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From holistic landscape synthesis to transdisciplinary landscape management

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Abstract

The concept of ‘landscape’ has multiple meaning and is intrinsically holistic. Since the Renaissance period different ways of dealing with the landscape have developed, each with its own perspective, concepts and methods. Three groups can be recognized: the natural sciences (where landscape ecology has a leading role), the human sciences (with historical geography and historical ecology, but also the humanistic and semiotic approach to landscape), and the applied sciences (with landscape design and architecture and planning). Each contributed to a new and deeper understanding of the landscape. These different trajectories of landscape research are compared. Common concepts, goals and language are not evident and it is not obvious how to make a new synthesis under the umbrella of a transdisciplinary landscape science. However, when it comes to management and planning all are

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dealing with the same land; a synthesis is needed and transdisciplinary cooperation is unavoidable.

Keywords: landscape science; landscape ecology; spatial planning; holism; sustainability

Introduction

This paper discusses the changes of some important concepts since landscape became a subject of research and management. In particular, the validity of some early concepts, such as holism, is discussed in the new context of sustainability and landscape management and participatory spatial planning. It will be demonstrated how landscape research developed historically along different trajectories, which have not yet converged into an integrated transdisciplinary landscape science. The recent developments in landscape research are driven by factors different from the past and which in fact are trying to keep up with ongoing changes in environment, society and landscape. However, when it comes to management and planning all approaches are dealing with particular areas of land; a synthesis is needed and transdisciplinary cooperation is unavoidable.

Today, many authors and scholars have a pessimistic view of the future of the landscape in the sense that it is expected that many more qualities will become lost and that the future is very uncertain (Lowenthal 1997; Kolen and Lemaire 1999; Austad 2000; Pedroli 2000; Lörzing and Simon 2001; Fairclough and Rippon 2002; Lemaire 2002; Van Mansvelt and Pedroli 2003). Some even speak of a crisis of the landscape (Lemaire 2002). The increasing pace and scale of the actual changes make the landscape difficult to manage in a sustainable manner and cause alienation for the people who live in it (Lowenthal 1997; Palang, Alumäe and Mander 2000; Lörzing and Simon 2001; Lemaire 2002; Cosgrove 2003). The profound transformation of most landscapes since the Second World War is characterized by a loss of diversity, an increasing homogeneity and a fundamental break with the past (Antrop 1997; 2003a). New landscapes are created without history and without ecological links to the natural context. The general trend is one of polarization between a very concentrated and intensely used land and vast areas of abandonment (Vos and Klijn 2000). In landscape-ecological research the term 'disturbance' became very popular and human activities are often seen as the causes of this disturbance (Antrop 2001).

In Europe, one of the first warnings that "something was going wrong with our landscapes" was given in the First (Dobříš) Assessment of Europe's Environment: "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).

Many initiatives have followed since, stressing different aspects of these endangered landscapes: natural (Wascher 2000), agricultural (Dramstad and Sogge 2003; Parris 2004), rural (Claval 2004), multifunctional land use (Brandt and Vejre 2004a; Mander and Antrop 2003), archaeological (Fairclough and Rippon 2002), humanistic and philosophical (Pedroli 2000). The problem has been addressed as a core topic in most of the recent conferences on the landscape, such as the meetings of the International Association for Landscape Ecology (IALE) (Mander and Palang

2004) and the Permanent European Conference on the Study of the Rural Landscape (PECSRL) (Palang et al. 2004). Workgroups and joint projects have boomed: Landscape Europe, Landscape Tomorrow, Ecoland, Europae Archaeologiae Consilium, European Landscape Character Assessment Initiative (ELCAI), the DELTA programme for strategic research, and others). In this series of events, the European Landscape Convention (Council of Europe 2000) is an important development as it triggered policymakers and also focused politicians in many countries on the landscape ‘problem’. The number of initiatives and projects dealing with the landscape is still growing and not all are really concerted, although most pretend to be integrated and inter- or transdisciplinary (Tress et al. 2003; Tress, Tress and Fry 2005). Clear definitions are important and transdisciplinary work demands a common language and good communication (Zonneveld 1995; Antrop 2001; Olwig 2002; 2004; Tress et al. 2003).

The emergence of landscape research

Early landscape descriptions dealt with the geographical characteristics of foreign regions or countries. With the renaissance period in the 15th century the first paintings and pictures of landscapes appeared in the Western world (Olwig 2002; 2004; Lörzing and Simon 2001). Kolen and Lemaire (1999) see this as the emergence of a landscape conscience. The systematic exploration and description of landscapes begin with the Age of Discovery, characterized by a rapid development of cartography and the growing interests of naturalists.

Alexander von Humboldt defined landscape concisely: “Landschaft ist der Totalcharakter einer Erdgegend” (“Landscape is the total character of a region of the Earth”, Zonneveld 1995). Although he was a pioneer in biogeography, physical geography and climatology, he always stressed in his writings the human and cultural aspects in the landscape and above all the aesthetical qualities, which he even considered mentally healing (Von Humboldt 1814).

The French geographer Vidal de la Blache (1922) had a more historical and humanistic approach to the landscape, although he used similar techniques of annotated sketches and his prose was not so different from von Humboldt’s. The main difference is that he recognized the importance of the local community in organizing the landscape, which results in a regional differentiation that is not only based on natural conditions but also on culture and is manifest in settlement patterns and territories. Also here, landscape is seen as a holistic unity, which is well expressed in the proper names given to the ‘pays’ or landscapes. The description of landscapes and regions became synthetic ‘tableaux’ of idealistic landscape models (Claval 2004), and many regional monographs were published (Antrop 2000b). Although both von Humboldt and Vidal de la Blache implicitly include the perception of landscape and its aesthetic qualities in their work, they do not study landscape perception and aesthetics as such.

In Central Europe and Scandinavia geographers developed the theoretical concepts of the ‘Landschaftskunde’ (Passarge 1919-1921; Granö 1929) or ‘Landschaftslehre’ (Neef 1967). The geographer Oppel used the term landscape science for the first time in 1884 (Troll 1950). ‘Landschaftskunde’ had a specific meaning as defined by Johannes Gabriel Granö: “Die Aufgabe der Landschaftskunde ist es, die Landschaften und die in bezug auf ihre Landschaften einheitlichen Gebietsganzheiten, m.a.W. die an den Beobachter gebundenen Fernsichten und die an den Raum gebundenen, in bezug auf ihre Fernsichterscheinungen einheitlichen Gebiete zu untersuchen, zu

beschreiben und zu deuten” (“The task of landscape science is to study, to describe and explain landscapes and the related perceived areas composed of viewsheds and the features and spatial units they contain”) (Granö 1929, p. 57). The landscape is seen as “die sichtbare Fernumgebung oder Fernsicht”, the visual surroundings, but extends the concept to “alle sinnlich wahrnehmbaren Sondererscheinungen”, i.e. all sensory experiences (Granö 1929, p. 56). Granö combined the approach of the landscape as a scientist and an artist, without integrating both (Jones 2003).

Inspired by the new way of observing the landscape using aerial photography, Carl Troll developed a methodological basis for a holistic, an ecological and integrated approach to the landscape (Troll 1939; 1950; 1959; 1966; 1968). He called “Luftbildforschung ist zu einem sehr hohen Grade Landschaftsökologie” (“aerial photography is to a high degree landscape ecology”) (Troll 1939). He introduced the term landscape ecology and called it an “Anschauungsweise”, a way of looking at the subject and he considered it “a marriage between biology and geography” (Zonneveld 1995). The introduction of the term landscape ecology in this sense promoted a new holistic and interdisciplinary synthesis in landscape research and also reconfirmed that perception is an integral part of the concept of landscape. At the same time Richard Hartshorne in ‘The Nature of Geography’ (1939) considered the term landscape with its multiple semantic meanings to be too confusing and abandons it as the object of study in geography in favour of concepts as region and space (Muir 1999). During the 1960s and 1970s a deductive, rationalistic and quantitative approach dominated the new orientation in geography. Based upon the optimistic development in economy and technology, the common focus of geographers upon landscape was lost and a divergence and specialization in geography started. Gradually geographers in Western Europe lost their interest in the landscape as a regional synthesis as well as in the visual appearance and aesthetics of the landscape as subject of study. Landscape synthesis was the concept used by few researchers during that time (Drdoš 1983; Snacken and Antrop 1983; Richter and Schönfelder 1986; Moss and Milne 1999). Zonneveld (1980) defined the loss of the regional holistic synthesis of landscape research in geography clearly in a paper entitled ‘Het gat in de geografie’, ‘the hole in geography’. He stimulated the landscape-ecological thinking, mainly from the German and Central-European schools, in the education of geography students in The Netherlands. The lack of an interdisciplinary and holistic approach of landscape study became clear in the fast changing environment in crisis, with new challenges of natural, ecological, cultural and social issues. The changing attitude towards landscape was also expressed in many philosophical essays such as ‘The Iconography of Landscape’ (Cosgrove and Daniels 1988), ‘Filosofie van het landschap’ (‘Philosophy of landscape’) by Lemaire (1970) and ‘De angst voor het nieuwe landschap’ (‘The fear of the new landscape’) by Lörzing (1982), ‘Past time, present place: Landscape and memory’ (Lowenthal 1975) and ‘Topophilia’ (Tuan 1974). The first attempt to restore the interdisciplinary approach of landscape research was made by the Landscape Research Group, which was founded in 1967, and initiated the publication of the journal ‘Landscape Research’. In 1972 the Working Group Landscape-Ecological Research (Werkgroep Landschapsecologisch Onderzoek, WLO) was created in The Netherlands (Zonneveld 2000), publishing the journal ‘Landschap’. It attracted different kinds of geographers, biologists and ecologists, as well as social scientists and planners. Historical landscape geographers were less involved. These conducted important work in the field of settlement geography (Renes 1982), mapping and classification of historical cultural landscapes in The

Netherlands (Vervloet 1984), and the emergence of historical ecology (Rackham 2000).

In 1981 the WLO organized an international and multidisciplinary meeting in Veldhoven to reflect upon the future of landscape research (Tjallingii and De Veer 1982). Basically, the broken link with the tradition of landscape ecology as defined by Troll in 1939 was re-established and led to the formal creation of landscape ecology. Also contacts between the Western-European approach with the schools of landscape science of the Central-European countries was renewed. Two new international journals were published focusing upon the landscape: *Landscape and Urban Planning* in 1986 and *Landscape Ecology* in 1987. In 1988 the International Association of Landscape Ecology (IALE) was created. Since then, landscape research expanded over many different disciplines. The earliest implementation of landscape-ecological concepts in planning and policymaking occurred in Slovakia (Ružicka and Miklos 1990). Debates are still going on about the specificity of landscape ecology and the definition of landscape. Moss (1999, p. 138) gives a practical approach: "To me, landscape ecology is simply about the study of landscapes and of the need to derive understanding about landscapes in order to enhance our abilities to manage them more effectively. Landscape ecology is not the only field to focus on the landscape but it has emerged in the last few decades because, quite clearly, existing approaches that sought to address a whole range of landscape-scale environmental issues were proving to be inadequate". Indeed, many new environmental problems demand a better understanding of the functioning of landscape and ask for rapid solutions at the appropriate scale of research and actions focused upon planning (Golley and Bellot 1991; Bastian 2001; 2004; Opdam, Foppen and Vos 2001).

The new transdisciplinary approach is mainly found in the domain of the new emerging landscape ecology (Naveh and Lieberman 1994; Zonneveld 1995; Brandt 1999; Wiens and Moss 1999; Moss 2000; Naveh 2000; Bastian 2001; Opdam, Foppen and Vos 2001; Tress et al. 2003). Thus as landscape research is widening new fundamental knowledge is needed as well as more practical applications. The integration is achieved by multiple exchanges of ideas and methods. When landscape ecology is seen as a transdisciplinary science it indicates that it is not just combining sciences (multidisciplinary), nor is it 'in between' sciences (interdisciplinary), rather it is situated above different sciences, trying to integrate them with a common perspective (Naveh and Lieberman 1994; Zonneveld 1995; Moss 1999). Nevertheless, activities parallel to the ones initiated by landscape ecologists continued to develop. Historical geographers, cultural geographers and landscape architects followed their own courses. In 2000, the journal 'Landscapes' was created as an interdisciplinary forum for these disciplines.

Today, landscape science refers to the whole of the disciplines involved in landscape research, such as landscape ecology, historical and regional landscape geography, geo-archaeology, landscape architecture and environmental (perceptual) psychology (Antrop 2000b). However, landscape science nowadays is not synonymous with the earlier German concept 'Landschaftskunde', which would be literally translated in 'landscape science'. The concept of 'landscape' has multiple meanings and subtle differences in different languages exist. Simplistic translations have caused much confusion and unnecessary disputes. A careful use of the language of landscapes has been stressed many times (Lowenthal 1961; Brandt 1998; 1999; Moss and Milne 1999; Naveh 2000; Zonneveld 1995; 2000; Antrop 2001; Claval 2004; 2005; Olwig 2002; 2004).

LANDSCAPE SCIENCE 2000

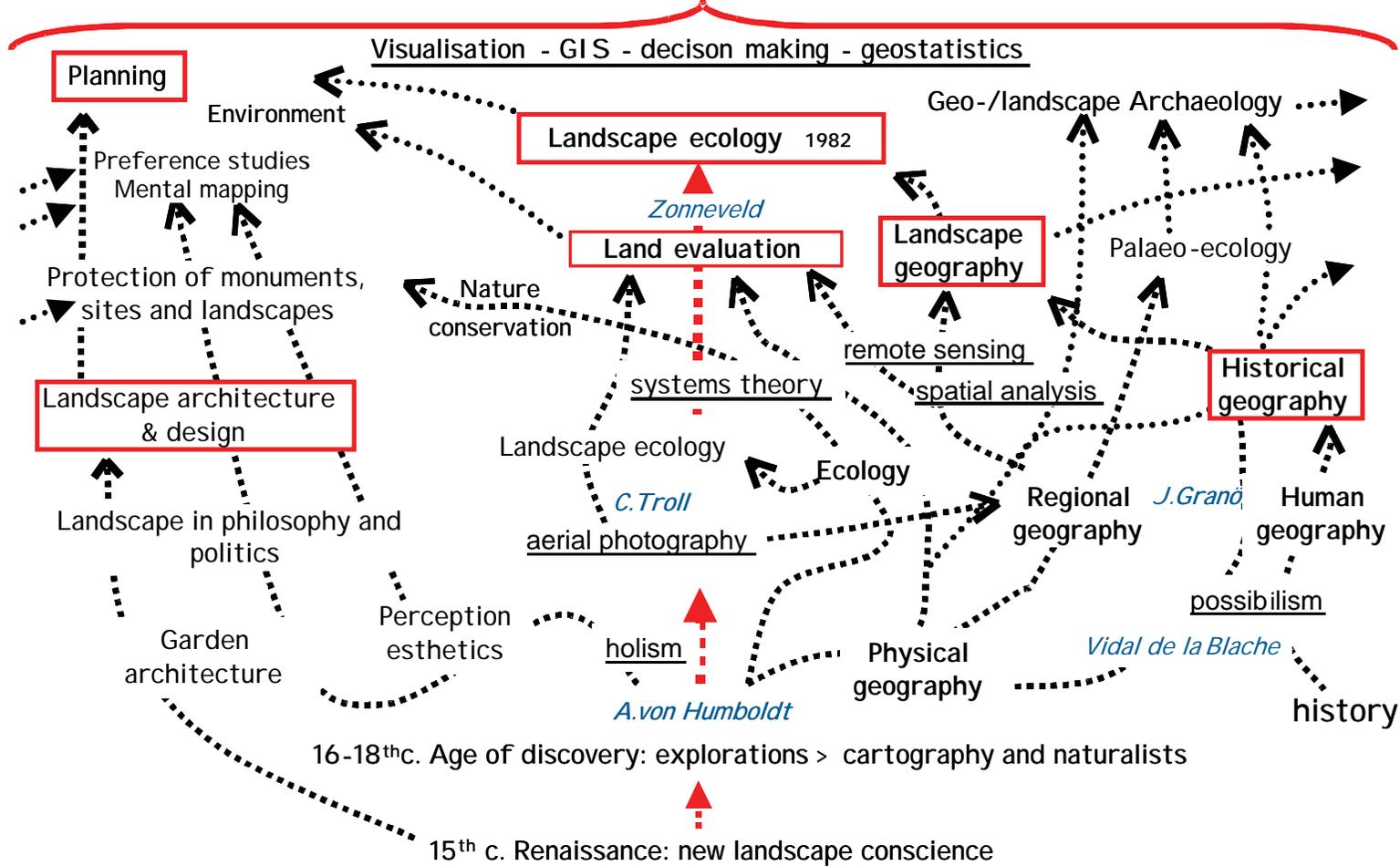


Figure 1. The development of landscape science (after Antrop 2000b)

Figure 1 summarizes the historical development of landscape research and the interaction between disciplines. Disciplines in square boxes are the actual ones that contributed actively to the development of landscape science. Printed in bold are disciplines (mainly geography and ecology) that defined basic concepts and methods for the actual landscape science. The concepts, techniques and methods that were important for this development are underlined. Some important scholars who stimulated the development are named in italics. The three arrows pointing to the outside right-hand side indicate that the umbrella of landscape science closes with the application of basic knowledge in the actual landscape management on the left.

The multiple meanings of landscape

In common language, the word landscape has multiple meanings, and these have been discussed since the beginning of the scientific study of landscape (Naveh and Lieberman 1994; Zonneveld 1995; Dover and Bunce 1998; Kolen and Lemaire 1999; Muir 1999; Antrop 2000b; Olwig 2002; Claval 2004). Landscape does not only refer to a complex phenomenon that can be described and analysed using objective scientific methods; it also refers to a subjective observation and experience and thus has a perceptive, aesthetic, artistic and existential meaning as well (Cosgrove and Daniels 1988; Lowenthal 1975; 1985). Consequently, the perceived landscape is immediately analysed by the observer, compared and evaluated with his/her knowledge and previous experiences. Landscape was also used to refer to an organized, managed or even administrative territory as expressed by the French concept 'pays', the German 'Landschaft' and the Dutch 'landschap'. Finally, the term landscape is also used as a metaphor, such as in media landscape or political landscape. English became the main common language in this domain, so many specific terms had to be translated. Brandt (1998) pointed out how difficult it is to translate many fundamental concepts used in the English-dominated landscape ecology to other languages. Many, subtle shifts in meaning occur and make exact understanding and communication difficult. Zonneveld (1995) stressed the exact meaning and epistemology of words in his book 'Land Ecology'. Indeed, correct use of concepts is an indicator of the maturity and purity of a discipline. Many textbooks of landscape ecology contain extensive definitions.

Considering all these aspects, it is not surprising that the approaches to landscape are very broad and not always clearly defined. Most interest groups dealing with the same area see different landscapes. The word landscape has complex and multiple meanings that shift in response to the context in which they are used and by the background of the users. Also, the meaning of the term changes with changing environmental conditions. For example, the historical geographer Muir (1999) describes the following: landscape history and landscape heritage, the practice of landscape history, the structure and scenery approach, landscapes of the mind, landscape, politics and power, the evaluation of landscape, the symbolic landscape, the aesthetic approach, landscape and place. Claval (2004) sees the landscape as the synthesis that embraces geo-ecological relations, spatial patterns, scenic and aesthetical qualities and even social and cultural traditions. Cosgrove (2003) distinguishes two approaches to the landscape: the ecological one and the semiotic one. Landscapes have a holistic, perceptive and dynamical character according to Antrop (2000b). The holistic character required a synthetic and transdisciplinary approach where natural and cultural aspects of our environment are structurally integrated (Naveh 1995; 2000). Berdoulay and Phipps (1985) recognize two

organizational forms of landscape: the ecological one and the visual or scenic one. The perceptive character indicates that landscape is essentially a reality in the eye of the beholder and can only be studied fully when considering the observer as well. Olwig (2002; 2004) attributes a political power to the scenic aspect that is expressed symbolically by shaping particular characteristic landscapes. Perceptive qualities of the landscape are important in settlement geography (Antrop 1988) and geo-archaeology (Fry et al. 2004). The dynamic character of the landscape refers to processes and to their functioning (Forman and Godron 1986). Landscapes change continuously and build a unique history. The relationship between natural and cultural aspects varies in time and space and forms a basis of the regional component, the chorology and history.

The European Landscape Convention defines landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe 2000). This definition contains many important elements. First, landscape refers to an area, ergo a well-defined territory that is organized and managed. People perceive landscapes, and thus their scenic and aesthetic qualities for humans should be considered. Different landscapes exist because of their distinct character, which is the result of the continuous interaction of natural processes and human activities. History and ecology are essential factors in the structuring and understanding of landscapes. No reference is made to ‘special’ landscapes such as ‘spectacular’ or ‘ordinary’ ones, to rural, industrial or urban ones; all landscapes should be considered equally.

The European Landscape Convention also defines landscape protection as “actions to conserve and maintain the significant or characteristic features of a landscape” and landscape planning as “a strong forward-looking action to enhance, restore or create landscapes” (Council of Europe 2000). The goals are twofold: preserving the landscape diversity that gives regions and places their unique character, and to improve the quality of landscapes if necessary by restoration and creation of new landscapes of quality. However, no time horizon is given, and sustainability can only be assumed. The definition of landscape in the Landscape Convention returns to the original concept where landscape is seen as a unique synthesis between the natural and cultural characteristics of a region.

Rethinking some fundamental concepts

Holism, scale and hierarchy, context

Holism is a bio-philosophical theory that originated with the naturalists during the early 19th century. Although Alexander von Humboldt did not use the term holism, the ‘Gestalt’ idea is present in most of his work. Holism was also important for the Gestalt psychology and in particular as a theory to explain how human perception works. It is therefore not surprising that von Humboldt in his writings emphasizes the aesthetic and the emotional experience of the landscape simultaneously with the rational observation and measurement of physical variables such as temperature. A similar approach is found in J.G. Granö’s work (Granö 2003). The perceptive dimension in landscape is fundamental, as the landscape concept integrates an area of land with its appearance, the scenery. Interaction between mental concept and construct, perception of the environment and adapted behaviour leads to landscaping, i.e. shaping and organizing the land according to the needs of a (local) society and according to political, ethic and aesthetic values (Olwig 2002). As the needs and values change, landscape becomes a dynamic phenomenon that is in continuous

transition. The holistic principle also implies that the significance of individual elements is not only determined by their intrinsic properties and values but is also determined by their *context*. This is a basis for coherence between elements forming an ensemble of greater complexity and often of a unique composition and history. Context values are important for ecology, aesthetics and heritage valuation (Antrop 2004a; 2004b).

According to holism, the landscape should be considered a complex whole that is more than the sum of its composing parts. This indicates that all elements in the spatial structure of the landscape are related to each other and form one complex system. Many new concepts were introduced to describe the properties of the meta-structure of the landscape. Common ones are pattern, patches, mosaic, structure, holon, connectivity and connectedness and context. Very often they are used as synonyms or in a rather loosely defined way, causing confusion.

For many researchers nowadays, holism is outdated and not taken seriously in scientific study (Antrop 2001). This may be because holism is an abstract concept that is inherently difficult to apply, in particular when using so called objective quantitative methods. A useful additional concept that allows an easier practical application of holism is the concept of a holon, which was introduced as building block of the Total Human Ecosystem by Naveh and Lieberman (1994). They defined a *holon* as an open system that is part of a hierarchy. The *ecodevice* concept is closely related (Van Wirdum 1982). A holon is a more or less autonomous subsystem that functions and has emergent properties as a whole. It contains holons at a lower hierarchical level and regulates them, while higher hierarchical levels also regulate it. As holons work more or less autonomously, we do not need to gather data of 'the whole is more than the sum of its composing parts' (which is impossible), but need only data of what is related to the intrinsic properties of the feature studied and its context that determines its major functioning. The context defines the scope of the study. The first step in the study should be the definition of the scale and context at which a feature should be studied. Hierarchical structuring of landscapes is a classic method in land evaluation of land classification (Webster and Beckett 1970; Vink 1980; Howard and Mitchell 1980; Pedroli 1983; Zonneveld 1995). It offers an approach to break down the extreme complexity of landscape into more comprehensive entities that can more easily be handled, classified, studied and managed. A first and important task in all landscape studies is the definition of the scale at which the study will be done; a task that is mostly achieved indirectly by the definition of the study area, the scope of the study, the density of surveying and sampling and the resolution of mapping. Scale became a core concept in landscape ecology (Forman and Godron 1986; Turner et al. 1989; Burel and Baudry 2003) as well as the information content in spatial patterns (Phipps 1981; 1984). Instead of a static property of a map, scale became an important explanatory variable in geostatistics.

Figure 2 to 4 illustrate the hierarchical and holistic principle for the landscape of La Geria in Lanzarote. Lanzarote is the most arid of the Canary Islands with only 152mm of annual rain and a continuous dry northeastern trade wind. La Geria is a valley between volcanoes filled with black ashes. In the 18th century a particular vineyard landscape of about 3000 ha was created here to produce the sweet malvasia wine. Vines were planted in circular pits dug in the volcanic ashes about one metre deep. Along the northeastern side a semi-circular open dry stonewall was build around each pit to protect it from the drying wind without causing turbulence.



Figure 2. Volcano with vineyard, La Geria, Lanzarote (photo: M. Antrop)



Figure 3. Pit in the volcanic ashes protected by a dry stonewall and containing a grape plant and working as an eco-device (La Geria, Lanzarote; photo: M. Antrop)



Figure 4. Dry stonewalls face the northeast to protect crops from the prevailing trade winds and are open to slow down the wind without causing turbulence (La Geria, Lanzarote; photo: M. Antrop)

All solar energy is concentrated in the pit and heats the volcanic ashes. During the night, these cool rapidly and as they are highly hygroscopic, they extract moisture from the air, which is concentrated in the pit with the plant. Each of the pits functions as a holon, an ecocodevice at the micro-scale. Repeating this thousands of times creates a new cultural landscape with a distinct identity at the regional scale. This example also illustrates the interaction between natural conditions and processes and human creativity.

The quantification of the landscape: landscape metrics

Landscape metrics or landscape indices were developed to describe and measure in a quantitative manner the 'transcendent' structural properties of landscapes. Many quantitative metrics are available today (Milne 1991; Turner and Gardner 1991; Turner et al. 1991; Farina 1998). The almost explosive development of landscape metrics was possible when spatial analysis using GIS and image processing became available and calculation facilities became powerful enough. A comprehensive overview is given by McGarigal and Marks (McGarigal and Marks 1995) with the FRAGSTATS software. Most of the landscape metrics focus upon the multi-scale spatial patterns formed by land cover for studying landscape-ecological functioning or assessing and monitoring diversity issues. The possibilities for making meaningful quantitative analysis of spatial patterns also depend upon the availability of geographical data, preferentially as maps.

Many landscape metrics remain abstract and are difficult to understand and to interpret. The method used for defining land units and describing their characteristics significantly determines the values of the landscape metrics obtained. They remain more as scientific tools than instruments of communication to be applied in planning

and transdisciplinary communication. The wide variety of landscape metrics resulted in a discussion about their real significance and applicability in planning (Dramstad, Fjellstad and Fry 1998; Fry 1998; Wrba 1998; Antrop and Van Eetvelde 2000; Botequilha Leitão and Ahern 2002; Parris 2004). In planning and policymaking synthetic and more transparent indicators are preferred, in particular when related to agricultural policy (Oñate et al. 2000; Dramstad and Sogge 2003; Wascher 2003; Parris 2004). Applications in the field of historical and human geography and geo-archaeology also offer new perspectives (Fry 2003; Van Eetvelde and Antrop 2005). Palmer (2004) related the concepts from landscape ecology and the meaning of some landscape metrics to scenic properties and landscape perception. The extent of the study should be based upon the organism's perception of the landscape. For humans this means a definition of home range (action radius) and viewshed. Patch size and shape metrics can be useful here. The grain is considered to be "the finest resolution at which an organism perceives spatial heterogeneity" (With 1994) or "the distance or area to which the species is sensitive in carrying out its functions" (Forman and Godron 1986, p. 125). For humans this means that sample areas should be similar to property lots (Palmer 2004). Humans perceive a rather limited number of different categories (approximately 5 to 10). Naturalness is considered to be positively related to scenic value; homogeneity is positively related to coherence and coherence is positively related to scenic value and visible landscape complexity (Palmer 2004). Palmer (2004) found that half of the variation of landscape preference valuation could be explained by landscape metrics describing the composition (area and percentage of land-use types) and configuration (such as homogeneity expressed by dominance, fragmentation, patch density or edge density, and diversity expressed by patch richness, evenness or entropy).

Spatial planning, landscape management and design

Future landscapes: learning to deal with uncertainty

The trends of the current landscape development in Europe are summarized by Vos and Klijn (2000) and confirmed by many national and regional studies. In general a polarization is going on between more and less intensive land use and the spatial concentration of activities. Important driving forces are transportation and mobility, urbanization and globalization (Antrop 1999; 2004a; 2000a). The result is a loss of landscape diversity and identity, of landscape character and sense of place. Simultaneously, landscape heterogeneity and complexity change and thus also processes and functions in the landscape. Future development becomes difficult to predict and uncertain, in particular in the highly urbanized landscapes (Antrop 2004c; Tress et al. 2004). Traditional landscapes become fragmented and are gradually replaced by new ones (Antrop 2003a; Van Eetvelde and Antrop 2004). Also, the pace and magnitude of the changes are increasing and full-scale up-to-date inventories become almost impossible to make. All this introduces new challenges for policymaking, research and management, in particular:

- the task to monitoring changes
- sustainable development and multifunctional uses of the landscape
- new forms of landscaping.

The implementation of landscape-ecological principles in policymaking and planning are still weak and of great concern for landscape researchers (Dale et al. 2000; Opdam, Foppen and Vos 2001; Bastian 2004). Multifunctionality becomes an

important issue here, as well as the sustainability and the use of concepts such as natural and human capital and landscape services (Haines-Young 2000; Brandt and Vejre 2004b; Haines-Young and Potschin 2004). Also new techniques for communication and visualization of scenarios of future development become important (Tress and Tress 2003).

Integrated monitoring and landscape character assessment

Integrated monitoring at the landscape scale becomes urgent and vital in the rapid changing landscapes to obtain the significant data to base research and decision-making upon. Many (national) schemes have been proposed (Agger and Brandt 1984; Bunce 1984; Ihse 1996; Dramstad et al. 2001; Brandt et al. 2002; Slak and Lee 2003; De Blust and Van Olmen 2004; Howard, Petit and Bunce 2004). Important efforts are made in the field of modelling and predicting land-use and land-cover changes (Fresco et al. 1997; Lambin et al. 1997; Agarwal et al. 2002), very often in the context of climatic change and processes of globalization and without concern of cultural, aesthetical and spiritual values of the landscape. Decision-making at the landscape scale implies dealing with uncertainty (Antrop 2004c). Also, the rapid changes made the preservation of the natural and cultural heritage an important issue again, “before it is too late” (Fairclough and Rippon 2002) and renewed the discussion of landscape values (Palang and Fry 2003; Antrop 2003b; 2004b; Haines-Young and Potschin 2004). Also landscape character assessment and typology have become important in particular in Europe (Wascher 2000; Vervloet and Spek 2003; Múcher et al. 2003; Pinto-Correia, Cancela d'Abreu and Oliveira 2003; 2004).

Sustainable landscapes, heritage and multifunctionality

The concept of sustainability in relation to landscapes can be approached in two different ways. First, it refers to the preservation of traditional techniques in rural or pastoral landscapes and of the land qualities and natural resources needed to sustain this over time. Second, it refers to a guiding principle for future landscaping.

The first approach implies also the preservation of inherent landscape qualities and values related to biodiversity, habitats and water, and to the cultural heritage. This can only be achieved when the traditional practices, local customs and functions that created these values can be understood and maintained (Austad 2000). The culture heritage consists of material objects in their landscape context and immaterial values such as the sense of place, local traditions and customs (Fairclough and Rippon 2002; Palang and Fry 2003; Claval 2004; Antrop 2005).

The second perspective to sustainable landscapes offers principles for future development, in particular to sustain the rural economy in any possible way. Haines-Young (2000) proposed the concept of natural capital as a new paradigm for landscape ecology, in particular when applying landscape-ecological principles in sustainable development and landscape management in the countryside. Botequilha Leitão and Ahern (2002) suggest the use of landscape metrics to evaluate sustainable landscape planning. Potschin and Haines-Young (2003) proposed the use of the German concept of ‘Leitbilder’ as a framework for concretizing the visions in sustainable landscape management, and Bastian (2004) sees it as an expression of an integrative approach to the landscape. The concept raises many still unsolved questions. Sustainability should be applied to a wide diversity of landscapes: natural and cultural ones, traditional and contemporary ones, spectacular and ordinary ones. What has to be sustained in each of those?

In the perspective of the general polarization of the land-use intensity, it is clear that no single solution to sustainability exists. The differences between the rural countryside and the urban development demand completely different approaches (European Commission 2001). Another important question is the definition of the scale and time horizon of sustainability one is aiming at. Also, as a planning guide, sustainability will be dependent upon the dynamics in a larger economical context and dependent of new technologies that might develop. Time or planning horizons in economical way are *a priori* defined according to the realization of the project, and they define the willingness to invest and engage for a predefined period of time. However, no such scopes are clearly defined today for the 'soft', un-monetized landscape values. A striking example of the deficit here is the number of world heritage sites that are listed as threatened (UNESCO 2003).

The concept of multifunctional landscapes is related to sustainable development. It emerged only recently during the international conference on multifunctional landscapes held in Roskilde, Denmark, in October 2000 and resulted in a whole series of publications (Brandt and Vejre 2004a; Fry 2001; Mander and Antrop 2003; Naveh 2001). The reason for this sudden interest is the refocusing of landscape researchers, in particular in Europe, upon the new challenges in landscape management in the concentration areas of population and activities where landscapes become highly dynamic.

Integrating landscape architecture and design

As Figure 1 shows, landscape architecture evolved along a separate trajectory through history. Landscape architecture evolved from the garden architecture of palaces, in particular in Western Europe since the Renaissance (Olwig 2002; Lörzing and Simon 2001; Jellicoe and Jellicoe 1975). It was closely related to new urban planning as realized in the founding of new residential cities. Olwig (2002; 2004) showed how landscape design became an instrument of national governance and autocratic dominance. Many concepts and principles of the 'landscape gardening' were also applied in the modern urban and spatial planning, in particular during the post-war rebuilding and the creation of new towns. During the 1960s to 1980s less attention was given to the shaping of landscape as part of planning policy. Since the 1990s, landscape architects have become more involved in spatial planning, in particular for 'finishing' and 'integrating' new infrastructures and reshaping congested urban centres. Landscape architects are arguably primarily creative designers of new landscapes rather than researchers studying existing landscapes. Landscape-ecological principles are only gradually integrated into landscape architecture and planning (Steinitz 2001; Nassauer 1992; 1995; 1997) and a lot needs to be done, in particular in the basic training of the designers.

The new synthesis demands a transdisciplinary cooperation

The holistic character of landscape means that multiple approaches to the landscape are possible. Each perspective uses its own concepts and methods and these are not always similar or comparable. Three perspectives can be recognized. The natural sciences, where landscape ecology has a leading role, analyse the changing spatial structure and its functioning using mapping. Furthermore they try to describe the holistic meta-reality of landscape as a complex system using quantitative indicators. The human sciences offer several approaches. The historical geography and historical ecology are most closely related to the approach of natural sciences as

they focus upon long-term changes and often use mapping as a tool to understand spatial patterns. The psychological, humanistic and semiotic approaches to the landscape focus upon the perception and experience of landscape and its existential meaning. The results are rarely mapped. Finally, some applied sciences developed their own approach to the landscape, such as landscape architecture and spatial planning. Their approach is partially analytical but most of all creative design. As such they try to remodel and shape landscapes for the future in an attempt to steer the spontaneous and rather chaotic changes that go on.

Profound reorganization of the land to adapt to changing societal needs is resulting in rapid and vast changes of the environment. In areas of increasingly intensive land use and concentration of people and activities, new landscapes must be designed to fit the multifunctional use of space in a more sustainable manner. Today, the concept of 'landscape' is in a profound transition. Landscape does not refer anymore solely to the traditional rural countryside or the spectacular nature. Multiple visions and values exist for the same landscape. A new holistic synthesis necessitates more elaborated transdisciplinary cooperation.

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