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Landscape researchers and managers are often asked help solve environmental and societal problems and so must develop interdisciplinary and transdisciplinary skills. Interdisciplinary research creates new knowledge by integrating people from the humanities, social sciences, and natural sciences. Transdisciplinary research adds an extra level of integration by involving non-academic stakeholders. This book describes the opportunities and limitations of these approaches. It discusses the expectations of policy-makers, funding bodies, stakeholders and scientists, and explores problems, successes, the need for specialist training and the development of evaluation criteria.

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interdisciplinarity and transdisciplinarity in european landscape studies

Interdisciplinary and Transdisciplinary Landscape Studies: Potential and Limitations

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Eds.: Bärbel Tress, Gunther Tress,
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Interdisciplinary and Transdisciplinary
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Bärbel Tress, Gunther Tress, Arnold van der Valk, Gary Fry (Editors)

DELTA SERIES 2, Wageningen

Content

Preface

In recent years, landscape is growing in attention on the level of individual citizens as well as international bodies such as the European Union. Research, planning and management of future landscapes ask for interdisciplinarity and transdisciplinarity that together constitutes a new Landscape Science.

All over the world, researchers that used to identify themselves as landscape ecologists, cultural historians, physical geographers etc. are discovering the strength of landscape as a common denominator for their activities. Also in Wageningen, the Netherlands, a broad expertise on landscapes is assembled, however, split up on several disciplines and institutes. At Alterra Green World Research and Wageningen University a strategic research program, the DELTA program, was initiated to foster interdisciplinarity and transdisciplinarity in landscape-related subjects.

In the framework of the DELTA program, an international seminar on "Potential and limitations of interdisciplinary and transdisciplinary landscape studies" was held on November 11-12, 2002 at Alterra Green World Research in Wageningen. The seminar was one of the activities of the DELTA program and the INTELS project, investigating Interdisciplinarity and Transdisciplinarity in European Landscape Studies, to improve development of theory, method and best practices of integrated research.

Thirty-five researchers from eleven countries participated and this booklet with its twenty-six contributions derived from the seminar gives evidence for the interesting themes and lively discussions that characterised the two-days meeting in Wageningen. I hope it will contribute to the development of Landscape Science.

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Interdisciplinarity and transdisciplinarity in landscape studies – the Wageningen DELTA approach

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Interdisciplinarity and transdisciplinarity are increasing in importance for landscape research and management. National research councils, the European Commission, as well as other research funds and policy action plans, are setting up programs that give priority to inter- and transdisciplinary approaches (BMWV, 1999; Brewer, 1999; BMBF, 2000; European Commission, 2000, 2002; RMNO, 2001; Norges Forskningsråd, 2002). Interdisciplinary and transdisciplinary research is expected to create new knowledge by synthesizing knowledge production in different disciplines. Additionally, interdisciplinary and transdisciplinary research face clear societal demands and are expected to contribute to problem solving.

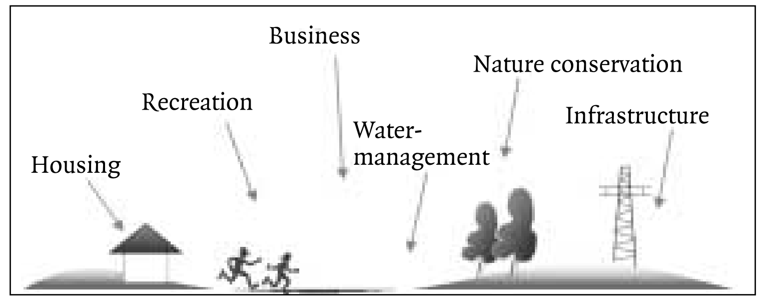
In Wageningen, the Netherlands, interdisciplinary and transdisciplinary efforts in landscape research and management are summarized as the DELTA approach. The approach bridges the humanities (known in the Netherlands as the "alpha-sciences"), natural sciences ("beta-sciences"), and social sciences ("gamma-sciences"). The idea of developing system innovations by crossing disciplinary borders, cooperating with stakeholders—where appropriate—and capitalising on the expertise of alpha, beta, and gamma sciences defines the DELTA approach and inspired the program's name.

The DELTA program is a strategic research program of Alterra Green World Research and Wageningen University for interdisciplinary and transdisciplinary studies in landscape-related fields. More information on the program is available at www.wur.nl/delta.

Why a DELTA approach in landscape studies?

Today's landscapes are—as part of the urbanisation process of the countryside—increasingly being used for several functions and interests such as housing, recreation, business and production, water management, nature conservation, agriculture, and infrastructure (Antrop, 2000; Valk, 2002a; Tress & Tress, 2003). Areas are under increasing pressure because more and more demands are being placed on them (figure 1). All these interests compete with each other for influence on, and space in, the countryside. However, as areas cannot be continuously enlarged, more and more functions must be integrated simultaneously in a given landscape. This development challenges future landscape research, planning and management and calls for system innovations.

Figure 1: Different interests in and functions of landscapes



Why are single disciplines unable to solve the challenges caused by different interests in the landscape and its different functions? A traditional approach offers different solutions for different sectors that are elaborated on by different disciplines. The DELTA approach advocates an integrated solution that combines the scientific excellence of several disciplines and capitalises on non-academic knowledge of stakeholders to solve landscape problems.

Definitions of interdisciplinarity and transdisciplinarity

The terms "interdisciplinary" and "transdisciplinary" are constantly used in scientific work, project descriptions, and research applications within academia (Tress & Tress, 2002). However, explanations and definitions are only offered in a few studies. The same lack of clear terminology persists within the academic community in Wageningen. But why is it necessary to come to a common understanding of these terms? A good reason is the need for exchange on experiences and knowledge on interdisciplinarity and transdisciplinarity, across knowledge communities, institutes, disciplines, and countries. If there is general uncertainty about the meanings of terms, confusion will result (Klein, 1990) and common discussion is impossible. Providing a definition is central to communication on interdisciplinary and transdisciplinary research. A common definition can of course be adapted to changing perceptions over time.

By *interdisciplinarity*, we mean projects that involve several unrelated academic disciplines in a way that forces them to cross subject boundaries to solve a common research goal. By *transdisciplinarity*, we mean projects that integrate both academic researchers from different unrelated disciplines and user-group participants to reach a common goal.

Landscapes – a boundary-crossing subject

The nature of landscapes is such as to require interdisciplinary communication and cooperation on research and management issues.

Several different disciplines focus research efforts on landscapes. They are successful in presenting new findings about landscapes within their specialisation, but collaboration – and thus transfer of knowledge across disciplinary boundaries – is seldom realised because a common approach that bridges the gaps between disciplines is missing. Different landscape concepts exist side by side. As landscape-related issues often touch on environmental, social, cultural, aesthetic and economic issues simultaneously, researchers must agree on their terms and work together to tackle complex challenges presented by landscapes (Nassauer, 1995; Naveh, 1995; Muir, 1999; Tress & Tress, 2001).

Landscapes have evolved as a result of complex interactions with and between people. The DELTA approach relies on a holistic landscape concept that includes landscapes' multiple dimensions within a system. All landscapes are shaped by nature and culture; research, planning and management of landscapes, therefore, demand an interdisciplinary effort that spans these two realms.

The DELTA program in Wageningen

Established in 1999, the DELTA program contributes to problem-solving in the field of planning/management of landscape, open space, metropolitan, urban and rural areas. It seeks to link people and knowledge by initiating, developing and promoting interdisciplinary and transdisciplinary landscape research, planning and management. The program develops theory and methods, conducts demonstration projects and offers training sessions on these topics. It is anticipated that the DELTA program will continue through 2005 (Valk, 2002b).

Interdisciplinary and transdisciplinary research connects directly to contemporary social issues and thus shifts the orientation of academic research. The DELTA program supplies information on best practices to researchers who can then apply this knowledge to concrete problem-solving on the regional level. This is not to suggest that the DELTA program relies solely on case studies, applied research and parallel studies of multidisciplinary teams acting without coordination among their disciplines. Rather, the program's ambition is to support strategic research that bridges the field of fundamental research and applied research.

The DELTA program draws on several fields of expertise: spatial development, landscape planning, landscape management, cultural history, sociology, perception studies, design studies, recreational and agriculture research, research on metropolitan areas and urbanisation processes, urban-rural relationships, land use studies, water management, ecology, stakeholder participation, and policy support.

The DELTA program bridges different research communities in the Netherlands as well. It constitutes the scientific and methodological structure for a recently established unit within academic research in Wageningen: the Landscape Centre. The Centre is a joint effort between researchers and activities based at Alterra Green World Research, a research centre for green open space, and those based at the Department of Environmental Sciences at Wageningen University. The cooperation of these two research communities enables an exchange of knowledge and experiences across institutional borders for the benefits of clients, researchers and students. Members of both institutes coordinate the program.

The DELTA program is conducted in four phases. In the first phase, experiences and examples of best practice are collected. In the second phase, elements for setting up a theoretical foundation for inter- and transdisciplinary landscape research and planning are identified. In phase three, best practices are reviewed and analysed. The last phase aims at developing a theory and presenting guidelines that make it possible to translate theory into practice.

Currently, the DELTA program focuses on two main activities:

I. Developing strategic knowledge in the field of interdisciplinary and transdisciplinary landscape research and planning (STRATIS)
II. Stimulating and facilitating knowledge exchange and dissemination in the field of interdisciplinarity and transdisciplinarity (SITEX).

Relevant activities within STRATIS are, for instance, investigations of the challenges presented by integration of interdisciplinary research and ways to improve interdisciplinary and transdisciplinary landscape studies in Europe. STRATIS develops tools and strategies for support of decision-making processes in planning and management. SITEX is responsible for national and international communication activities, such as dissemination of research results in publications, seminars, project support and training activities in-house and outside.

The DELTA seminar 2002 and its outcomes

In November 2002, the DELTA program together with the INTELS project (www.intels.cc), a project within the DELTA program, organised an international seminar on the expectations and practice of interdisciplinarity and transdisciplinarity in Europe. Representatives from research, education, policy and funding bodies were invited to discuss the potential growth and limitations of interdisciplinarity and transdisciplinarity in landscape studies. Thirty-five delegates from eleven countries participated in two-days of meetings in Wageningen and discussed expectations, obstacles, and achievements of integrated research.

Five themes were identified as central to the discussion of interdisciplinary and transdisciplinary landscape studies

I. Expectations of policy-makers, funding bodies and end-users
II. Expectations of scientists
III. Successes and problems encountered
IV. Training needs of professionals in research and policy
V. Evaluation criteria

For each theme, one plenary lecture was delivered to give an overview on recent developments. Additionally, three delegates presented short statements on the same topic highlighting specific experiences or adding general remarks.

The book at hand presents the outcomes of the seminar and includes revised plenary lectures and the delegates' statements. Organized along these five themes the book includes a short introduction to each topic and raises issues from discussions in the sessions. We would like to thank all seminar delegates for their contributions to the seminar and this book.

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I

Expectations of policy-makers, funding bodies and end-users towards interdisciplinary and transdisciplinary research

On policy expectations

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"Do policy-makers, funding bodies, and end-users have expectations towards interdisciplinary and transdisciplinary landscape studies at all?" This was one of the questions raised in the discussion on policy expectations. "Do those bodies, which fund research, have an interest in landscape researchers working interdisciplinary or transdisciplinary?" Yes, they do. Currently, an increasing number of landscape studies are set up facing the challenge of interdisciplinary or transdisciplinary approaches. The main motivation for these studies comes not from research but from policy-makers, funding bodies and end-users. Connected with this motivation are high *expectations* towards interdisciplinarity and transdisciplinarity. However, these expectations are seldom analysed when discussing problems and limitations of the approaches.

Funding bodies can look back on more than one decade of experiences with interdisciplinary and transdisciplinary research. The contributions from Wächter and Uhrwing report examples from Germany and Sweden. In both cases, policy motivated the setting up of environmental research programs with preferences for integrative research across disciplines. The need for research of such a kind comes from societal demands. Funding bodies then face the challenge of transferring those requests into scientific research questions. Expectations are high and go towards policy advice, problem-solving and increasing scientific knowledge.

These expectations impose new tasks on researchers. Mansfeld discusses one of those tasks, the scientist as a facilitator of knowledge transfer to society. Society and their needs may call for a mediator of different interests related to planning and management of landscapes. Whether researchers are asked questions they hardly can answer is not considered in policy expectations.

The "Social-Ecological Research"-Program

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The "Social-Ecological Research"-Program was installed by the German Federal Ministry of Education and Research in 1999, immediately after the new German Government, consisting of the Social Democrats and the Green Party, was elected. This does not mean that the preceding government, formed by the Conservatives, had a negative attitude towards interdisciplinary and transdisciplinary research. These types of research were already established, especially in the field of environmental research. The new government, however, showed a particular open mind towards the work of a number of independent research institutes, which were founded in Germany at the beginning of the 1980s. These institutes – known as the "Green Institutes" – practised a kind of environmental research, which was characterised by a close co-operation with partners from the outside of science. They aimed for a better understanding of societal needs and thus the creation of solutions that would really come up to these needs. The "Green Institutes" criticised the practice of environmental research because of its concentration on technical solutions and because of the domination of the natural and technical sciences. Since the middle of the 90s this criticism was supported by the reports of the Scientific Advisory Board and the Scientific Board on Global Environmental Chance. Both institutions claimed a stronger integration of social and human sciences into environmental research.

To meet these demands the Federal Ministry for Education and Research gave an order to the "Institute for Social-Ecological Research" (ISOE) in Frankfurt to work out a draft for a new research program, which should also consider the experiences of the "Green Institutes". At the end of 1999 ISOE submitted a framework program for social-ecological research (Bundesministerium für Bildung und Forschung, 2000; Jahn et al., 2000). Subsequently the Ministry adopted a new approach to establishing the program. The framework program was discussed by representatives from various parts of the German scientific community and then reformulated. As a second step, the Ministry funded 27 studies in order to specify the research contents on the basis of the framework program (Balzer & Wächter, 2002).

The research topics that resulted in this process cover a broad field, going beyond landscape studies. They include investigations on the transformations of the energy and water sector, food production and agriculture, key technologies as well as regional and landscape studies[1]. Besides investigating these topics it is one of the major goals of the program to push forward interdisciplinary and transdisciplinary research in general by consolidating its theoretical and methodological basis.

What can we learn from interdisciplinary environmental research since the 1970s?

The demand for interdisciplinary and transdisciplinary research came about due to multi-level problems, which were connected with rapidly social and technical advances. It is well known that this situation became apparent after World War II, when the shady side of technical progress manifested itself in so-called "environmental disasters". Policy makers reacted to this situation by establishing programs for environmental research. From the outset, a crucial point of these programs was the desire for a better understanding of interactions between human and nature. The established science and research system was criticised for neglecting the secondary effects of its results. One could say that politicians and scientists hoped for a better kind of science; one that would be holistic in the sense that all these effects were considered. It was taken for granted that this new type of science would have an interdisciplinary character. Today we can look back on about 30 years of interdisciplinary and transdisciplinary research that were accompanied by some disillusions. It has turned out that on the one hand disciplinary results are often not integrated but remain isolated from each other, on the other hand it can often be observed that one discipline dominates and the others act merely as assisting sciences.

To characterise the first type – we also talk of multidisciplinarity – requires the following procedure: Different disciplines work on a certain theme without producing a common definition of the problem that needs to be solved. As a result, scientists submit different problem analyses and solution strategies, which are not connected. It is generally expected that the person co-ordinating the whole project will make the integration of results. This however is impossible because a common goal cannot be found after the answers have already been given (Kötter, 1997). I would like to refer here to my own experiences in the field of urban ecology. At the "Centre for Environmental Research" in Leipzig we worked on the topic "Sustainable development of cities and towns". The topic was investigated by medical scientists (epidemiological affects of air pollution), sociologists (segregation of urban populations), geographers (land use) and ecologists (urban green). After a couple of years, we had many results but they did not focus on a common problem. We noted that the point where we went wrong was that we did not take enough time at the beginning of the project to work on a clear strategy (Daschkeit et al., 2001; Wächter, 2001).

Regarding the second type of interdisciplinarity I would like to highlight the role of ecology within environmental research. Since the early 70s great hopes were pinned on ecology to be the above-mentioned "better holistic science". Ecologists should be able to tell us how ecosystems work. Based on this ecological knowledge scientists from different disciplines should then work out social strategies to change the behaviour of man in a way that would be adapted to the functioning of ecosystems. A prominent example for this scientific approach is the UNESCO-program "Man and the Biosphere" (MAB). This program focussed on the concept of ecosystem ecology, hoping that with the help of this concept it would be possible to completely understand the way ecosystems function. However scientists had to admit that then and even now they have not been successful in completely understanding the way ecosystems work. The complexity, even of natural ecosystems, is too high. Still more complicated is the ability to describe anthropogenic ecosystems (e.g. cities), because in this case social data have to be integrated into the system as well (Whyte, 1985). The case of MAB-studies showed that only quantitative social data were integrated and thus the social sciences were subjected to the methodology of the natural sciences (Wehling, 1995).

What we draw from these experiences is – provided that the goal is interdisciplinarity practised by equal disciplines – that disciplines have to be self-reflective and possibly adaptable. Coming back to the example of ecology the question has to be posed, whether this discipline is really able to provide proven knowledge about the status of nature. Although there is an ongoing discussion on the theory of ecology since the 80s, the interest amongst ecologists is still rather low. One question that is discussed amongst the theorists is if ecosystems are facts or constructions (Jax, 2002). If they were considered to be mere constructions it would not be possible to claim ecological perceptions based on the concept of ecosystem ecology to be objective. To the contrary many ecologists – and natural scientists in general – believe now as before that they can deliver objective insights into the essence of nature.

Consequences: What do policy makers expect from social-ecological research?

Interdisciplinary and transdisciplinary research is a reaction on societal problems and needs. In general, policy makers have the expectation that the results of interdisciplinary and transdisciplinary research should be useful for policy. As to the "Social-Ecological Research" program, policy makers put hope into the results to become politically relevant by delivering a contribution to the German sustainability strategy (Bundesregierung, 2002). In addition, policy makers are aware that science itself has to change in order to produce this kind of useful results. Thus social-ecological research is also expected to have an impact on the scientific system.

Some crucial expectations towards social-ecological research are:

I. Integrative instead of additive interdisciplinarity: Interdisciplinary research should not be restricted to the presence of different disciplines. Scientists should at least submit a concept that describes how they will integrate disciplinary investigations.

II. Contributions to the theoretical and methodological consolidation of social-ecological research: Scientist ought to include theoretical matters in their research program. For this additional means are at disposal that can be used for example to carry out workshops.

III. The production of results that correspond with social needs: Projects ought to focus on problems, which are of social relevance and they should deliver results that can be applied into different fields of practice. Co-operation with potential end-users is demanded. That sounds simple, but in practice it is not since there is a gap between the scientific system and the world outside. Normally scientists find the problems they want to solve within the sphere of science and at a later stage hand over their perceptions and innovative products to society. It does not look very clever to ask society what kinds of problems need to be solved. Moreover the integration of so-called amateur-knowledge into scientific work is not easy to do. These points might explain, why we can find many best practice examples without a theoretical foundation and many scientific perceptions that are not compatible with societal needs.

IV. The above-mentioned "Green Institutes" gathered much experience in co-operation with partners from the outside of science. In order to prepare this knowledge for a broader use, these institutes are supplied with special means. For this reason the "Social-Ecological-Research"-Program comprises a segment called "Infrastructure Development". We feel that the scientific community does not hold this kind of transdisciplinary research, practised by these institutes, in high esteem. Because it is related to the normative concept of sustainability it is presumed to be normative itself. Scientists, however, claim to be objective in a way that they do not evaluate any situation to be good or bad. We consider sustainability research to be problematic at this point, because in fact scientists are often asked by society to decide what should be done and what would be good for humans and nature.

V. For the proposals of our research program scientists are expected to do theoretical work as well as applied research: This in general is difficult and the German academic system also hampers the process. The disciplinary structure of universities makes it difficult to work in an interdisciplinary way. Especially, junior scientists are often dependent on a certain mental school of thought and do not have the freedom to put a critical distance between themselves and their discipline. In order to deal with this situation it was decided to support interdisciplinary groups of junior scientists, who want to qualify themselves in interdisciplinary and transdisciplinary approaches. The groups will be financed for a period of five years. During this time, each member has to go ahead one step in the academic career, whilst the group has to practice interdisciplinarity and transdisciplinarity within the frame of a common research-project.

First experiences with the "Social-Ecological Research"- Program

Projects within the different parts of the program (Infrastructure Development, Qualification of Junior Scientists, "normal" research projects) have just started; therefore, it is not yet possible to strike the balance. First experiences are mainly based on the phase of program announcements and the evaluation of applications. Difficulties in meeting the program demands are obvious with regard to the following points:

I. So far, it seems to be very difficult to bridge from the foundation of an interdisciplinary team to real interdisciplinary work. Many of the applications submitted stress that natural, human and social sciences will work together, but normally it is not explained how integration will be done.

II. Binding evaluation criteria for inter- and transdisciplinary research are lacking. We try to solve this problem by committing a higher number of experts for evaluation as usual. The commissions consist of experts representing different disciplines and experts coming from the fields of practice that are concerned. Normally also an expert in science theory takes part. And of course we take care that all experts have experiences in interdisciplinary and transdisciplinary research themselves. Due to this proceeding the evaluation level is very high. An unanimous vote is only exceptionally reached. Decision-making normally is a very hard and exhausting procedure – for the experts as well as for the applicants.

In the field of landscape studies some special experiences can be mentioned. One can say that landscape studies are the "classical topic" of interdisciplinary environmental research. Already in the 1970s the factor "land use" has been regarded to provide a suitable access for studying interactions between man and nature. Therefore it was an open question, whether it would make sense to initiate social-ecological research in this field. 15 experts discussed this question by the end of October 2001. Their opinion was, that research up to now has not been satisfactory with regard to interdisciplinarity and transdisciplinarity. The experts therefore recommended to initiate research in this field again. However, scientists should be asked to concentrate on synthesis work in a way that their research concepts should base on an analysis of research that has already been done in the fields in question. A call for proposal was opened in February 2002 (Bundesministerium für Bildung und Forschung, 2002) and 45 drafts were received on the call. Unfortunately, we had to state that only a small number of applicants met our demands. The desire for synthesis of existing knowledge often was ignored or misunderstood. In most of the applications synthesis was interpreted as an analysis of investigations made in a certain region or space. This result underlines the presumption that self-reflective work is either not attractive or scientists are not trained to do it.

In addition, we are aware that the demands of social-ecological research are difficult to be mediated and maybe the demands are simply too high. Perhaps we will have to realise that within the projects either theoretical or applied work can be done – but not both at the same time. Due to this we regard each project, to a certain degree, to be an experiment. Scientists as well as experts and program co-ordinators are learning by doing.

1) More information available at: www.gsf.de/ptukf/sozialoeko_forschung.html or www.sozial-oekologische-forschung.org

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MISTRA and interdisciplinarity – experiences and expectations

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MISTRA, The Swedish Foundation for Strategic Environmental Research, funds research of strategic importance for a good living environment. Landscape studies are an important part of this strategic research. According to MISTRA's statutes, we shall finance large concerted research efforts that span the boundaries between disciplines. Since the start of MISTRA in 1994, it has financed several large interdisciplinary research programmes, and has now collected some experiences of interdisciplinary research programmes. And from this, we also have some expectations for the future.

A high-risk enterprise

Environmental problems are urgent, but our capacity to respond is far from matching the forces of environmental change. While a great deal of high-quality science does illuminate environmental problems, it is often incomplete, and it often lacks the interdisciplinary integration and synthesis needed to permit the problems to be seen in a larger context.

Science has evolved through specialization, but also through recombination and unification. The advancement of knowledge is driven by a tension between disciplinary specialization and an endeavour to recombine and make connections. Specialization enhances efficiency, and there are strong personal incentives for researchers to specialize; only by concentrating on a narrow field an individual can get to know enough to make a significant new contribution.

However, many real-life problems are not structured along disciplinary lines, and this provides a driving force for interdisciplinarity. What is more, contact between disciplines can give rise to innovation, and many breakthroughs have indeed been the result of cross-fertilization between different sciences or scientific traditions. Interdisciplinary work offers the possibilities of transcending disciplinary barriers and creating new and better structures. Certainly it is a high-risk enterprise, but where it succeeds, the benefits can be considerable.

Shared versus different conceptual frameworks

An interdisciplinary research team has to work out a shared conceptual and analytical framework to guide its efforts. What is more, interdisciplinary and problem-oriented inquiry has to consider and answer entirely new questions. Such questions provide the context for the analysis, suggest procedures for carrying it out, and highlight what is still missing – thus stimulating the imagination to create unexpected alternatives for consideration. It is necessary to ask which goals are sought and by whom, which trends affect the realization of those goals, what the future course of events is likely to be if there is no intervention, and what can be done to change that course of events in a desirable direction.

A number of potential problems need to be faced: existing conceptual and analytical frameworks may differ significantly between disciplines, the same concept may be interpreted very differently, and sometimes there may be a complete lack of suitable conceptual tools. Between ecological and political science, for example, there are subtle but important differences in basic views of the meaning of terms like "ecosystem management". If glossed over, such differences may create confusion and conflict, but if looked at and analysed carefully, they provide ample scope for mutual learning.

Recipes for success

What lessons can then be learnt from examples of interdisciplinary research? What concrete suggestions can be made in the areas of methods, organization and management?

Problem-solving

The problems to be solved should be focused, but they must be defined with great care. Different interested parties may conceptualise them in different ways. Rigid definitions may block subsequent thinking. Various tools – including systems analysis – can be used to develop the analysis, and it is important to teach practical problem-solving skills and to provide a "toolbox" for young researchers.

Programme identity and teamwork

It is essential to create a programme identity, to ensure that people share objectives and identify with the group to which they belong. Clear formulation and communication of the goals is another "must". Complex issues require teamwork, and, by pooling information and covering each other's blind spots, a creative group can outstrip individuals in many ways. In a group, ideas, hypotheses and insights can be multiplied and critical assessment is facilitated.

Mutual respect, openness and active communication can foster a creative atmosphere. However, the pressure of outside events may also add creative elements. Frustration sometimes triggers ideas as to how to solve a problem. Ideally, each specialist should be at the cutting edge of his or her speciality, and at the same time understand the broader context. Such researchers get things done and keep communication alive.

Leadership

A good programme leader is respected among scientists, has visions and is able to motivate his or her associates. The good leader has an ability to build bridges between cultures, is ethically responsible and able to create a good working climate. It is easy to sketch an ideal "manager-type" leader, but identifying what makes a research unit effective is a delicate business. Different kinds of leadership may be appropriate for different tasks, but the key word is empathy.

Quality and critical mass

To reach quality it is necessary to concentrate on a few projects with high pace and competitiveness and secure critical masses in personnel and infrastructural resources. To succeed it is important not to fight the host organization – join it instead. Make sure that the programme "melts" into the existing university or institute structure. Do also try to create win-win partnerships over disciplinary borders and with actors outside academia.

Training

Interdisciplinary perspectives, problem orientation and a feeling for the context should be introduced to the students as early as possible. This does not require large amounts of time, if it is done the right way. Students will benefit from a broader outlook and a better understanding of the world outside academia. They will be better equipped to step out into society if they have developed a greater ability to plan and run projects. However, it is also vital that students acquire a good knowledge of stringent scientific methods. They must have core competence and know how to apply scientific approaches to problem solving. Students need to be firmly established in their areas of expertise, while also understanding the context.

Quality control

Criteria of scientific quality have been developed within individual disciplines. How, then, do we evaluate the quality of interdisciplinary research? It is not enough to assess the scientific quality of the individual parts of the programme; there also has to be some means of judging cooperation and cross-fertilization. Quality indicators for interdisciplinary research need to be agreed on.

There is a risk of conflict between front-line research at the project level and the effort needed to get a joint programme going and function as a whole. Science is very competitive, and individual researchers are under constant pressure to get things published. The pay-off from joint efforts is potentially high, but it is much slower coming through than in the case of individual projects.

Exchanging experiences for future interdisciplinary research

There is a global trend towards integrating knowledge for practical purposes. Possible ways of accelerating this trend include a greater emphasis on synthesis work; clarification and replication of best practices; and an endeavour to bring interdisciplinarity out of the mist and teach practical skills for problem solving. All of this must be done with due respect for context. The strategy used to solve an environmental problem must fit into the relevant political and social structures. Obviously, not all practices are replicable.

The need for knowledge brokers

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In this paper the hypothesis is put forward that transdisciplinary knowledge in spatial planning can only be achieved if there is a "knowledge broker" between the constituent research disciplines and the complex reality of land use (figure 1). A 'knowledge broker' is defined as a person that tries to facilitate the flow of different forms of knowledge and know-how contained in interacting parties, to optimise the process of problem solving.

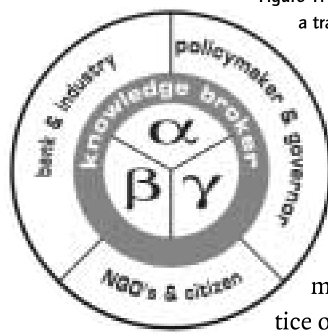

Figure 1: Positioning of knowledge brokership within a transdisciplinary process.

Spatial planning in a changing world

Within the current practice of planning in the urban-rural landscape, there is a need to build bridges between knowledge and action because of the demands of public interest (Friedmann, 1987). The practice of government is changing to governance. It is a shift from hierarchical forms of steering to more interactive forms of policy making and management. This comes forth out of the change in proportions between public parties, market parties, societal organisations and citizens. Society has changed from prosperity and welfare, in the mid 20th century, to a market dominated society and information society, in the last decades of 20th century. Currently, development goes towards a society with man as social individual (During, 2002). In spatial planning, the interaction between civil society, market and government becomes now a kind of negotiation planning such as the formation of public private corporations or communities of practice (Wenger, 1998). Parallel to this development, the role of (scientific) knowledge changes. Among actors, different types of knowledge flow, from scientific disciplinary knowledge to tacit, explicit and implicit knowledge or local knowledge (Nonaka & Takeuchi, 1997; NRLO, 1999). Planning, seen as bridge between knowledge and action, becomes a sort of social learning that develops via confrontation and interactive empowerment of different sorts of knowledge (Hidding et al., 2003).

Within hierarchical structures, the demand from decision makers for knowledge and innovations was mostly monodirectional, unique, and steady. Current spatial planning processes asks for development of network-knowledge in which demand and answer are more intertwined; knowledge building is seen as a learning process, a style of living, with options to choose from (During, 2002). The development of this network-knowledge needs a different type of handling and steering than the conventional way of knowledge building. It asks for different types of competencies of the facilitator responsible for the knowledge development.

Expectations towards integrative landscape planning

In landscape studies, landscape is considered to be the result of integrated land use, as a unifying unit, in which need for integrated planning to support decision-making is known since long. Good examples can be found in integrated river management (Silva, 1996). Within this unifying concept abiotic, biotic and human interactions and processes intermingle. However, in daily planning practice, sectoral planning of agriculture, environmental solutions, industrial areas, city growth, nature, recreation, water or infrastructure still prevails.

Quality of life in urbanised landscapes is under strong pressure, especially, in metropolitan areas, where urban and rural landscape is in intense contact. The demand for sustainable land use is pressing. New solutions in landscape planning are required to achieve better living quality. But this is a complex business! Sectoral approaches do not work any longer. For instance a waterboard cannot make decisions on land use without cooperation and knowledge of farmers, conservationist or even city planners. Those responsible for the welfare and quality of landscape in total or of parts of it are searching for the same kind of integrated solutions: from the point of view of landscape users, managers or landscape guardians there is the stringent need for knowledge on integrated approaches to solve the complex problems in landscapes.

The problem owners have a series of expectations and demands

Policy makers and governors expect integrated decision making on complex problems. They want to know how to deal with global issues on regional scale and ask for a regional approach, reaching across their own borderlines or jurisdictions. They ask for new ways to listen to people's wishes and to organise the process. They want integrated planning and ask advice on facilitation and on the building of process architecture for their complex processes. In fact, politicians and governors have dropped the hot load of their complex problems of management and steering in a changing society on the lap of investigators, scientists and planners.

Funding bodies, banks, industry as well as public parties explicitly ask for realistic views, concrete results and realistic projects. They want new solutions, innovations, and they want to know where to build, what to invest and how to combine realistically and opportunistically. They appreciate a good image and want to be involved in the working process.

User groups such as industries, NGOs and citizens expect planning and decision making to be bottom up instead of top down. It should be an offensive process instead of a defensive one. They ask for involvement and therefore need facilitation to acquire and spread knowledge. They want to influence planning processes and if they are involved, they want to stay involved all way, not only in idea building and support, but also in direction of the use of money and instruments.

Thus a common goal for the different type of problem owners in landscape planning processes can be defined and used as a shared working philosophy.

This shared philosophy of policy-makers, governors, banks, industry, private parties, NGOs, and citizens is the conviction that economic growth and making profit can only be realised in a sustainable manner, if it is in balance with people's wishes (expectations, dreams and emotions) and a good quality of life (essentially healthy environment).

The kind of knowledge needed to solve this commonly perceived goal

New forms of landscape planning ask for an integrated, interdisciplinary approach because the wishes and aims of all actors involved are multidimensional, dealing with social, economic, cultural and environmental issues. It requires a new form of knowledge and knowledge development to find better solutions. One option is to apply a transdisciplinary approach combining natural sciences, humanities and social sciences with knowledge from the non-academic world such as public and private bodies and stakeholders (Tress & Tress, 2001; Woestenburg & Valk, 2002) .

As During (2002) formulates it, knowledge as a learning process has requirements such as open mindedness, transparency and good communication. Therefore, landscape planning asks, besides for fundamental sectoral knowledge, for knowledge "in-between", to connect disciplines and different types of knowledge. It demands for know-how and expertise to arrange the process, skill and nimbleness to bring stakeholders together, capability to built the process architecture, craftsmanship and agility to facilitate the interaction, and experience and competence to compile it to something more than the sum of its parts.

An example of such an integrated, interactive planning process in which a transdisciplinary approach was followed, is the regional dialogue carried out in the Netherlands in 2001 with 350 actors involved (van Mansfeld, 2002). Its purpose was to combine forces, to integrate regional developments, to establish connectivity between the urban and rural areas, to work across (physical) borders, to create widespread support, to search for innovations, and to develop new planning methods, but also to realise concrete innovative projects that contribute to a better future for the region and higher quality of life. Knowledge brokership was practiced in this case.

Its assets, determined by the realised knowledge input were:

I. Transdisciplinary-interactive approach, region oriented, with use of the "design approach" and dealing with an inventory of opinions (Nonaka & Takeuchi, 1997; Wintjes, 2000).
II. Directed towards sustainable innovation: new creative solutions for complex problems.
III. Building a bridge between fundamental and applied research.
IV. Implicit knowledge must be made explicit (iterative process).
V. Strategy for creation, mixing, spreading and use of different kinds of knowledge.
VI. Opinion and solutions were formed with active commitment of crucial parties and with a broad and general support.
VII. The developed ideas are to be realized in co-operation between actors involved between etween
VIII. Co-operation is obtained and defensive reactions are minimised.

The knowledge broker: facilitator in transdisciplinary landscape planning

One of the things learnt in the above-mentioned case was the need for professionals that have to steer the multidimensional interaction of people, knowledge and facts. Considering the expectations of the policymakers, funding agencies and banks, NGOs, and citizens involved in landscape planning and their common goal as formulated above as working philosophy, this asks for persons with many abilities. To manage transdisciplinary processes and to stimulate the learning process in it, special competences are needed (see table 1). Within the many possible forms of knowledge, a knowledge broker has to facilitate the flow between the different forms of knowledge and know-how contained in the many actors, to optimise the use of all these forms of knowledge in the process of problem solving in transdisciplinary landscape planning.

Thus within transdisciplinary studies, the knowledge brokership can be recognised as an essential part, functioning on the edge between the disciplines, between the constituent research, and the complex reality of land use.

Table 1: A summary of required qualities of a knowledge broker

- Inspired communicator to bridge the gap between governors, policymakers and citizens
- Caretaker for dynamical quality management in a region
- Instigator of magical moments in the planning process (Kersten & Kranendonk, 2002)
- Facilitator of the working method "design approach"
- A reformulater of the basic issues, to keep the working process transparent
- Intermediary between public and private sectors and scientific investigators
- A builder of process architecture, to plan the process and the interactions
- Administrator,
- A planner
- Manager of conflicts
- Creator of a safe learning environment
- Mediator to create consent (versus consensus)
- Stimulator for open mindedness of contributors
- Sectoral knowledge carrier on landscape issues
- Group builder (stimulating joint identity)
- A learning attitude

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II Expectations of scientists towards interdisciplinary and transdisciplinary research

On expectations of scientists

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Discussing expectations of scientists towards interdisciplinarity and transdisciplinarity is obvious considering the number of integrated research programs that are currently running on national as well as international levels. These programs, as was explained in the previous chapter, are mainly motivated by funding bodies' believes that integrated approaches are suitable to solve complex landscape related problems. Scientists that participate in integrated projects widely acknowledge that there are real world problems related to landscapes, which are going across the established scientific disciplines. They are aware that producing a fundamental solution for these problems might only be possible if different disciplines combine their body of knowledge and make a common effort. And yet, when summing up individually expressed expectations, scientists have the underlying idea that interdisciplinarity and transdisciplinarity would give them better understanding of their research problem. Their main expectation is that interdisciplinarity and transdisciplinarity will enable them to gain deeper understanding on the landscape as a whole.

To Antrop, the need for bridging different knowledge cultures is arbitrary, and its current renaissance an attempt to re-introduce lost skills. Methods and holistic concepts that were introduced to geography earlier are now rediscovered and applied by landscape researchers. Palang illustrates that landscape research needs contribution from all scientific domains to gain insights on a landscape level. Tobias, points out that only an integrated research effort will be able to enhance knowledge on complex landscape problems; in her case the management of peri-urban environments. While fully acknowledging this need, she simultaneously refers to substantial problems that are related to the conduction of interdisciplinary research projects. Here the contribution of Lenz, who suggests a tool to assess integrated approaches to improve their quality and manageability, is in its place.

In the seminar discussion it became apparent that expectations of scientists will only be fulfilled when the practical problems of interdisciplinary and transdisciplinary projects can be overcome. This also implies that scientists should be more specific to express, what integrated approaches can and what they cannot. This means to be open about the existing difficulties and to discuss them within the scientific community, but also to express them to funding bodies.

Expectations of scientists towards interdisciplinary and transdisciplinary research

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Abstract

Some personal thoughts are discussed based upon the author's experience of landscape research as a geographer to whom the holistic character of landscape as the result of natural processes and human activities is obvious and thus the interdisciplinary approach as well. The growing demand for interdisciplinary and transdisciplinary landscape research is recent and is an attempt to reintroduce lost skills. Interdisciplinarity was lost when scientific disciplines were specialising and society became too complex to be comprehended as a whole. The scientific specialisation develops parallel to the economic specialisation and the market-oriented competition. These processes change landscapes but also the way research is done. Inter- and transdisciplinarity are often used in a very pragmatic way that is when it is convenient for getting funding, strengthens the position of one's own discipline or helps promotion. Also, landscape sciences hardly receive a solid position in the academic world. Managing the landscape values and planning future landscapes demands applied research and transdisciplinarity seems most appropriate in this field. Many reasons make real transdisciplinary difficult to achieve. Many landscape sciences are young and still have to develop a common theoretical basis. In applications, many contradictory interpretations are passed on to the public and the decision makers. Therefore, they easily rely upon their own direct experience of the landscape, that is the scenery, and use a completely different set of concepts and language than scientists do. Their position in transdisciplinary research is sometimes ambiguous. As commissioners of applied research they are partners and evaluators at the same time. Also, policy goals about landscape are still very vague.

Introduction: to get the right context, my position

Following thoughts are personal and based upon experiences in the broad field that geography covers, in particular the one related to different aspects of landscape science. The context of these experiences is important to understand and improve the discussion.

At the university of Ghent, geography remained united after the quantitative 'revolution' caused by the New Orientation during the 1960-70s (Antrop, 2000). This means that human and physical geography never split. Besides these two thematic research domains there was a third one, regional geography, focussing upon the synthesis between human and physical geography and attempting to grasp and understand the whole of a given region, which was expressed in the landscape. As in many other universities, aerial photography and later remote sensing and GIS were introduced by this regional approach. Also, the focus upon the landscape was characteristic and the 'natural' research links were rapidly formed with land evaluation in soil science, land classification schemes, then with planning and landscape ecology, later with land information systems, and recently with landscape archaeology. Particularly in Ghent and since the 1960s, the approach of the landscape was characterized by a close integration of human and physical geography, historical geography and archaeology, soil science and ecology, using common techniques of regional surveying such as aerial photo interpretation, remote sensing, cartography and spatial analysis based upon intensive field work. Essentially, this was interdisciplinary *avant la lettre* and holistic, although these terms were rarely used then. Thus, in my mind, an interdisciplinary and holistic approach of the landscape is 'normal' or 'natural'. Much of the confusion today and the renewed discussion of interdisciplinarity is the result of the gradual specialisation of the sciences, both human and natural ones, and the introduction of quantitative techniques, which caused a shift from a holistic approach to a reductionist one. The creation of this "gap in geography" was well described by the late Jan Zonneveld (1980).

Expectations of scientists are very diverse

Scientists, academics and researchers, seem similar concepts, but maybe they are not. Also, science without adjective often refers in a restricted sense to the natural sciences alone, those who set up experiments and test observations using hard facts and search laws. Other sciences such as human or social sciences need some additional reference. Academics are involved in education and their task is to transmit scientific knowledge to future generations. Researchers are not committed to this kind of communication; their task is making fundamental research and publishing the results, mainly inside their own scientific community where everyone speaks a similar language. At universities, academics and researchers can find a common working place. Also, academic teaching should be strongly rooted in ongoing research. Academics today have three tasks to fulfil in their mission: research, education/teaching and provide service to society, i.e. demonstrating to society and policy makers the usefulness of their work. The focus of each academic can be different. Also, the merit system varies a lot between faculties and universities, which influences the way academics work. Very often, the research done by academics is rated lower than the work of the 'pure', fundamental researcher. This specialisation often results in competition in the search of funding or in carrier development. The basic 'vital' questions for many however remain the same:

I. Where and how do I find money for doing research?
II. How can I make promotion?
III. What priorities and how to balance between tasks?

If interdisciplinary or transdisciplinary research helps in one of these, then they might be interesting. Then, new questions arise, in many cases in the following order:

I. What can I learn, use, borrow from other disciplines?
II. What can I offer other disciplines?

However, interdisciplinary research can compete with existing, well-settled research domains as well. In this case, it might be seen as a threat for the established privileges. Indicators for this are the evaluation of research proposals and the distribution of research funds and scholarships. Although interdisciplinary research is officially promoted, the evaluation of scholarships and research proposals is apparently based on ad hoc bases and explicit criteria or rules are not clear. My experience coincides with the observations that Fry (2001), Moss (2000) and Zonneveld (2000) made about the market-oriented trend of academic management, policy and the merit evaluation. These are not stimulating transdisciplinary working, in particular regarding the field of landscape ecology.

Expectations of society and thus policy on scientists

As most of research is paid by society, scientists should pay back by providing results that are significant to society or relevant for policy making. This became rapidly an important factor in obtaining funds that make research possible. Although not often called as such, this trend introduced the transdisciplinary approach as well.

Two aspects are important for the discussion. First, how does applied research differ from fundamental research? Second, how does changing societal priorities and changing policy affect research?

Applied research differs from fundamental research in many ways:

I. The objectives are largely defined by the commissioner and the 'products' (results) that are expected are listed a priori in detail. However, very often the commissioner has only a vague idea about these and it is very common that in the beginning of the process they have no idea how to use the results;
II. Time pressure is important and strict and financial penalties become common;
III. The research processes is regularly controlled and evaluated by an external steering committee;
IV. The research results are reported confidentially and become the property of the commissioner. The results can be published only after their implementation in policy and with the permission of the commissioner.

The approach looks very much transdisciplinary, but the input by the different disciplines and partners involved can be very unbalanced. Many times I experienced a shift in the objectives leading to a growing contradiction in the vision between the scientists and the commissioners. Very often the role of the administrators becomes one of an 'official' and external guardian of the research done by scientists. The approach therefore is not really transdisciplinary but rather goal oriented interdisciplinary (Moss, 2000).

Changing policy reflects changes in societal priorities. In our society free-market rules play the dominant role and affect gradually the organisation structure of the public administration as well as research institutions. Following discussion reflects my experience in the Flemish situation, which I guess is not a unique case.

Succeeding reorganisations of the administration in the different regions of the federal Belgian state show a growing specialisation and fragmentation in the relationship between scientific research and policy-making. From the 1950s to the 1990s mainly universities were asked occasionally to support policy by making specific research. Gathering of new original data and their analysis were important tasks of scientists. The practical implementation of the results however was given to specialized engineering agencies or institutions. A typical example from that period was the land re-allotment in agriculture: academicians did the necessary soil studies, while planners and agronomists working in governmental agencies carried out the practical realisation.

This pattern changed with the growing problems related to the environmental deterioration and the increasing complexity of our society. Also, most activities became more (free) market oriented, including all kind of applied research. Many private research agencies appeared with the growing demand for very specific research in many domains, in particular stimulated by the demand for environmental impact assessment.

The simultaneous transformation of the country into a federal state is special to Belgium. This induced fundamental reforms in administration and an important outsourcing of technical and applied know-how. Many semi-independent governmental agencies were formed as well as research institutions with a mission to provide policy makers with the necessary but adapted scientific knowledge. This stimulated a brain drain in the universities in some fields such as forestry, agronomy, engineering, biology-ecology, archaeology, etc. In a first phase, those who possessed the original basic data were privileged: the academic world was still in the running. With the general implementation of electronic data and GIS as the most powerful integrating tool, governmental institutions gradually concentrated the properties and rights of policy relevant data, although in most cases they are still unable to analyse or even handle digital data themselves. Again, outsourcing of the tasks is the result, but this time private companies, governmental agencies and universities are in a competing situation. Gradually, the academic world is loosing its unique position of collecting and analysing original data, in particular in the field of environmental and natural sciences, thus also landscape ecology. Most governmental initiatives stimulated interdisciplinary projects based upon collaboration between the academics, private corporations and governmental institutions.

Recently, a new trend becomes apparent that related to the institutional reforms of the academic world, partially stimulated by the Bologna declaration. This results in a redefinition of the mission of academics in society. Universities should focus upon research-based education, in particular fundamental research, which productivity can be measured and evaluated through the system of citation indices and peer-reviewed publications. Policy oriented and applied research that results in (confidential) reports, are not considered as research but as a 'scientific service', which however is only considered valuable in the amount of financial support universities receive. The only conclusion I can make is that the general policy aims to redistribute the available financial means for research amongst a growing number of actors based upon a free market principle of competition by redefining the mission and goals of each of them. Commissioners of research, both private or public, are leading the game, not as research partners, but as bureaucratic and steering boards that are more concerned in the achievement of their own policy objectives than in the results of the scientific research, especially when these are rather disturbing for their policy plans. The trend is not stimulating real transdisciplinarity, but unidirectional interdisciplinarity, in the sense Moss (2000) used it, and controlled by the policy-makers.

It should be noted, however, that for Flanders region in particular, the implementation of ideas of landscape ecology in diverse domains of policy making was rather successful. Although, landscape ecologists are few and do not form a formal organized group in Flanders, most work together on a interdisciplinary problem-oriented basis. The result is that many ideas are implemented into policy and even legislation.

Interdisciplinarity and transdisciplinarity in landscape science

An academic discipline?

The formal recognition of landscape research, landscape ecology in particular, as an academic discipline remains difficult (Fry, 2001; Zonneveld, 2000; Moss, 1999, 2000). To cite Isaak Zonneveld: "Is landscape ecology 'a science or state of mind?'" (Zonneveld, 2000, p. 40). He answers "both" but is warning at the same time for the dangers of today's managerial, commercial and competitive interests of universities that override learning and scientific vision, where profit seems to prevail over prophecy. I think Isaak Zonneveld made a pertinent analysis at the 25th years celebration of the Dutch working society of landscape ecology (WLO) in 1997: "The danger of falling back into monodisciplinarity is not imaginary; it is the way of least resistance, the 'entropy of science'" (Zonneveld, 2000, p. 39).

Your old stuff is my innovation

This statement is illustrated in many ways in landscape research. The revival in the 1980s of landscape ecology, originally founded before the Second World War, is the most striking example. Landscape ecologists discovered the importance of scale and geographical techniques of shape and network analysis that were introduced by geographers during the 1960s with the New Orientation in geography. Also the methods of land evaluation developed by soil scientists and soundly based upon aerial photo interpretation, was rediscovered (Zonneveld, 1995). Similar is the revival of geographical models such as gravity and diffusion models. Ideas of Von Thünen and Christaller are "in" again. More recently, landscape ecologists became interested in urban sprawl and borrow models from older urban studies. Landscape archaeologists discover spatial analysis tools and site analysis that have been used by geographers for decades. New technologies, based on remote sensing and GIS, are important factors in the diffusion of research techniques in very different disciplines. They are powerful tools for interdisciplinary integration and building a common methodology and language (Antrop, 2001).

Research is scale-dependent, so is interdisciplinary

Most landscape research is bound to a pre-defined study area. Its size and the research objectives are important factors or even constraints in determining the scale of the study. Small-scale studies are often more specific and thematic and involve a limited form of interdisciplinarity between very similar scientific disciplines. Research in global warming is an example. Large-scale, detailed studies involve more real objects of the landscape and more participants and interest groups are likely to be involved. Inter- and transdisciplinary work can hardly be avoided at these scales. At this level, not only concepts and language differ, but also culture and particular interests.

Are we really searching a common language: English or Esperanto?

Landscape science is divided by language. Landscape has multiple meanings that also differ between languages (Claval, 2002; Zonneveld, 2000, 1995). Simple literal translation is seldom the best solution. The dominance of English in any science, including landscape science can be regarded as a specialisation and reductionism of the broad meaning the concept 'landscape' has in other languages (Brandt, 1998). The correct use of concepts is vital for a clear theoretical foundation of a discipline (Zonneveld, 1995) and is very important in inter/transdisciplinary landscape research. Actually, the communication between the different disciplines involved uses an extremely restricted set of common concepts (Antrop, 2001). Few researchers in landscape science approach landscape in a holistic way (Antrop, 2001; Palang et al., 2000; Naveh, 2001, 2000). Landscape ecologists with a biophysical background and landscape architects have to be persuaded that landscapes are the expression of the deep and strong relationships and interactions between culture and nature (Tress et al., 2001; Nassauer, 1995; Naveh, 1995). The lack of a common language in landscape science is also reflected in the lack of a broad, well-developed and sound theoretical foundation (Fry, 2001; Moss, 1999). Discussing the "Top 10, List for Landscape Ecology in the 21st Century, Wu and Hobbs (2002) demonstrated the need for more direct working together between the different landscape disciplines, both in basic research as in applications. Also, the communication with the public and decision makers should be stimulated and even so with education.

Conclusions

The nature of landscape demands a basic research approach that is holistic, dynamic and multi-scale. The landscape conceived as the perceivable whole that is the result of the interaction between natural processes and human actions cannot be studied by one discipline using a particular set of methods and concepts. Dealing seriously with the landscape as the object of research, means interdisciplinarity.

Landscape is also the perceivable environment of all and considered as a common heritage. However, no one really possesses it or takes care of it. Numerous actors cause continuously changes in the landscape. Today, these changes become considered as negative in various aspects. Decision makers and the public demand some actions to steer them and in order to know how, applied research is demanded. A transdisciplinary approach is obvious and logic here. However, besides an interest in the landscape as such, many other interests determine the way research is carried out, and how science evolves. Many trends here do not show a stimulation of real transdisciplinarity and the creation of real win-win situations for all. Very indicative is achievement of setting up a global theoretical basis of dealing with the landscape as a whole and the creation of a common language understandable and meaningful to all who participate.

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How does an elephant look like?

Some experiences and some more fears about interdisciplinary landscape research

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Let me start with an old figure (see fig. 1) from the human geographer Robert Sack (cf. Couclelis, 1992, originally from Sack 1980), where he explains the place of landscape in respect to the science, arts and social sciences. Here, landscape reaches out of any of these domains; which means that none of them can explore the landscape thoroughly.

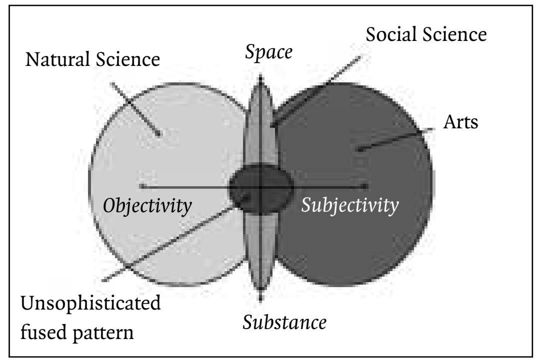

Figure 1: Sack's framework of space conceptions

Let me also remind you the old Indian story about blind men studying the elephant. One gets hold of the leg, another the tail, third one the ear, fourth the trunk, fifth one touches the side of the elephant. And when the elephant itself is gone, the men start arguing whether the elephant looks like a wall, a column, a rope, a cabbage or a broom.

Often landscape is studied like the blind men studied the elephant. Teams are gathered that consist of broom, rope, cabbage, wall and column scientists, but most often they are unable to describe the elephant in a proper way, i.e. the project report consists of chapters about brooms, columns, walls, cabbages and ropes, but the chapter about *the elephant itself* has been forgotten. One has to admit this approach is a serious step forward, comparing to a project report that deals only with a broom or a rope, but still it is not perfect.

So, one of the expectations should be that the landscape research team is able to understand what *the elephant* is. And the precondition is that all the rope and broom scientists should be able to "compile" the elephant based on their disciplinary knowledge.

How to reach this? First, get the research question right. It is extremely important to understand what one is looking for. Interdisciplinary research is not always the best possible way to solve all problems, sometimes a narrow disciplinary approach does the trick much better, although focusing on the leg or tail and not on the elephant. What comes next? Gather a bigger team, so that all possible aspects are covered? The result is that team grows too big and unmanageable. Include people who have wider knowledge? For the last 50-60 years we have been educating narrow specialists who are not always able to understand the wider context of their research, and consequently we are dealing with the same issues geographers of the 1920s did. Furthermore, the Soviet landscape science that existed from 1950s till 1990s has once tried to integrate all sorts of natural sciences in landscape research, but that attempt failed for three reasons (Roosaare, 1989):

I. static classifications are unable to handle landscape components that occur as more or less continuous fields with fuzzy borders;
II. units classified on the basis of genesis, leading component, spatial relations etc do not form uniform systems;
III. as time was difficult to integrate into the study, dynamics of the system was explained using static and cinematic models, which of course failed.

Here I see another problem - amateurism. Often people who try to expand their study into another discipline include a nice sentence in the *Methods* part: "We used social scientific methods to study the problem". And that is all. All those cabbage and rope scientists have their particular methods of studying cabbages and ropes. Try to imagine now a broom scientist making a study on cabbages using his particular methods, e.g. measuring nitrate contents in soils using interviews. Nobody will take him seriously; claiming that we used inter- or multidisciplinary methods without knowing or using them makes one an amateur. Science needs professionals, not amateurs. Can amateurs make science?

Inter- or transdisciplinary approaches are extremely demanding - you have to be specialist in so many fields, or, find other people willing to cooperate and share their approaches and experiences. But is there anybody ready to share? Very seldom! Everybody sits in his own ivory tower and fires the others with statements like my approach is the best; you others do not know anything.

The third problem is how to study landscape. As nobody exactly seems to know what it is, there are several methods available how to study. Complex and qualified use of these is what gives results. But a precondition is that none of these methods will be disqualified only because it does not study 'that' landscape.

In addition to narrow-mindedness and amateurism, when one really wants to study the elephant it might easily be a little too big mouthful. There are so many aspects, there are so many nuances, and there are so many details to take into account that lead to serious generalization. And that result might not interest the customer any more.

To summarize: in order to get a full picture of the elephant, one has to handle it as a whole. In landscape terms, the study should focus both on the visible and the perceivable parts of the landscape, but as well describing the driving forces or underlying processes behind the landscape (Fig 2; see Keisteri, 1990; Palang et al., 2000; Antrop, 2000; Naveh, 2000). Or, as Henri Décamps (2000) once nicely put it: Landscapes depend on cultural preferences and desires; they are relative entities, where natural environmental processes and culture interact.

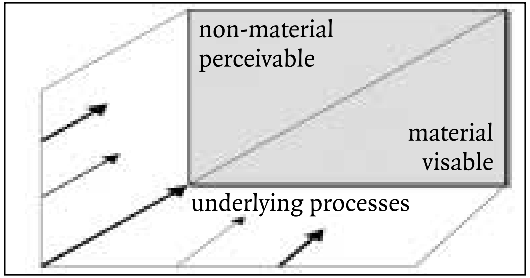

Figure 2: Model landscape consisting of three layers (Palang et al., 2000; modified after Keisteri, 1990)

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Do we make better land use decisions by inter- and transdisciplinary work?

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Oriented research in a research focus

The Swiss Federal Research Institute WSL has established four research foci on specific topics (www.wsl.ch/programme). A WSL research focus consists of several single projects that are oriented to a comprehensive research topic of current importance. The research objectives require close cooperation between researchers in different fields and address the needs of target groups from practice. The results of the single projects are combined in a synthesis to enhance knowledge about the central topic.

The latest research focus 'land resources management in peri-urban environments' was designed in 2001 and the first projects have recently started their work (www.wsl.ch/programme/periurban). In this research focus, the biophysical and socio-economic prerequisites for sustainable land use in peri-urban regions are analysed. On this basis, scenarios of possible land use allocation are designed and evaluated for certain regions. Further, the potential of land use negotiation is examined with the regional decision makers.

The methodological approach is the development of a comprehensive decision support system with the contributions of several single research projects. The criteria are derived from scientific models that are generated in the different projects. These projects face the relevant questions in ecology, economics and society of the concerned regions. A current example is the evaluation of compatible land uses for restored sites that were formerly used as gravel pits (Lerch et al., 1999). Such an evaluation will respect besides economic and demographic aspects also the people's demands on landscape (Buchecker, 1999) and the ecological consequences, as e.g. soil compaction on restored agricultural land (Friedli et al., 1998). Regional land use scenarios are created with multicriteria decision methods as they are described by Janssen (1996) and Roy & Bouyssou (1993) and visualized by geographical information systems and virtual reality programs. Ideal procedures of land use negotiation are designed according to the principles of game theory. Then, their implementation is tested by the real decision makers with the help of the visualized land use scenarios. The research focus is structured in five modules, where the different projects will be attributed to (see figure 1).

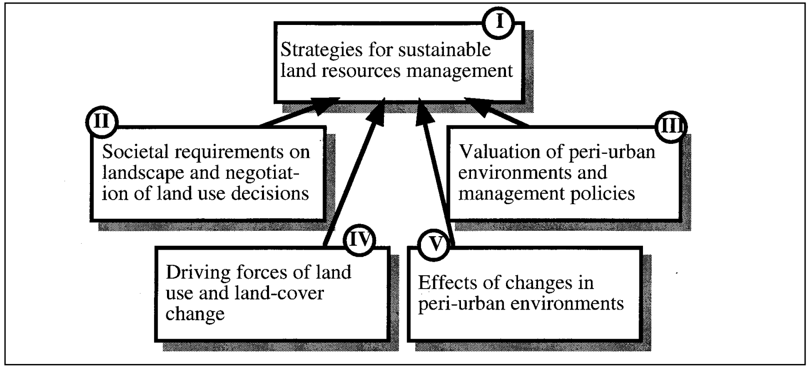

Figure 1: the five modules of the research focus 'land resources management in peri-urban environments'. The outcomes of the different research projects in the modules II to V will be brought together in a synthesis, which will be created in module I.

The need for inter- and transdisciplinarity in research on decision-making

The core work of the synthesis is the development of the multicriteria decision system that allows the evaluation of different land use scenarios in respect of sustainable landscape development. Interdisciplinary work is an indispensable prerequisite to reach this goal. The different aspects of sustainability, ecology, economy and society, are subject of different scientific disciplines. A comprehensive and well-balanced set of criteria requires intensive cooperation of the different research projects generating these criteria.

The decision system will be applied for the development and evaluation of land use scenarios in a certain peri-urban region. This step requires cooperation with stakeholders (Beroggi, 1999). The planned scenarios make most sense in regions with upcoming landscape development or with a high demand of landscape upgrading. Here, land use decisions are necessary and, in addition, the public is aware of this necessity. Politicians and authorities help to identify regions for the application of the results. In addition, local stakeholders (local authorities, interest groups representing different segments of the local population) help to identify the relevant problems of the region and to define sustainable landscape development for the specific region. They contribute to the latter by expressing their expectations and ideal views about their everyday landscape.

Finally, analysis and optimisation of land use negotiation is the result of integrated work from scientists and practitioners. Negotiation strategies currently implemented in practice are analysed by scientists to identify the problems. Scientists then may develop theoretically optimised negotiation strategies, e.g. on the principles of game theory. However, these optimised strategies must be tested in practical experiments to judge their feasibility. In addition, the evaluation of the scenarios by the real stakeholders within the negotiation experiments will enable plausibility checks of the MCA-model. This kind of evaluation by experts familiar with the decision problem – which is called face validation – is considered the only feasible way to validate MCA-models (Qureshi et al., 1999).

Expected problems with inter- and transdisciplinary research

Although the given research questions of this research focus seems very suited for inter- and transdisciplinary research, problems are occurred already now. Researchers from different disciplines have different scientific languages. It takes much time and effort to find a suitable way of communication. However, interdisciplinary work does not only fail because of the lack of a common language. Interdisciplinary work requires a comprehensive focus on the overall problem. This is in conflict with the detailed in-depth thinking in disciplinary research. A disciplinary researcher may not be satisfied with a "superficial" look at his/her aspects of the problem.

Cooperation between the different research projects can be designed as mutual or parallel work. An interdisciplinary synthesis can be elaborated, when all the projects run on their own but at the same time (parallel work). Interdisciplinarity in the whole work process can only be achieved by mutual work of the different projects. However, in this case the different projects depend on each other very strongly and run the risk of being blocked due to delay in other projects.

The participants of this seminar agreed that steering different researchers towards a common focus requires strength in management and patience in communication. The success, particularly for mutual work, depends to a great deal on personal chemistry. However, WSL-research foci are instruments of innovation in research, and all researchers of the institute are requested to contribute to them. So the head of a research focus cannot only expect participants of "convenient" personal chemistry, but should also try to convince "opponents".

There are also problems with the exchange of science and practice. Although in this research focus science is oriented on practical problems, there are different time scales for the expected solution. Science is supposed to identify and help avoiding future problems that practice has not even realised yet. Scientific approaches shall provide long-term solutions of the problem, and their elaboration often takes too much time for a practitioner. Practice focuses on urgent problems and, therefore, needs quick solutions. For this reason, practitioners often are very unhappy about the slow outcome of scientific research.

A similar "scaling problem" considers the extent of the problem focus. Scientists are supposed to have a fundamental and comprehensive look at the problem and the problem context, while practitioners give a strong priority on urgent aspects of the problem. In this way, scientific results are too general to be applied for a very specific part of a practical problem.

Concluding questions

I conclude my contribution with three questions that have not been answered in a satisfactory way at the seminar. A reason might be that they touch the key problems of inter- and transdisciplinary research.

I. Can we get long-term visions of sustainable landscape development from practice? Can *scientific* questions be formulated by practice?

II. Can we generate operable sustainability criteria in science that satisfy practice in concrete problems? Can science solve *practical* problems?

III. How much communication between science and practice and between different disciplines do we need for effective and efficient problem solving? Do we always have to aspire mutual work or can we be satisfied with parallel work? Can I call my research focus interdisciplinary, if only one third of all the projects make a direct contribution to the synthesis?

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Assessment Science in interdisciplinary and transdisciplinary research

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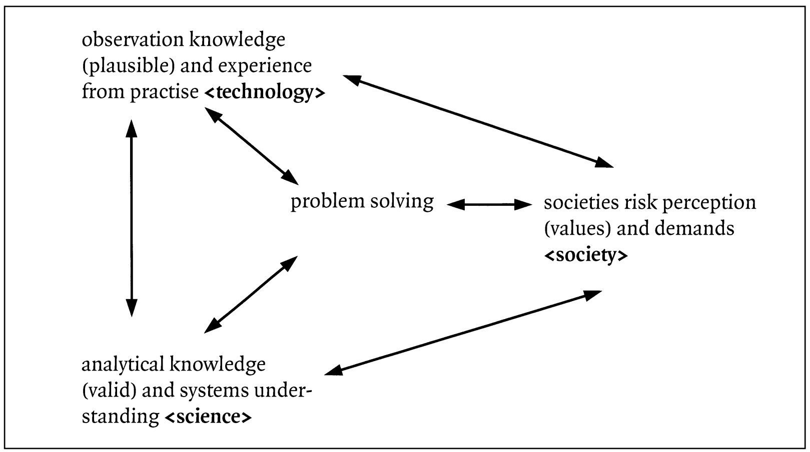
Introduction

On a landscape level, we have to deal with human-environment systems and landscapes. In inter- and transdisciplinary research on this level we have to use a set of methods, which in combination leads to a new quality of scientific approach (see Lenz, 1991).

My hypotheses are that each scientific discipline has its methods and inter- and transdisciplinary research is somehow a "new" scientific discipline (like it was engineering, landscape ecology etc.). Because of its explicit problem-orientation, something like an "assessment science" could strongly contribute to

Figure 1: Joint problem solving amongst science, technology, and society (Lenz, 1991)



inter- and transdisciplinary research. Assessment here has to be understood in the sense of an integrated assessment in the process of problem solving amongst science, technology and society (Lenz, 1991, see Figure 1). As this is a major part of such projects – either in research or in practice – it has to be based on conceptual frameworks and theories.

I would like to argue that there is a severe lack of assessment science for human-environment systems. The "old" scientific approaches coming from risk and impact assessment (toxicology, statistics etc.) are too "narrow", and the "new" ones coming from planning/practice such as check lists for environmental impact assessment are often too "soft". In total, they do not cope with the complexity, and there is a lack of science for systematic assessment approaches including decision-making.

Some assessment methods/frameworks

The following short list of assessment approaches should elucidate what could be a set of approaches to be further checked and exploited for inter- and transdisciplinary research. Figure 2 elucidates one of them.

I. Environmental Impact Assessment; Risk Assessment; Integrated Assessment (e.g. "missing link in the acid rain debate", Streets, 1989; see Figure 2)
II. Reality-Assessment, Value-Assessment, Tool-Assessment (System Dynamic Modelling and Model-Moderation (as a new teaching concept for transdisciplinary studies, Förster, R., Heeb, J. & W. Hoffelner, 2002)
III. Driving forces, pressure, state, impact, response (DPSIR) and other Indicator-concepts (Mortensen, 1997)
IV. Action Research and "Out-reach" components (Lewin, 1953)
V. Participatory Rapid Appraisal (PRA) (cf. a discussion of participatory approaches in integrated assessment by Marjolein van Asselt & Rijkens-Klomp, 2002)
VI. Environmental Impact Assessment and Multilevel Approach (EIAMA); a general framework suggested by Lenz (2002)

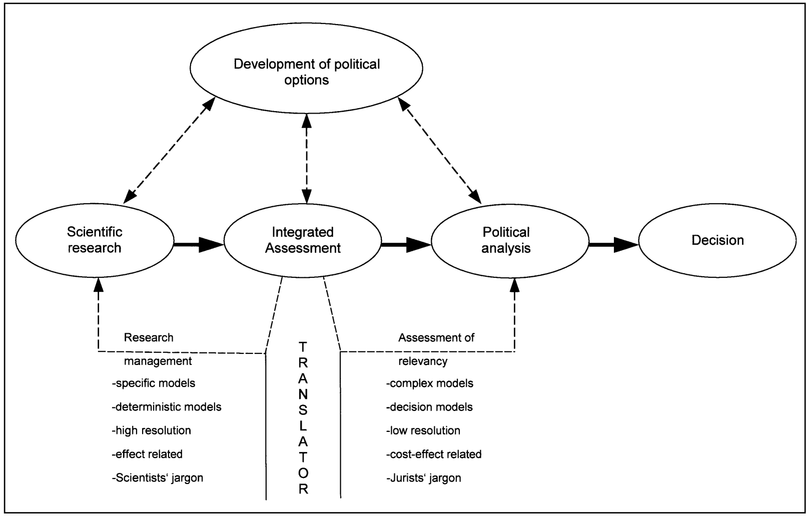


Figure 2: Integrated Assessment as missing link in the acid rain debate (Streets, 1989)

Discussion and conclusion

In the following you may find some quotations from the talks of the first day of the seminar, expressing the needs as well as the current situation in theory and concepts for inter- and transdisciplinary approaches:

"...scientifically based integration of humanities and landscape ecology..."
"...monodisciplinary approaches are impossible..."
"...solving landscape related problems and increase scientific progress..."
"...elucidate the consequences, structure the problem..."
"...need of shared conceptual frameworks..."
"...detect methodological links...transdisciplinarity *is* working..."
"...need for knowledge etc. brokerage..."
"...markets and demands are existing: *sell* this..."
"...practise vs. research: do not mix...", *but please interrelate them?*
"...old wine in new tubes...?"
"...interdisciplinary is normal (for good geographers"...*and ecologists*)

It is concluded that most of the problems in society-environment systems can only be tackled within a team consisting of different disciplines, working inter- or transdisciplinary. This means that conceptual frameworks, sets of methods and underlying theories have to be digged out or developed, in order to better characterize inter- and transdisciplinary approaches. We often can find parallels in the use of methods independently of disciplines; e.g. action research developed in social sciences is closely related to reflexive, stepwise planning as well as research in ecology, and also with methods like "adaptive management" in economy!

Besides the needs for theories and concepts, a management issue for "managing transdisciplinary approaches" arose from practical experience. Reasons are also laid in "disciplinary flee-powers" – which means the affinity of each discipline to rather intensify its own research than to look for interfaces to others - , which will occur during inter- and transdisciplinary processes and have to be faced with the integration needs, as well as with changes in the project development. One overarching framework to better couple science with society

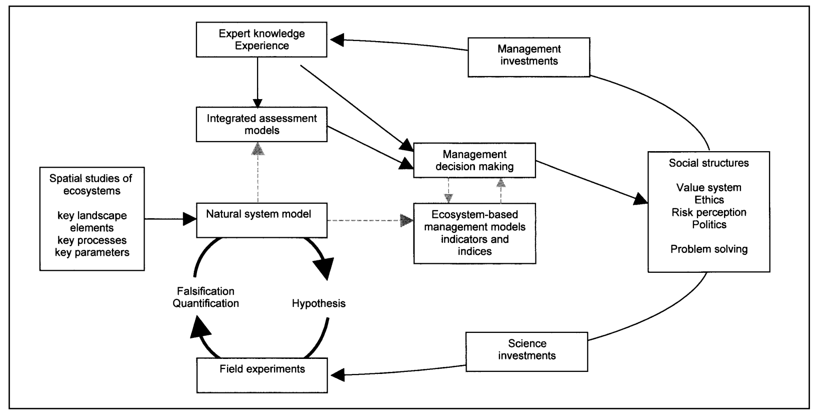


Figure 3: The figure shows the central role of environmental indicators and indices in a complex, integrative and transdisciplinary relationship of the environment-society system. "Assessment science" should help to optimise the interconnectivity of the various compartments and interactions.

especially with the use of indicators was suggested by Lenz et al. (2000, 2001); see Figure 3) and further explained in Lenz (2002).

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III Successes and problems when conducting interdisciplinary and transdisciplinary research

On successes and problems

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Some of the central problems related to the success or failure of integrative studies relate to our understanding of disciplinary cultures and the nature of interdisciplinarity and what it can achieve. Few studies achieve a level of interdisciplinarity where disciplinary boundaries are crossed and new integrative theory results. Problems exist with the language used by different disciplines, approaches to sampling and even what constitutes data. This can make it very difficult if not impossible to combine the results of participating disciplines. We also need to ask ourselves why are we integrating disciplines at all and why these particular ones.

Reflection on some of these basic epistemological problems was the topic of the paper by Winder. Issues related to disciplinary differences and the more important differences between knowledge cultures that can develop in closely related fields of research are discussed. The placing together of certain constellations of knowledge cultures would appear to be doomed to failure. To integrate contrasting intellectual cultures would require researchers to give up their own belief systems and to deny their knowledge culture and the knowledge community that supports it. Perhaps the best we can achieve is a better understanding of the perspectives and interpretation of landscape issues by diverse knowledge cultures. This would require developing respect for these views but also maintaining the right to agree to disagree.

This theme was continued by Assche, who discusses the importance of understanding of what disciplines are and the nature of disciplinary boundaries as important factors in successful interdisciplinary research.

Disciplinary perceptions and how these can affect interdisciplinary practices were discussed by Haaften. Her theory is that different disciplines have different attitudes to nature and this can act as a barrier to interdisciplinarity. In this model it would be expected that ecologists are most caring, e.g. for forest resources, whereas forest scientists were least. These differences, reflecting differences in attitudes to resource us, can be major obstacles for achieving scientific communication.

Supporting inter- and transdisciplinary (ID and TD) research is the issue taken up by Hollaender. This paper presents the results of empirical studies of ID and TD programmes with the aim of identifying success factors. Some of the most important findings relate to the importance of management support in mediation, conflict resolution and motivation. The study also takes up the issue of defining a focussed research question and defining shared goals. Within projects the delegation and integration of tasks are seen as important management factors. ID or TD practices are not ends in themselves but may have diverse goals, which may make evaluation difficult.

A general theme in the papers in this section was the need to accept the limitations of integrating widely different knowledge cultures. In some cases it will be difficult or impossible. A project structure that challenges the beliefs and attitudes of researchers representing different knowledge communities is unlikely to be a good start. Project management that mediates between knowledge cultures is seen as important by project participants.

Successes and problems when conducting interdisciplinary or transdisciplinary (= integrative) research

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My approach here is theoretical. Theoreticians are practitioners with poor memories. We simplify and distil practical experience into a set of statements that can be unpacked and re-assembled as required. Theoreticians often define familiar words in an unfamiliar way. When we do so, we make no demand that you accept those definitions as authoritative, or change the way you speak. We are using the words as a device to encourage you to think about familiar but vague ideas in an unfamiliar and rather precise way. Of course, I would be delighted if you adopted my usage and shared it with your peers, but my principal aim is to communicate beliefs and ideas. Many of the ideas you will encounter here can be applied with equal force to inter-disciplinary and trans-disciplinary (participative) research. However, it can be very difficult to maintain the standards of professional courtesy I demand when serious conflicts arise between stakeholders. For some of you, this will be a complicating factor. I am not going to write about conflict resolution skills here, though they can be important, especially in participative work.

Knowledge communities and disciplines

One of the ironies of an academic calling is that communities of scholars each speak a local dialect that is partly (sometimes largely) incomprehensible across community boundaries. Although English seems to be emerging as the twenty-first century equivalent of mediaeval Latin, we remain a people divided by its common language. Each of our dialects corresponds to a *knowledge system* and those who speak and write it are the custodians of that knowledge system in the present generation.

Sometimes a knowledge system coincides with a recognisable academic discipline, but often it does not. Archaeology, for example resolves into two knowledge communities. Pre-historians are those who study the archaeological record prior to the widespread use of writing. They are generally more open to scientific method and more dependent on field data than proto-historians, who are expert in more conventional, literature-based styles of analysis and research. Specialists in the Roman and Neolithic periods of the same country deal with different types of record and address different types of question, even when they are both digging.

Thus the terms "interdisciplinary", "transdisciplinary" and "multidisciplinary" are confusing. A convention is gradually emerging at meetings like this of using *multidisciplinary* to represent a patchwork of studies, each located in a well-defined discipline and "stitched together" by some editor at the end of a project. The other two words, *interdisciplinary* and *transdisciplinary* require a genuine intellectual synergy across boundaries. In this meeting, we use *transdisciplinarity* to indicate participative research that involves stakeholders who are not academics.

These are useful ideas but somewhat over-simplified because the concept of an intellectual discipline has changed and the word itself has become debased. Etymologically, a discipline signifies a set of constraints embraced by the members of a community; a monastic discipline would be the type specimen. However, contemporary usage also applies the word to a set of people who happen to study a domain of experience and so can be corralled together in university departments. There is no necessary connection between these so-called "disciplines" and an ontologically recognisable knowledge community united by a shared set of intellectual disciplines (*sensu stricto*).

A prehistorian and a biologist can often work together very easily because they belong to adjacent knowledge communities. A prehistorian and a proto-historian may have a harder time working together. Although both are archaeologists, they seldom belong to adjacent knowledge communities. On the other hand, proto-historians and epigraphers or social geographers often work together effortlessly. Their respective knowledge communities and dialects are very close.

The distinction of disciplines from communities corresponds to that of "etic" from "emic" in linguistics. Disciplines are defined etically using materialistic categories: geography is the study of mappable spaces, archaeology the study of the buried past, and so on. Communities are emic constructs that represent the internal operation and signification that give our research meaning. Disciplines are fixed, governable, institutionalised conventions, while knowledge communities are flexible, dynamic, often subversive and sometimes viciously competitive.

Research across disciplines is easy as long as you avoid crossing community boundaries. Research across communities (*integrative research*) is like herding weasels.

Knowledge, information, data, observation and belief

Observations are sensory experiences articulated with *beliefs*. When I observe a blade of grass growing from the crack between paving stones, I receive a bundle of sensory experience, which I recognise as a "blade of grass" and locate in the "crack" between "two" "paving-stones". I believe that blades of grass, cracks and paving stones are ontologically real and use these beliefs to "make sense" of my experiences. A lot of sensory stimuli are filtered out by our belief system and systematically ignored, but some resonate with them and are consciously acknowledged.

Data are formally recorded observations. They can be discursive (a sentence, perhaps) or numeric (recorded on paper or on a computer). When you receive data, you must articulate it with a set of interpretive protocols (your own belief system) in order to reconstitute them as meaningful observations. By this broad definition of data, the words I speak in my presentation or write in the paper that accompanies it are data (*sensu lato*). The principal difference between data and "raw" observation is that the latter pass through at least two cognitive filters. The observer filters sensory experience once and codifies the resulting observation as data for storage or transmission. Every time the data are recalled from store they must be re-filtered before they "make sense".

Some writers distinguish data from *metadata*. Metadata are data generated to summarise large datasets. If I take a set of weights and compute a mean or read a book and write an abstract, I am creating metadata. Like any other sort of data, metadata must pass through our cognitive filters before they make sense.

Information consists of observations that shape a person's beliefs. The difference is that between "*So What*?" and "*Aha!*". When I tell you that scientists have found a blade of grass growing between two paving stones, you are quite likely to consider this a useless or trivial communication. *So what?* You know what it means (it's a perfectly good observation) but it has no impact on your beliefs.

However, if I were to tell you that scientists had found a blade of grass growing on Mars (and you believed me) it might change your beliefs. *Aha!* The distinction of observation from information is dynamic. The *Aha!* moment that re-shapes our belief systems is seldom repeated in a simple way. Familiarity breeds contempt, so that yesterday's *Aha!* becomes tomorrow's *So what?*

Knowledge is a shared set of beliefs that allow people to communicate, co-operate and co-ordinate their actions. Humans negotiate knowledge by communicating with each other. We seem to be programmed to try to understand the messages we receive from our senses, especially those that come from other people. This is particularly true when we are young. There are many "Aha!" moments in the first decade of life, rather fewer in the seventh. As our belief systems converge onto that of the community (communities) into which we are accepted, our knowledge becomes resistant to change. We begin to filter sensory experience and messages from others that does not resonate with beliefs.

What I am saying is very straightforward but very important. Our beliefs serve as cognitive filters that determine what we can and cannot observe. Knowledge is a socially constructed, communal belief system. That means that if there was one person left alive in the world, there would be no knowledge!

I am the custodian of a set of beliefs. You have beliefs too. Our knowledge consists of all the beliefs we share. Our belief systems are shaped by our experience (they become more resistant to change as we get older). As your beliefs or my beliefs change, the knowledge we share reforms as the intersection of our respective belief systems. This is so by definition.

This line of argument can be extended to communities of three or more people without loss of generality. To paraphrase William of Ockham, knowledge is a set of beliefs that exists within a defined community by negotiation and common consent. Members of the same knowledge community have similar cognitive filters and so are more likely to make some observations than others.

A belief spectrum: Culture, creed, theory

Beliefs are important because they enable us to make sense of our experiences, to negotiate knowledge systems and to co-operate with others by forming coherent knowledge communities. Different knowledge communities often have logically irreconcilable belief systems. Integrative research requires representatives of two or more communities to co-operate, but they can only do so if they are prepared to make temporary compromises and learn from each other. The people best qualified to represent a knowledge community are usually mature, but mature people are not necessarily those best equipped to learn and compromise.

To take this line of argument further, it is helpful to distinguish a spectrum of belief that stretches from culture to theory.

Cultural Beliefs are beliefs that are so deeply engrained, we do not question them and are scarcely even aware of them. In practice, culture can best be identified negatively in terms of the things we do not think of doing and the observations we are not capable of making. I am a scientist and a *rationalist*. By this, I mean that any knowledge system that appears logically incoherent must be flawed. The logical methods and patterns of reasoning underpinned by mathematical analysis are part of rationalist culture. I will not entertain an irrational argument.

When cultural beliefs are questioned, humans often respond defensively, even aggressively because our culture defines our sense of who and what we are. Specialists in integrative research, like social anthropologists, need special training and a slightly unusual temperament if they are to manage the symptoms of "culture shock" effectively. A good starting point is to be prepared to say (and hear others say): "I am not prepared to give way on that point, it is part of my intellectual culture". If you can do that without feeling threatened or angry, you are in with a chance.

Creedal Beliefs are deeply embedded but explicitly held. For most biologists, the so-called "theory" of evolution is actually creedal. I can conceive of a world in which there is no evolution but have found evolution such a rewarding idea. I consciously reject it.

Theories (*sensu stricto*) are the weakest type of belief. Theories are created in provisional form and tested explicitly for coherence, consistency and utility. We often depend on theories in our daily work while recognising that they are not secure. For example, my own research hinges on the theory that mathematical models are useful tools for the management of our cultural and natural life-support systems. I am aware that this may not be true and prepared to put this belief to the test but have taken it as an organising principle for much of my adult life.

The line between research and non-research

Research consists of activities that contribute to the maintenance and development of knowledge and *knowledge*, the shared belief-system of a living community. This means that making observations and generating data are not research. Knowledge is a living tradition; the shared beliefs of a community of people who communicate through the spoken and written word.

When social scientists use their expertise to elicit new knowledge among stakeholders and write a report in the grey literature, or atmospheric physicists mount major observation projects to monitor ozone depletion, they do not contribute directly to the maintenance and development of knowledge in their respective fields. Knowledge transfer occurs when the data we gather have been analysed and the results fed back into the academic communities that sustain us.

Many academics engage in out-reach and resource enhancement projects. Indeed, these activities are rather important; they provide a source of third-strand[1] revenue, they help us maintain closer links with the people who fund our work, provide data and resources for pure and policy-relevant research: you cannot go to the library to observe current ozone levels over the North Pole or the attitudes of contemporary teenagers. Those active in this work write fewer papers than colleagues who use well-curated archives and library resources. We have to do our own "spade-work". It is wholly proper that we should be rewarded for our efforts and skills; but it is not research until it has been synthesised and fed back.

The influence of academic literature on knowledge communities is often ephemeral. Like motes of plankton sinking into the abyss, books and articles that lie unread in the library stacks are the sludgy artefacts of old knowledge systems. Exegesis is the process of bringing those traces back into the light and forcing new life into them. Since belief-systems change constantly, these resurrected traces are interpreted in new ways by successive generations. There is no knowledge in a library or a database; knowledge is carried in and out by those who use it.

Knowledge communities have shared culture, creed and theory sets that predispose them to similar interpretations of the same evidence. This is why I argue that out-reach and data capture do not constitute research. Research requires us to synthesise and organise those experiences and transmit into our knowledge community in the form of publications and lectures. Some humanists under the influence of notable theoreticians like Michel Foucault, refer to the social production and maintenance of knowledge as *discourse*. By analogy, a knowledge system frozen in time is a *universe of discourse*.

Effective discourse involves both *information* and *theory*; it is a concentrated synthesis of personal experience, intended to change the beliefs of the recipients. By this conception, then, theory-building and effective communication are the hallmarks of effective research.

1) Revenue that does not come from teaching or research

Emergence and the ill-posed problem

Mathematicians sometimes talk about the *well-posed problem*. A well-posed problem is a problem whose solution exists and is unique. It is sometimes possible to prove that a problem is ill-posed and, when this is so, we know it is time to call off the search. A problem can only be declared well- or ill-posed with respect to a definite belief system: we need axioms to decide whether the solution to a problem is possibly deducible or not.

Different knowledge communities have different belief systems and so are naturally predisposed to different conceptions of a problem. Imagine a subterranean aquifer close to the sea which is becoming salinized because of water abstraction. How can we solve the problem of salinization?

For an engineer, the solution may consist of a channel to carry water from one catchment to another, for an agronomist, the answer may be the adoption of drip irrigation, for a hydrologist, artificial recharge may be the solution and, for a conservationist, the solution may be to prevent or tax water abstraction.

Engineers, for example, believe it is possible to build canals and irrigation systems (this is part of engineering culture). They also believe the will exists to find a technical fix to the problem (why else call in engineers) and they have strong theoretical grounds for believing that importing large amounts of fresh water will reduce the need to abstract. They will consider the economic cost of this exercise and the likely availability of sweet water elsewhere but they are unlikely to consider the culture of the farmer: they bound the "problem-system" so as to exclude all those factors which they, as engineers, are not able to control.

Sociologists and anthropologists are more likely to consider the cultural receptivity of the farmer but are unlikely to take much notice of sub-surface geology. These issues lie beyond their principal area of competence. Once again, they bound the problem-system to include the factors they believe to be most significant.

This is a very general problem-solving method. We throw a boundary around our knowledge systems that corresponds, in broad terms, to the core beliefs of our respective knowledge communities. We do not deny the existence of exogenous factors beyond our understanding and control, we simply reduce it to a source of exogenous noise that we cannot, or cannot be bothered to represent or consider.

The only way we can apply rational methods to ill-posed problems is by negotiating "boundary conditions" that allow us to specify a belief-system within which the problem at hand appears well-posed. Any solution we propose to this problem must then be offered *ceteris paribus*[2]. However, it is often the case that other things are not equal: that the aspects of the problem we exclude from our belief-system are among the critical determinants of system behaviour. When this occurs, emergent phenomena may vitiate our work, leading to unforeseen and, within the knowledge system at hand, unforeseeable consequences.

The concept of emergence is sufficiently important and general to demand a definition. A phenomenon is *emergent* if it is not logically entailed from the belief system we have selected to tackle a given problem. Having defined the idea of emergence, the notion of complexity follows naturally. A belief-system is *complex* if it acknowledges the possibility of emergence.

Why do we need integrative research?

Nineteenth century philosophers of science were of the opinion that emergence, as defined here, was an illusion. Every scientific problem could be reduced to the laws of physics. Physical laws were deterministic, so we could, at least in principle, predict the GNP of Albania from Newton's laws and knowledge of the positions and velocities of all the atoms in the world. Problems of Newtonian mechanics are universally well-posed, so nineteenth century physicists and philosophers of science felt justified in assuming that every problem in social and natural science could be solved. The fact that the solutions to these problems consistently eluded us was due either to methodological constraints or to errors and inconsistencies in the way we specified problems. The problem with biologists and social scientists was their reluctance to grasp the nettle and formulate their research agendas with a proper level of scientific precision.

2) "other things being equal"

Many biologists and social scientists found these ideas unpersuasive, but influential philosophers of science were convinced. Economics, sociology, anthropology, archaeology, biology and geography were second-rate sciences in which the apparent absence of well-posed problems was caused by our failure to mathematicise.

In the early twentieth century this reductionist view had to be abandoned as developments in the field called "the new quantum mechanics" forced physicists to accept that certain phenomena were emergent and could not be predicted from fundamental the laws of physics, even in theory. Similar developments took place in biology and the social science. Celebrated theorems in mathematics were derived that disproved the reductionist thesis. Every finite belief system is too weak to allow us to deduce the truth or falsity of all statements. As the impact of these parallel discoveries was felt in a range of disciplines, scientists, mathematicians and philosophers were forced to accept complexity, though the impact of this on the practice of science was marginal.

Mature scientists continued to do what they had always done: they maintained the boundaries of their collective belief system (and taught the rising generation to respect those boundaries too). In research, they specified boundary conditions that reduced all exogenous factors to random "noise" and published their solutions *ceteris paribus*. They hid in their own knowledge communities and waited for the fuss to die down.

However, by the 1930s and 40s some younger academics began to take an interest in complex belief-systems where the only well-posed problems were trivial. There were many approaches to these problems some of which, though fruitful, failed to capture popular attention. Among the survivors, Operational Research, Cybernetics and General System Theory are significant because they appear to have coalesced into a more or less coherent methodological tendency which we can reasonable call "Systems Theory". In its simplest formulation, a *system* is a bounded set of components in articulation.

Systems theoreticians divide systems into rationally consistent elements, or sub-systems. Each element represents a local belief-system with its own internal logic. We might choose to construct a hydrological system and link it to an economic system or even a cultural system, for example. Each of these sub-systems is connected to its own environment and used to specify a locally well-posed problem and all the noisy, emergent aspects of the business are excluded. Then the theoretician connects each system to the others so that the behaviour of the hydrological system, for example, is used to specify some aspect of the boundary conditions for the economic system (water availability and water quality, for example). In the same way, the economic system provides part of the boundary conditions for the hydrological system (cost-benefit functions to drive water abstraction. By integrating simple, local systems in this way, we are able to produce a complex system that can be used to investigate emergent phenomena.

Many conventional textbooks of system method emphasise the mathematical utility of systems method. It is often very easy to convert a system specification into a mathematical simulation, especially now that we have object-orientated computational methods. However, at its most fundamental, a system is a formal representation of a composite belief-system; a set of universes of discourse each susceptible to changes of state driven by information flows between them and by flows of information passing across the system border. The deterministic and structural mechanisms we incorporate and the linkages we forge between sub-systems are formal representations of cultural, creedal and theoretical beliefs about the way the world works. Systems methods are devices for exploring complex belief systems or epistemologies, not monolithic representations of some objective, ontological reality.

We cannot investigate complex systems without integrating knowledge from more than one knowledge community. The engineer and the sociologist, the anthropologist and the chemist need each to help specify boundary conditions for their own sub-system. This is integrative research.

Integrative research is difficult because each specialist comes to the task with a personal conception of "the problem" at hand. That conception bounds the sub-system in such a way that colleagues must be able to specify the required boundary conditions. In practice, every specialist wants to shove the most difficult (ill-posed) problems outside his or her sub-system boundaries and arguments between specialists usually focus question about who is going to pick up the really nasty bits.

Some compromise is essential because some of the nasty bits cannot be modelled at all. A group of social scientists cannot expect a climatologist to simulate daily weather conditions on a 500-metre grid. At our current state of understanding, local weather remains an emergent phenomenon. Similarly, a social scientist cannot tell a climatologist how the residents of a certain village will respond to reduced rainfall over the next 100 years. Given current belief-systems, human behaviour on that scale is emergent.

The process of integrative research requires us to negotiate compromises between researchers that allow them to construct a composite knowledge system that capitalises on perceived strengths without compromising the logical consistency of the whole. In practice, this means that people must ignore some of their own theoretical and creedal beliefs for the duration of the work. Sub-systems must be bounded in such a way that only information (*sensu stricto*) flows across sub-system boundaries. Palaeobotanist can always identify olive pips, but it is much harder for palaeobotanists to engage in a meaningful discourse with post-structuralists about what an olive really is. One person's information is another's background noise.

How many knowledge communities are there?

Probably hundreds, but these "species" of intellectual activity seem to resolve into three, well-defined genera. The first believes that research is to enable scientists to move *from* the specification of a well-posed problem *towards* a definitive solution. Some engineers, neo-classical economists and technologists believe in well-posed problems and precise problem specifications and so belong to this *reductionist* genus.

The second genus consists of communities that believe research to be a device for moving *towards* a defensible problem specification. This is the *constructionist* genus. Experience shows that some engineers, neo-classical economists and technologists find this process tedious in the extreme and do not wish to participate. Many social or political scientists and systems thinkers find it stimulating.

The third genus believes that any attempt to formulate general problem statements is either ethically or intellectually indefensible. This *deconstructionist* genus consists of communities that believe the task of the researcher is to criticise and comment, but not to synthesise or generalise. I cannot imagine individuals drawn from the first two communities undertaking collaborative research with one whose deconstructionism is culturally embedded. Generalisation is so deeply embedded in our intellectual culture; we would be paralysed without it.

Reductionists and constructionists also find it hard to work together, because one has been acculturated into a knowledge domain that believes problem specifications are static while the other believes they are, and must be, dynamic. Nonetheless, the potential benefits of integrating them are considerable. Each has a blind spot where the other sees most clearly. Constructionists innovate, reductionists implement. Once again however, the extreme position, where reductionism is culturally embedded, is almost impossible to integrate.

In an emergent universe of discourse, problems are never well-posed, and our collective perception of those problems is determined by our cultural, creedal and theoretical positions. Perceiving a problem is only part of the process; we also need to develop a strategy to solve it. As we act to manage our cultural and natural life-support systems, our beliefs and conceptual filters change and we perceive the world differently. By articulating constructionist and reductionist method, we can create a reflexive or *appreciative* system in which the cultural and natural domains co-evolve.

Conclusions: Making the theory work in practice

Integrative research requires people from different knowledge communities to negotiate a temporary suspension of beliefs. In practice, theory-beliefs can usually be set aside quite easily. Creedal beliefs can occasionally be suspended for the duration of a project, but are much harder to banish or dismiss. Cultural beliefs are those that define the knowledge communities to which we belong. They are actually part of our sense of personal identity.

The temporary suspension of belief is an uncomfortable experience and noone should be forced to do it. I will assume, therefore, that everyone involved in an integrative project is there because they are genuinely willing to try. This being so, it is good practice to monitor one's own feelings for evidence of anger, frustration or intellectual isolation. When we experience this, it usually indicates that someone has trampled a culturally or creedally embedded belief.

We then need to ask three questions:

I. What belief was under question?
II. Is it really part of my intellectual culture or can I let it go for the duration of this project?
III. Is it really an intellectual axiom (a creedal belief) or can I treat it as a theory and subject it to explicit scrutiny?

The first question is often very difficult to face, but it can usually be answered quite clearly if one is sufficiently well-motivated. The second question may involve something of a struggle. With sufficient motivation it is sometimes possible to convert cultural beliefs into creedal beliefs. Creedal beliefs should not be ignored but they can sometimes be set aside, provided our colleagues realise their significance to us. Persuading ourselves that a creedal belief is actually a theory can be a liberating experience because it helps us to open our minds to new perceptions and new knowledge. This is integrative research at its most rewarding.

In practice, integrative research usually works best when most of those involved have been well-educated in a relevant knowledge domain. By *well-educated* I do not mean that they can reel offer a lot of data or facts. I mean that they have been inducted into a knowledge community that may, or may not correspond to a recognised academic discipline, and have spent enough years contemplating their education to have unpacked and developed it into a mature intellectual position with a firmly grounded culture, creed and theoretical base. This is very important; you cannot cross intellectual boundaries if you don't have an intuitive sense of where your own boundaries are.

Working across intellectual boundaries is tiring and the best rate of progress is made when we restrict the time we spend doing this. My experience favours short, highly focussed meetings in small groups with a well-defined outcome in mind. Meetings should be separated by substantial periods of preparatory work within a comfortable, familiar knowledge community. When the meetings take place, arguments are inevitable, but mutual respect is mandatory. Social activities are very important because they help build friendship between those present.

The task of negotiating integrative knowledge becomes more difficult as the distance between knowledge communities and the size of the group increases. When very different communities are involved, people must speak plainly and minimise dependence on jargon. Almost every knowledge community restricts access to knowledge resources by using an arcane language but it is a luxury we cannot afford in integrative research. Ideas so simple a first year undergraduate can understand them can get mangled beyond recognition when one professor speaks to another.

As Peter Smeets put it, we must create a "safe environment" if we want people to take risks and remove barriers to communication. It is best to work in small groups (ideally up to 7) where everybody has a clear understanding of what they are working towards. There should be no spectators. Negotiations go worst in large groups of relative strangers where arrogant, anti-social behaviour is often uncriticised and careless reasoning can remain unchallenged.

Communications break down when someone refuses to sacrifice cherished beliefs. That someone may be a hard scientist refusing to accept that humans are not rational actors, or a humanist refusing to discuss problem specification on the grounds that to do so would be to cave in to scientific hegemony. If there aren't many people present, you can often recover. If you really cannot make progress, declare the meeting a failure, explain why and adjourn it. When you re-convene (after a cooling off period, perhaps in another place) it may help to bring in an independent facilitator, either a colleague not involved in the project or a specialist in conflict resolution. Remember, however, that bringing in a new person increases group size and the failure of the last meeting will make the next one feel less safe.

Sometimes people who really wanted to participate, discover, when they try it, that they do not enjoy the process. Treat them with courtesy. Disruption and aggression are unacceptable but a quiet affirmation that some beliefs cannot be set aside should be respected. When colleagues refuse to give way, it usually means that their sense of identity is threatened. Some people are temperamentally unsuited to this work and you may have to ask them to find a deputy and withdraw. However, this is rare, especially when all those involved are committed to the work.

Some researchers, especially those who have not yet unpacked and assembled all they have been taught, imagine that the work demands a form of epistemological *relativism* (the pretence that any knowledge system is as good as another). In practice, relativism will put you at a disadvantage. If you have a weak understanding of your own intellectual culture, you will be blown like a straw in the wind. You need a strong sense of your own intellectual identity and of the intrinsic value of your own perspective to play your part in this work.

Any attempt to engineer an intellectual "melting pot" in which every participant is completely embedded will be self-defeating because all those contributing will be acculturated into a single, over-arching world-view. I could only join such a community by cutting myself off from my intellectual roots and repudiating some of the knowledge I shared with the knowledge communities in which I had been inducted. Integrative research is a device for harnessing diverse knowledge systems, not obliterating them. That is why I advocate that most of those involved in integrative research be well-educated in a relevant knowledge domain.

Indeed, in integrative contexts, cultural relativism and deconstructionism are vanities that will quickly lose you the respect of colleagues and stakeholders. Why should anyone who has embraced the discipline *(sensu stricto)* of becoming well-educated, respect the opinions of one who does not show a similar level of commitment to his/her chosen knowledge tradition? You will be expected to believe that your own knowledge system is best, but required to respect the opinions of others and to make an effort to accommodate their views. Sometimes you must agree to disagree.

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Success factors in inter- and transdisciplinary research: Selected results from the program Urban Ecology

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Expectations and practices in inter- (ID) and transdisciplinary (TD) research

The expectations concerning inter- and transdisciplinary research are high. Ideally, inter- and transdisciplinary research increases the applicability and practical relevance of research results, not only in landscape ecology or environmental sciences but in many different domains. These advantages concern as well diagnosis and explanation of a problem as the development and perhaps even implementation of solutions for it. Integration of various disciplinary perspectives is also expected to lead to a more profound scientific understanding of the phenomena under study

Trans- or interdisciplinarity is not an end in itself. It is meant to achieve particular aims. The desired goals of research projects across disciplinary boundaries generally are much broader than disciplinary defined designs. Moreover, TD projects generally involve the cooperation of non-academic participants. Goals defined within such projects therefore often include an explicit reference to societal value

However, not much is known about what can be done to support ID and TD in achieving these aims. In order to understand what can be expected, what works and what does not work, empirical studies of pioneering programs provide important insights which are vital for planning and designing new programs and projects. With a growing orientation towards sustainable development, this form of research will become even more important in the future, making the study of success factors even more salient. Empirical analyses can show us what can be expected of TD programs, where their intellectual and practical boundaries are and what the social and scientific relevance of their results can be. These are very important topics both for future scientific management and for science policy.

The statement contains a selection of results from two studies, concentrating on questions of integration and management. The case, from which the data are mainly drawn, is the program Urban Ecology. Additional data derives from the D-A-CH survey, which comprised four programs from Germany, Austria and Switzerland.

The program Urban Ecology

The German Federal Ministry for Education, Science, Research and Technology took a pioneering position when it established the Research Program "Ecological Research in Urban Regions and Industrial Landscapes" (Urban Ecology) in 1991. Problem-oriented interdisciplinarity and a combination of applied/oriented and theoretical/basic research characterized this program. A TD approach was expected to lead to a better understanding of the complexity of urban systems where the overlapping of natural, social and economic spheres is particularly relevant. Problem-oriented TD cooperation should ensure the applicability of results. The five research associations that were established each cooperated with two model cities. Disciplines ranged from sociology, economy, law and planning to ecology and engineering sciences.

These worked together for a period ranging from three to five years, involving scientists from more than thirty research institutes. The research of these five groups thematically covered "ecologically responsible mobility in cities" (two groups), "management of water-resources in cities" (two groups) and "solutions for urban land-use conflicts" (one group). In a case study on the five research associations of the research program, success factors were studied and qualitative analyses conducted.

The study of this program is particularly promising and can offer many insights for a number of reasons:

I. new forms of research organization were practised by establishing interdisciplinary teams which comprised natural and social scientists
II. the program was intended to increase applicability of research results and theoretical foundations at the same time through cooperation with practice and combination of basic and applied research perspectives
III. focussing on integration of concepts and disciplines

The D-A-CH questionnaire (conducted in 1999)

In the D-A-CH survey 285 researchers from four research programs (n=600) completed a questionnaire dealing with their experiences in inter- and transdisciplinary work. These were questions on research management, leadership and personal skills as well as on communication between research groups and forms of cooperation with experts from outside academia. The questionnaire also included three open questions concerning strengths and weaknesses of TD cooperation and recommendations for project organization.

The participating programs were I) "Urban Ecology" funded by the German Federal Ministry of Research, II) "Global environmental Change – Social and behavioural dimensions", a priority program funded by the Deutsche Forschungsgemeinschaft, III) the "Cultural Landscape Research", initiated by the Austrian Federal Ministry of Science and Transport and IV) the "Swiss Priority Program Environment", funded by the Swiss National Science Foundation (A project team from all four programs was involved).

What do members of ID/ TD research teams recommend?

Within the questionnaire, three open questions were posed concerning problems in cooperation and recommendations for the future planning of research. The following graphic shows the answers to the open question: Which advice would you give for the planning of future TD projects? The participants could name up to six recommendations. In the analyses, all different statements were recorded and then grouped into eight different content areas.

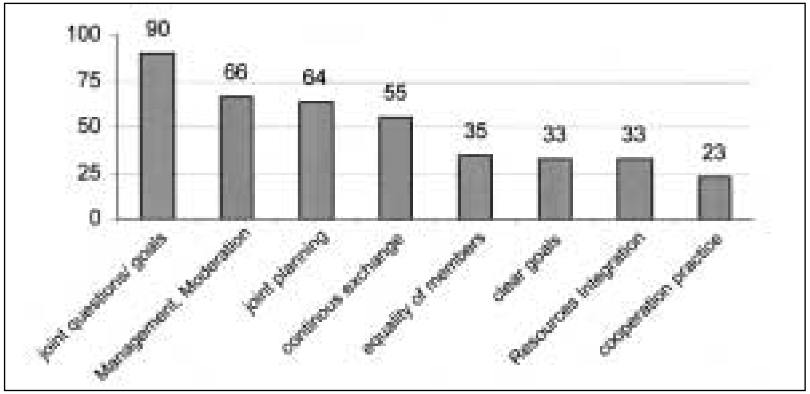

Figure 1: Recommendations for TD projects (Source: D-A-CH questionnaire)

The most important recommendation of the respondents was to formulate and stick to "joint questions and goals". This was mentioned 90 times. Directly followed by this recommendation, mentioned 66 times by the respondents, was the advice to "establish good management and moderation". Moderation here is to be understood in the sense of mediation, as e.g. mediating different points of view in a conflict situation. The need for management was among the most important and frequent recommendations derived from the answers of the members of the research teams. "Joint planning" (64) was also important which is also central to achieve "joint questions and goals" (90) as well as "clear goals" (33). The respondents further pointed out that "continuous exchange" (55) is a prerequisite for success, which again highlights the necessity of an active management of communication.

Their recommendation to ensure the "equality of members" (35) shows that democratic forms of cooperation seem more appropriate than hierarchical settings. These recommendations indicate that careful planning and active management of communication and co-ordination are vital to the success of TD research. Interestingly, traditional scientific qualifications were not mentioned explicitly in the recommendations.

What kind of management is needed?

The following diagram from the D-A-CH questionnaire shows the ratings for different characteristics and abilities of research management as the responding scientists experienced it in their respective research programs. The diagram shows the difference between the actual performance and the rated importance of the different characteristics and abilities of management. The figure shows two dimensions. Firstly it shows in ranked order which abilities of management are regarded as most important. Secondly it shows the actual abilities that the management of the projects in the four programs possessed according to the researchers participating in the study.

The blank boxes (actual performance) show that the abilities of management are highest for the "public representation of projects" (average 4.9) and their specialist "scientific expertise" (4.89), followed by "management does not take advantage of group" (4.77). Management is also "open for suggestions and criticism" (4.73). Its relatively "worst" rating, with an average of 3.66, management receives for "supporting the solution of conflicts in the team". Obviously, the leaders of the groups support the groups considerably less with this task.

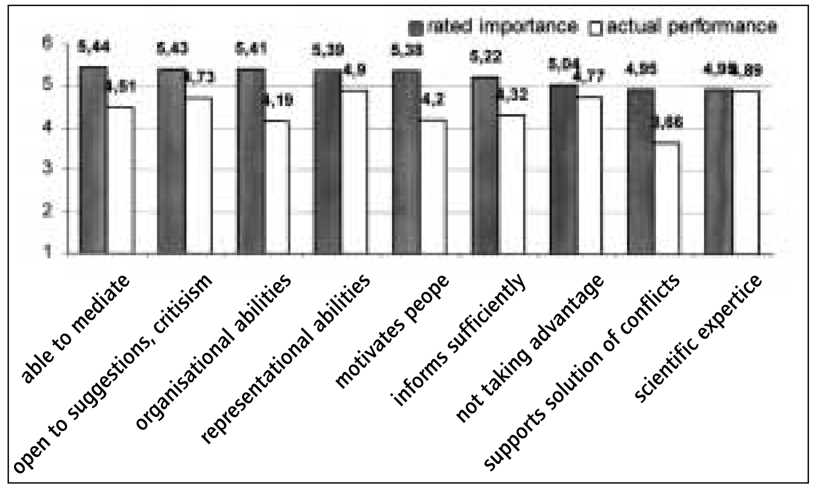

Figure 2: Importance and actual performance of TD management abilities (Source: D-A-C-H- questionnaire)

Looking at the ranked order of most important abilities (rated importance) respectively, the interpretation of the data leads to very interesting conclusions concerning the relevance of the management abilities that where named as the most important in the questionnaire. This can be regarded as an idealized preference ranking.

The ability to "mediate different positions" (5.44) and "openness" (5.43), followed by "organizational abilities" (5.41) are the top three. The importance of specialist scientific knowledge, "scientific expertise" (4.95), is rated much lower. Regarding such specialist knowledge, the data show almost no difference between the actual performance of management (scientific expertise 4.89) and the rated importance of management abilities. In contrast, for all other items there is a sometimes considerable, difference between performance and rated importance. This fact is interesting, since it implies that of course, scientific expertise is not unimportant, yet that for management it is only one qualification among others. A closer examination of these differences between rated importance and actual performance allows conclusions about the areas where the management of TD research should build additional competencies, e.g. in mediation, organizational abilities, motivation of members' etc.

Selected results and recommendations

The presented data and the following results and recommendations, which are selected here, represent only a small portion of findings and conclusions.

Management is important

As the observations presented in the above text indicate, management is very important for the success of ID and TD research. Notably, its abilities in mediation, in supporting the solutions of conflicts and in motivating team members should be taken care of. Management here is understood as comprising different management tasks. These can be performed by the leader, a team or single person. The following observations rely on the qualitative study of the program Urban ecology.

Thematic scope and concentration on joint problems

A broad problem formulation may seem very open and easy at first, since it leaves freedom to all disciplines involved. However, a broad scope that leads merely to a loose thematic connection pays for this with difficulties in the integration of the project as a whole. Focussing on a joint problem definition in the planning phase, therefore, can be vital for the success of work as it progresses. However, problem definitions that are open for revision and change when the members of the team see this as relevant allow for readjusting. Notably, concentration on one central goal may have its benefits but, as a possible weakness, might result in one-dimensionality as well.

One should keep in mind that the structuring of research questions is always also an act of construction and selection. Already in the planning stage and during the phase of formulating research questions and defining what actually the research problem is, management should take care that the defined subprojects are designed in a way that they will be integratable. This is not only important in the planning phase, but also during the various working phases.

Delegation of integration tasks

The actual task of integration can under circumstances be delegated, for instance to a specially appointed manager or a research groups leader. However, it is difficult to delegate the responsibility for overall integration to a collective body such as a research subgroup. Rather, it is recommendable that integration is a shared responsibility and to establish a form of integration where active contribution is supported.

When delegating integration as a special task to a subgroup, due to the complexity of results, such subgroups mostly heavily rely on the expertise of the persons that did the research in the first place. This results in them becoming dependent on the cooperative behaviour of the projects that "deliver" results. Integration thus is to be conceptualized as a common responsibility. It is important to keep in mind that integration is to be seen as a process of iterative steps that has to be dealt with repeatedly, from the planning phase throughout the working phase.

Integration in a sectoral world, however, proved problematic for the research groups. The group led by the engineers was regarded as highly successful. They copied the municipalities' sectoral structures within their own organization. Results were then delivered to the different departments. In contrast to this strategy, another group stressed the importance of arriving at integrated results. These should be economically viable, ecologically sound and socially acceptable at the same time. Regarding application of their results, they experienced that the sectorally structured administration of the city had difficulties in "digesting" their integrated results.

Diversity of partners

The German Urban Ecology program is an example of TD projects in which not only scientists produced knowledge and delivered it to their partners in the municipalities. The knowledge transfer also took place in the other direction. The problem that arose out of this constellation resulted from the fact that practice and science follow their own logics. This started with the question along which criteria the research project was to be structured. In order to make cooperation with practice possible at all in the first place, a practical relevance of the project had to be identified. Generalizing from this experience, this means that research questions have to be found that are both theoretically interesting and practically relevant at the same time. Another possibility can be to define at least some parts of the whole project in a way that they have something to offer to motivate practitioners to engage in the TD cooperation.

Conclusion

The selected results show that further empirical investigation of research practices is very promising for designing and planning future projects and programs. "Learning by doing" seems the only way how research can become more successful in the future. In order to be able to learn, however, the experiences of other programs have to be made available through study and analysis.

The discussion on the workshop showed that dealing with interdisciplinarity and transdisciplinarity leads us to *rethink our notion of disciplines.* This is not merely a theoretical exercise but is relevant for supporting this form of research adequately. What also became clear is that ID and TD practices are *not an end in itself.* When evaluating this kind of research one has to keep in mind not to start evaluating "THE interdisciplinarity". There is no such thing as the "ideal" interdisciplinarity. Interdisciplinarity denominates a range of research practices that may comprise very heterogeneous goals and types of research. Therefore, any evaluation has to be "relative", taking the diversity of these research practices into account.

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Understanding the nature of disciplinary boundaries as a reason for success in interdisciplinary research

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Interdisciplinary research can succeed or not. Reasons for success and failure are manifold. I argue that one of the explanations for success is a thorough understanding of the nature of disciplinary boundaries. These boundaries are the rivers evidently to be crossed to create something like an interdisciplinary research project. If one fails to grasp the nature of the boundaries involved, the bridges will unavoidably collapse or will not be constructed at all, leaving a sum of disciplinary motivated projects instead of an interdisciplinary one. Considering the amount of literature devoted to boundaries and interdisciplinary research, and considering the available space in this article, we must limit ourselves to a very concise treatment of the subject. However, I hope to convince the reader of at least one thing: that disciplinary boundaries have several natures, and that this should be kept in mind constantly when conducting interdisciplinary research.

Let's start with a metaphor: knowledge is a puzzle. Very few people might agree on this at first, but it can be a proper description of an assumption commonly held by scientists, maybe more widely spread throughout the natural sciences. If we say a lot of scientists tend to see knowledge as a puzzle, we intend to say that they consider the whole of all possible knowledge of the world as a puzzle. So, at every moment in time some pieces are missing and some are at the wrong place. Scientific progress creates a better picture of reality. Disciplines in this view are groups of pieces with a common subject, e.g. the castle on a picture of a Swiss jigsaw-landscape.

Of course, this is partly true. Like every metaphor, it is also partly untrue. Knowledge is also a social product, and it bears the mark of its origin. It would

be better to say that the shape of the jigsaw pieces changes, that the overall shape of the puzzle changes and that the resulting picture can vary markedly across time and space. This is the case because science is not a reflection of reality but a construction of reality, and not only a body of knowledge but also a group of people. A discipline is not an amount of knowledge related to one of the subjects on the puzzle that shows us reality. It is an amount of knowledge, yes. But since this knowledge is socially constructed, we should also consider that a discipline is a group of people.

Evident and trivial as it may seem, this simple assertion has consequences not always understood in research contexts. Some of the consequences are related to the nature of disciplinary boundaries. What the French sociologist Bourdieu called the sociology of the academy plays a pivotal role in the creation of knowledge. Knowledge is created in an institute; some knowledge is more probable than other to emerge from this context. The rules and codes of the institute influence the interpretation and validation of produced knowledge. If I decide to dye my hair green and purple, I make a slim chance to be taken seriously within the scientific community in general and the community of my discipline in specific.

A scientific discipline is part of an institute. Institutions, like all organisations, cannot easily erase themselves; they have a tendency to perpetuate themselves. This can imply several things. One of them is the solidification of the disciplinary boundaries. Since reputations are built within disciplines, recognition is gained within a disciplinary community, funding is organised along disciplinary lines, validation procedures are routed in disciplines, the disciplinary boundaries are not likely to disappear. Scientific specialisation is creating more and more boundaries.

A discipline is also a group as such, by which I mean just a group of people, regardless of other characteristics, comparable to an ethnic group. And ethnic groups unavoidably have ethnic boundaries. The moment a group of people starts to perceive itself as a group different from other groups, ethnic boundaries are emerging. People define themselves in contrast to others. The smaller the difference between two groups may appear to an outsider, the more minute differentiae will be stressed by themselves. A discipline needs identity and identity necessarily creates and maintains difference. In this respect the focus on details to highlight the difference between Germans and Dutch, in spite of their general similarity, is comparable to identity formation with and boundary maintenance between planners and architects.

A group of people can use everything as a sign of its identity. An organisation, like a discipline, can actively maintain the difference with other groups and therefore strengthen the group identity. It is also a symbol for this identity. Dress codes, hairstyles, hobbies, political orientation, it can all become a sign for the disciplinary identity, and solidify the boundaries.

A special group of distinguishing codes is codes of communication. Vocabulary, syntax and style are different in every discipline. Obviously, this is related to the subject. In mathematics, one will rarely meet the word 'dog'. However, the language used in a discipline is also a tool to refrain the public and other disciplines from participating freely in internal discussions. Because such a weak boundary could mean for outsiders that the discipline is a soft one, that it is not very scientific, disciplinary language produces a smoke-curtain.

At this point, it seems fruitful to move back to the puzzle and the domain of knowledge and reality. It was said that the shape of the puzzle and everything on it, are constantly changing. It can also be repeated that language creates and maintains disciplinary boundaries. Now I want to link these assertions to the notion of discourse proposed by the French sociologist and philosopher Michel Foucault. A discipline is a discourse in his sense; it is a structured set of ideas and the language associated to it that makes reality accessible for human thought. In the same movement, it creates reality. Discourses are contingent, cannot escape historicity, they are dynamic, and they partly define a group of people. Foucault showed how disciplines are discourses, how they originated in contexts strongly defined by power relations and by the contingent, historic, content of certain basic concepts like body, soul, matter and order. And he showed that the further evolution of the disciplines couldn't be explained without recourse to the starting point.

Bruno Latour, our next French sociologist, added fascinating glosses on this theory by pointing at the importance of methods, techniques and technology in the development and the self-definition of positive sciences. A discipline's path of evolution is partly determined by the machines and methods developed and used. If another method had been invented, the discipline would have looked differently, and the same goes for the reality produced. At the same time, methods and machines define the group of people using them: we are not only the people who study proteins, not only the people different from others, but also the people using these methods and these techniques. Upon hearing a question addressed to them, scientists often run quickly to familiar methods and techniques, because they are familiar and because they are part of their self-definition as this or that kind of scientist.

So, a discipline is also a discourse. This implies that it unveils certain aspects of reality while covering other aspects at the same time. In the Foucaldian perspective, this is the paradoxical nature of human knowledge: the structures producing knowledge hide other knowledge, make some other knowledge-producing structures less likely to be developed. Here we appear to hear a compelling argument for interdisciplinary research. If every discipline hides knowledge, another one can fill the gaps. Then we would end up with the puzzle after all.

Unfortunately, Foucault did not make life so easy for us. A discipline is not just covering a part of reality, no, it creates it owns image of it, thanks to all the mechanisms mentioned in this text, among which the strongest are the boundary- maintaining mechanisms. We could use the metaphor of the filter: if a discipline is a filter, then an interdisciplinary research project can be a series of filters. Crossing the boundaries then implies filtering information several times in a row. The result would be a very poor image of reality instead of a richer one.

This does not mean that interdisciplinary research is impossible; it rather suggests that the reflection on a common language is of foremost importance. It also suggests that a common language should not be defined by simply finding the common denominator of the participating discipline's languages. Instead, there is a need of constant reflection on the used language and concepts, and an effort to construct a common conceptual framework, featuring at least some new concepts.

The reader has noticed that an analysis of disciplinary boundaries has in this text been combined with an analysis of the concept of discipline. I consider this necessary, because disciplines define themselves and can be defined in several ways, and the chosen type of definition evidently influences the characteristics and the role of boundaries:

A discipline is an amount of knowledge on a certain subject.
A discipline is something creating its own subject.
A discipline is a discourse, a structure producing knowledge. It is something contingent, historic, dynamic, linked to a group of people.
A discipline is an organisation of people, an institution, self- perpetuating.
A discipline is a group of people, using all types of distinctive codes.
A discipline is a language.

Such a list reflects the complex identity of a scientific discipline. Every aspect of its identity produces and maintains its own type of boundaries, using different mechanisms. Identities, boundaries and mechanisms could very partially be unveiled in this text. It may however stand out very clearly that one important reason for success and failure in interdisciplinary research is a raised awareness of the nature of the disciplinary boundaries to be crossed. Some bridges are likely to be built, others not.

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Notes on the discussion on this paper at the Alterra- seminar

1. A distinction was made by Nick Winder between discipline and community, where discipline is considered as the top-down aspect of the knowledge-system, the institutionalized context of the knowledge-production. Community is in his view the group of people sharing [scientific] views, a bottom-up phenomenon. I presented concepts comparable to discipline and community while talking about institute and group, as aspects of the multiple identity of discipline. Therefore, I partly agree with him. The importance of his distinction deserves to be underlined, but could be placed in a somewhat different context [a disciplines' identity has many sides].

I do not fully agree with the linkage he makes between the concept couple discipline – community and the couple top-down – bottom-up. Indeed, the concept of institute is likely to entail more notions of hierarchy than the concept of group. But at the same time, groups can partly identify themselves by referring to and attaching to the structures of an institute. Order can be imposed and order can be asked for. A prisoner needs the prison after twenty years of imprisonment. He identifies with the institution, its rules, its order. Therefore, it seems difficult to maintain that a discipline in Nick Winder's conception [discipline as institution] is fully a top-down phenomenon and irrelevant for the formation of identity.

2. Arnold van der Valk mentioned the numerous difficulties experienced in the practical application of my plea for a constant reflection on common language and common frameworks. I wish not to deny these difficulties. It should also be acknowledged that some projects can fail because the task implied in the plea is in some cases an impossible one. However, I do not consider the plea as something trivial or unrealistic, since a lot of very real projects start with the definition of a common language or at least a common conceptual framework, before going back to usual, which is monodisciplinary work or interdisciplinary work without reflection on the communication. Some of these very real projects fail because after a while people started to realize that the communicative transparency created by the common framework was a false one, that people were referring to different things and concepts all the time, and using

different basic assumptions without being aware of that. Far from stating that a complete awareness of one's own conceptual world is ever possible, I only wanted to stress the necessity in interdisciplinary projects to raise this awareness.

Disciplinary perception and interdisciplinary communication in management of natural resources

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Introduction

It is recognized worldwide that problems related to sustainable production are complex and can only be resolved through interdisciplinary cooperation. Problems related to interdisciplinarity are experienced in any project where disciplines work together to achieve sustainability. These universal problems are the subject of this statement. They are discussed in the context of sustainable management of natural resources.

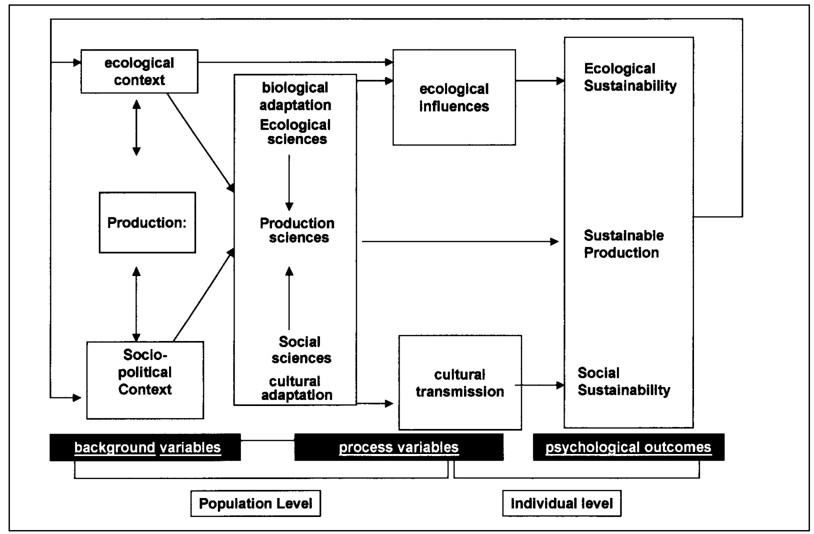

Figure 1. The eco-cultural model: three groups of sciences (ecology, production, social) perceive sustainable production in different ways (adapted from Berry et al., 1998)

The model (Figure 1) used to grasp the interdisciplinary dynamics of sustainability is the eco-cultural model as developed by cross-cultural psychologists (Berry et al., 1988). They suppose that individual behaviour can only be understood when both cultural and biological features of our species are taken into account. The flow of the figure is from population level variables, influencing the individual outcomes. This connects with the point of view of cross-cultural psychologists that individual and group differences in psychological characteristics are a function of population level factors. So, it might be that farmers display individual behaviour, due to pressures at community level, like the pressures currently coming from eco-activists to use agro-industry resources more sustainable.

The ecological context (Figure 1) is the setting in which human organisms and the physical environment interact. To understand the psychological outcomes at the individual level, we need to study a system where:

I. the ecological context and the socio-political context function as background variables;
II. ecological influences (studied by ecological scientists) function as process variables by which a degree of biological adaptation is achieved;
III. cultural transmission functions as process variables to bring about cultural adaptation and is studied by the social scientists; and.
IV. observable behaviour at the individual level and inferred characteristics are displayed as psychological outcomes, studied by psychologists.

A third group of scientists – in the production sciences – study the most rational way humans exploit natural systems for their own needs. They can be considered as operating at the interface between nature and culture. In an era of substantial technological change, together with the consequent cultural changes this brings, almost all communities are in the process of rapid change, with high risks for ecological and social sustainability, which are essential for sustainable production.

The existence of different perspectives for assessing the sustainability of agricultural development has been pointed out by several authors (e.g., Giampietro, 1997). In spite of minor differences in definition, there seems to be agreement that at least three fundamental perspectives should be considered:

I. The ecological view: agricultural techniques must be environmentally sound;
II. The production view: agricultural techniques must be economically viable;
III. The social view: agricultural techniques must be acceptable to farmers and society, given their culture, ethics, and religion.

Integration of the three kinds of sustainability seems to be necessary for the future of the human race. This integration creates a need for interdisciplinary communication among widely differing groups of stakeholders which has been the subject of study already for several decades and seems to give the same problems as intercultural communication (Klein, 1990).

Scientific perception

Differences in professional perception of scientists (Figure 2) are reflected in paradigms, the methodology of their discipline, their scientific attitudes towards nature, and the scale and time dimensions of their discipline. To understand the perception scheme (Figure 2) it is supposed that within a particular context, which can be defined as a village or region, a profound change occurs, like salinization, or more general environmental degradation, that causes upheaval within the community. This change is called a stressor. This stressor has a significance that is experienced by all of the people who have to cope with it, like farmers, members of land care groups, as well as the soil scientists, agronomists and social scientists. This experience, or the way the change is perceived, is different for each individual, for each social group, and thus for each scientific group. Those differences in perception can be analysed on an individual level and at group level. Remarks in this statement are confined to the individual level.

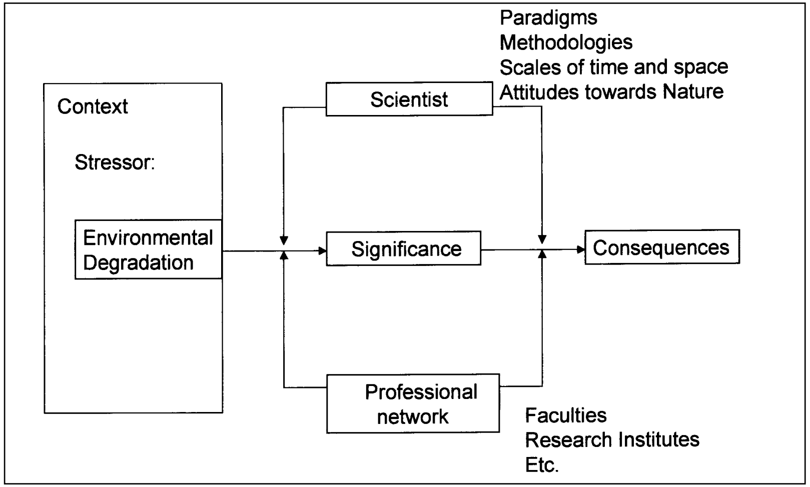

Figure 2. Perception scheme

How the professional network influences the perception of the individual scientists (Figure 2) is described by the anthropologist Mary Douglas (Douglas, 1987) among others. Although important, it will not be considered further in this statement other than to remark that the disciplinary way in which western society has organized its institutions makes it very difficult to achieve adequate change. Actual and observable behaviour is a refection of the consequences of any changes in a production system (Figure 1) and mirrors the significance of the stressor as sensed by the perceiver. For this statement we suppose that paradigms, the methodology of a discipline, and the scales of space and time dimensions of a discipline are more or less known. Scientific attitudes towards nature seem to be less known.

Scientific attitudes towards nature

People reflect their opinion about reality in their attitudes towards nature. Theories about the relationship between humans and their environment can be derived from natural or physical sciences (ecology, physics etc.) or from social and behavioural sciences (e.g. economics). In the social sciences, there is the everlasting discussion of man as a part of nature versus man and culture against nature (e.g. nature-nurture discussion in psychology). It seems like:

"Man inhabits two worlds. One is the natural world of plants and animals, of soils and airs and waters which preceded him by billions of years and of which he is a part. The other is the world of social institutions and artefacts he builds for himself, using his tools and engines, his science and his dreams to fashion an environment obedient to human purpose and direction" (Kates, 1988).

The idea of nature as a function of social organization, and the way individuals are caught up within systems of knowledge, are things that are too complex to be taken into account in this study of attitudes, but should be an important aspect for further research.

The philosopher Zweers defined 6 different attitudes towards nature (Zweers, 1995). In research associated with a large interdisciplinary project in Cameroon, the categorisation of Zweers was used to see if there were disciplinary differences in attitudes towards nature (Van Haaften, 2002; Van Haaften and Henrison, 1996). The categories used were:

I. Man as despot. Man as an absolute governor who modifies the environment to his need, without any consideration.
II. Man as enlightened governor. Man governs nature but is conscious of the dependability on nature, the limits of its resources, and the resilience of ecosystems.
III. Man as steward. Man manages or governs in the name of somebody else. He is accountable to a supernatural authority or to society, including the next generations.
IV. Man as partner of nature. The image of partner makes this option quite different from the preceding concepts, because one works with a partner on the basis of equivalence to attain a common goal.
V. Man as participant of nature. It belongs to the specific human capacities to be part of nature in his own way, by recognising the value and experiencing the meaning.
VI. "Unio Mystica". This concept is directed towards religiosity and identifica-

tion (“Oneness with nature”). One can not talk about it in a reflective way.

With a factor analysis, two factors could be determined (Figure 3), which were called the ‘relative care for nature’ and the ‘relative distance of nature’.

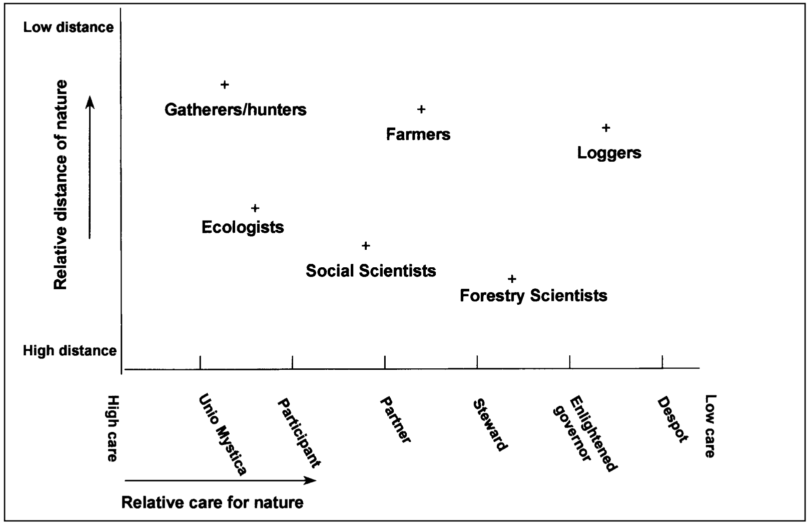

Figure 3: Two factors composing Attitudes towards Nature

It appeared that the three direct users of forest resources, the Bantu farmers, the Pygmy nomads, and the commercial loggers were considered to exhibit the least distance to nature. Their relative care for nature however was judged completely differently. Loggers were seen as the least caring group without any consideration, while the nomads (Bagieli) were considered as the most participating and caring group. It should be noted that this concerns the images the interviewees have.

Interestingly, groups of scientists seem to repeat the pattern of the users of forest resources: the ecologists were considered to exhibit the most care and the forest scientists the least. These findings are important for interdisciplinary communication. Those biases can seriously upset free scientific communication. Team management has to acknowledge these biases and to facilitate communication. These findings are relevant in three respects. In the first place, attitudes towards nature express the idea of reality. In the second place, it is possible that those attitudes are the source, or largely the source, of the interdisciplinary communication problem and, in the third place, the different attitudes can block scientific communication.

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IV Needs for training of professionals in research and policy

On needs for training

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This section deals with the short and long-term educational needs of policy and research staff. The main focus is on the education of researchers from university courses to the in-service needs of landscape professionals and their managers. One of the clear messages from the section is that much greater knowledge of the nature of interdisciplinarity is needed. This knowledge should also include deeper insights into when interdisciplinary approaches are appropriate and their limitations.

The overview paper by Fry looks at the needs of integrative educational courses from school level through university and research education to landscape professionals in work and policy. The PhD student level was discussed in depth, as this is the level where much interdisciplinary research takes place. The paper raises several arguments against this policy that can cause several practical problems ranging from missing the opportunity to join an academic knowledge-community to not reaching sufficient depth nor integration to able to publish findings.

The paper by Bohnsack describes a multi-university MSc course that aims to be integrative. The course includes diverse aspects of ecosystem conservation and management with an emphasis on ecology and nature conservation. Students found the course important for broadening their horizons and understanding different disciplinary perspectives. The main areas where improvements are suggested are to facilitate students in integrating the various information given them, and to reach sufficient depth in selected aspects to understand better the implications for management. This dual need for broad knowledge and sufficient depth to understand the implications of landscape planning decisions was much discussed at the workshop reflecting the on-going, active debate in higher education.

The integration of knowledge was also taken up in the paper by de Nooy-van Tol that presented the Wageningen Initiative for Strategic Innovation. This programme aims to support researchers wishing to increase interdisciplinarity and especially transdisciplinary aspects of their work. The paper presents a summary of the characteristic and prerequisites for transdisciplinary research and requests the development of new ways of assessing the quality of research to reward transdisciplinary research.

The issue of professional training, was also taken up by Groot in a paper that looks at the fundamental changes needed in our university educational system to promote multi-actor learning systems and research (transdisciplinarity). Process managers are seen as important members of research teams and have the specific task of mediating between disciplines and moving studies towards inter or transdisciplinary concepts, theories, methods and solutions.

There was an active discussion on these papers which focused on what is and is not research as well as the evaluation of integrative and participatory research. The reality of being able to force disciplines into some form of joint theory or multiple perception of reality was also questioned. Joining interpretative approaches with natural sciences approaches seems especially problematical, as it requires one or other to abandon their knowledge culture. The best that can be hoped for may be to foster a greater understanding between different perceptions of reality - fully accepting that the realities shared by different knowledge cultures may remain different. The challenge may be how to reach a productive form of dialogue between actors who agree to disagree.

Training needs for interdisciplinary research

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Why do we need education and training strategies for interdisciplinarity?

The countryside is currently a mess of interests often providing land owners and managers with conflicting advice and grant aid schemes. We have a situation where different types of researcher with different disciplinary backgrounds are studying different aspects of landscape for different sectoral interests. Both academic institutions and policy have supported or made worse this trend over a long period. Fortunately, the situation is changing and policy is now in favour of integrated approaches to landscape: approaches that demand new forms of integrated knowledge from research environments. In addition, researchers are no longer expected just to provide knowledge that is passed on to others to interpret and apply, instead they are increasingly expected to interpret research findings and to be part of the implementation process working together with a variety of stakeholders. The EU 6th Framework is an example of this trend and includes specific requests for changes in the content structure and institutional focus of science in the broadest sense. This would involve increased relationships between scientific research and other fields of activity such as innovation, education, professions and public debate. The role of research thus becomes an expanded concept including its use as the provider of reliable knowledge, as a means of diffusing and communicating this knowledge and as a user of this knowledge for a variety of purposes (FP6, Area 1.1.3 Science and technology in the knowledge based society). Two of the main characteristics of the new demands on research are to improve the dialogue between disciplines and to involve users of research in the research process. These demands involve significant changes in researcher and research management behaviour, changes that require a package of educational and training initiatives.

Education for interdisciplinarity

Education for the future knowledge society presents many and varied challenges. One of these is whether it is possible to identifying key skills that will enable pupils to cope with the challenges of the knowledge society and with moving between different knowledge cultures. The importance of knowledge acquisition in this process and the degree to which such key skills can be transferred to new situations remains controversial. However, the future should see weaker boundaries between disciplines and a wider view of the remit of research in society. This process starts early, making sure pupils maintain a broad understanding of what constitutes reliable knowledge. Education at school level seems to be doing a good job. Trends in education throughout Europe show greater emphasis on project-based learning at school level. In fact one finds in schools a collection of education activities that support interdisciplinary approaches, but it seems to go wrong at university where mono-disciplinary approaches still dominate.

There are many good integrated courses especially in environmental sciences and new courses are constantly developing. The weakness in higher education systems is that courses are often taught by disciplinary experts. The integration between, for example, ecology and economy is left to the students. A further problem is that the concept of interdisciplinarity is not well understood - even by those teaching interdisciplinary courses.

Post-graduate students - the losers

At school level there are many promising educational developments where projects involve several subject disciplines. At the graduate level there are increasing opportunities to take courses across departments even though many are unlinked disciplinary course modules. However at the research training level we can see several problem areas. Of these, two of the most serious are the limited availability of supervisors in interdisciplinary research methods, and problems associated with a lack of disciplinary identity by the students. There are few suitable supervisors available to take responsibility for research training - most lack either motivation/commitment to interdisciplinarity or experience as an interdisciplinary researcher. It is expected that the situation will improve but it will take time. In the meantime, too many PhD students are given research tasks that their supervisors cannot tackle. The conclusion is that interdisciplinary studies will be a hard internship, one that may lead to poorer chances of completion or longer time to complete. Even more worrying is that an interdisciplinary PhD topic may place students at a disadvantage in obtaining a research job when their PhD is completed. There are several reasons for this, it may take longer to complete an interdisciplinary study, fewer publications may result and the work may not be seen as relevant as a disciplinary thesis to an appointments board. Similar arguments can apply to teaching appointments where there is a clear need for the new appointee to be responsible for specific disciplinary course units.

What can be done for PhD students?

There are several things that can be done to help students through the many traps and tests awaiting anyone wishing to plunge into an interdisciplinary PhD study. The first of these is simply to provide huge amounts of support at the supervisor and institutional levels. If institutes apply for financing to start interdisciplinary PhD projects, one assumes they are committed. This commitment should focus on measures to combat the feeling of isolation that interdisciplinary students often experience. They often lack the strong disciplinary identity shared by students of single disciplines and all the methods and norms that follow disciplinary cultures. In addition, the student may also feel not at home in the host institute. These problems require careful handling in a supportive atmosphere. Where supervision is across disciplinary boundaries, or those of knowledge cultures, it might be an advantage to use supervisory teams (carefully selected). The students will require more careful follow-up and hence an increase in supervision time may be necessary. A wider range of courses and seminars may be required to help understand the epistemological basis of different knowledge cultures and to understand the dominant methodological approaches and theoretical underpinning across a range of subjects. Providing opportunities to mix with other students sharing the same problems and to develop their own knowledge culture is also an important supportive activity. In their own institute, students need to fill that they are doing a worthwhile study, that they are respected and that they belong. The development of research schools in Europe has been an important measure supporting interdisciplinary PhD students. Some of these include process managers neutral to the department and subject with the task of facilitating the progress of the interdisciplinary research student.

Training challenges for existing researchers

Understanding the areas of conflict and academic challenge in interdisciplinary approaches is an important step in being able to cope with varying disciplinary beliefs and norms. These differences can be related to the nature of data, the capture of data, sampling protocols, analysis etc. but also to more practical considerations such as where and what to publish. How can training courses be used to move people from the comfort of their own disciplines to join in interdisciplinary projects? The same can be asked about the training for transdisciplinary research linking specific real world planning issues to research via the participation of stakeholders in the research process. Should we be expecting researchers to re-train to accept this broader reshaping of the research task or is it more appropriate and efficient to work as teams of researchers, information and process managers with specific responsibilities towards reaching a solution?

It might be necessary for disciplinary researchers to get updated on other subject disciplines and knowledge cultures, including greater insights into their own.

Training programmes, often in the form of crash courses, may be a useful way to help researchers deal with some of the frustrations and barriers to interdisciplinary research. Courses can warn of potential pitfalls and conflicts before they happen. In this category I would include publishing the results of interdisciplinary projects, leadership and management aspects, writing grant applications and career development.

Research careers and interdisciplinarity

The widely held belief that interdisciplinary research, and more so transdisciplinary approaches, faces difficulty in gaining research merit and publishing results needs very careful handing. It would appear that it is more difficult to produce publications from interdisciplinary studies. However, the reason for this is less clear. It is certainly not because there is a lack of suitable journals and there is no evidence of bias against interdisciplinary studies. There may be problems in writing across the stylistic and presentation norms of several disciplines, the selection of an appropriate journal etc., and these may be improved by specialist courses.

The training needs of research managers

The first need of research managers is a clear understanding of why their staff is involved in interdisciplinary studies, the nature of interdisciplinary research as well as its potential and limitations. Why are researchers engaging in these approaches and what is the institutional framework? Such considerations include identifying the boundaries between research and other activities such as development and consultancy work. Mangers and funding bodies also need information on the academic challenges that face successful interdisciplinary approaches. Practical advice such as setting modest ambitions regarding scale of project and an awareness of the important role of personal chemistry and group dynamics are also important. Beyond this understanding of the nature of the interdisciplinary research process, the main need of research management is an understanding of suitable infrastructures to support interdisciplinary research, as these differ somewhat from most disciplinary needs. There may be need for more time and administrative assistance, opportunities for meetings, clearer time and space management etc. Clear policy on rewarding interdisciplinary effort and explicit signs of support are also important for researchers. Review of the institutional merit system might include how different types of research and development will be assessed and rewarded.

The development of such background skills and knowledge contributes to the ability of managers to provide a secure environment where inter and transdisciplinarity can thrive.

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The new multi-University MSc in Applied Science "Ecosystem Conservation & Landscape Management" (Ireland, Netherlands, Finland)

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Introduction

The new MSc in Ecosystem Conservation & Landscape Management is a 20-month full-time multi-disciplinary course run jointly by University College Cork (UCC) and the National University of Ireland, Galway (NUIG) in conjunction with the Universities of Nijmegen and Utrecht, The Netherlands, and the University of Helsinki, Finland. The aim of the course is to train and educate graduates in the area of nature conservation and management of habitats and ecosystems and to provide an understanding of disciplines which impinge upon these in order to meet the growing demand for such personnel at home and abroad. The programme includes taught courses in all three countries, placements in state agencies and private consultancies in the Netherlands, field excursions in Finland and field and project work in Ireland. The first cycle of the course commenced in 2000 and cycles run consecutively. The admission requirements are at least a 2nd Class Grade 1 Degree in Ecology, Environmental Science, a relevant Biological Science or related area or the equivalent industrial experience in the subject area.

This short paper aims to give an overview of the course and - drawing on feedback from the 1st cycle students - to highlight problems as well as opportunities encountered in running a multi-disciplinary, multi-university course.

Syllabus

The course involves taught Modules with a strong practical and field work component, practical placement in industry and state organisations and a 4-month research project. The course is run at four centres:

Year 1: January to April at University College Cork (UCC),

April to July at the Universities of Nijmegen/Utrecht, The Netherlands, September to December at the University of Helsinki, Finland

Year 2: January to end of April at the National University of Ireland, Galway, May to end of August - Project work at UCC or NUI, Galway or with State Agencies, Research Institutes or other relevant bodies.

The sequence and location of modules offered are as follows:

University College Cork, Cork, Ireland (UCC):

- The Physical Environment (1 unit)
- Populations and Communities (1 unit)
- Principles of Conservation (1 unit)

National University of Ireland, Galway (NUI, Galway):

- Introduction to Hydrology (1 unit)

Universities of Nijmegen and Utrecht, The Netherlands:

- Management of Aquatic Ecosystems (1 unit)
- Restoration Ecology (0.5 unit)
- Planning, Policy and Legislation in Conservation (1 unit)
- Practical Conservation Management (1 unit)

University of Helsinki, Finland:

- Introduction to Fennoscandian Biogeography (0.5 unit)
- Workshops in Conservation Biology (0.5 unit)
- Landscape Ecology and Geographic Information Systems (1 unit)
- Conservation Ecology (1 unit)
- Field Excursion in the Taiga (0.5 unit)

National University of Ireland, Galway (NUI, Galway):

- Ecological Survey Techniques and Data Analysis (1 unit)
- Management and Monitoring in Ecosystem Conservation (1 unit)
- Landscape Ecological Processes with Special Topics in Nature Conservation (2 units)

UCC/NUI,Galway and Irish State Agencies, NGOs, etc.

- Conservation and Management Project (3 units)

These courses are based in the NUl, Galway Burren Field Station, Carron, Co. Clare.

First cycle students – Background and progress

The ten students (maximum number of places = 12) of the first cycle held BSc degrees in Zoology (4), Ecology (4) and Environmental Sciences (2) and all but one were Irish. It is planned to broaden the spectrum of students' nationalities by the 3rd cycle (2004/5). Of the ten MSc students two have gone on to study for PhDs. The remainder initially went on to transitional employment ranging from university-based research, environmental education, agri-environmental planning, transportation planning, NGO support to college lab demonstration and unskilled jobs. Six of the students are known to currently be engaged in professional work as:

I. Research officers, University College Cork, Zoology Dept. (2)
II. Ecologist with Irish State Conservation Body
III. Intern at IUCN Species Survival Commission
IV. Transportation Planner, Environmental Consultancy Firm
V. Research assistant, National Environmental Education Centre

Interdisciplinarity - what the students say:

The following are quotes and extracts taken from comments the 1st cycle students provided just prior to this conference when asked whether they felt their training needs had been met, what the shortcomings were in their opinion, and whether they felt they had been given sufficient insights into other disciplines to be able to effectively work and communicate with people from other disciplines in their professional work.

On the positive side:

a. *"I have been introduced to some terms and ideas that maybe most ecologists would be completely unaware of ..."*
b. *"The travel aspect of the course provided the possibility to see problems experienced in other countries/agencies and the ways in which they tackled them..."*
c. *"The training has given me the ability to deal with documents relating to geology, hydrology, soils, planning and legislation and to sift out and use the relevant information and to get information from people in these areas."*
d. *"The course gave a crucial insight into other disciplines: that they're there and how they work."*
e. *"Overall: a good foundation to build on and a lot to learn."*

On the negative side:

a. *Flora/fauna identification skills and fieldwork were not sufficiently developed.*
b. *Knowledge in related disciplines was gained, but it was "not related back to ecology".*
c. *"Currently I don't feel qualified enough to be in a position to do many jobs - unless they are very general."*
d. *"I know bits and pieces about lots, but I know a lot about very little!"*
e. *"The main problem was the lack of communication between the various institutions, which is crucial when you want to train people in lots of different disciplines."*
f. *"Sometimes those chosen to teach us were not too sure what they were meant to be teaching a bunch of ecologists..."*

The second cycle and beyond

Based on the experience with the first cycle of the course some changes have been made, including a stronger emphasis on flora/fauna identification skills and fieldwork, more advanced modules to be taught in Helsinki, and attempts at improving coordination between the various universities and lecturers. In the longer term EU funding will be sought for a major course review and the pending EU enlargement may offer interesting opportunities for an additional (or replacement) national partner.

Questions & conclusions

Students are clearly keen to embrace inter- and transdisciplinary studies. They seek practical experience and a safe space for making mistakes before going out into the 'real world'.

The question arises as to how the teachers or 'learning facilitators' can give students a good grounding in a wide variety of fields/disciplines and a more in-depth and thorough knowledge of their main subject/focus.

Given that students in such a multi-disciplinary course come from quite different backgrounds it would seem that teaching methods are required which encourage students to share knowledge/experience gained in their primary degree.

A course of this nature clearly needs a dedicated, skilled, multidisciplinary coordinator

I. to assure coherence of the syllabus;
II. to avoid duplication of module content;
III. to review and modify the syllabus on an ongoing basis in order to meet professional training needs.

Needs for training of professionals

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Prelude

My contribution based on the experiences I have with WISI, Wageningen Initiative for Strategic Innovation. WISI is project of Wageningen University and Research Centre (WUR). Its aim is to stimulate and support all scientists who feel the need to work in an interdisciplinary and participatory way, but need extra time, facilities, skills and moral support in their daily surroundings. The WISI project was a direct result of an inventory of the threats and problems encountered, and the opportunities for interdisciplinary approaches. The inventory was carried out in 2000 in reaction to the demand of scientists. WISI did the inventory by way of a colloquium series, focussing on different subjects; the publication of the outcome of the colloquium series is in Dutch, but for those interested I have added a summary of characteristics and preconditions in English.

Why conducting transdisciplinary research in the first place?

To change our research and research methods towards a more interdisciplinary and even transdisciplinary approach is not something we would do just for the fun of it, or because of the enthusiasm of a few pioneer scientists; I believe that there's an urgent need for it that comes forth from two directions:

I. Historic insights: real innovation and breakthroughs in science and technology only happen on the interfaces of specialist scientific disciplines
II. Developments in society: the problems we –society– are faced with when trying to make use of our resources in a sustainable way, can only be solved when we look at processes in an integrated manner, a holistic approach, to understand the complexity of what we do.

Landscape research as a forefront runner

In landscape research this is particularly so, as landscape can be defined as the (process-) result of the interaction between humans and nature in their effort to organise life/society. More specific: economic, socially, and culturally administered processes interact with the available resources –soil, water, ecological systems and the morphological landscape– which results in the landscape as we experience it in its different forms all over the world. Thus landscape tells us something about the way we make use of and misuse the resources, deplete them. But also how, by means of strict general regulations for one particular land use (e.g. agriculture, or nature conservation), we harass the people who want to interact with their environment in an integrated, locally supportive, sustainable way, whether it be Dutch or Portuguese farmers, or local communities in the Sahel.

We need quite a number of disciplines if only to make a (scientific) image of the interrelations that exist, and then we don't even count yet with the people who inhabit the particular area we are talking about: people with their own implicit knowledge of both their environment and how it reacts to what we do with it; people to whom the landscape is meaningful in different ways.

Conclusion: It's quite obvious that one cannot understand the complex web of interrelations from the viewpoint of a single discipline, nor from a scientific viewpoint alone. And next to that, we know that when we start making assumptions or presuppositions regarding the possible solutions of the problem, even as objective scientists, we are guided by our personal principles, and values, and by the "illusion" of our own disciplinary perception, which often stand in the way for a proper solution.

Abilities needed for transdisciplinary research

The above brings us to the question which abilities are needed in order to be able to actually do research in a transdisciplinary way, to cope with the complexity and the value systems? Which expertise, skills, competencies are helpful? For the discussion about this I would like to share with you my experiences with the WISI project, which is focussed on supporting scientists and students to develop those skills and competencies.

Description of the goals and approach of WISI

Within the WISI project, we have not prescribed certain skills, as we believed very strongly in supporting professionals with inspiring ideas instead of a top-down approach. So, we have offered project leaders, who wished to learn alongside an actual project, to finance whatever support they felt they needed, as long as it was directed towards improving transdisciplinary work, and for this endeavour we did have a few criteria (cf. appendix).

All the items that turned up were different and appeared to be more and more interesting, as along the way we were learning together about the needs for professionals:

I. A course in communication skills
II. Time for a participatory pre-phase of a project to define the (complex) question together (quite a number)
III. Support for an "atelier", a number of creative sessions with all the stakeholders involved in an area, to design a road towards a solution.
IV. Support at the beginning and during the project for Scenario-casting techniques
V. Support at the beginning and during the project for system approaches
VI. Support for a pilot course, here in Wageningen, about system approaches
VII. Two workshops for the scientists involved in organic agriculture, as in this field problem solving is particularly interested in holistic and system approaches, in implicit experiential knowledge.
VIII. The first workshop offered 8 parallel 2 hour sessions from which 2 could be visited in a day, in order to make acquaintance with a certain approach; if interested a whole day workshop on a certain approach was organized as a follow up. This was very effective, but most people said they would prefer a longer course in a certain approach.
IX. A project to find out about combining implicit with explicit knowledge in a scientific way

Needs of professionals when doing transdisciplinary research

What did we learn about the real needs of professionals in order to enable them to work in transdisciplinary ways?

Communication: we need to learn to be open to other paradigms (other cultures) of other disciplines, or at least to be aware of the fact that other disciplines are like other cultures, and it needs quite some communication to really understand each other; This presupposes that one is able to articulate which specific contribution can be made from your own discipline, or field of work.

Philosophy of science: We need to be aware of our 'value system', or 'attitude towards nature'. We need to have better insights in scientific methods other than the regular cause-effect approaches, like *inductive approaches* (derived from experiences in practical experiments) and *deductive* approaches, constructivist and positivistic and also which methodologies may be used.

Systems approaches: we need to learn how to deal with complex systems, in which there are no clear materialistic cause-effect relations but multifactor networks that develop. For this we need to learn about the different 'systems approaches' that are possible, hard systems, soft systems, chaos systems, and related methodologies, like multifactor analysis.

We need to learn to *reflect on the real and complex question* at hand, before focussing on the part of the problem that, from a disciplinary point of view, can be solved, and as a consequence is often offered as 'the solution' to the whole problem. In our present society we find this very often with the economic scientists, who believe that their solution to the problem is the only solution. The problem with looking at issues in such an integrated approach, is often that it is regarded as not scientific.

While working on the above, we discovered that the circumstances wherein the scientist work are equally important, to allow them to fulfil their needs. Two important matters are for example:

I. research management needs to appreciate and stimulate this approach;
II. validation and review assessments should be geared towards appreciating transdisciplinary work.

With regard to the first, appreciation and stimulation by the research management, we have learned that there's still a lot of work to be done in an increasingly market- and profit-oriented organisation in which it is easier to resolve to disciplinary research (not so time consuming, clear solutions). With regard to the latter, the assessments of research, a new question comes up: *What is scientific?* Some people regard science as the search for an insight why things are as they are, in order to improve the world in a sustainable way. Others have come to believe that science is a sort of religion, and when you don't behave according to the set rules you are not a scientist. The latter is very difficult when you want to work at an issue in an interdisciplinary way. Especially, when aiming at participatory knowledge development we need to learn how to involve implicit knowledge, and experience, in our common explicit scientific approaches. This is a new field, about which a lot is to learn. How can transdisciplinary research be evaluated in a scientific way?

Appendix: Summary of the characteristics and preconditions for transdisciplinary research

Characteristics:

I. integration of expertise, an alloy more than a mosaic
II. interactive knowledge development with society via stakeholders
III. looking for integral solutions for complex problems
IV. the presence of (and necessity to deal with) different paradigms and different values
V. respect for the interests and commitments of the different stakeholders, which means a certain awareness and responsibility for the scientists involved.
VI. A common goal, based on a joint formulation of questions.

Applications of transdisciplinary work are:

I. contribute to a sustainable use and development of our natural resources
II. development of theory and methodology
III. development of research-skills
IV. training of students in theory, methods and skills

Challenges for transdisciplinary approaches are:

I. the enrichment of explicit and implicit knowledge
II. de commitment of stakeholders
III. a real interaction of demand and supply
IV. innovation
V. the creation of public support through a jointly designed solution'/ future development.

Results of transdisciplinary approaches are:

I. research products, scientific publications
II. solutions for complex problems
III. social processes
IV. new working relations and combinations of stakeholders

The new roles for scientists are:

I. participant in a knowledge arena where scientific knowledge is shared
II. development of science and knowledge,
III. assembly of knowledge
IV. process manager

Preconditions for transdisciplinary research:

I. The means for transdisciplinary approaches :
   a. flexible availability /input of experts and stakeholders
   b. adequate working space, e.g. with audio visual equipment
   c. training and support for such ways of working
   d. extra time for pre-project phases, for proper problem articulation, communication, etc.
II. organisational preconditions: the university and the institutes should develop and stimulate the interdisciplinary and interactive knowledge development through the creation of expert centres focussing on certain complex problems.
III. Process-supporting skills
IV. A certain attitude: interest in other paradigms, respect for stakeholders, curiosity in other approaches, creativity, etc.
V. Transdisciplinary work needs to be properly valuated and rewarded. Next to the current rewarding system for scientists in disciplinary scientific journals
VI. Systems approaches for the triangle ecology + sociology + economy
VII. T-shaped knowledge, and scientists with a T-shaped profile, being a combination of disciplinary and more generalist knowledge
VIII. Education in transdisciplinary approaches, another rewarding system should be developed which rewards interdisciplinary work and societal relevance just as much.

Development of Delta professionals: the need for fundamental change in mainstream education on landscape related issues

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Introduction

Landscapes are under severe pressure. These landscapes are being used for several functions and interests that compete with each other for influence on and space in the countryside. The application of only a disciplinary or sectoral perspective does no longer provide us with satisfactory answers for dealing with diverse claims of the various stakeholders in the open space. Therefore, through interdisciplinary and transdisciplinary research the Wageningen Delta program takes up the challenge to search for an integrated perspective combining scientific expertise with non-academic knowledge of stakeholders for dealing with regional issues. However, it appears that for effectively conducting interdisciplinary and transdisciplinary research specific competence is required which is not offered by the mainstream landscape studies. Landscape studies are not unique in this weakness. Similar shortcomings can be observed in related fields such as environmental or agricultural education.

This contribution highlights the need for change in mainstream education on landscape related issues (e.g., land use planning and design, landscape architecture). For the argumentation, first I will describe the required competencies of inter- or transdisciplinary professionals/researchers which next, I will compare with the characteristics of mainstream landscape related studies. The comparison leads me to conclude on the necessary changes in the current landscape educational system. Being a member of the Wageningen tradition, I will refer to the members of inter- and transdisciplinary research teams as Delta professionals. Moreover, in this statement a distinction is made between the Delta professional being a member of an inter- or transdisciplinary research team and the process manager sometimes referred to as facilitator, project manager or intermediary. The latter can also be considered a team member of an inter- or transdisciplinary research team, but with a specific role i.e., enabling inter- and cross- disciplinary and sectoral relationships as well as maintaining an inter- or transdisciplinary focus.

Competencies of Delta professionals:

Working professionally in inter- or transdisciplinary research teams requires specific competencies including:

Communicating across different scientific disciplines and to "non-academics" through dialogue

Each discipline or non-academic field can be characterised by a specific culture and as such a specific language, concepts, theories and methodologies. It appears that the communication across different disciplines and to non-academics is one of the major challenge professionals in transdisciplinary research face. This competence cannot a priori be acquired within traditional academic (disciplinary) education.

Moreover, communication across different disciplines and to non-academics requires *dialogue* rather than *discussion.* In a discussion participants try to win the debate through argumentation. They operate within the dominant discourse. Dialogue might enable a 'break out' of the standard way of thinking and acting but requires competence in building mutual respect and understanding.

Understanding and dealing with multi-stakeholder dynamics

Effectively performing inter- or transdisciplinary research teams require professionals who understand and have the ability *to deal with multi-stakeholder dynamics such* as leadership, 'group think' and conflicts. Conflicts are inherent to transdisciplinary research because of different cultures, values and interests. Therefore, Delta professionals need sufficient expertise in analysing and dealing with conflicts. Moreover, for effective team work it appears to be important that the Delta professionals learn how to manage tasks on their own (Förster, 2000) or, in other words, they need to learn how to become *self-organising systems.*

Forcing together multiple (disciplinary and non- disciplinary) perspectives towards inter- or transdisciplinary concepts, theories and methodologies, and solutions

In addition to a good disciplinary understanding, Delta professionals in inter- and transdisciplinary research teams have to take up the challenge to leave their comfortable inward-looking disciplinary nests. These professionals should be *willing and able to (jointly) approach an issue from different (disciplinary and/or sectoral) perspectives.* They should be willing and able forcing together perspectives from what remain fragmented natural/technical or social disciplines by developing new concepts, methodologies and language that are shared across the disciplines and sectors. Such a development of inter- or transdisciplinary theories and methodologies requires understanding about the various disciplines existent in the team but even more the willingness and ability to question the assumptions underlying these theories and methodologies. Moreover, in order to guarantee quality, one should make use of each other's disciplinary methods only if the assumptions and theoretical underpinnings of these methods are shared among the team members.

The above mentioned competencies require that Delta professionals accept the key principle of "*multiple perceptions of reality*" *i.e.* everyone's view is heavy with interpretation, bias, and meaning which implies that there are multiple possible descriptions of any real world phenomenon.

Competencies of process managers of inter- or transdisciplinary research teams

Even if the research team members have the competencies described in the previous part, the presence of a team member with a specific facilitation or process management task can highly increase the performance of the team. Most of the described competencies also count for process managers, however some additional ones are required.

Developing mutual trust and understanding

A key competence of a process manager involves the building of mutual trust and respect in order to develop a learning environment that is conducive for researchers and other stakeholders to look beyond one's own (disciplinary or sectoral) perspective. Often misunderstanding and mistrust among researchers are rooted in the difference of research paradigms (e.g., positivism, constructivism). The ability to make explicit these different paradigms and to encourage researchers to question them contributes to the development of an environment from which joint learning can emerge. Likewise, the ability to help stakeholders to question their own and each other's perceptions, experiences, objectives and values appears to be an important competence for process managers as well.

The moment a safe learning environment starts to emerge, process managers bring in their ability to effectively *assist team members in jointly defining the issue at stake from various perspectives.*

Developing a common vocabulary

A common language that is shared across the various disciplines and sectors appears to be essential for dealing with the societal issue at stake as well as for developing new inter- or transdisciplinary concepts, theories and methodologies. The use of metaphors, analogues, drawings, graphs and pictures appears to be useful for facilitators in developing a shared language (Jeffrey, 2000).

Mediation

Because conflicts in inter- or transdisciplinary research are inevitable due to the multiple (and often conflicting) values, interests and perceptions among the team members, good competence in different mediation strategies such as integrative and distributive mediation is an essential requirement for process managers (Groot, 2002). Inter- and transdisciplinary research has potential for conflict especially when participants have to jointly define the issue at stake and its stakeholders, jointly develop (scientific) models and jointly develop and decide on improvements.

Maintain a focus on inter- or transdisciplinary issues

Experience shows that it is important that process managers are able to maintain an inter- or transdisciplinary focus during the whole research process. Such focus requires the competence in building cross-disciplinary co-operation in order to jointly develop new inter- and transdisciplinary concepts, theories and methodologies as well as improvements for the societal issue at stake.

The generation of new inter- and transdisciplinary knowledge is one of the future challenges of collaborative research. However, literature on landscape studies (or any other related field) hardly provides any operational guidelines. In addition to the more process type of competencies as described in this section, the training of the Delta professionals (including process managers) needs to emphasise competence building in the joint development of new inter- and transdisciplinary concepts, theories and methodologies.

Characteristics of the Delta-oriented educational system

As inter- and transdisciplinary research are not to be understood as a new science replacing disciplinary research, the educational system described in this section should be considered additional to the current educational system. The section below provides a comparison between the mainstream landscape studies (1) and a Delta-oriented educational system (2) that enables participants to learn conducting inter- and/or transdisciplinary research (Groot, 2002):

(1) Mainstream studies on landscape related issues

Aim:

Developing discipline-based scientist

Learning focus:

Learning *about* (natural, technical, ecological, social, economic) *systems;* Learning about disciplinary understanding by studying systems ‘out there’.

Curriculum:

Systematic building block curricula in a set of sequence designed by lecturers; Disciplinary subjects.

Learning environment and sources:

Mostly in classrooms and (design) labs; Manuals, lectures.

Good performance assessed by:

Assessment of students by lecturer through examination of theory and practice.

(2) Delta oriented educational system (inter- and transdisciplinary studies on landscape related issues)

Aim:

Developing professionals with the competence in the management of societal/complex issues.

Learning focus:

Learning how *to become a learning system* considering each professional action to be shaped by values, norms and interests.

Curriculum:

Learning how to deal with ‘real world issues’ through direct involvement in them; Participants work in teams of academics, professionals, process managers and other stakeholders; Participants largely decide on and organise their own curriculum; Inter and transdisciplinary team work, including multi-stakeholder dynamics (e.g., conflict management and negotiation, intercultural communication, self-organising learning systems); Facilitation/process management.

Learning environment and sources:

Participants are immersed periodically in messy real world situations; Trials, experiences.

Good performance assessed by:

Self-, peer and stakeholder assessment on progress in competencies.

Changing the competence of the lecturers in universities or other educational institutes only cannot develop a Delta-oriented educational system. It also demands a change in attitude of the management of these institutes as well as in the relationship between universities and society.

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V
Evaluation criteria for interdisciplinarity and transdisciplinarity

On evaluation criteria

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Transdisciplinary science is hard to evaluate. Conventional methods equate low publication and citation rates with poor research, even if the science is brilliant and the stakeholders love it. Few reviewers have relevant experience, and interdisciplinary work may take decades to win peer approval, even in journals that welcome our submissions.

Evaluation is measuring research quality. We have many stakeholders with disparate priorities, and this creates challenges (see Spaapen et al. and Aenis & Nagel). Discussants raised three issues. The first is that we may forget what research is. Research is activity that contributes to the maintenance and development of knowledge. When academics join the planning process, for example, that is *consultancy*, not research.

The second issue was whether we use the *profile* of a project to evaluate the *quality* of the research it has done. This is only defensible if some project profiles are universally better than others. Profiles reflect the priorities of funding agencies (Spaapen et al.) but do not evaluate research quality. How can you say whether biochemistry is generally higher or lower quality research than historical geography?

The third issue was whether transdisciplinary research is always desirable. Zierhofer and Klijn tackle this question from different perspectives. Klijn, for example, believes professional reform and a common language would solve the problem of extreme specialisation. Zierhofer is not persuaded we should legislate against diversity.

If high quality research is that which develops new knowledge, evaluators might supplement the usual publication and citation measures by asking the people involved in the project. Although some evaluators mistrust subjective depositions, the evidence is robust. People know when they learn something; some get enthusiastic, others get nervous or defensive, but *nobody fails to notice.*

Evaluators need only decide *whether* people's beliefs have changed. They can do this quickly using a portfolio of questionnaires and publication indicators to measure a project's impact on knowledge communities. If stakeholders want to know *which* beliefs have changed, let them read the report: that is why we wrote it, after all!

Towards the evaluation of transdisciplinary research

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Introduction

Transdisciplinary research is encouraged these days by several policy lines, both at the national and local level. We are aware of the ongoing discussion in the literature about what exactly is transdisciplinary research (Shinn, 1999), but we don't want to go into that discussion here. Thus, leaving out debates about precise definitions, here we refer to research as transdisciplinary if it to some extent is conducted in a societal context with active stakeholder participation. Viewed that way, transdisciplinary research is carried out much more than academics probably realize. With the growth of such research, the question of quality and relevance needs special attention. As a rule, most traditional evaluations focus on the so-called scientific quality of research, and most reward systems in the science system take the same viewpoint. From the point of view of researchers involved in transdisciplinary research this is not very satisfying because the work they do and the output they produce is – at least partly – of a different nature and does not meet the criteria in these traditional evaluations. Also from the point of public interest, in as far as societal relevance and accountability are important criteria; there is dissatisfaction with the limited range of traditional evaluations.

Sci_Quest, a research network interested in research policy questions with a special interest in evaluations, has been studying this issue for over a decade now. Our main interest is in the assessment of scientific research in a policy context, or broader in a societal context.

The demand from government (and society) for more accountability and external influence on the priority setting in science goes back to the 1980s. Then this policy change caused a lot of turmoil in the universities, because it was felt as a threat to academic and institutional autonomy. But even then, for some researchers it was a more happy turn of events. These were the ones operating in fields with a more or less clear link to a societal practice. That regards for example research done in agricultural sciences, or in medical fields, or in technical areas.

It is in these areas that sci_Quest got the opportunity to develop a method for doing a broader kind of evaluation. In 1998 we did a project here in Wageningen, and in 2002 we did a project for two pharmaceutical faculties in Utrecht and Groningen.

Context of our search for an evaluation method

The context of our efforts, then and now, are the quality evaluations organised by the VSNU, the Association of Universities in the Netherlands. In the past, university research was assessed in the usual disciplinary oriented evaluations, including a site visit by peers, performed every five year. But with the changing policy demand for broader evaluation, and also more and more research in the universities that did not seem to fit the more traditional evaluations, policy was in need of a different kind of approach to evaluations. Therefore, the VSNU, in collaboration with the Consultative Committee for the Dutch Sector councils (COS), asked sci_Quest to develop a new evaluation method that was able to address specific problems of transdisciplinary research, of research with a clear societal mission. First in the agricultural sciences, later in the pharmaceutical sciences.

Our assignment entailed the development of a method that could be used in the overall system for evaluation in the Netherlands. It meant coming up with a report that would represent the different research groups in a comprehensive way, so that it would enable a group of international reviewers, peers, to assess the group's broader range of activities in the light of its chosen mission. In other words, the evaluation had to be *mission-oriented.* We were asked to provide systematic and comprehensive information on issues that regarded both the scientific and societal value of research. Also, we should include in our method the interaction with the user or stakeholder environment.

For us, the assignment meant to find a new evaluation method, we also needed to understand the relations between a research group and its relevant context: how does it relate to its context, what is the role of the various stakeholders in that context, and how does that relate to the mission of the group.

Research in the context of stakeholders

Taking the example of research groups in the agricultural sciences, it is clear that they perform their work in a context of application (which not necessarily means that all their research is applied). Research has to be scientifically sound and credible to colleague researchers. But it also has to meet the interests of a variegated group of stakeholders like farmers, local and national government (regulations), consumers (preferences), etc. Research, in other words has to attune a pluralism of interests and values. Research functions in different ways in different social domains, and innovations are more likely to succeed if the research meets the interests of the different social groups involved, and are open to external expertise. The make-up of this context of application depends strongly on the research strategy of the groups.

Furthermore, research programs and their contexts are in a dynamic relation. Initial goals may get lost if new opportunities emerge. Research for example on nitrate and sulphate cycles, initially only relevant for the agricultural production, now finds new relevance in research on global climate change and the greenhouse effect. The research strategy of a group may change accordingly; new projects may be formulated (and/or old ones reformulated) to meet criteria of the national and international organization funding climate research. The program then will function in a new environment with new standards for what is good and relevant research.

A uniform yardstick as it is used in the more traditional evaluations would do no justice to the specific nature of a research strategy and the dynamic nature of it in relation to a changing environment.

If research is conducted in the context of application, as a rule there is a lot of interaction with experts from other (sometimes non-scientific) areas. Many specialties within the field of agricultural sciences are problem-oriented (and work in the context of application). In the project we did here in Wageningen, we looked at research groups operating in fields like: crop- and grassland sciences, plant production systems, soil tillage, farm technology, irrigation and water engineering. A number of the groups were oriented towards development, i.e. 'third world' problems. All these research programs typically combine insights of several disciplines and technical expertises, operating in a policy-context in which interaction with a variation of users is a necessary condition to make solutions work.

And, also in the pharmaceutical sciences, we see research that is transdisciplinary. Pharmaceutical research, obviously, is characterized by a close cooperation between university research and industry, if only for the fact that research groups need the funding coming from industry. But its broader societal relevance is also clear. Academic pharmaceutical research has been known to have close contacts with professionals (pharmacists, chemists and patients). The variegated character of this stakeholder environment of pharmaceutical research can easily be described in terms of the 'mode 2' research (Gibbons et al. 1994, Nowotny et al. 2001).

In both these areas, research not only transgresses disciplinary boundaries, but also those of professional and lay expertises. For research policy that is trying to assess such transdisciplinary research, it is extremely difficult to understand and weigh all these different influences in an evaluation process. And this is aggravated because measurements (and data) for the so-called scientific quality of research seem to be abundant compared to the societal quality indicators.

Theoretical background

In developing our method, we built on a wide set of literature from the area of science and technology studies. The following three areas are the most important:

I. the authors of the 'new production of knowledge' (Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow, 1994, 2001)
II. a group of French researchers, most prominent among them Michel Callon and Phillipe Larédo, who developed a so-called compass card for research labs
III. work from the area of innovations studies, a wide group of researchers, but we used in particular the work of a Dutch group working in the organization for technological research (TNO-STB)

Through the work of Gibbons et al. (1994) we learned that two factors are especially important in the interaction and communication among the various actors in the network around scientific groups: the *mobility of scientists* (because it is essential for cross-fertilization of knowledge and know how) and the way *problems are selected, priorities are set.* How and why are some problems selected and others not, and what are the differences between fields? This connects to the third area mentioned above (innovation studies), to which we will come back soon.

We used these two factors, mobility and interaction and communication patterns, as a heuristic in finding differences in the research contexts of groups. The context of research groups may differ considerably as some groups are mainly oriented towards the translation of practical problems into a scientific approach (i.e. the modelling of agricultural production processes), while other groups are at the end of application phase and design all sorts of apparatus to improve the yield of crops.

In the more recent book by the same authors, Re-thinking science (Nowotny et al., 2001), we can read what the ultimate goal is of the new production of knowledge, that is to produce knowledge that is socially robust. This socially robust knowledge is a complex concept; the authors oppose it to the traditional knowledge that is looking for the truth, even the absolute truth. Socially robust knowledge is more flexible and open-ended, it is relative, and it can and will be tested and validated by a variety of actors in the network.

An example of the work in agricultural research may clarify this a little bit. When we think of the work on genetically modified food, research in that area has to attune new fundamental scientific knowledge with professional principles and societal acceptance.

The second theoretical area, the work on the so-called compass card of research groups, inspired us to see whether we could find a way to represent a research group through the variegated activities it performs in a context of application.

The compass card distinguishes social domains or contexts for knowledge production, for example the international scientific community, a professional, commercial and a policy context. In each of these contexts, different expectations exist with respect to the research; in each different norms, values and priorities influence to a certain extent the development of a research program. Interaction mechanisms and -patterns are bound to differ between these contexts. Callon et al. (1994) distinguish within these social domains 4 interaction channels that are characteristic for communication between scientists and environment: texts, people, artefacts and money. In our research we aimed at developing different indicators in each of these interaction channels.

Finally, the third area that was interesting for us regards the work of a Dutch research group (from TNO-STB). The work of that group focuses on the importance of learning processes in the development of social and technological innovations. They stand in the tradition of scholars that see innovation in terms of an evolutionary process: innovation takes place in a mix of technical and non-technical networks, partly overlapping, in which scientific, political, economical, technical and socio-cultural factors play a role. Various options ('variations') are tried out in a so-called selection environment, in which, over time, social structures evolve (sometimes referred to as 'technological regimes'). This perhaps sounds rather deterministic, but that is not the case, there are 'countervailing powers' (experts will always have disagreements, there are random elements, for example unexpected developments from neighbouring fields), and because of this, learning processes are important. These learning processes may differ by field/area, but also by production phase. The authors distinguish three phases in the production, referred to as articulation, attunement, and fine-tuning. In the first phase a broad group of stakeholders can influence the direction of research, in the second a more or less stable environment for the particular topic starts to get shape, in the last, experiments outside the lab take place.

From these theoretical observations, we conclude that to find a form of evaluation that fits this transdisciplinary research, we had to focus our approach on the idea that research production, the transfer of knowledge, its impact in social domains and the emergence of sustainable partnerships, occur in heterogeneous networks comprising different actors pursuing distinct objectives. A successful method would have to do justice to what goes on in these networks, and ask the question how and how much different agendas of different actors bear influence on an institute's mission (or a research group's mission).

In that sense we are not so much evaluating a research group or program, but a process of interaction. And we are not so much looking for indicators that can tell us how good or bad the 'quality' of the research is, but we are looking for indicators that tell us whether the group succeeds in fulfilling its mission in a relevant context.

Of course we assume that a group that does not produce good quality research will not likely produce research that is relevant for specific stakeholders. Our approach, therefore, positions the unit of evaluation in the environment at large, that is in a broad array of societal domains where partnerships with stakeholders develop into a sustainable mutual learning environment.

The model

To evaluate such transdisciplinary research in a reliable way, an assessment needs to be both *comprehensive* (that is, review the variegated activities of the research group) and *interactive* (that is, allow for influence of stakeholders in the evaluation process). Summarised, our approach combines the two requirements as follows: (A detailed description of this approach can be found in Spaapen and Wamelink, 1999).

Step 1 – Research Embedment and Performance Profile (REPP)

On the basis of quantitative data we develop a so-called Research Embedment and Performance Profile (REPP). The REPP provides a visual representation of two critical factors:

I. The wider societal reference group for a scientific project [embedment]
II. The degree to which a project serves or does not serve the interests of the wider reference group [performance]

Data are drawn from research inputs, outputs and activities in various societal domains, and computed into a radar-like graph (see figure 1). The idea is that the various activities of research groups in different social domains are depicted in a single representation. The different pictures may be described in terms of different missions of research programs, for example a program can be more industry driven, or policy driven or science driven.

Step 2 – Stakeholder analysis

The stakeholder analysis consists of two parts, a chart of the environment of relevant stakeholders and a survey among principal stakeholders. The chart distinguishes stakeholders according to their institutional background and to the role they play in the research production process (colleague, intermediary, user). The survey focuses on the interaction mechanisms between researchers and context. Stakeholders are asked about their relationship with the researchers, about their own goals and needs, and about their assessment of the research program. The analysis results in a description of the stakeholder environment in terms of learning environments, that is different typologies of the ways different actors in the innovation process interact with each other and learn form each other. These learning environments will be different depending on the phase of research and the goals of the programs.

Step3 - Feed back

Finally, the results of both exercises will be brought together and confronted with the mission. As such, it can (and should) be input into a discussion about the research program between researchers, reviewers, policy makers and other stakeholders. To facilitate the discussion, we aim confronting the different types of missions of research programs (for example a program can be more industry oriented, or policy oriented, or science oriented) and the different types of learning environments (for example focussing on agenda setting, or focussing on developing models or protocols).

The three steps together form a comprehensive evaluation tool that is summarised in figure 1.

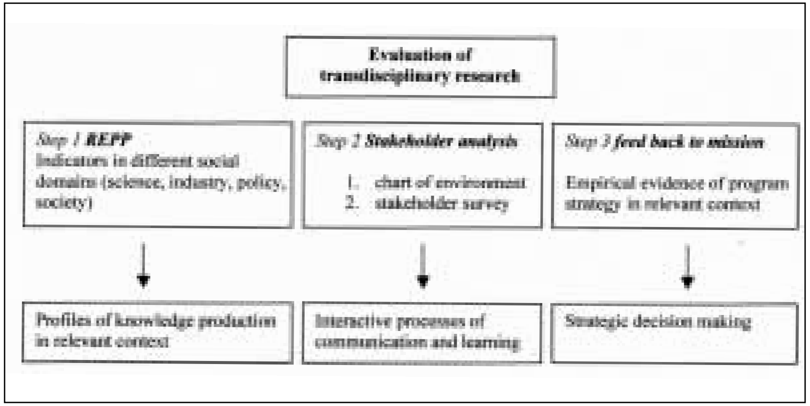

Figure 1: 3-step method

Conclusions

Programs performing in a context of application are functioning in a broad array of social domains. To evaluate that work, one has to evaluate the relations with these different domains. [This is in principle not different from what is happening in the evaluation of scientific quality; only there the relations are mainly through texts] The key dynamic of evaluation is feedback to the mission of a research program, and negotiation in relation to the context in which research is performed.

Our method is not to be taken as a direct and objective measure for quality. Good research can have many profiles and successful innovation can take place in several learning environments. Quality is a heterogeneous concept that can mean many different things to different actors involved.

Advantage of our method is that it gives a reconstruction of both the relevant environment and the performance of the group in that environment.

The leading question in our evaluation is: which of the claims made in the mission of the research group have been achieved empirically? If the group claims to contribute to the development of sustainable greenhouse production, does the embedment and performance profile show so? And can a productive learning environment for these innovations be distinguished in the stakeholder analysis.

Finally, we would like to show you an example of the REPP (figure 2). It represents one of the groups we studied in 1998 in Wageningen. Clearly, this program is science oriented. We distinguished five different domains. In each we calculated a number of indicators that were felt by the field representative of the activities of research groups in those domains. For each of the indicators we set some kind of benchmark, in consultancy with researchers and policy makers. The resulting scores were plotted in a radar-like graph, which represents the variegated activities of the group in a balanced way. Four of the five domains are self-evident, the fifth one, called collaboration and visibility, refers to a particular situation at that time, which is the integration of the University in Wageningen and the DLO-institutes (applied research) into what is now called the Wageningen University and Research Centre. In that particular domain the involvement of each group in terms of actual collaboration was measured.

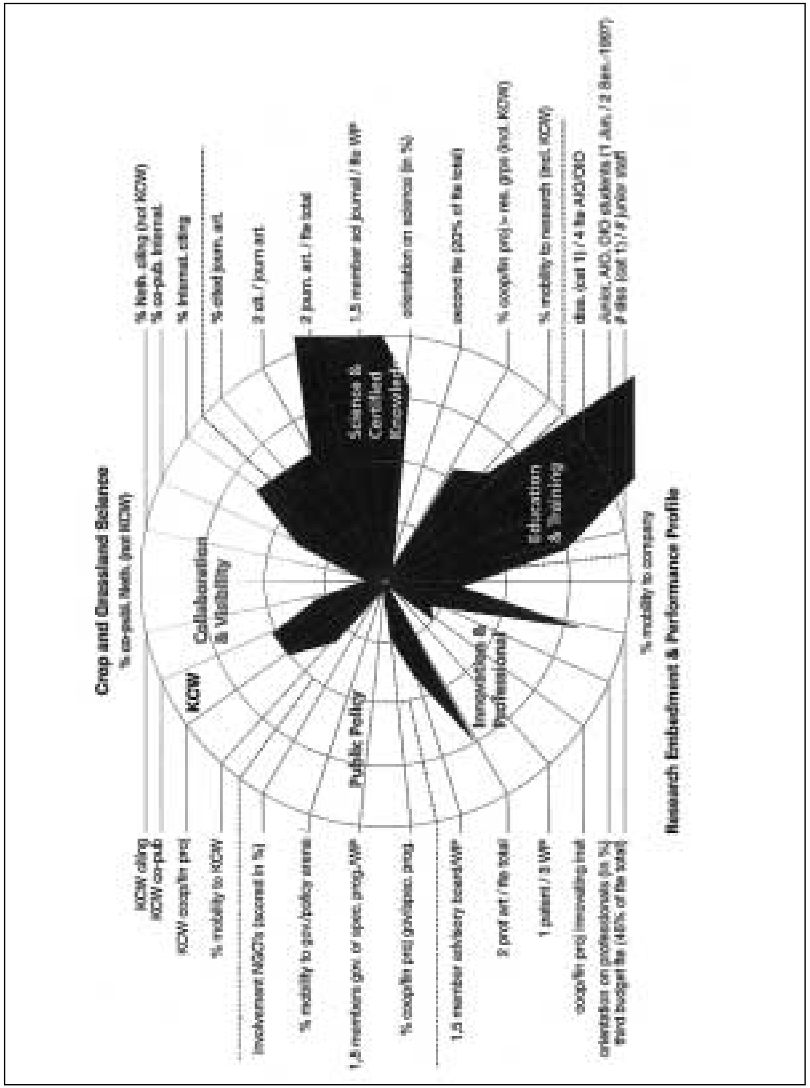

Figure 2: REPP model

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Impact indicator definition within a transdisciplinary research group

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Introduction

Agricultural researchers are faced with a paradox that seems hard to resolve. In the last two decades, public funding has been increasingly hard to obtain and, at the same time, accountability is stressed more seriously than before (Maredia, Byerlee and Anderson, 2000). The concept of accountability itself has been broadened and deepened. In addition to the monitoring of expenditure and the evaluation of research results, the quality of the research process and considerations concerning the impact of research have become important concerns. Both are particularly relevant for transdisciplinary research (TDR): "Joint problem solving among science, technology and society ..." is increasingly seen as "... an answer to the demand for greater customer, stakeholder, and user orientation of research and for raising its level of utility." (Klein et al., 2001, p. 20). TDR with its main pillars "interdisciplinary co-operation of researchers", "participation of stakeholders", and "mutual learning" is methodologically not a new approach. What is new is the claim to generate solutions for complex problems coupled with at least partial implementation of research results. It is the explicit objective of transdisciplinary research to create impact on end-user level and it is set apart from "development" by the fact that research activities still dominate and short-term impacts may be marginal.

In the following, we would like to report some experiences in impact assessment gained within the framework of the GRANO project (see Müller et al., 2002). These experiences - positive and negative - cover a period of roughly 4 1/2 years. They show that even in a situation where major actors are committed to monitoring and evaluating research *outputs*, assessing research *impact* faces enormous difficulties, of which the mayor was the logical problem of linking cause (= the outcome of a research project) and effect (= changes in society or the environment), a major challenge to indicator definition. The problem is particularly serious in the case of TDR as a whole as the problems addressed will generally require rather complex solutions and even smaller projects may influence a wide range of factors. However, as long as resources for impact assessment are limited, measurement may be based on a reduced and possibly simplified set of impact indicators (Defila and Di Giulio, 1999). The challenge is to negotiate this set within an interdisciplinary team and find acceptable compromises.

1) Parts of this article have been published in Nagel & Aenis (2002)

The framework

Evaluation is no end-in-itself and the question of who will use its results and for what purpose will have a strong influence on the way the evaluation function is performed (Patton, 1997): Society - in the case of public research represented by the *donors* - is committed to sustainable rural development and, thus, to long term *impact*. Planning, implementation, as well as contents and form of impact assessment must facilitate uptake of research results. If this is the case, it is very likely that impact assessment results themselves will be taken seriously. If "impact" is a proven fact, it is a good argument for further promoting the project's outputs. For a transdisciplinary project dealing with natural resource management *regional stakeholders* are important addressees for impact assessment. At least indirectly, their decisions on land-use will be influenced by knowledge of positive or negative outcomes of project activities. One would assume that *researchers* themselves are especially interested in learning about the impact of their work. We have the feeling that this is not always the case.

Planning and evaluation are closely linked as the latter is done on the basis of predetermined objectives. This seemingly trivial statement hides, however, an enormous complexity, both in terms of methodology as well as in terms of evaluation practice. *Impact* can or should only be *assessed* on the basis of objectives set at the beginning of a research process. A well-defined research plan therefore must include not only a specification of intended results but also a plausible explanation of how these results will change, for example, the behaviour of people, the quality of goods or the state of the environment. Thus, researchers justify a priori the resources they are going to use. Ideally, the impact of a research programme would have to be measured ex-post, i.e., at a time when the tangible or intangible research products have been taken up by the intended users and have produced identifiable benefits. The question remains: How to overcome this time-lag?

Though there is no prescription for using a specific planning instrument for research, it has been shown both in theory and in practice that the Logical Framework (or: log-frame) planning approach is a tool which lends itself well to research planning at all level (TAC Secretariat, 1999).

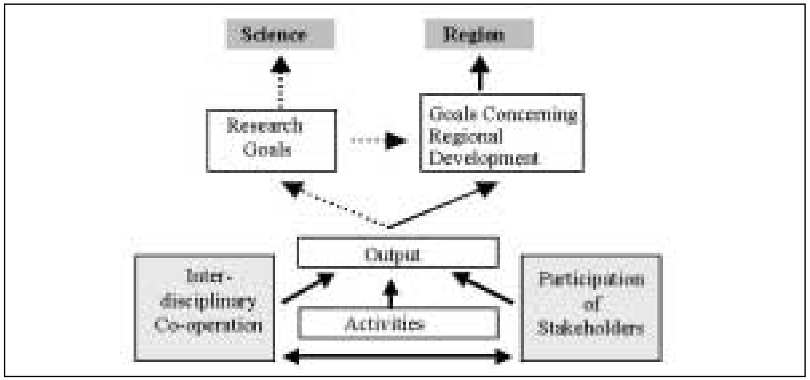

Figure 1: Goal system and impact pathways of a transdisciplinary research project

A look at a schematic goal system of a supposed transdisciplinary research project reveals the problem (Figure 1). Given a project on regional resource management, most likely one of the main objectives is a relevant "contribution to sustainable land-use". The impact of the project will be measured in the contribution of the project to regional goals. Due to the fact that solutions are always problem-specific (and therefore project-specific), regional development indicators cannot be generalised.

The traditional scientific pathway is limited, too. Usually there is neither such a thing as a transdisciplinary scientific community (represented by institutions, peers and publications) in which impact could be created (or proved) nor is there a scientific evaluation system for transdisciplinary research established. This means that peer review faces a great challenge (Gibbons et al., 1994).

Characteristic for transdisciplinary projects is the importance of the meta-level of *interdisciplinarity* (which means the communication process among interdisciplinary researchers), and of *participation* (meaning communication between researchers and regional actors). Usually these projects are still dominated by researchers. The approach of interdisciplinary co-operation is a main factor to support the promotion of participation. At the same time "new ways of participation require new forms of interdisciplinarity ..." (Müller et al., 2002).

Indicators specify each objective in terms of quality, quantity, time, and location. We assume that for different evaluation purposes different level of objectives have to be indicated:

i. With regard to impact assessment, the logical levels to be indexed are the purpose level (uptake of innovation) and the goal level (benefit for the users). At these level "impact" may be observed.
ii. Project management has to consider project output and the respective meta-level as a proxy for efficiency and effectiveness.
iii. Impact monitoring, an ongoing impact assessment (Balzer & Nagel, 2000), combines both. It is practically, however, much more complex and therefore difficult to implement.

Problems of indicator definition in a research group

Research planning needs to define at least two levels of objectives (project outputs and purposes/goals) and specify them with indicators. Impact assessment measures achievements with the help of these indicators and, in fact, impact assessment starts with the systematic elaboration of objectives at the beginning of a research project. A first methodological challenge for GRANO was how to adapt this condition to the realities of a transdisciplinary project and the rules of donors.

When in 1997 about 20 researchers from 7 institutes came together to write a proposal for "ecologically sound concepts for the formation of regionally typical agricultural landscapes in north-eastern Germany", both participation of local stakeholders and interdisciplinary co-operation of researchers were seen as axiomatic. Research planning foresaw involvement of stakeholders in the complete cycle of goal definition, planning, implementation, and evaluation. What, in theory, seemed to be simple and politically correct was in fact conflict prone when it came to funding procedures. Donors require a formal proposal with well-defined outcomes in a relatively short time. Being committed to the principle of participation, the research team, on the other hand, realised that defining a complete goal system together with operational planning for all sub-projects would not only require more time but would have to be started as an open-ended process. To answer the donor's request for well defined output planning, regional development goals were defined as output hypotheses and sub-projects were planned under the assumption that these were preliminary and could/would be changed once the "real" goals were defined. In addition, the process of planning, implementing, evaluating, and establishing a transdisciplinary project in all its phases - including the aspect of impact assessment - became a research goal at the meta-level. Agreement of the funding agency to this procedure was coupled with strong pressure to start local R&D activities immediately. This and methodological considerations called for a rapid but still participatory approach to situational analysis, strategic and operational planning, and project implementation. For GRANO this meant:

I. Identifying local stakeholders through a snowball system;
II. Focusing the situation analysis on subjective views with regard to only 3 questions (subjective view of problems, reasons and solutions, especially in an environmental context);
III. Defining visions, development objectives, and potential project areas at regional planning workshops;
IV. Decentralised operational planning within GRANO working groups, including feedback from relevant actors. (documented in Müller et al., 2000)

Though all relevant groups judged the overall outcome of this process positively, there were serious shortcomings concerning the (non-) definition of indicators (output and impact) at this point. If indicator definition is indeed as crucial as mentioned above, why this neglect? In TDR, indicator definition is the result of a process of negotiation between all relevant stakeholders and not a dictate by scientists. Even if scientists accept this view, we are dealing with a time-consuming process. None of the interest groups were willing to invest the necessary time in an activity of which they did not see an immediate benefit. As a consequence, implementation of local R&D projects, which was given absolute priority by external evaluators, started with rather vague purpose definitions. Ad-hoc activities replaced for a certain time systematic planning procedures - with negative consequences for impact assessment.

Activities for impact assessment did not start before donors finally gave the go-ahead for the full project period. Due to the earlier neglect, indicators now emerged - quasi inductively – from the activities that were undertaken to reach the R&D objectives, which had been redefined and sharpened as planned. Obviously, elaborating success indicators while outputs are already being produced presents a serious challenge to the integrity of researchers. One could easily be accused of defining only those impacts, which were certain to be achieved. In addition, monitoring was done almost exclusively by project personnel, introducing another possible bias.

Solutions found were rather pragmatic and – compared with the GRANO standards of participation and scientific rigidity – may be classified as only "second best". First, it was decided to divide responsibility for indicator definition within the research team. Indicators at the meta-level (participation and interdisciplinary co-operation) as well as for assessing the quality of the research process were prepared by experts ("process advisors") and subsequently discussed and adopted by the full research team during one of the regular workshops. The definition of impact indicators for the practical field projects was decentralised and delegated to the project teams. Some of the resulting difficulties are listed below:

I. Trivial indicators: Downsizing of expected impacts and of assessment activities;
II. Logical mix-up: Lack of clear distinction between output and impact indicators;
III. Too many indicators: Unrealistic assumptions concerning evaluation resources (time, personnel, collaborators).

Notwithstanding the problems mentioned above, the elaboration of indicators for short-term effects (output indicators) proved fairly successful. The set of impact indicators showed considerable weaknesses, however. We conclude that an iterative approach would have been more helpful. (Re-)Defining or sharpening output indicators requires teams to reflect on previously set objectives and helps to come to a shared understanding. Concentrating on *direct* impact of these outputs increases chances for realistic impact hypotheses.

Actors and resources

Actors, both internal and external to the project, were playing different and partly overlapping roles. Involving all *researchers* of a team in indicator definition requires major investments in communication, qualification, and co-ordination of the process:

I. Good researchers are not necessarily qualified planners. Unless there is a clear and mutual understanding of the planning logic, meaningful indicator definition is virtually impossible.
II. A multi-disciplinary group will tend to define disciplinary indicators and hence have problems in deciding on a shared set. Hard negotiations occurred between natural scientists who wanted to measure "environmental quality objectives", social scientist who looked at "social learning" processes, and economists who were interested in "profitability".
III. Acceptance of the principle of impact orientation may fade once the research project progresses, resulting in unwillingness to define impact indicators.

For *management* and *process advisors*, organising impact assessment proved to be a full-time job over a number of months: preparation of impact assessment for the comprehensive programme output, facilitation of research teams, and co-ordination of the overall process. Together with one pilot group, a structure and procedure for defining indicators was developed to be used by other groups. The intention was, i.e., to have teams agree on a limited number of indicators as well as on the data collection methods. Unfortunately, this methodology did not spread by itself. As the experience from the pilot group showed, further (and considerable) inputs in terms of facilitation and training would have been necessary to ensure timely success.

Investing in communication always seemed to produce the desired effects – in the long run. After a third round, teams were finally able to agree on a reasonable set of indicators. With growing openness and trust, natural and social scientists were re-discovering common ground: "In order for nitrification to decrease, land users' minds have to change. Information from our project may help."

Outside *experts or consultants* can complement the expertise available within the team. They will face problems similar to those of internal process advisors unless the research teams specify tasks and experts work "on demand". Excellent experiences were made as one team commissioned a survey to capture feedback from extension staff and farmers on extension instruments and topics. The team defined "criteria of acceptance" beforehand and asked the consultant to develop indicators and conduct the survey on her own. Results were fed back to the team. "Acceptance" is not yet full and final impact in the sense of changing peoples' behaviour. But it is a pre-condition and therefore a good proxy.

External reviewers' assessment role is ambiguous. They will judge a proposal ex ante, but whether they do this in terms of outputs or impacts is not necessarily clearly defined. Strictly speaking, they should use the same scientific rigidity (and thus define indicators) that we have prescribed for the implementation of the research project itself. This is, of course, rarely the case. Once the project has developed its own set of objectives and indicators, a monitoring of project progress - also with regard to potential direct impacts - becomes fairly easy for the review team. In the case of GRANO, the participatory approach chosen delayed the implementation of field activities. At the first intermediate evaluation, reviewers could thus be provided neither with exact information on short-term outputs nor on presumed long term impact. This caused considerable irritation, which was only overcome after R&D activities had actually started.

Although "participation" was a central theme, we did not find a sensible solution for ensuring the integration of *regional stakeholders* in long-term impact assessment. Apart from the neglect mentioned before, two objective difficulties must be highlighted. GRANO operated in rather large geographical areas. Stakeholders were thus not only very heterogeneous but also large in number. Already during the initial planning process, compromises with regard to representation had to be made. Even the fairly small group of original workshop participants cannot be expected to co-operate permanently in impact assessment. The project consequently decided to involve regional stakeholders only in an exemplary way.

Secondly, experience gained as part of the "participatory M&E" sub-project show that local partners are clearly more interested in project *outputs* than in the more abstract concept of *impact*. There were, however, also positive findings: active involvement in the implementation of single field projects (and not necessarily the whole R&D project) increases interest in evaluation. In other words, local partners are not necessarily unwilling or unable to co-operate but they should not be overburdened by project demands.

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What makes a project a better project? Reflections on the assessment of transdisciplinary research

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MGU and its interest in transdisciplinarity

A few months after the accident in Chernobyl in 1986, a huge fire in a chemical plant near Basel threatened the health of the city population and poisoned the river Rhine for a while. Under the impression of this event the government of Canton Basel Landschaft followed an initiative of the University of Basel and created a foundation to promote problem-oriented environmental research and education within the University of Basel and thereby foster the accountability of science. In 1992, the coordination office "Mensch - Gesellschaft - Umwelt"[1] (MGU) became operative. Since then, this institution has established a curriculum ranging from additional courses to postgraduate master diploma, which is offered to most faculties. MGU offers training facilities that aim to develop resources for future transdisciplinary work, whether as scientist or as professional in a non-scientific institution, particularly by providing courses, which improve the communicative and managerial basic competences, and project courses, in which students of various disciplines research in relation to or even in cooperation with non-scientific partners and institutions. In addition MGU funds a tri-annual research program of about 1.5 million Euros, which is reserved for transdisciplinary projects exclusively. MGU has thus the task to assess and develop the quality of transdisciplinary research.

But why does it have to be transdisciplinarity at all? This focus is the outcome of discussions that cannot be reconstructed here in detail. However, essential was the idea that most environmental problems are complex problems, which touch a variety of real world interests. The definition of the problem and the selection of appropriate solutions transcend either the competence or the legitimacy of scientists and thus require the representation of viewpoints and interests of particular segments of society. This is usually achieved by some kind of participation of non-scientists within research projects, e.g. well informed locals, stakeholders, politicians, representatives from authorities and so on. Such ways of problem oriented research will not only take into account knowledge about facts, but as well knowledge about objectives and values, and about measures and their consequences.

Science may contribute in various ways to the rationalization of discourses, particularly by analysing the relations between facts, values, norms and ethical principles and by systematically evaluating strategic alternatives. But much of the problem-relevant knowledge is knowledge about unique circumstances or knowledge of locals. Besides this, scientific involvement reaches its limits where it starts to deprive individuals from chances to express their opinions and political preferences themselves. In sum, therefore, a considerable part of research devoted to issues of environmental risks and sustainability has to transcend not only the borders of scientific disciplines, but the borders of science and academic interests as well. Applying an institutional definition of transdisciplinary research, which is to incorporate various disciplines and non-scientific partners within one project-framework, MGU sorted out transdisciplinary from other kinds of projects.

Still, in order to distribute scarce resources among a surplus of projects in a fair way, the problem remains of assessing the quality of project applications and of produced results. The latter of which may not only include conventional research reports but also the initiation of social processes or any kind of other practical achievements. Indeed, up to now MGU has not yet resolved this problem to its full satisfaction, and therefore intends to investigate the possibilities of assessing and rating transdisciplinary research projects – ex ante and ex post.

1) This may be translated as mankind - society - environment.

The interest of MGU is not only with individual research projects, but stretches also to the training for transdisciplinary work as into the field of policy of science. It is particularly the latter field of debate within which a bulk of heterogeneous expectations towards transdisciplinary research have been stated. However, in the end these have to match the possibilities of concrete project work, for which specific training is certainly favourable. Therefore, for the time being the focus of MGU is directed towards the research floor.

Approaching the assessment of transdisciplinary research projects

In order to assess research projects in a comparable manner, a variety of dimensions have to be defined, which serve to "measure" the qualities of projects. To be able to monitor transdisciplinarity, these dimensions should cover relevant aspects of the cooperation between disciplines and beyond the institutional limits of science. Let me suggest a few possibilities, which do neither exclude each other nor represent a comprehensive list:

I. If the distinction between facts, goals and measures is accepted, the design of projects could be evaluated in respect of their way to take system-knowledge, knowledge of objectives and transformation-knowledge into account.

II. Regarding the production of goods and services it is quite common to speak of a production chain and of the added values of single steps in the production process. In a similar manner also scientific contributions to the solution of complex problems may be considered to be steps in the production of knowledge. By consequence, the added value of transdisciplinary projects might be evaluated in respect of those parts of a "problem-chain" that have been declared or may be assumed as the project target.

III. Transdisciplinarity, as MGU understands it, always involves some partners external to scientific institutions and to research in the classical sense. Projects will thus differ considerably in respect of their incorporation of these external partners and the functions they fulfil. How do these persons and institutions participate? What is their specific contribution to the definition of a problem and the production of knowledge? To what extend and in what ways does the core of the research process depend on them? Does their participation in the project mirror their relevance for the solution of the problem? And so on.

IV. By definition, transdisciplinary research projects reveal some division of labour. The spectrum of such cooperative knowledge production ranges from rather simple serial coordination on the one side (science as assembly line) to the quite ambitious thematic synthesis on the other side (science as knowledge integration). Again, one may assess the added value in respect of the solution of complex problems.

Disclaimer

Beware! The approaches presented so far provide basically an analytical tool kit, which allows us to detect and monitor structural differences between projects. But on its own it is not sufficient to come to decision of which project is better or worse. It is equally legitimate to carry out simple or complex projects, to involve laypersons, stakeholders and interest groups in the definition of a research question or to take up a genuine scientific question.

These and other dimensions may help us to classify projects according their kind and degree of transdisciplinarity. But does this tell us much about their contribution to the solution of complex problems in the field of sustainability? On the one hand small scale and simple projects may efficiently provide very important missing pieces to the jigsaw puzzle. On the other hand complex programs may result in an output not so different from everyday intuitions, which would put the invested research effort into question. Moreover, also relying on internal criteria, like objectives, missions and ambitions of projects, does not really take us much further: Some projects are modest, and manage to reach their goals, but not much more. Others are perhaps too ambitious, never achieve what they promised, but nevertheless provide excellent results.

No doubt, classical disciplinary criteria will always have to be met. There is never good research that does not fulfil methodological requirements and theoretical standards. But beside this banal insight, it is hard to see what kind of external criterion might really lead beyond a crude formalism. This, however, could signify, that evaluations of transdisciplinary research will have to include non-scientific criteria. Do we then have to leave the formulation of extra-scientific criteria to the market, to political representatives or to a public discourse?

Conclusion

Even if we would come to conclude that assessing transdisciplinary research is in the end a transdisciplinary task itself, it will always refer to professional skills and competencies. While there seems to be no easy way to avoid the arbitrariness of determining which is a better transdisciplinary project, there are manifold possibilities to analyse and monitor organizational features and qualities of cooperative research projects. Assessments of that kind, however, will provide at least valuable foundations for the professionalization of the field, which is a precondition for the success of transdisciplinary research in the long run.

Acknowledgments

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Resources

Coordination office "Mensch-Gesellschaft-Umwelt" (MGU), University of Basel:
www.unibas.ch/mgu/

Further information on transdisciplinarity: **www.transdisciplinarity.ch/**

Interfakultäre Koordinationsstelle Allgemeine Ökologie (IKAÖ), University of Berne:
www.ikaoe.unibe.ch/

Transdisciplinary case studies at ETH Zurich:
www.fallstudie.ethz.ch/ITdNet/itdnet_home.html

On inter- or transdisciplinarity: inherent handicaps and some solutions?

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Introduction

We live in the aftermath of extreme specialization in scientific branches and witness the revival of integration. Also, our image and credentials in society have sometimes dropped, whether we like it or not. The main reason is that society has to cope with complex problems and does not accept partial, e.g. technocratic, solutions from specialists for problems that require a broader scope, a more balanced decision-making process rooted in the desire to create sustainable solutions. Together with the division of science in disciplines and sub-disciplines the organization of visions on reality (in paradigms), research activities (programs) and researchers (in disciplinary communities) seem to have become conservative in its own. Centripetal forces dominate. Reasons are bureaucratic sluggishness and territorial behaviour, the prestige of specialists among colleagues and in the public opinion, psychological characteristics of researchers and the amount of time, money, energy needed for interdisciplinary ventures. Last but not least: integration is less easy than sometimes thought. It requires more abilities than analytical brightness and relies heavily on other skills and knowledge. New theories, concepts and methods are required. Some elaboration is given below, as well as suggestions to overcome or minimize some of the handicaps.

Handicaps: some underlying factors.

1. The organization of science in universities, research institutes, advisory councils, flows of money and criteria to give it to scientists often form a heritage

from many decades of specialization and branching of sciences. Even recently we sometimes experience a drop back in some universities returning to even more disciplinary boundaries than before (Wageningen University).

II. The organization, availability and impact factors of scientific journals that are often highly specialized. Interdisciplinary research has less and less highly regarded media. As pointed out by Gary Fry (elsewhere in this publication) this perception is maybe not realistic, as many journals try to promote integrative studies and more and more journals on interdisciplinary studies are available. Maybe the scientists themselves are not yet able to produce good results.

III. Social and psychological factors play a role unconsciously: how nice (and safe) it is to be among disciplinary fellows; it is easy and socially safe to be amongst members of the same church. Psychologically it feels comfortable being a specialist and experience that you are constantly updated instead of being amongst aliens that don't automatically regard your discipline as relevant or interesting?

IV. Prestige in the world communities of specialists: you belong to the happy few of real specialists. You might even be asked to present your knowledge on television!

V. Merit systems and criteria: formal personal, program or institute assessments (reviews, visitation procedures) on quality or output of scientific results and adherent consequences for salary or career. Who recognizes the omnivorous animal as the target species to be protected? Who is paying the ferryman, taking care of connecting scientific results back and forth between scientific domains?

VI. The practical experiences in interdisciplinary projects: it consumes a lot of time to see what others do and why, to learn their languages, to experience the relative importance of your own profession. It consumes much time and energy to explain what your contribution could be, and quite often you have to be content with the relative anonymity in publications. When your last interdisciplinary projects have ended, it takes a lot to do all this again with new, inexperienced people.

VII. In interactive processes (in a trans-disciplinary set up) cooperating with target groups, non-scientific people the above problems could be amplified. Some of these groups are not impressed by scientific theories or methods and jargon and not used to our sectarian way of reasoning and arguing.

VIII. The management of inter- or trans-disciplinary research is by definition teamwork; it requires more social and managerial skills, whereas communication needs are much larger than working alone or in homogeneous groups. Many scientists are not equipped by nature or by training and education, nor inclined to invest time or energy in these non-scientific activities.

IX. Let's admit that interdisciplinarity, ultimately targeted at dealing with complex problems and a set of conflicting expectations of target groups with strongly varying perspectives and values, is hard work. How can ecologists and economists find a level that they understand and respect each others visions and findings and cook a meal out of very differing ingredients that is digestible for a decision maker. Can we manage different paradigms, theories, concepts, and methods? Maybe we have to design new, overarching concepts. Have we been successful so far?

Can we solve some of our handicaps or at least lessen the pain?

Referring to the above we suggest some recommendations that improve the situation

Problem definition

Articulation of problems and questions: nothing works like an explicit definition of the problem, so that goals, expectations are clear, stimulating and shared by participants.

Organization

I. Re-organization of the scientific communities: of course this can help; either by a drastic reshuffling or by other means: why not launch a special group or small institute dealing with complexity from an interdisciplinary approach

II. Reorganization of financing structures and criteria: Insofar research programs, review systems (ante), review criteria promote disciplinary approaches rather than integrated approaches, this system can be refocussed. Also ex – post reviews could be adjusted as well as merit systems for programmes, project, individual researchers, groups or complete institutes
III. Promote horizontal mobility of researchers: Exchange of researchers, especially aimed at creating synergy between disciplines could help. The crucial condition is that they work on clear problems and that their contribution is felt necessary

Content

I. Invest in common language, theory, unifying concepts: This is a neglected part of research; for reasons of uncertainty, time or money researchers are inclined to choose for their own, proven methods or concepts and definitions, instead of discussing their meaning and the compatibility in interdisciplinary processes. The role of language cannot be overestimated in communicating among scientist, to communicate with stakeholders, to present results. Experiences show that long-term misunderstandings between scientists can remain for a too long time during research projects, causing inefficiency, loss of time, money and good humour. A deliberate choice or new design of (unifying) concepts is often a sine qua non.
II. Change scientific evaluation criteria in a sense that added value of integration theories, concepts, methods or applicability of results are recognized.
III. However, do a better job as well, deliver quality and show it: what failures were avoided by your research, what were the profits?

Teambuilding and team processes

I. Studying complexity in inter- or trans-disciplinary teams requires knowledge of your own system characteristics: what makes a team a team, what are the favourable stars to be born under ? Do we know the tricks to develop a good and efficient team-process?

II. Try to build upon experiences and good chemistry: organize continuity
III. Analyse successes and failures: from both you can learn!
IV. Recognize the role of leadership which is something else than appointing the smartest or oldest of disciplinarians
V. Invest in training and raising scientific and societal consciousness (paradigms, languages, cultural differences, basics in communications, the processes within teams, applicability of results) in all stages of academic studies and on-the-job training

Various

I. Launch a new magazine if necessary, try to convince existing ones that integrative research could be interesting to show the role of disciplinary fields in a broader context
II. Don’t forget: make it fun!
III. Do not complain, do ….!

Conclusion

Potential and limitations of interdisciplinary and transdisciplinary landscape studies

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Introduction

In the light of an increasing demand for studies applying interdisciplinarity or transdisciplinarity, the two-days seminar held in Wageningen in November 2002 was initiated to facilitate exchange of information and experiences on the expectations and practice of interdisciplinarity and transdisciplinarity in Europe on landscape studies. The seminar linked to an ongoing discussion within research and policy on the role and expectations towards interdisciplinarity and transdisciplinarity in the field of landscapes (Décamps, 2000; Klijn & Vos, 2000; Moss, 2000; Antrop, 2001; Fry, 2001; Tress & Tress, 2001; Tress et al. 2001; Opdam et al., 2002; Wu & Hobbs, 2002).

The paper illustrates the potential and limitations of interdisciplinary and transdisciplinary landscape studies. The conclusions are based on the findings of the INTELS study investigating interdisciplinarity and transdisciplinarity in European landscape studies (www.intels.cc), the contributions in this book, and the Delta seminar discussions.

Terminology and definitions

We realize that confusion regarding the terminology is complicating not only communication on concepts such as interdisciplinarity, but also makes exchange of knowledge and matching expectations with achievements impossible. We stress the need for clarifying concepts and making meanings explicit in any discussion or publication. Therefore, we suggest 6 definitions of the main

concepts used in the discussion on interdisciplinary and transdisciplinary studies: disciplinarity, multidisciplinarity, participatory studies, interdisciplinarity, transdisciplinarity and integrated studies.

Disciplinarity: Projects that take place within the bounds of currently recognized academic disciplines. We fully appreciate the artificial nature of these bounds and that they are dynamic.

Multidisciplinarity: Projects that make a research effort of different academic disciplines, related to one subject, but with multiple disciplinary goals. Participants exchange knowledge, but have not the aim to cross subject boundaries to create new knowledge and theory. The research process progresses as parallel disciplinary efforts without integration.

Participatory studies: Projects that involve academic researchers and non-academic participants to solve a problem. Academic researchers and non-academic participants exchange knowledge, but the focus is not on the integration of the different knowledge cultures to create new knowledge. It can be a disciplinary or multidisciplinary study that includes non-academic participants. It is not necessarily research.

Interdisciplinarity: Projects that involve several unrelated academic disciplines in a way that forces them to cross subject boundaries to create new knowledge and theory and solve a common research goal. By unrelated, we mean that they have contrasting research paradigms. We might consider the differences between qualitative and quantitative approaches or between analytical and interpretative approaches that bring together disciplines from the humanities and the natural sciences.

Transdisciplinarity: Projects that both integrate academic researchers from different unrelated disciplines and non-academic participants, such as land managers and the public, to research a common goal and create new knowledge. Transdisciplinarity combines interdisciplinarity with a participatory approach.

Integrated Studies: Projects that either work interdisciplinary or transdisciplinary, in that new knowledge and theory emerges from the *integration* of disciplinary knowledge.

Motivations and expectations

Various motivations for integrated studies are found among scientists, program leaders, policy-makers, funding bodies, research councils and society. One prominent motivation is that current societal and environmental problems go across disciplinary boundaries and thus need common effort across disciplines. Brewer (1999, p. 328) put this motivation into a cynical statement: "The world has problems, but universities have departments." Of course, real world problems always touch more than one sector and are composed of e.g. economy, environment, policy, psychology, and culture. Research is expected to meet societal demands and contribute to problem solving. This is currently politically correct and reflects the demand for research to "pay back" public funding. Because disciplinary—or traditional—ways of research do not always meet these demands satisfactorily, more concrete solutions are expected from integrated studies. Researchers' motivations are often related to contributing to societal demands, but also steered by the availability of research funds.

Academia and research funding have high expectations towards integrated studies. It is argued that the integration of knowledge from different disciplines and knowledge communities can create new knowledge not available from other ways of doing research. This new knowledge is expected to solve environmental and societal problems related to landscapes. It can, however, be questioned whether these are realistic expectations. One argument for having high expectations is that they can steer and motivate research activities and help to focus on more concrete outputs. Against these arguments is that these expectations seem to be unrealistically high and endanger even the small efforts that are reached in the field of integrated studies. If expectations are too high, then small steps in the progress of integration will be classed as failure instead of progress. The integration of disciplines is very difficult and may take longer than the duration of a single research project or program. We must therefore be careful to be realistic concerning rates of process and also the limitations of any form of research to solve management problems.

Reaching integration should also be seen as a research aim of its own. Progresses in scientific studies of landscapes often do not include specific reference to integration or how this will be achieved. Only in recently started initiatives improving the knowledge body and skills in interdisciplinarity or transdisciplinarity appear among the aims of research programs.

This is essential, as integration is the way to produce new knowledge and theory, and this is, what after all determines whether something is research or not. Only when the data have been gathered, analysed, interpreted (including theory building) and fed back to the academic community (Winder, 2003), can we can talk about research. This means that the collection of data, collation of experiences, observation or facilitation of processes alone are not research, and thus not the ultimate aim of interdisciplinarity and transdisciplinarity as scientific approaches.

Disciplines and crossing boundaries

Integrated studies cannot substitute disciplinary or multidisciplinary efforts. We reject the idea that interdisciplinary and transdisciplinary research is "better" than disciplinary and multidisciplinary research. The different approaches are all useful and each is suitable to specific research questions. High-quality disciplinary research is a precondition for achieving good integrated research.

The seminar showed the need for rethinking the concept of disciplines and disciplinarity (Klein, 1996; Schanz et al., 1999; Lattuca, 2001). When doing integrated research, it is necessary to understand the meaning of disciplines and their boundaries. Disciplines are not static and are often split up into sub-disciplines that are moving towards or away from each other. New disciplines appear and old ones disappear, reflecting changes in knowledge cultures and as well as institutional and financial conditions. Some boundaries might be harder to cross than others. Sometimes boundaries between sub-disciplines can be more difficult to cross than among unrelated disciplines. When applying interdisciplinarity or transdisciplinarity these boundaries have to be identified and understood.

A realistic and critical perception of the value of interdisciplinarity and transdisciplinarity will help in using the concepts more precisely. Studies that include researchers from humanities, natural sciences and social sciences are not automatically integrated studies. Efforts are needed to reach integration and to create knew knowledge, otherwise the results will be multidisciplinary research. We emphasise again that there is nothing wrong in doing multidisciplinary studies. For many academic purposes and for meeting the many demands of funding bodies it is the most appropriate approach, but we recommend not labelling such studies as being interdisciplinary or transdisciplinary. If integration is aimed at, a conceptual foundation to reach integration and new knowledge is needed.

Successes and problems

Landscapes are complex, some may perceive them even as too complex for a study, but others perceive the complexity ideally suited to stimulate an integrated perspective in research. The latter is the reason why integrated approaches are seen as *the* way to solve landscape-related problems. But also here, researchers have to ask themselves whether they are not promising too much.

Achieving integration is difficult and realization often fails. Project organisation, project design and the day-to-day working environment for project work are determining factors for success and failure. Coordination of the research team in space and time is a major aspect of project organisation having influence on success. Leadership and management style as well as frequency and aim of project meetings are other factors. Projects that have no clear strategy on how to deal with these issues have difficulties in being successful. Project design—whether being parallel or integrated—is also important, although, in practice, there is often no evidence of a conscious choice made by projects. Often we can see that projects are willing to integrate, however, they do not start with a common problem formulation, but instead start in small independent (disciplinary) groups. During the course of the project these groups work more or less independently from each other. Only at the final stages, does integration

of the groups become an aim, but this is seldom realized because it comes far too late in the project process (Mogalle, 2001). In a real integrated project design, the interdependencies of project participants span the whole project and integration starts at the beginning.

Personal chemistry of researchers in integrated studies is another key to success. Mutual trust, motivation and pleasure in doing the work is important in any research projects, but when different disciplines are involved the common ground of project participants is smaller than in projects with participants coming from the same or related disciplines. If this cannot be balanced by personal chemistry, motivation and trust, success is more difficult to reach. Smaller research teams are therefore more suited to crossing disciplinary boundaries than larger ones.

Training for integration

In contrast to many other scientific methods and tools (e.g. GIS-programs, quantitative statistics, interview techniques), which no one would apply without beforehand acquiring the necessary skills, we still observe that interdisciplinary and transdisciplinary studies are started without participants and leaders acquiring firm knowledge of these approaches. Project participants frequently have enormous problems in making integration work and they finally end as parallel multidisciplinary studies instead. One of the main reasons for this is a lack of skills and in-depth understanding of interdisciplinarity by participants and leaders of inter- and transdisciplinary studies.

Another point of consideration is that integrated studies frequently have to combat unsuitable research environments and research management. Integrated studies may take a much longer time to define a common research goal, and thus need more funding in the early project phase. Participants should as far as possible have opportunity for daily contact and spontaneous discussions, because mutual trust and understanding is a basic prerequisite for reaching integration. To achieve this, it might, however, be necessary, to create temporary environments that bring interdisciplinary teams together across institutional boundaries. Research management can do much to foster inter- and transdisciplinary studies. But this requires research managers to be knowledgeable on the side about how to create sound environments for inter- and transdisciplinary teams. To increase the potential of integrated research approaches, training should be provided on three levels: for participants, project leaders and research managers.

Method and theory development

In spite of their practical applicability and problem solution potential, interdisciplinarity and transdisciplinarity still are research approaches. This implies that one could expect that they have an underlying epistemological theory, as well as integrated theoretical concepts, resulting from the practical experiences of research projects. However, these are weak points of current integrated studies. So far no coherent interdisciplinary or transdisciplinary theory has emerged from landscape research (Tress & Tress, 2001). The same goes for development of integrated theoretical concepts and methodologies. Seldom efforts are made for a systematic collection of results and experiences of integrated studies, in order to generate new knowledge and to constantly improve the applied methods and tools (Smoliner et al., 2001). The implicit knowledge gained from practical experiences is not made explicit and can therefore not be used by the scientific community (Nonaka & Takeuchi, 1995). This invalidates a basic academic tradition: to build on existing knowledge. Instead, most integrated studies start from scratch and thus slow down progress for this field – a clear limitation for integrated research.

Evaluation criteria

What is a good interdisciplinary or transdisciplinary study? First attempts were made, to develop sets of evaluation criteria for integrated projects (Defila & Di Giulio, 1999; Spaapen & Wamelink, 1999; Mogalle, 2001). There are however no widely recognized quality standards that could be used to evaluate projects ex-ante, intermediary and ex-post. Quality standards would have two main advantages: They would make it easier for funding bodies, to distinguish real interdisciplinary projects from those that only play with the name to improve their chance for getting support. And they would serve as guidelines for researchers that would set the standards their projects should live up to. Development of such standards would contribute significantly to improving interdisciplinary and transdisciplinary projects. One main criterion would be the degree of integration that actually is reached in a project and how this contributes to the end product(s). The lack of a recognized quality standard for integrated studies is a current limitation and a threat to their future development as funding bodies increasingly receive proposals and results that all claim to be interdisciplinary or transdisciplinary from widely different projects.

Merit system

A merit system gives scientists rewards for certain activities, which their institute, university or the scientific community in general regard as important achievements. Current academic merit systems are tailored for disciplinary approaches and regard peer-reviewed publications in international journals as main criteria of success. Likewise promotion of scientists is mostly based on disciplinary efforts. This is a limitation for integrated approaches. If more scientists are to work with integrated approaches in the future, their involvement should have equal chances for being rewarded than disciplinary efforts. Because integrated projects with their orientation towards problem solution, have not only publications as targeted products, a merit system for integrated approaches would need academia to acknowledge a wider range of research products, than only peer-reviewed publications. Assessment of these products, however, will require the development of an extensive, systematic, transparent and fair system of peer-reviewed achievement.

Potential and limitations

In the field of landscape research, new knowledge can be expected from applying approaches that cross disciplinary boundaries. New knowledge emerging from integrated studies will be more than the collection of knowledge from different disciplines. It will be integrative in a way that overshadows the single disciplinary contributions.

To improve the success rate of integrated studies, the expectations between scientists and funding bodies need to be more balanced and it needs to be made transparent, what integrated approaches can achieve and what they cannot. First of all – and against current opinion - integrated studies are not the solution to each and any problem and will not necessarily result in win-win situations. Working interdisciplinary or transdisciplinary will not prevent power struggles and will not tell policy makers what needs to be done. But they certainly can inform about different alternatives and their consequences, provide a better basis for decision-making and identify barriers to problem solution. Finally, and probably most important, integrated research can provide new insights into old problems.

Integrated approaches currently are pushed and driven forward by funding agencies and research policy, not by academia. From academics, this willingness to invest in integrated problem solutions should be seen as an advance of trust for this kind of research. However, this advance can easily be jeopardized, if integrated approaches fail to live up to what they promise – if their claimed added value compared with disciplinary approaches does not become apparent. Added value, however, is only reached by projects that are successful in reaching integration and produce new knowledge that make a significant contribution to solving complex problems. Sloppiness, playing with names and low quality are the greatest threats to integrated approaches and only strong efforts towards higher quality and commonly acknowledged standards will ensure future trustworthiness. Concerning funding bodies, these should be more precise in what they expect from integrated approaches, and to recognize the limitations of both these and other research approaches in solving environmental problems or conflicts.

Having stressed all the difficulties, we also would like to remark that successful interdisciplinary and transdisciplinary projects do exist, which produced results that would not have been possible with disciplinary efforts. Participants from integrated studies report that their involvement gave them unexpected new insights not only in other fields of research, but also in their own subject. These insights fundamentally changed the way they perceived their own discipline and, sometimes, science in general. All those involved in integrated research are challenged to prove that their efforts provide added value to academia and society. The main motivation for adopting interdisciplinarity and transdisciplinarity research approaches is that we appreciate doing integrated research – not only because of its problem solving potential but also because of its intellectual challenge.

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