

## New perspectives for landscape ecology

Brandt, Jesper

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## New perspectives for Landscape Ecology

Jesper Brandt  
Dept. of Geography and International Development Studies  
Roskilde University  
P. Box. 260, 4000 Roskilde, Denmark  
Fax +46 74 30 32, E-mail: brandt@ruc.dk

### Landscape ecology as an interdisciplinary scientific field of interest

There are different ways of looking at Landscape Ecology: We can see it as a series of inner developments within science and the more applied branches, and put emphasis on how they have amalgamated into what we today see as modern landscape ecology. But we can also look at it from a more social point of view: What are the social needs and tendencies that have furthered the development of landscape ecology, and for what social reasons has it been necessary to merge different disciplines and schools together in the complicated scientific organisation of modern landscape ecology? Both viewpoints are certainly relevant, however up to now we have mostly been focusing on the first one in our endeavour to formulate the history and development of modern landscape ecology.

Let me first briefly repeat this history: It tells us that landscape ecology is considered a rather new phenomenon, with roots in central Europe going back mainly to the Second World War and spreading rapidly over the rest of the world from the middle of the 80s, with the first textbook in English from 1984 (Neef 1982, Naveh and Lieberman 1984, 1994, Schreiber 1990, Forman 1990).

The first time the term 'landscape ecology' turned up was probably in 1939 in an article on 'air photos and ecological soil science' written by the German biogeographer Ernst Troll. In this article he elaborated extensively on the perspectives of air photo interpretation with many examples from all over the world. Towards the end he put 'landscape ecology' into a concluding remark, only once and almost offhandedly, saying: *Luftbildforschung ist zu einem sehr hohen Grade Landschaftsökologie. Die Luftbildforschung wirkt außerdem in hervorragendem Maße wissenschaftsverbindend* [Air photo research is to a great extent landscape ecology. In addition, air photo research integrates science extremely well] (Troll 1939). For Troll the goal was a broad marriage of geography and biology. This marriage has been the basis of our history of Landscape Ecology ever since, however in a much narrower form than we tend to admit: Within physical geography a geo-ecological school developed in central Europe uniting the different subdisciplines into a landscape study with emphasis on integrated structural studies with the most important result being the distinction between the topological and the chorological dimensions and the classification and hierarchical ordering of landscape types in the chorological dimension (Neef 1956). This was closely paralleled by a bio-ecological tradition among botanically oriented biologists, which was the result of a development within a spatially oriented vegetation science (Tüxen 1968). Although differences still exist in the terminologies and foci of these studies, it is clear that a geo-bio-ecological integration has been established and that landscape ecology as an

interdisciplinary field has furthered this integration into what Zonneveld has called the ecology OF the landscape (Zonneveld 1995). Zoologists, however, went in quite another direction. Starting their landscape ecological interest with the practical perspectives of conservation biology, their interest for the spatial aspect developed rapidly in the wake of the incipient island-bio-geography of the late sixties (MacArthur and Wilson 1967), resulting in the development of dispersal ecology and metapopulation theory (Gilpin and Hanski, 1991).

Up until the last few years, however, this development can also be seen as an internal specialisation within biology - as the invention of the spatial dimension in biology - rather than as a result of an interdisciplinary co-operation (Merriam 1995). Zonneveld has called this spatial biology for ecology IN the landscape, stressing the difference from the former geo-bio-ecologically oriented ecology of the landscape. But it is also clear that it has been his dream to integrate especially these two traditions in the study of landscape functions that he considers to be the core of landscape ecology. Landscape ecology *sensu strictu*, he calls it.

Around this core of landscape ecology *sensu strictu* a 'theoretical foundation' for landscape ecology has been formulated and the contribution of different disciplines and applied sciences to this theoretical foundation has been mentioned (Forman and Godron 1986, Zonneveld 1990 and 1995, Forman 1995, Farina 1998). Much emphasis has been put on the development of quantitative spatial landscape ecology which dominates the rapidly developing US-landscape ecology, as well as the international journal Landscape Ecology. Parallel to this, and especially within the recent history of the field that is, after the foundation of IALE in 1982, it has been stressed how new perspectives, especially within cultural aspects of landscape ecology have widened the universe of landscape ecology (Naveh and Liebermann 1995). This has partly been due to IALE -initiated activities involving scientists interested in landscapes, coming from social sciences and the humanities (Svobodová 1990, Svobodová and Uhde 1993), and partly due to a growing involvement in landscape ecology from especially American landscape architecture and planning (Ahern 1991, Nassauer 1997). An additional paradigm of global co-operation among all types of disciplines with relevance to landscape studies has been formulated, stating that landscape ecology is a science not just 'combining sciences (which is *multi-disciplinarity*), not 'in between' (which is *interdisciplinarity*), but above a series of sciences and integrating them: namely a *transdisciplinary* science for the study of the Total Human Environment (Naveh and Lieberman 1984, Zonneveld 1995).

Especially Naveh and Zonneveld have put much effort into the formulation of a meta theory for this transdisciplinary science based on general system theory, biocybernetics, information theory, fuzzy set theory, hierarchy theory etc. (Naveh and Liebermann 1984 and 1994, Naveh 1996, Zonneveld 1995)

Having changed the focus of Landscape Ecology from a mere marriage of physical geography and spatial ecology to a broad transdisciplinary science, we need to revise our history somewhat. In fact it is not that important that Troll used the phrase 'landscape ecology' for the first time in 1939, and certainly not all important roots of modern landscape ecology are to be found within central European biology and geography. We should stimulate scientists from all disciplines related to our transdisciplinary science to write the history of landscape ecology from their disciplinary point of view: Which theories, methods and ways of practice relevant for landscape ecology have developed

historically within the single disciplines, and how can these traditions contribute to the interdisciplinary co-operation within landscape ecology?

For the individual scientist, coming from a recognised discipline or field of interest, and considering joining the interdisciplinary field of landscape ecology, this history might be very important. He or she should, after all, wish to be not just a part of the science, but also of its history.

When scientists are labelled, and especially when we are labelling ourselves, we tend to consider it a process, reflecting the most inner core of the logic's of our educational and scientific knowledge. At least we tend to argue as if this were the case. But at the same time we also experience, that such a discussion very often bring our emotions to the boil, because it is also very deeply a matter of our personal identity, as well as our social status. We have used the most sensitive part of our adult life to get socialised into a certain discipline, and we are inclined to defend this identity and social status by all means, at least until we think we have something better. I say this to stress that every organisation of science to a high degree is a social matter of crucial importance for the individual scientist.

#### Perspectives for landscape ecology as a special part of the environmental movement

However, I will also remind you of another, more sociological fact about modern landscape ecology: Underlying much of the endeavour to organise landscape ecology at a global scale has been without doubt the environmental crisis of modern society, the growing concern for the environmental problems and the formation of the environmental movement since the 1960s and 70s. This movement started first of all as a concern among natural scientists and the environmental problems were correspondingly also for many years seen as problems which solutions were primarily linked to a better understanding of the nature of our environment and to the development of better technical management of the man-nature-relationship. Not until the publication of the Brundtland-report, and in the course of the subsequent Rio-process, was it gradually acknowledged that the social and political aspects of ecological problems had to be taken into account; very often both the roots and solutions of environmental problems were to be found in a better understanding and management of the social organisation of the use of nature, as well as a better understanding of how different groups of people and interests perceive the environment, develop notions and ideals concerning the future of the environment, and react to different proposals or tendencies in the use and planning of the environment.

The societal perspective for modern landscape ecology is closely related to this development. Landscape ecology contributes by focusing on how many environmental problems are related to the way human-induced land-use and flow of matter and energy interact with the landscape structure and landscape dynamics of our environment - and especially by stressing how a large part of these problems are related to land use changes, often in the form of development of one-sided types of land use that do not take into account the multifaceted character of the landscapes in which they are implemented. A better and much more detailed natural scientific knowledge of the structure and dynamics of landscapes and landscape functions is certainly fundamental for this endeavour. It has also been increasingly recognised, that progress within these fields should not be separated from the study of the human aspects of landscapes, since the majority of

decisions related to land use and landscape planning and management are closely related to the ways in which different groups and interests perceive the landscape and the landscape ecological problems related to it (Nassauer 1997).

I think this general recognition is the real reason why landscape ecology has developed more and more towards a very broad interdisciplinary field, and that a certain competition among different schools and disciplines for the right way to look at landscapes from an ecological point of view has been replaced by a more open-minded, liberal and, in fact, not just academic way of co-operation between disciplines and traditions that are quite far from each other and certainly very difficult to integrate.

In a concluding lecture at the last world congress for landscape ecology on The Future of our Landscapes held in Toulouse in August 1995, the Australian landscape ecologist Richard Hobbs expressed the problems of landscape ecology very clearly by saying: "Although it must be acknowledged that landscape ecology is still a developing science, this does not allow us to develop it in an academic vacuum. How much landscape ecology currently finds its way into land-use planning decisions? Or into landscape design?...I suggest, that in its present condition, landscape ecology has surprisingly little to offer those wishing to plan and manage the landscapes of the future". To solve the problem Hobbs recommended a more goal-oriented participation in the process of shaping future landscapes: "...the Earth and its landscapes are under unprecedented threat from human activities, and there is an urgent need for rapid action to deal with these threats in a rigorous and effective way". He criticised our limited ability to use and develop our interdisciplinary network of landscape ecology: "Landscape ecology brings together an impressive variety of disciplines and outlooks. So far, we have failed to capitalise on this variety, and indeed often fail to see the value of different perspectives. Landscape ecology should be able to take the lead in integrating the many biological, geographical and sociological perspectives and the practical and theoretical approaches needed to tackle today's environmental problems" (Hobbs 1997).

However at the same time he presented the following model showing the present state of landscape ecology, including the relation between function, structure and change of the landscape and adding a list of what he considers important components.

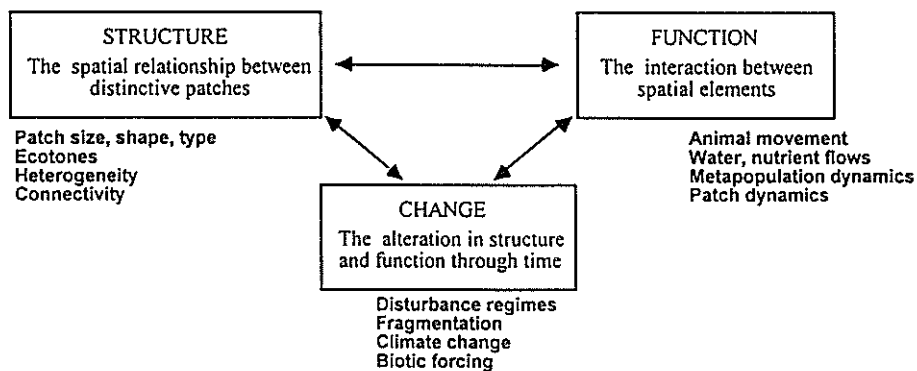


Fig. 2. "Landscape ecology can be considered as the study of landscape structure, function and change. Some of the important components of each of these are listed." (Hobbs, 1997)

I think he very nicely illustrates the problem of interdisciplinarity in landscape ecology: Here we get a good deal of biology, some geography - but not the economic and cultural part of it - , and no sociology or planning. What about all the human activities that not only represent threats to the landscapes - disturbances! - but also have to deliver the solutions to the problems? What about the main forces regulating these human activities, namely economy and power? What about the concepts of landscapes in human minds that are materialised in the ownership pattern and the artefacts of the existing real-cultural landscapes that partly give rise to serious landscape ecological problems, but also represent some of our highest valued landscapes which we want to save?

They are missing totally. And I am afraid that the promotion of such a picture of landscape ecology can explain why many scientists within social science and the humanities are sceptical of the invitation to join landscape ecology - especially when they are told that landscape ecology will form the basis for the planning and management of our future landscapes. It reminds me of a Danish philosopher (Tage Bild), who 25 years ago defined the term Ecologism as the combination of high competence within the natural sciences and illiteracy within social sciences, thus indicating that many ecological studies of the human environment are in practice very naive in their imagination of the possibilities of implementing natural science directly into planning and management.

This comment is of course not quite fair, since landscape ecologists have constantly invited all types of disciplines to join our transdisciplinary science, recognising the principle need for all types of disciplines and specialists to serve a common goal. But it might indicate that we have some problems in handling and guiding the process of transdisciplinarity that we have initiated.

### A common framework for Landscape Ecology

In the latest mission statement of IALE the broad character of Landscape Ecology has been emphasised:

*"The International Association for Landscape Ecology (IALE) aims to develop landscape ecology as the scientific basis for the analysis, planning and management of the landscapes of the world".*

*"Landscape ecology is the study of spatial variation in landscapes at a variety of scales. It includes the biophysical and societal causes and consequences of landscape heterogeneity. Above all, it is broadly interdisciplinary."*

*"The conceptual and theoretical core of landscape ecology has become distinct and recognised, effectively linking natural sciences with related human disciplines. Landscape ecology can be portrayed by several of its core themes:*

- 1) the spatial pattern or structure of landscapes, ranging from wilderness to cities,*
- 2) the relationship between pattern and process in landscapes,*
- 3) the relationship of human activity to landscape pattern, process and change,*
- 4) the effect of scale and disturbance on the landscape".*

(The IALE Mission Statement, 1998)

However, we have to admit that this is not a straightforward development. Despite the general intentions of interdisciplinarity and social relevance among the majority of landscape ecologists, our practices are tied to the more or less narrow disciplines from which we come. But this is not that bad; in fact, it is quite the opposite, since it makes it clear that we join landscape ecology as specialists offering our expertise for a common goal. The problem is that our different roles within landscape ecology are very unclearly defined; that we still have fundamental problems in communicating with each other, and understanding each other's role. We simply know too little about our different ways of thinking. We need a conceptual framework that makes our role and contributions more clear, wherever we come from. That is a framework, that e.g. also makes it clear, how social studies and the humanities are not only welcome just to widen the scope of landscape ecology, but are indispensable to secure the common goals. This is not the case today. In the minds of most of our non-landscape ecological colleagues within science and planning, landscape ecology is still associated primarily with different nature scientific traditions. And also among many geo- and bio-ecologists working within landscape ecology, nature scientific analysis of the relation between structure, function and change in the landscape remains the core, even if they support the inclusion of the study of humanistic and social problems related to the use of our landscapes. So, as already mentioned, Isi Zonneveld, who first president of IALE, that without doubt has been one of the landscape ecologists most actively advocating a broad interdisciplinary organisation of landscape ecology, keeps this core as "landscape ecology sensu strictu", thereby demonstrating his inclination to nature scientific interpretations of the landscape (Zonneveld 1995). Also between the different nature scientific traditions joining landscape ecology there are very different opinions of how to interpret basic concepts and theory concerning landscapes. So, landscape structure does not mean the same for a soil geographer, a dispersal ecologist and a landscape planner. They might not even be aware of the differences and their importance.

For this reason I think we need a framework for our common landscape ecological work that can not only give a perspective for our joint endeavour, but also can indicate the different ways of looking at and approaching the ecology of landscapes as well as the specific roles of the different disciplines joining the family of landscape ecology.

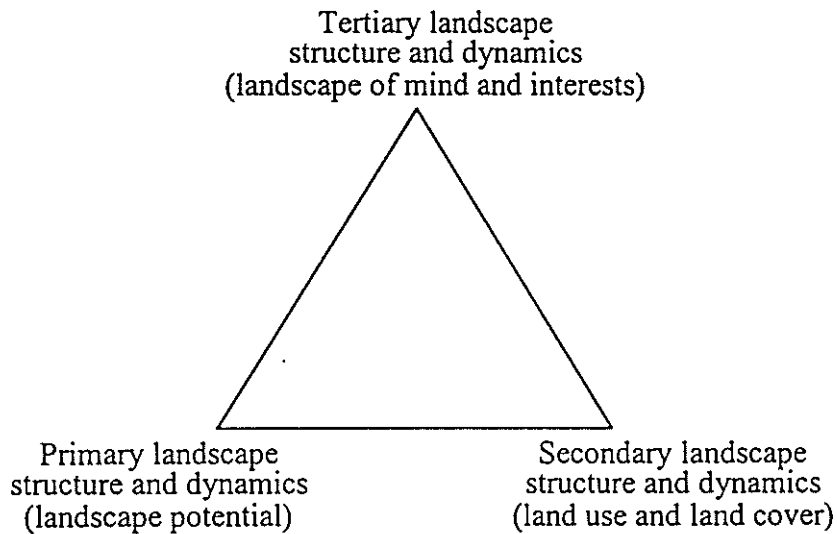
Let me show you a very first draft of such a framework:

If we can agree, that the overall practical role of landscape ecology in our modern society in general is to support a sustainable development by giving a scientific basis for a better adjustment of our land use to the natural structure and dynamics of our landscapes, to the preservation of biodiversity at the different landscape levels, and to more sustainable needs of a future social organisation in our landscapes, we can distinguish between three basic tasks that have to be dealt with:

1. The study of basic landscape structures that express the landscape potential to which society should purposefully adjust its land use to prevent landscape ecological problems
2. The study of actual (and historical) land use and land cover to elucidate present (and historical) landscape ecological connections, and related landscape ecological problems
3. The study of social landscapes and landscapes in the minds of groups and interests in society, to analyse how landscape ecological connections are perceived among individuals and groups, with the goal of contributing to solving landscape ecological conflicts in society, and to assisting the development of an ecological planning, management and use of our landscapes, as a part of a sustainable development.

These three types of studies are related to three very different types of landscape concepts. To stress these landscape conceptual differences we could name them in parallel as the study of:

- The primary landscape structure and dynamics, comprising the geo-ecology and the potentials of our landscapes,
- the secondary landscape structure and dynamics, consisting of land cover, land use and their dynamics, and
- the tertiary landscape structure and dynamics, dealing with the landscapes of our minds and interests so essential for land users and the decisions of landscape planning and management.



At first glance, you might recognise these study areas as a division of labour between three major disciplines that have already joined landscape ecology, namely 1) geography, 2) biology and 3) landscape architecture and planning. But this is not the point. They are not congruous with this division. What is essential here is, on the one hand, that these three types of landscape structure and dynamics are based on very different ways of looking at landscapes, and on the other hand, that these differences are complementary, supporting each other in the landscape ecological analysis for the planning and management of our landscapes. It is probably even this complementarity that constitutes the rationality of trying to merge together a transdisciplinary landscape ecology.

1. The study of the primary landscape structure and dynamics has mainly developed within physical geography (but also within applied sciences such as agriculture, forestry and engineering), putting emphasis on the integrated study of the structure and dynamics of the abiotic components in the landscape: the parent material, geomorphology, climate, soil and water (see e.g. Leser, 1982). A parallel school of landscape science developed within vegetation science, where the study of natural and semi-natural vegetation could add a biotic component to the geo-complex studied by the physical geographers (Tüxen, 1968). Due to human disturbances, the linkages between vegetation and the geo-ecological components are much less pronounced in intensively used landscapes, but the relation of the vegetation scientists to the geo-ecologists has been maintained also in such types of landscapes through the study and mapping of potential vegetation. As already mentioned, the distinction between the topological dimension, studying the vertical interrelation



between the geo-components at a given spot, and the chorological dimension, studying the horizontal relations between different types and patterns of topological units is a basic conceptual result of these geo-ecological and plant sociological schools, giving rise to a specific frame of reference concerning landscape interpretation, namely that landscapes are composed of different types of basic land units that can be considered homogeneous with respect to their more stable abiotic components, and can be grouped in a spatial hierarchy of characteristic heterogeneous compositions at different levels (Klijn, 1997).

2. The secondary landscape structure and dynamics deal with the actual or historical land cover and land use. Traditionally these studies have been split up into studies of the structure and dynamics of the main types of human land use, such as agriculture, forestry, urban areas and infrastructure, and the study of the structure and dynamics of different types of land cover with natural and semi-natural vegetation. Economic geographers in general, and more specifically agriculturalists, foresters, urban planners and engineers have dealt with the first part, whereas biologists and conservationists are concerned with the other part, which, in fact, constitutes a good deal of what is today considered the object of modern landscape ecology. This is very nicely demonstrated through the above model of Hobbs. Forman's definition of a landscape as "a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout" (Forman and Godron 1986) is based on an analysis of the actual land cover and land use, however with priority given to the study of natural and semi-natural types of ecosystems, embedded in a matrix of a dominating land use. The relation between biodiversity and the heterogeneity of land cover and land use is a central issue of these studies.

There has been an explosion of literature during recent years concerning biologically oriented studies of spatial ecology linked to island theory, metapopulation theory and the study of connectivity in fragmented landscapes (see Forman 1995, Farina 1998). However, we should not forget that the general landscape ecological purpose of these studies should be to find ways for more ecologically sound ways of land use, and that this links such studies to other traditions within landscape ecology:

First, the study of the matrix, especially the intensive forms of land use should be a part of landscape ecology, not only the remnant natural and semi-natural habitats for wildlife. As a consequence, agriculturalists, foresters and planners ought to engage more in landscape ecology than they do today. The basic problem is that such specialists within land use traditionally follow goals of one-sided intensification and homogenisation of land use, and that a rather unholy coalition between dominant land users and conservationists has often developed, leaving marginal areas to the conservationists in exchange for the security of an unlimited intensification of the use of the matrix. This segregation model of landscape planning is seldom a sustainable way of landscape management. Instead, the total landscape should be studied both from a land use point of view and a biotope or habitat point of view, focusing on new ways of land use that can combine an extensification of single types of land use with other land use functions in a multiple landscape adapted form (Cook and van Lier, 1994).

Secondly, a systematic comparison of the land use and land cover with the primary landscape structure and dynamics is necessary and can be achieved through the reconstruction of land use and biotope patterns in landscapes that have been subject to an intensive and one-sided land use. This can be done both in a systematic and quantitative

way, since there exists a spatial parallel between the landscape concepts related to the primary and secondary structures (Brandt, 1992, Meyer, 1997). Although Forman's landscape definition is primarily related to the actual land cover structure, the definition: "A heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout" is so broad, that it can actually be interpreted geo-ecologically as a definition of the chorological levels of the geo-ecological hierarchy also. Combining diversity studies of the primary and secondary landscape structures is central to the description of what Naveh has called ecodiversity.

3. The tertiary landscape structure and dynamics relate to the structure and change of landscapes in the minds of human individuals and groups and interests. Since these mental maps will often have a direct impact on the decisions made by land users and planners it is important to have a detailed knowledge of them and to find ways of communication between such landscape concepts and related ideals and the concepts and conclusions related to the primary and secondary landscape structures and their interrelation. In fact, to talk about the landscape structure and dynamics of the mind is today in many ways a misrepresentation since modern people, especially modern urban people, have only very vague ideas about landscapes and the linkage between social activity and landscape conditions and consequences. In the course of industrialisation we have become used to a spatial perception of our environment that ignores the heterogeneity of our landscapes and the structure and dynamics related to it. And this is precisely one of the biggest challenges for landscape ecology, and one of the reasons why we have to move more into interdisciplinary landscape studies in the future involving social scientific and humanistic entrances to landscape ecology. Often our mental maps are mere signs of communication without much linkage to the material reality. But they have a tremendous influence. Let me give you an example.

During the last 20 years we have made intensive studies of the development of what we call small biotopes in Danish agricultural landscapes (Agger and Brandt, 1988, Brandt et al. 1994): All the small landscape elements situated in and between the fields, such as small ponds and marl pits, archaeological barrows, hedgerows, ditches, game plantations etc. Especially during the 60s and 70s, these small biotopes disappeared at a tremendous rate from the Danish agricultural landscape. Since the beginning of the 80s, however, the situation has stabilised, and in general these landscape elements are not very threatened for the time being. We have of course been looking for first of all technological and economic reasons for this development. Apparently the reasons were easily found: they were related to the decline in the 1970s of the rapid industrialisation and structural rationalisation of modern Danish agriculture funded through the mortgaging of exploding land prices, resulting in increased field size within bigger agricultural units; to the subsequent stabilisation of the biotope pattern and its linkages to the agricultural overproduction and related extensivisation within the European Union; and later to a conservation legislation, protecting a growing part of these landscape elements. But this is only part of the truth. Probably the most important single factor behind this stabilisation is that Danish farmers have changed their minds concerning their landscapes as a part of a growing environmental awareness. We have interviewed them over the years. It is our impression that they regret much of the removal of small biotopes during the 1970s. They will not defend it economically, although of course they could save some time in their tractors and combines. The biotopes on their holdings were often established by their forefathers, they contribute to wildlife, game and landscape amenity, things that the farmers appreciated today more than ever. In the 1970s, however, the farmers' landscape

ideal was still dominated by abstract spatial economics, influenced by the imagination of the apparently efficient farms of the American Midwest of the USA: Good stewardship was at that time equivalent to big machines and big fields, and an active modern farmer in the 1970s adapted to this ideal by creating a correspondent homogenisation of the Danish agricultural landscape. From a spatially abstract point of view, it should have been economically advantageous; in practice, however, the landscape heterogeneity often lowered the benefit, when compared to the accompanying disadvantages of growing soil heterogeneity, erosion, and diminishing value for wildlife, game and landscape amenity. If field size really should have had substantial influence on the economy, it should have influenced the prices taken by the machine stations for taking care of the land. But this is not the case in Denmark. So here, thorough studies in the motives for land use changes are really needed. Parallel to this, economic accounts of the costs of establishment, maintenance, and removal of different types of landscape elements, and their influence on the economy of farmers (not only the agricultural part of it), would also certainly be an important basis for such studies.

## Conclusion

To elucidate the breadth of modern landscape ecology we have set up a triangle with notions on primary, secondary and tertiary landscape structure and dynamics. This is of course a sort of trick, serving as a rough simplification of some main perspectives for Landscape Ecology. The purpose has been:

- to indicate how the transdisciplinary character of landscape ecology gives rise to different types of focus that has to be acknowledged and co-ordinated
- to shed light on the different roles of the disciplines and sub-disciplines engaged in landscape ecology, and
- to emphasise the importance of different and changing landscape concepts among the different disciplines that have to be managed by co-operation within landscape ecology.

When the ecology of our landscapes - and of course especially of our cultural landscapes - has to be studied in an interdisciplinary context, natural science will not be the only contributing field and may not even play a leading part in this interdisciplinarity. Only through interdisciplinary studies is it possible to grasp the complexity and richness of our man-made landscapes in a way relevant for those wishing to plan and manage the landscapes of the future.

On the other hand, we also have to realise that the interdisciplinarity in landscape ecology is extremely difficult. This is due not only to different terminologies, but also to the fact that many disciplines that we have to consider important for landscape ecology in fact have only general relations to a landscape concept at all. This also means that they have difficulties in formulating their specific contribution to an interdisciplinary landscape ecological research group. And finally: There is an enormous gap between the dominating nature scientific concept of landscapes as concrete material systems of the environment and the concepts of landscape dominating humanities and social sciences as pure mental constructions of the mind, only to be understood and handled in a social and historical context. This is probably the biggest challenge we are facing.

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