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a summing-up and outlook

Brandt, Jesper

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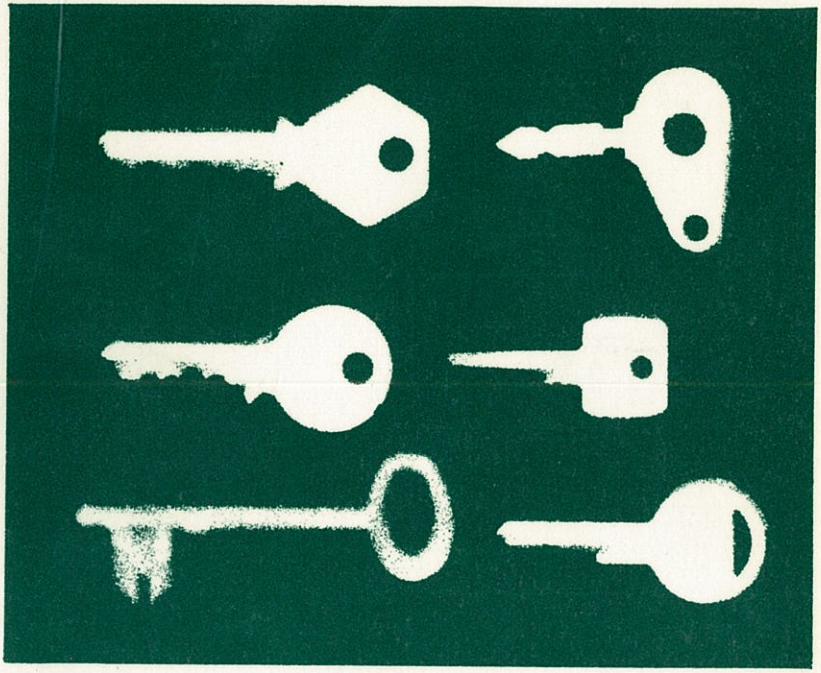
KEY CONCEPTS IN LANDSCAPE ECOLOGY

PROCEEDINGS OF THE 1998 EUROPEAN CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR LANDSCAPE ECOLOGY



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Closing Lecture

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Key concepts and interdisciplinarity in Landscape Ecology: A summing-up and outlook

J. Brandt

Department of Geography and International Development Studies, Roskilde University, House 19.1. P. Box 260, DK4000 Roskilde, Denmark. e-mail: brandt@ruc.dk

Abstract

Interdisciplinarity in landscape ecology is both seen as an expansion of spatially oriented geo- or bio-ecology into adjacent disciplines and applied sciences, planning and management, and as a broad transdisciplinary co-operation of very different mutually inspiring disciplines and practitioners dealing with landscapes. This conference is primarily of the first type.

Today landscape ecological key concepts have proved more complicated to handle than was thought of 15 years ago. Growing empirical experience and difficulties by interpreting and generalising the results are a part of the reason. Different cultural traditions with importance for our conception of landscapes and different landscape histories with different length of cultural impact adds to the problems of interdisciplinarity within landscape ecology. However, the link to practical landscape planning and management helps integrating the cultural and scientific differences. It also helps to formulate hypotheses to be tested by experiments and field investigations. Quantitative methods by landscape classification and refinement of quantitative measure to describe and analyse landscapes are under rapid development, but a more critical attitude towards their use, and an increased emphasis on their ecological interpretation is needed. Examples of practical landscape planning are important to follow, to see how landscape ecological research can contribute to its future development. A 200 years old example of landscape planning, very similar to ideals of modern landscape ecological planning is presented, and the problems of developing a democratic founded landscape ecological planning is presented.

Different types of interdisciplinarity in Landscape Ecology

At the first IALE-seminar on "Methodology in Landscape Ecological Research and Planning", held in Roskilde in 1984 the then president of IALE, Isi Zonneveld, was asked to give a conclusion and outlook from the meeting. He did it in a very fine way, and typically for him he started by saying: "I have to request that we orient ourselves well. To see exactly where we are, we have to take our bearings on clear landmarks and set out our track into the future, the unknown (promised) land" (Zonneveld, 1984). And this is indeed the case. I can repeat his answer: I am sure that all of you as active scientists, consultants and planners can orient

yourself well and find your clear landmarks. I suppose, that this is also what has been meant with the symbol of the IALE(UK): Different scientists from different disciplines, joining a common goal. However, for landscape ecology, as an interdisciplinary science, we all know, that in reality it is not that easy. Often we see different landmarks, or see the same landmarks in different ways. After tediously having agreed in a multidisciplinary team on a clear landmark often its clarity seems to be lost when we move towards it, and again we interpret it differently. This is a normal problem within science, but especially difficult to tackle within an interdisciplinary or transdisciplinary context. It is also closely related to our perception of interdisciplinarity: how is the interdisciplinarity of landscape ecology actually to be understood? Is it a transdisciplinarity of equally involved disciplines, mutually inspiring each other in their search for solving complex problems related to the use of our landscapes. Or is there a priority among the disciplines giving a focus of a trend-setting group of discipline-oriented theories and methods and a periphery of different outlooking supporters within landscape ecology that can add to the formulation of the social perspectives? Both opinions exist in parallel within the landscape ecology of today, clearly demonstrated in the different organisation of the two big landscape ecological events in Europe this Autumn: This European IALE congress on "Key Concepts in Landscape Ecology" arranged by IALE(UK) (3-5th September), and the meeting of the Czech IALE in Prague (6-13th September)on "Present and Historical Nature-Culture Interactions in Landscapes".

Here, it seems obvious to me, that the logo of IALE(UK) is not only a symbol of inter-disciplinarity, but additionally also a logo giving a certain priority to "nature scientific", primarily biological traditions: It is also a flower, symbolising the synthesising power of plants in the landscape, focusing on landscape ecology as an extension of classical ecology into a spatial ecology, that forms a core of an interdisciplinarity within landscape ecology, where this core can be supported mainly by biologically oriented physical geographers, GIS-experts and land use-oriented scientists of different but mainly nature scientific origin. In contrast, the Prague meeting is very broad in its perspective and arrangement, thereby also attracting social scientists and people working in the humanities, focusing on visual aspects of the landscape, and the importance of the landscapes of our minds.

Key concepts in spatial ecology: Pressure from practise

Obviously, "to take our bearings on clear landmarks and set out our track into the future", is most easy, and will be most efficient, if you have a certain priority in the interdisciplinary work, by focusing on some few good interrelated key concepts, that can be discussed mainly on a common theoretical and methodological basis. This has been the clear purpose of this meeting, by focussing on spatial ecological concepts like landscape heterogeneity and biodiversity, fragmentation and connectivity, corridors and dispersal etc., and the relation of these concepts to landscape planning and policy. It is desperately needed: these concepts are not only central to landscape ecology as a science, but they have in fact constituted much of modern applied landscape ecology. Indeed, have already been heavily implemented in practical landscape planning despite there being only a minimum of empirical evidence on the concepts available. Without doubt modern landscape ecology has been pushed forward socially as a science first of all by the tremendous need in practical planning for a better documentation and a firm use of these concepts. So certainly we are responsable for progress in these fields.

From the contributions at this meeting, I think we must conclude, that the mentioned

spatial ecological key concepts have generally proved to be much more complicated to handle scientifically than we thought of 15 years ago, and that their status as clear landmarks for the future, has been rather blurred during the years, parallel to our growing empirical knowledge. But we also have to add: of course it is so. The pure, beautiful theoretical constructions have been smudged by the confrontation with the complicated empirical reality. And this is progress for landscape ecology as a science, as long as we systematically try to obtain a better adaptation of the concepts and models to the reality. We should never forget that, in our frustrations of not fulfilling the immediate needs for a support to simple policy-oriented principles in landscape ecological planning. However, this should not either lure us into a general scepticism towards the use of landscape ecology in landscape planning and management, rather it should stimulate the interest of spatial ecologists in other aspects of landscape ecology related to geo-ecology, traditional landscape geography, planning theory, the study of multi-purpose land-use, landscape perception, landscape aesthetics and landscape design. Additionally, such a broader orientation might also help produce a growing critical attitude towards basic assumptions and traditions within "nature science". Assumptions that might not be general sustainable when the scientific principles of classical ecology, expanded via spatial ecology, are used as the basis for a broad interdisciplinary landscape ecology, one which is mainly for use in cultural landscapes. I will return to this theme later, but here I only stress that both the more specialised spatial ecology-oriented interdisciplinarity and the broad all-embracing transdisciplinarity is needed for the future of landscape ecology. As landscape ecologists we must learn to go on two legs: the one of specialisation and the one of integration (Brandt, 1998). In many ways it is this combination that makes us as landscape ecologists. As (Fry, 1998) comprises this problem in his contribution today, quoting (Lawton, 1991), we should be working together to overcome the major uncertainties in our subject, among other things by looking for agreement on protocols needed, instead of building up opposing camps.

Problems in interdisciplinary co-operation

The integration within European landscape ecology is not only a matter of more or less broad co-operation between different disciplines. It is also a question of developing a better communication between different cultures and traditions. Within Europe, there are different landscape ecological traditions, related to different cultures concerning the perception of the landscape. These cultures are deeply reflected in the different languages, supporting different landscape terminology. The fact, that English in practise is **the** international language for scientific communication might influence the integration process more than we tend to admit: the long landscape scientific traditions e.g. in France, the German-speaking countries and in Eastern Europe are still too weakly represented in the international landscape ecological discussion, although their historical importance for the development of landscape ecology is well known and respected. This is not so much because of missing linguistic translations, but due to cultural barriers, that complicates the communication.: Very few, if any, German textbooks on landscape ecology have, up to now, been translated into English, simply because it is an extremely difficult task. A direct linguistic translation, if at all possible would basically remain German, difficult to understand for an English-speaking audience, due to a lot of unfamiliar types of conceptual context. Here we need to find ways for a better communication between these different cultures. I hope that the establishment of a German-speaking chapter of IALE early this spring will help to revitalise the great German traditions and give power to a more visible influence on international English-speaking landscape ecology. The same goes for other strong traditions within Europe, e.g. within Russian landscape ecology, that is almost unknown

in the English-speaking part of the world. For instance, did you know that a landscape ecological institute in Irkutsk, with a staff of over 200 scientists, for more than a generation has been working with quantitatively based investigations of the structure and dynamics of Siberian landscapes?! Russian landscape ecology had an important influence on the development of east European, and through that also German landscape ecology. It should be considered one of the main roots of modern landscape ecology. But due to the present economical situation the institute in Irkutsk is now in a desperate situation, and close to closing, and much valuable landscape ecological knowledge based on long-term landscape monitoring programmes might never be communicated into the international community (Snytko, *et al.*, 1995).

Certainly we can incorporate such stories in our history of landscape ecology, but to get this richness of experience better integrated into the practice of today's landscape ecological research and planning is a much more difficult task.

Differences in landscape history

However, here we should not be too pessimistic. In the long run, first of all the link to application and planning will help us overcome many of these problems. In the modern history of landscape ecology, much emphasis has been put on the differences between European and American traditions. Certainly they are present, and some will stay; but in my opinion these differences have been somewhat exaggerated. Although it might not have been that visible in the more narrow academic world, the general link to practical landscape planning has worked as an important integrating factor, also at a global scale. All landscape ecological theories and methods, and all landscape ecological traditions with immediate relevance for practical planning have been more or less introduced to most national scientific social environments related to landscape ecology. Often, the differences in trends are more a question of which disciplines or groups of disciplines and applied fields are nationally in the front of calling themselves landscape ecologists, or personally engaged in national chapters of IALE. So, even if American landscape ecology is often considered to be dominated by quantitative modelling, e.g. around the journal Landscape Ecology, many other trends are in fact actively involved in North American Landscape Ecology and the US Chapter of IALE. So, for example, central European traditions within geo-ecology are clearly recognisable among American foresters and geographers working on landscape classification, and maybe even dominant among Canadian landscape ecologists, although still working more in parallel to, than integrated with, the dominant model-oriented spatial-ecological biologists.

However, between America and Europe, somewhat different ways of handling landscape ecological theory and method are obviously related to the different degree of cultural impact in space and time on the landscapes of the world. The general interest in applying concepts of patches, corridors and connectivity to the study and management of fragmented landscapes, has been typical for most developed countries in temperate and Mediterranean countries, but even 10 years ago it was clear that American, and also Australian and other landscape ecologists coming from sparsely populated regions, were putting these concepts into another historical, and partly also practical, context than their European colleagues. American and Australian fragmented landscapes are primarily seen and studied as a reflection of human disturbance of a former natural landscape, putting the question of protection or restoration of the biodiversity of these landscapes on the agenda for the development of spatial ecology. Also many landscape ecologists working with boreal forests consider problems of fragmentation as a

new problem. (Kouki and Löfman, 1998) pay attention to the fact, that almost one fifth of the forest area of the world has disappeared within the last centuries, and that perhaps only one fifth of the remaining original forest cover remains in large tracts of relatively undisturbed forests, primarily in Canada, Russia and Alaska. They show, how the remaining often intensively managed forests has been a subject of a fragmentation process, that has been very differentiated in time and space due to differences in the history of forest use.

The landscape ecological problems of European fragmented landscapes are much more related to alterations within old already fragmented cultural landscapes, where the concern for biodiversity and landscape stability is closely related to the cultural history. Here the discussion of fragmentation, connectivity and corridors has to be seen in another, and generally broader context.

These differences are also somewhat reflected in the contributions to this meeting. The four levels of habitat destruction and related degrees of habitat modification presented in the contribution of (Hobbs and Wilson, 1998) reflects first of all the problems of "the new world". Here, a priority list for conservation can relatively easily be set up, giving first priority for the maintenance of elements which are currently in 'good condition' (which means culturally undisturbed conditions), the second priority to improvement of elements that have been modified in some way, the third priority to reconstruction of fragmented and finally relict areas through buffer areas, corridors and provision of additional habitats. Although the first priority of maintenance will involve ensuring the continuation of population, community and ecosystem processes, it should not be considered a static approach. (Hobbs and Wilson,1998) emphasise that maintenance should be considered in the context of the dynamic nature of ecosystems, which implies that community structure and composition will change over time and in response to disturbance and climatic events. The contribution of (Johnson, 1998) on river regulation and landscape change in the Great Plains of North America offers a good example of the necessity of providing detailed knowledge on such ecosystem dynamics for a strategy of maintenance, here to ensure the high biodiversity of the pioneering *Populus* forests under different flow and management conditions.

In (Hobbs and Wilson, 1998)'s priority list it is only natural, that they put the question, of "how far are corridors the right answer to problems of connectivity". Only a minor part of the species complement are movement-limited, the land use intensity of the new world is generally at a lower level due to a lower population pressure, which facilitates connectivity without corridors, and thus eventually making stepping-stones an efficient alternative to corridors in a reconstruction strategy, where necessary.

In the density populated old cultural landscapes of Europe - and certainly also Asia and the middle east - the situation is different. Here, the biological diversity is historically embedded in an already old, highly fragmented, landscape culturally enriched by a variety of man-made types of patches and corridors, related to variant forms of traditional agriculture. Certainly a decreasing connectivity since the industrialisation of European agriculture after the second world war can be observed, but the destroyed habitats are generally of historically new origin, typically a cultural product of the agricultural history of the former century. The remaining habitats are mostly also cultural or, at least, are very seldom relicts of an intact original natural landscape. I find it plausible to expect that biodiversity in such old cultural landscapes might have adapted to these conditions: that the combination of - at the regional level - the traditional networks of regional corridors in Europe related to the topography-

dependent variations in the land use and the dense hydrographical network, and - at the local level - the generally patchy, corridor-rich agricultural landscapes, might have favoured movement-limited species in comparison with habitat-limited and process-limited species. If so, the biodiversity of European landscape must be considered to be under much greater threat from the destruction of corridors following agricultural industrialisation and the rapid extension of barriers in the form of infrastructural elements in the densely populated areas of Europe, so obviously lowering connectivity.

This only strengthens the need for sound information on the biological functions of corridors in fragmented landscapes. Here, the gap between this urgent need, and the few experimental studies of the movement function of corridors, observed within the last 4 years by (Hobbs and Wilson, 1998) is indeed striking. And that none of the studies considered looked at the response of species to the addition of a corridor in a fragmented landscape, is alarming. Even if it is partly due to relevant investigations not being incorporated into the international science citation systems, it is a very serious problem for landscape ecology as a science, that such a central theme is not covered in the internationally available literature.

Connectivity in fragmented landscapes: theory, methods – and practise

(Baudry and Burel, 1998) document how the definition of dispersal varies among specialists, mainly due to the very different types of movement observed, not only between different species, but also within a given species, related to different types of activities, working at different scales in time and space. They refer to the dominant view that connectivity is a species-dependant landscape parameter, changing over time. As early as 1986 (Baudry and Merriam, 1988) made the distinction between connectivity as a functional concept, and connectedness, as a structural characteristics of the spatial pattern, useful in the further investigation of movements in the landscape, but not in itself giving sufficient information on connectivity. But at that time it was anyway a dominating paradigm, that connectivity in agricultural landscapes first of all was related to patches of woodlots in a matrix, that was seldom defined, but thought of as an hostile or neutral space, that species had to cross to move from patch to patch, and where wooded corridors were the only noticeable elements in the matrix that could permit forest species to move among woodlots. More recently, the incorporation of a heterogeneous space between optimal habitats has become more and more common. This has also posed several technical difficulties, partly due to its ever-changing character in time and space. Here the concept of permeability - or resistance, as by (Villalba *et al.*, 1998) - as a friction parameter that decreases or enhances connectivity has been introduced. Basically (Baudry and Burel, 1998) still advocate a structural approach for the examination of potential interaction between landscape structure and species behaviour. Here the definition of *a priori* occupied, connected patches under a variety of assumptions, is used in a design of randomness-based simulations of landscape changes, that can show how differences in fragmentation, including variations e.g. in permeability influence clusters of connected patches, within which movement can take place. The functional aspect of connectivity is however introduced in the simulation by integrating differences in species perception of patterns by using a range of scales of perception in the simulation. Among the results of the simulations are indications that crop rotation has a large impact on spatial pattern and connectivity, especially for crop dwelling species. One of the new problems facing this more detailed model of connectivity, is the problem of assessing the scale at which a given species perceives its environment. This is difficult, since it is neither linked to body size or taxonomic group, nor to ways of dispersal. At

the same time this type of knowledge has been shown to be absolutely necessary for determining guidelines for landscape management, e.g. by using changes in farming mosaic to control population dynamics (Coulson, 1992).

Another way to improve our knowledge of connectivity and the functionality of fragmented landscapes is to combine the detailed monitoring of spatial distributions of species with GIS-based models as here presented by (Villalba *et al.*, 1998). They have concentrated on one species, using the opportunity of combining several years of population studies of red squirrels in the province of Antwerp with a GIS-based model for simulation of the relationship between complex landscape patterns and function. In these simulations, all permanent patches are sources of movement of individuals simultaneously thus allowing for the calculation of a potential connectivity at any site in the landscape. The potentials are compared with the actual location of patches with permanent, temporary and no-squirrel population. This is done under two different types of conditions, namely by different maximum dispersal distances, with and without inclusion of information on the landscape resistance in the area. The resistance rules are mainly oriented towards the barrier effect of different linear features, whereas no differentiation is applied to the background matrix. If connectivity was the only factor regulating the population the location of squirrel populations should follow the potentials. This is however only partly the case. The permanent populations are shown not to be related to the highest connectivity, but more to the patch size, especially by low maximal dispersal distance. The study also throws into relief, that the resistance of the background matrix has a much stronger influence on the connectivity than the barrier effect of the linear elements. From a practical point of view it is concluded, that the model allows one to identify the patches more likely to receive squirrels from the permanent populations and to identify sets of highly connected patches that form sub-units within the study area.

It is stimulating to confront the findings of (Hobbs and Wilson, 1998) and the model-oriented investigations of (Baudry and Burel 1998), and (Villalba *et al.*, 1998) with the report by (Šustek 1998) on the experiences related to the extensive research carried out in the former Czechoslovakia to support landscape ecological planning and the establishment of landscape corridors. Certainly as an entomologist he is oriented towards quite another scale, but Šustek points out some good general reasons not only for the lacking bio-geographical experiments around the construction of corridors, but also for the often contradictory results of field investigations. These include the often false assumption of homogeneity in the landscape matrix, which in practice varies enormously: not only in terms of relief and climate at the regional level, but also locally, down to what he calls the crypto-heterogeneity of single fields. Such variations, which reflect very slight local differences in soil humidity or structure, may influence experimental conditions in a way that is extremely difficult to predict. Competition and/or predation between groups of species is another confusing factor, resulting in diverging interpretations of distribution patterns. Soil trophicity and zoocoenotic differentiation, as well as seasonal and temporary changes are other differentiating factors of a test area. These also need to be included any realistic experimental design because they influence the resulting functionality of a corridor.

Accordingly, but at a more general level (Fry, 1998) explains why landscape ecological studies are seldom comparable. He lists several reasons why it is so difficult go generalise from landscape ecological research: Landscapes are difficult to map, not at least their habitat quality. They are rarely in a stable state. Landscape change might influence species interaction, and

structures good for one species may be poor for another. Effects are often long-term, difficult to measure, and studies doing it often confuse statistical and ecological significance. We need more standardised experimental design, better mapping protocols, and more robust indicators of landscape quality, if we will establish better links between various mathematical indices of landscape structure and biodiversity, sustainability, amenity or aesthetic landscape qualities.

(Šustek, 1998) shows another way to go, at least temporarily, namely through expert judgements, closely related to a full-scale differentiated planning design and implementation process, constantly giving opportunities for different types of experimental design, and constantly provoking practical use judgements. These would operate through field investigations, experiments, and alternative judgements, involving interdisciplinary panels of partly overlapping groups of scientists. This fruitful co-operation of science and planning has in fact been the case in the Czech and Slovakian republics, and maybe especially in South Moravia. Šustek describes this planning system as an analogy to the Biotopvernetzung in Germany, the National Ecological Network in the Netherlands, and the greenways in USA. To me, this is a rather modest comparison, because these systems differ in their point of departure and in their degree of landscape ecological integration. Where the Dutch ecological network, and partly also the German Biotopvernetzung are primarily based on a biologically oriented spatial ecology for nature conservation, and the greenway-tradition has its origin in American landscape-architecture, the Czech and Slovakian "Territorial System of Ecological Stability (TSES)" are more related to the strong geo-ecologically oriented tradition within East European landscape ecology. Here the landscape-ecological planning has developed in close co-operation, partly also in tough competition, with different disciplines and schools, trying to influence, and take advantage of the integrated territorial planning system. Certainly as Šustek points out, this system has important aspects for ecological dispersal, but this is not the only function of setting up bio-centres, corridors and interaction elements at different levels. Basically the goal is landscape - not just nature - protection, through a planned improvement of the stability of the, more or less, cultural landscapes in these countries; not only through introduction of stabilising patches and corridor, but also through a complementary, more landscape ecological, sound management of the matrix, called 'the eco-stabilising measures for TSES' (Miklós, 1996).. And therefore it is not called just an ecological network, but a "Territorial System of Ecological Stability (TSES)", or "Territorial System of Landscape Ecological Stability (TSLES)", as it is called in the Czech Republic Following this goal, it is not at all that clear that priority should be given to maintenance, over improvement, over reconstruction of landscape elements, as (Hobbs and Wilson 1998) suggest. Of course, some nature conservationists in Slovakia will defend this point of view, seeing the TSES system first of all as means to improve the conditions for the most important, often remotely located, nature protection areas. But this is not the main point of TSES: looking at a TSES map of Slovakia shows clearly that some of the landscapes most in need of landscape ecological stabilisation are the intensively used open south-western lowlands with only few protecting elements paired with a very intensive land use. The industrialisation and collectivisation of agriculture has been very hard on these landscapes, not only from a geo-ecological or landscape architecture point of view, but also from a more far-sighted general landscape ecological point of view. So here, there are almost no classical nature conservation interests left to protect, but the need for landscape protection is urgent! I find it a very interesting observation from Šustek, that the missing spatial information in ancient entomological books might be explained not by their ignorance of spatial heterogeneity, but by the fact, that the former diversified cultural landscapes offered suitable refuge all over, at a time where no, or almost no, artificial fertilisers and pesticides were in use.

Obviously, the many landscape ecological rules-of-thumb in such a system, based on expert judgement are, and should be, open for constant criticism, but also as scientists we should support the standpoint of Šustek, that even such rules which have been included into the law regulating landscape planning and management in these areas do create better conditions, and do not exclude later corrections.

Problems in quantitative landscape ecology

The classification of European Landscapes for further landscape ecological studies has been a central task since the beginning of landscape ecology as a science. In particular, the wish to introduce quantitative based classifications have been dominant in modern times. This is also a central point in the contribution of (Jongman *et al.* 1998) stressing the importance of using quantitative classification methods from ecology to improve our understanding of landscape character. On one level there is a long tradition in this field with the many quantitative based classifications within climatology and plant geography in the first half of this century. The problem however has been how to represent the complex landscape character at different levels in a quantitative way. Traditionally it has been handled by a deductive landscape classification, where the landscape has been divided according to different principles into still smaller entities, within which the landscape complex could be described in more detail. One of the more well-known European examples was the comprehensive Handbuch der naturräumliche Gliederung Deutchlands (Handbook of the nature spatial division of Germany), an interesting common German project elaborated during the worst years of the cold war, at the middle of the fifties (Meynen und Schmidthüsen 1953). The majority of the most experienced landscape researchers of Germany were involved in the project, and without doubt both the landscape division and the description mirrored the highest expert competence on complex landscape characters of that time. But it was primarily qualitative descriptive. The growing need for more exact characteristics to be applied in planning and management forced many of these researchers to find other ways. First of all by turning the hierarchical principle of the landscape description upside down. They now concentrated on the detailed landscape analysis, building up the hierarchy of landscape complexes through that. This was an inductive landscape analysis, putting emphasis on the detailed quantitative characteristic of the landscape content, instead of a deductive analysis, deemed to concentrate on the demarcation of the landscape units, and only giving a qualitative characterisation of the relative differences between the units. In 1956 Ernst Neef from Dresden (Neef 1956) formulated the division of the landscape analysis into the topological dimension and the different levels of the chorological dimension. He set up plans for an empirical-based quantitative description and classification of the lowest level of land units: the topological units - physiotopes or ecotopes - and their quantitatively described combinations into different classifications of chorological landscape units - microchores, mesochores and macrochores. Throughout the 1960s and '70s this strategy was systematically followed by his pupils (e.g. Haase 1964; Mannsfeld 1983), ending up in a comprehensive system of quantitatively-based landscape characterisations of the former GDR (Haase 1985), additionally interpreted and oriented towards different practical purposes. Parallel to this, other geo-ecologically oriented schools of landscape ecologists in Eastern Europe, Western Germany and The Netherlands developed in the same direction.

Ernst Neef was the main speaker at the first world-wide landscape ecological congress in Veldhoven in the Netherlands in 1981. At that time, and during his last years, he began to express a more and more critical attitude towards this quantitative development in the complex

characterisation especially of our cultural landscapes. He was concerned about what he called 'Der Verlust der Anschaulichkeit', the loss of lucidity, the problem, that the analysis as a simplification of components and factors dissolve the geographical reality as a lucid form, a Gestalt, to which our experiences through social practise is very much related. So, it is of utmost importance, that the result of the analysis is always placed in a common understanding of the real object being investigated (Brandt and Holmes 1995). Neef postulated that this return of analytical statements to the original frame of reference is often missing. For example: that we allocate different pixels to landscape units or produce quantitative indices of heterogeneity or connectivity in different land units, without seriously relating these to an understandable reference for our landscapes, although this is where we started. It is like using temperature data without knowledge of the freezing and boiling points of water and without experience with hot and cold. Neef gave several explanations for this state of affairs, mostly related to general trends in the social development of science: the fragmentation of science because of specialisation that makes interdisciplinarity and synthesis difficult tasks, the quantification and mathematisation that have biased science towards elementary and less complex problems, the general low status in the scientific community of popular scientific publications. The devaluation of physionomical descriptions in science and the liquidation of aesthetic aspects have both resulted the building of hypotheses that are often artificially nourished through statistical material rather than basic field studies. The results are that interpretation is often very difficult and that the translation into normal daily language often shows that the mathematical derived results were already known. The problem raised by (Fry 1998) on confusion of statistical and ecological significance is closely related to these problems of interdisciplinary in quantitative landscape ecology: Fry not only points out that our ability to quantify landscape change is running ahead of our ability to quantify its effect on biodiversity and landscape values. He also stresses that the ecological significance of results often is unexplored in reports or assumed to be in proportion to the statistical significance of the results. This is a clear sign of 'der Verlust der Anschaulichkeit', the loss of lucidity, by the uncritical use of quantitative analysis in landscape ecological research.

Quantitative measures within landscape ecology are without doubt a relevant goal. But used in isolation, they can not only lead down blind alleys, but can also be dangerous by their simplification of complex structures and processes. They deserve to be handled with great caution if not general scepticism. Probably the most important lesson to be learned from the late Neef is that the lucid presentation, either in plain words, or in instructive graphic form is of utmost importance as a control of the growth of knowledge coming out of mathematical methods and statistics used in landscape ecology. I disagree with the viewpoint of (Jongman *et al.* 1998) that one should distinguish between a quantitatively-based classification of natural landscape features and a qualitatively-based classification of cultural features and management, and that this difference should constitute a natural barrier for the integration of natural and cultural aspects in the quantitative land classification. There are no principal differences in both the possibilities and constraints of quantifying natural and cultural aspects of the landscapes, only different traditions and experiences. It should be our job as interdisciplinary working landscape ecologists to overcome this perceived in the future.

Perspectives in landscape ecological planning and management

The presentation of (Harms *et al.*, 1998) is interesting by focusing on good examples of

landscape ecological restoration, not only repairing on former unsustainable types of land use, but additionally using the improved landscape ecological conditions as active attractors for economic opportunities. The basic arguments are, as far as I can see, the following. Until the introduction of fertiliser and the general industrialisation of agricultural production, the impact of man on the European landscapes generally enriched the countryside and favoured the biodiversity of species. Later, our landscapes were highly modified primarily by intensification of land-use and scale enlargement. The solution is creation of new small-scale landscapes and a more extensive land use that will attract outdoor recreation and a growing middle class looking for high-quality working and living environments. However, in most of these cases the initiating factor seems to be a regional economic crisis, manifested in an extensivation or even desertification of the land use, and the prospect being a shift towards a much more intensive land use through recreation or urban use. But only a minor part of the European landscapes can be reconstructed through the extensive investments related to such a development, and we need solutions for landscapes with an average level of capital input, not to mention all the marginal areas not able to attract capital at all. What will be the landscape ecological solution for these areas?

The Central City Belt Study is interesting by presenting different scenarios not only for the territorial layout, but also for the relative strength between the involved economic and political forces. The mutual benefit of economic rationality and landscape ecological planning is indeed difficult to evaluate, and one of the most important problems to elucidate is, how far it presupposes a central planning authority (or if decentralisation has taken place, a strong democratic and cultural debate) and control, one sufficient to ensure that landscape ecological considerations will be respected.

Democracy and landscape ecology: Wörlitzer Park. A lesson from the past

Centralised landscape ecological planning is indeed not new, it is well known from history. Allow me finally to continue Harms *et al.*, (1998)'s landscape ecological planning excursion on the Continent, with another, but 200 years old, example (Lein, 1964; Hirsch, 1985; Brandt, 1987):

Once-upon-a-time, at the end of the 19th Century, there was a little principality, called Anhalt-Dessau south of the Elbe in the eastern part of Germany. With an area of only 700 km^2 it was jammed in between the political and militarily powerful states of Prussia and Saxonia. It was a rich country based on an active agricultural export: cereals to Hamburg, hops to Berlin and further to Scandinavia, tobaccos and cigars to Saxonia. Also large amounts of wool and cloth were exported. But for the little principality the many trade restrictions were a source of constant problems for the economy. Prince Leopold III, Friedrich Franz (1740-1817) tried to remedy these obstacles by substituting military expenditures with a neutral and pacifist foreign policy and by making the land an economical and cultural refuge for the many new ideas, characterising the period around the French revolution. He surrounded himself with a host of economic, political and cultural advisers, and in the most paternal way he channelled the majority of the state budget into an educational standard, agro-economic development support, a comprehensive and exemplary construction of roads and a public social- and health-service very advanced for that period. The figurehead and integrating profession in this enlightened and prosperous society was a carefully planned elaboration of the cultural landscape, where the leading principle was the integration of the cultural - partly deep ecological - movements of the time, with the most modern and rational economic creations. A number of primarily British,

but also Dutch, French and Italian inspired landscape parks were constructed in the different parts of the country - we could call them core areas - and connected by a network of main roads and avenues, with independent paths for pedestrians separated from the traffic by a poly-rowed layout of fruit trees, adding to the agricultural production. An intensive use of the matrix was furthered by a modernisation of the agricultural land use, the reclamation of cultural wet meadows for intensive grazing and extensive planting of forest on former outfields. The landscape parks were not considered isolated pieces of garden architecture for the noblemen. On the contrary, they were first of all model farms working as an extension service, inspiration and cultural enlightenment for the agricultural population. Certainly different types of magnificent garden architecture were related to a central castle, but the parks were kept rural through the construction of extensive wet and dry corridors working as interactive elements framing a matrix of agricultural fields, deliberately stretching right into the hart of the park. The model farms included crop growing and breeding stations placed at the farmers disposal, and the park-character, larded with historical and cultural monuments, was also a way to attract the surrounding inhabitants, and present to them a unity of the past, the present and the future cultural achievements in a natural harmony between the useful and the beautiful.

The principality could not last and was dissolved around 1825. Since then, most of the parks in the Anhalt-Dessau 'Gardenstate' have been eroded away through 200 years of land-scape development. One park, however, has remained intact, namely the park of Wörlitz, that during the last generations worked as an important recreational resort for the densily populated conurbation of Halle-Dessau-Bitterfeld, an industrial area that covered over half of the heavily polluting chemical industry of the former GDR.

Surprisingly many of the ideals of contemporary ecological planning models can be recognised in this park, interesting by still being situated in the open land. Some interesting differences also occurs: Autensity, a difficult but a very important aspect of biological and cultural diversity of today's ecological debate, is non-existent (Lein, 1973). Just the number of different trees and shrubs exceed 700 due to the many exotics. The same boldness - or disre-spect, if you will - goes for the buildings, comprising almost all thinkable architectural styles from the antique to new classicism. However, a certain autensity, namely a clear functionality was mostly present, although often hidden. It was not a museum, or a conservation object. Even temples and other historical buildings, constructed viewpoint, channel system, etc. had clear functions within the agricultural production system. And additionally it was an open, amusing, school book for education in nature and history. Over the channels bridges in differ-ent styles was constructed: From an imaginative primeval bridge, a Roman stone bridge, and a south-American sun-bridge from the Incas, to a model of an English iron-bridge, brand-new at the time around the 1790s, when this part of the garden was built. So, the inclusion of a modest East German bridge in concrete to facilitate the transport of heavy agricultural machines over the corridors in fact fits well into the history.

The example might be interpreted as a dream for a landscape ecologist with political ambitions. If so, he or she will have a problem. Namely a problem of democracy. The con-struction of this "well-managed and besides extremely decorative country" as a contemporary, Johann Wolfgang von Goethe described it, was not democratic, but a result of an absolute monarchy, although an enlightened one. I doubt, if the population was at all actively involved in the planning and management of the country. And I don't know, what would have hap-

pened, if it had been the case. Certainly, public pressure had an influence at that time. The French revolution was a challenge to the ruling class, and inspired the cultural elite around Prince Franz. The many reforms should have contained social discontent through the establishment of social and economic security and a systematic socialisation through enlightenment, education and a lot of social, often landscape-related activities - e.g. Olympic games between the villages, where the final rounds were gathered on grounds, built into the landscape parks. It sounds familiar to most of us, using the holiday by zapping from the football world championship, to tour-de-France in our global village, leaving the planning of our future landscapes to a technocracy of professional planners and interest groups. Who will plan the future landscape ecological garden states? Is it a professional job for landscape ecologists? If so, how should a democratic landscape ecological planning be organised? Or should our role primarily be seen to protect nature and society against scrupleless short-sighted interference with our landscapes, organised by what Šustek calls the 'biologically uneducated klepto- and technocracy'?

If we want to develop an integrated landscape ecology based on what we consider as urgent social need for an ecological reconstruction of our use of the landscapes, we cannot escape to formulating such questions. And I am looking forward to an answer!

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