.5' grid cell shown in the maps. Patch density (PD) was expressed as the number of spatial landscape units per 0.5' grid cell and is an indicator for the spatial heterogeneity of the landscape. Table 1 gives the average patch richness and patch density by country as well as their variation coefficient expressed as a percentage. Countries that are not completely covered by maps of cultural themes are marked with an asterisk (*).



Results and discussion

HOW DOES EUROPE'S LANDSCAPE DIVERSITY LOOKS LIKE?

The richness of the landscape types of Europe according to the LANMAP2 varies between 1 and 14 landscape types per grid of 0.5' and the patch density as measure for the heterogeneity varies between 1 and 38. In general, there is a clear gradient from high to low landscape diversity going from the west to the east.

In LANMAP2 only land cover is interpreted as a cultural landscape component. Cultural themes which are significant for the landscape character are not included, such as settlement types and patterns, traditional rural architecture and building materials, farming styles, field patterns, hedgerow and planting patterns, signs and place names. The sea was considered as 'no data'. Land cover is unsatisfactory to be used as the sole component of cultural landscape character as is clearly shown by the erroneous mapping of the cultural landscape diversity for the Study Programme on European Spatial Planning using CORINE Land Cover data (Anzuini et al. 2000).

The richness of the composite map of the three selected cultural themes varies from 1 to 11 categories per grid cell of 0.5'. The patch density varies from 1 to 35. The pattern of the patch density is in certain areas different from the LANMAP2 typology which is mainly based upon natural components. It indicates more spatial heterogeneity and fragmentation. The map borders of the cultural themes show as artefacts in the map overlay.

The richness and patch density are highly correlated. The patch density between LANMAP2 and the cultural composite map is however significantly different, indicating that information of the spatial heterogeneity of the three selected cultural themes is not expressed in the LANMAP2 typology.

The summary by country (table 1) shows a wide variation in the coefficient of variation for both patch richness and patch density, in particular for the cultural themes (CULMAP). The effect of the size of the country in relation to the 0.5' grid, as well as the irregularity of the coastline and occurrence of islands determines largely the outcome of the patch based indicators. Comparing Scandinavian and Mediterranean countries shows this clearly. A closer look at the base map of Europe used in both classifications shows distinct differences in detail between the countries and affects seriously the meaning of the patch based metrics.

Country	LANMAP2				CULMAP			
	PR_avg	PR_CV%	PD_avg	PD_CV%	PR_avg	PR_CV%	PD_avg	PD_CV%
Albania	6	32	9	51	2	51	3	52
Armenia *	8	29	19	29				
Austria	7	29	14	29	3	53	3	56
Azerbaijan *	6	49	13	59				
Belarus	4	37	13	37	1	38	1	38
Belgium	6	39	16	40	3	63	4	71
Bosnia Herzegovina	6	29	11	43	3	35	4	57
Bulgaria	5	37	10	43	3	62	3	65
Croatia	5	45	9	52	2	66	6	54
Czech Republic	6	27	15	30	2	53	3	53
Denmark	3	53	5	52	2	53	6	58
Estonia	3	43	8	56	1	50	3	62
Finland	3	54	8	59	1	13	12	99
France	6	37	12	46	3	62	4	64
Georgia *	7	39	15	47				
Germany	6	35	12	42	3	58	5	80
Greece	3	66	6	68	1	52	5	63
Hungary	5	39	11	41	2	51	2	55
Iceland	4	56	6	60	1	0	3	99
Ireland	5	58	9	58	2	45	5	60
Italy	5	50	9	63	2	63	3	83
Latvia	4	41	7	58	2	48	2	46
Lithuania	4	32	10	39	2	49	2	49
Luxembourg	5	19	13	44	3	35	3	30
Macedonia	8	24	13	25	3	62	3	61
Malta	1	0	2	29	1	0	3	40
Moldova	4	40	11	49	3	53	4	64
Montenegro	5	43	9	51	3	52	3	52
Netherlands	5	42	12	45	2	68	4	61
Norway	5	44	9	49	1	26	10	77
Poland	5	35	11	41	2	53	3	59
Portugal	5	37	12	44	2	49	2	59
Romania	6	31	11	39	3	39	3	39
Russia *	3	54	8	69	1	50	2	93
Serbia	6	37	11	37	3	49	3	53
Slovakia	6	27	12	35	2	51	2	51
Slovenia	7	27	14	36	4	45	4	42
Spain	5	44	11	50	2	48	2	58
Sweden	4	62	7	65	1	31	7	101
Switzerland	8	30	15	28	4	34	5	50
Turkey *	6	42	12	51	2	55	2	67
Ukraine *	4	48	8	63	2	68	2	82
United Kingdom	3	63	7	80	2	76	6	65

Table 1: Average (avg) patch richness (PR) and patch density (PD) and variation coefficient (CV%) for European countries on the LANMAP2 and CULMAP classifications. Countries indicated by an * are not completely covered by the thematic maps.

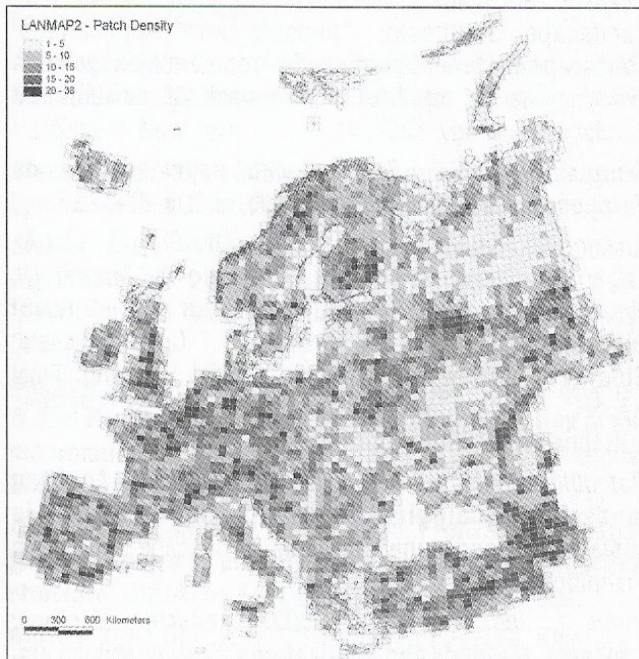
ORIGINS OF EUROPE'S LANDSCAPE DIVERSITY

The diversity and heterogeneity of the European landscapes derives from a long interaction between varied natural and cultural factors and the particular shape of the continent (Antrop, 1992; Jordan, 1973). Europe has a highly contorted and dissected coastline creating many large peninsulas and sea straits. During history, the continental seas were seldom barriers in the development of civilizations and nations (Jordan-Bychkov and Bychkova-Jordan, 2002; Duroselle, 1990). The interior of the continent shows in the western and central part many compartments formed by mountain ridges and tectonic basis or river valleys. Each of these formed a niche for settling of different ethnic groups as is still indicated by the

distribution of languages in Europe. These compartments formed the cradle for the establishment of most nation-states of Europe. To the east, land becomes more flat and vast plains extend. The political borders between the states were more stable during history in the more compartmented part of Europe (Jordan-Bychkov and Bychkova-Jordan, 2002).

Landscape is the result of the interaction of natural processes and human activities during history (Council of Europe, 2000). Consequently, landscape diversity results from a combination of the variation of the natural conditions of the land and cultural impact of human occupation and land organisation. This means that landscape diversity refers both to the traditional landscapes

which developed in close relationship with the natural environment and with deep cultural roots, but also to the great variety of all new developments. Complex and fragmented landscapes of the urban fringe often score the highest diversity metrics (Antrop and Van Eetvelde, 2000). A typology and diversity of the new emerging landscape is still very generally defined and not yet mapped (Vos and Klijin, 2000).



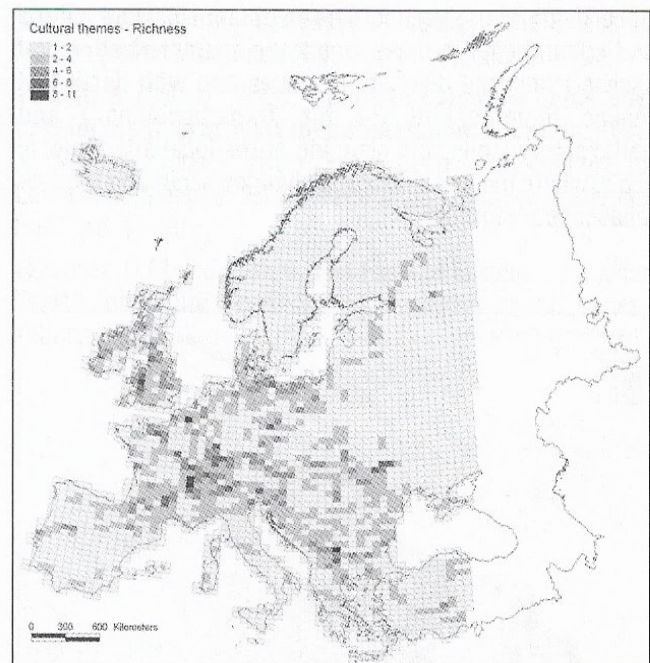
LANDSCAPE DIVERSITY AS A COMMON PLANNING GOAL?

According to the European Landscape Convention all landscape covering the totality of the territories of the member states should be considered. In order to preserve the landscape diversity as important indicator for character and cultural identity of landscapes and regions, several measures are proposed to protect, restore, enhance and even create landscape quality. Also, transborder cooperation is promoted. Landscape diversity is an indicator for achieving these goals, which necessitate international concerted action, including monitoring of landscape changes.

Landscape diversity is used here as a general concept and not as a numerical indicator for the assessment. Several numerical indicators are needed to assess and monitor various aspects of the concept of landscape diversity. Richness and patch density of landscaper types per spatial unit are the simplest ones. Additional ones could be fractal dimension and Shannon-Weaver entropy. The mapping of richness and patch density of landscape diversity and heterogeneity at a European scale shows a lot of variation. This indicates that adapted planning strategies need to be developed according to the regional context. Different planning goals concerning landscape diversity are needed for areas with a high typological variation (high richness) and high heterogeneity (high patch density) than

for areas with low typological variation and high heterogeneity, which indicates here high fragmentation.

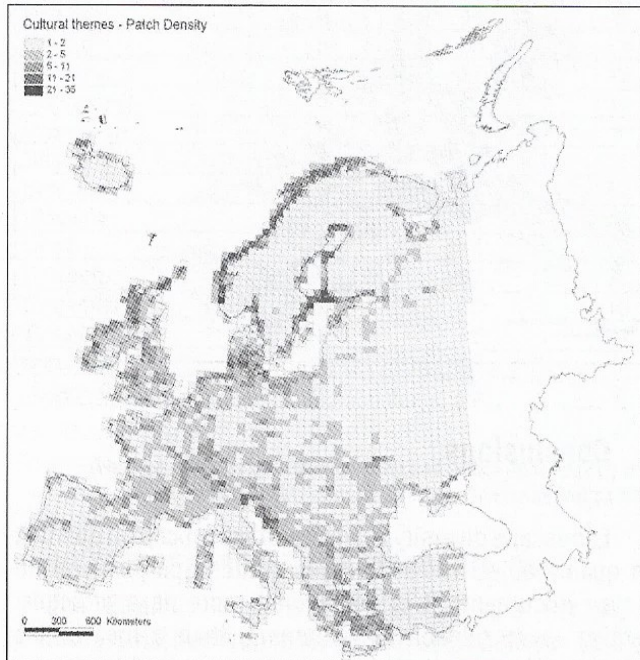
Landscape planning becomes increasingly transdisciplinary and participatory. Communication is important and clear definitions must be used. Landscape diversity does not need a formal definition when it is used as a general concept such as sustainable development. To avoid confusion the term landscape diversity as a formally defined numerical indicator, richness and heterogeneity are suitable alternatives. The formulation of these indicators is highly dependent on the scale (grid size) and the number of categories for each theme, as well as the map detail, and on the number of selected themes. As a communication tool, mapping landscape diversity depends additionally on the classification methods used and on the number of classes selected in the representation.



Conclusions

Landscape diversity is an important concept in defining in quality objectives in European landscape planning. In policy documents it is considered more as a principle, similar to sustainable development, than a measurable criterion. However, in landscape research, and landscape ecology in particular, landscape diversity is also formally defined and expressed and a landscape metric. Also, several definitions exist to describe various aspects of the complex concept of landscape diversity and other terms are used as well, such as heterogeneity. Patch richness and patch density are the two simplest landscape metrics to describe both the typological and spatial variation. The use of these landscape metrics to assess landscape diversity and to monitor changes in the progress of planning efforts demands clear definition, a strict formulation of the

procedure to calculate them and demand critical interpretation. In particular patch based metrics and metrics based on already generalised thematic maps must be used with the utmost caution. Much of the outcome depends on the (quality of the) selected data sources and parameters. Critical analysis of the data sources is necessary, in particular when these are aggregations from different sources. International co-operation is needed to collect necessary data, to deal with transfrontier landscapes and to maintain and enhance Europe's landscape diversity as a whole. There is need to make a balanced assessment of natural and cultural features. On natural landscape components such as climate, topography, parent material and land cover, and standardized data covering the whole of Europe are available. For many cultural features only very generalised maps exist and detailed information is only available at local or regional scale and often use no standard descriptions. Special efforts are needed here to obtain balanced natural and cultural data to make landscape characterisation and assess landscape diversity at scales and with detail that makes them useful for the transdisciplinary and participatory landscape planning at the local and regional scale, where the real landscape changes occur and the new landscape are formed.



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