Landscape Approach for Sustainable Development

From Applied Research to Transdisciplinary Knowledge Production

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Abstract

Sustainable development (SD) as a process and ultimately sustainability as a goal are key challenges for humanity. There are many policies that support the shift to more sustainable natural resource management. While many different concepts and approaches have been proposed, few practical ways to implement SD and sustainability have succeeded on the ground in real landscapes. To consider a larger geographical area, and to include both social and ecological systems and their interactions, is termed landscape approach. I define and operationalise the landscape approach and its five core features; (1) a geographical area, (2) collaboration among stakeholders, (3) a commitment to sustainable development, (4) knowledge production, and (5) sharing of knowledge and experiences. The five papers in this thesis investigated different features of the landscape approach. Paper I concludes that both Biosphere Reserve and Model Forest (MF) qualify as landscape approaches. In paper II the Kovdozersky MF in NW Russia was evaluated with the aim to support its development. The MF was mainly driven by forest sector actors and a model for local participation was under development. In addition they were influenced by Nordic forestry because they perceived it being a role model for sustainable forest management. In paper III the motivation for initiation of two Russian and two Swedish MF initiatives were studied, and a framework for analysis of local partnerships was presented. Motivations for initiation were diverse and included conservation of pristine forests, to create a Russian model for intensive industrial forest management, rural development, and to prevent conflicts between the forest industry and conservationists. In paper IV I presented a simple model based on natural forest disturbance regimes to identify forest site types where alternatives to clear-felling would be feasible for ecological reasons. In paper V a model for transdisciplinary knowledge production as a collaborative learning process was presented, and a transdisciplinary research programme was analysed. I conclude that the landscape approach can contribute to SD and that collaboration among stakeholders and activities that produce real outcomes on the ground are needed.

Keywords: collaborative learning, integrative research, natural resource management, partnership, sustainable forest management, governance, rural development

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Dedication

I dedicate this thesis to everyone that tries to contribute to a more sustainable world.

Leadership in a sustainable learning community, to a large extent, consists of continually facilitating the emergence of new structures and incorporating the best of them in the organisation's design. This type of systemic leadership is not limited to a single individual, but can be shared, and responsibility then becomes a capacity of the whole.

How does one facilitate emergence? Emergence can be facilitated by creating a learning culture, by encouraging continual questioning and rewarding innovation. In other words, leadership means creating conditions rather than giving directions.

Fritjof Capra

Contents

List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Axelsson, R., Angelstam, P. Landscape approach for sustainable development and sustainability: an exploratory study of Biosphere Reserve and Model Forest (manuscript).

II Elbakidze, M., Angelstam, P., Axelsson, R. (2007). Sustainable forest management as an approach to regional development in the Russian Federation: state and trends in Kovdozersky Model Forest in the Barents region. *Scandinavian Journal of Forest Research 22, 568-581.*

III Elbakidze, M., Angelstam, P., Sandström, C., Axelsson, R. Multi-stakeholder collaboration in Russian and Swedish Model Forest initiatives: adaptive governance towards sustainable forest management? *Ecology and Society (manuscript re-submitted after minor revision).*

IV Axelsson, R., Angelstam, P., Svensson, J. (2007). Natural forest and cultural woodland with continuous tree cover in Sweden: How much remains and how is it managed? *Scandinavian Journal of Forest Research 22, 545-558.*

V Axelsson, R., Angelstam, P., Ljung, M., Henningsson, M., Folkeson, L., Blicharska, M., Göransson, G., Sjölund, A., Mikusinski, G., Törnblom, J., Antonson, H., Frisk, M., Skoog, J., Jönsson, S. Transdisciplinary knowledge production? Evaluation of a research program about landscape values and sustainable transport infrastructure (manuscript).

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Abbreviations

BR	Biosphere Reserve
CBD	Convention on Biological Diversity
EC	European Community
EUA	European University Association
FAO	Food and Agriculture Organization of the United Nations
IMFN	International Model Forest Network
IMFNS	International Model Forest Network Secretariat
MAB	Man and the Biosphere Programme
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MF	Model Forest
MOA	Ministry of Agriculture
NGO	Non Government Organisation
SD	Sustainable Development
SFM	Sustainable Forest Management
SLU	Swedish University of Agricultural Sciences
SSNC	Swedish Society for Nature Conservation
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	Swedish Research Council

Foreword

In 2007 I participated in a conference arranged by the society "Science for Sustainable Development" (Swe: VHU- Vetenskap för Hållbar Utveckling) in Linköping, Sweden. One of the key-note speakers was Anders Wijkman, then an EU parliament member. Anders talked about his work in support of sustainable development, and especially environmental work. In his speech he emphasized the importance of inter- and transdisciplinary research. However, he said this is hard, and commented: "…when we arrange inter- and transdisciplinary meetings with researchers in Brussels the trend is that they try to position themselves instead of taking up collaboration". He also said that researchers seem to like to continue to deliver disciplinary results to us politicians hoping that we can solve the sustainability challenge, which we are not capable of doing. My PhD thesis is a response to this situation and an effort to support inter- and transdisciplinary knowledge production as an important part of the sustainable development process.

Another important experience for me was in 2004 when I did a first piece of research in a case study about biodiversity on a small island in the Philippine archipelago. Several local and international organisations worked with conservation of rare species, but few if any worked with local people. The last remaining forest habitats were felled by illegal loggers while researchers found new species in the remaining patches of forest. One conservation organisation had its own "conservation rangers" that collected illegal traps, chainsaws and similar things from local people. Another conservation organisation said that "sure we can support social projects as long as they directly benefit our conservation projects". Only one person that I met, Professor Lucia Lastimosa was convinced that to succeed in conservation there was a need for conservationists to involve themselves with local people, and to create a collaborative learning process to identify solutions that would work for both people and biodiversity. "You need to

work with people to find solutions that work for conservation", she said. Lucia told me beautiful stories about good examples where she had influenced local people to improve their practice.

The School for Forest Engineers (Swe: Skogsmästarskolan) was established 1945 in Skinnskatteberg. It was one of the founding partners of the Swedish University of Agricultural Sciences, which was established in 1977. From 2009 the School for Forest Engineers officially became a complete regional university campus when research and PhD education was given as official tasks to us. The education of forest engineers, a BSc in forest management, has developed to meet the need for practical foresters with hands on skills.

In Sweden foresters have managed very well to implement the sustained wood yield paradigm, and thus satisfy economical dimensions of forestry. Today, however, international, national and business policies have shifted toward a more comprehensive understanding of forests and forestry. This is termed sustainable forest management. Accordingly, the education of foresters in Sweden will need to continue to develop to meet these societal demands. This is a very interesting challenge for me and others who are a part of the faculty of forest sciences at the Swedish University of Agricultural Sciences. My own challenge at the School for Forest Engineers is to practise what I have learnt during my PhD studies, and to contribute to sustainable forest management in the Bergslagen region, where Skinnskatteberg is located, nationally in Sweden, and globally, as a large collaborative learning process. The research, the education, involvement in development projects, and to connect with local stakeholders and actors are all important parts of this mission of the department.

Some disciplinary scholars might say that this thesis is so wide in scope so there is no way a PhD student could grasp all of it. Surely I have not been able to dig deep enough in each scientific field to satisfy each individual disciplinary requirement. There are even Swedish professors that have advised me to write this thesis as a disciplinary thesis, to stay in my own scientific discipline. Another professor advised one of my PhD student colleagues that research should not aim to solve real life problems, "The rationale of academic studies is namely to contribute to theory, not to the accumulation of practical knowledge in general". I have considered this matter very seriously and received at the conclusion that research should be useful outside the academic world and support sustainable development. This does not mean that there is no need for disciplinary research. On the contrary all researchers need to understand where in the large and complex task of sustainability research their work would fit in and contribute to

solutions. However, some researchers need to work with the large and complex task itself with a holistic view. I am also aware that no single researcher can solve large and complex tasks like sustainable development on their own, and especially not a PhD student with only a few years and limited resources available. In the same way as a collaborative learning process among stakeholder is an important approach to dealing with or handle sustainability problems in a landscape, I argue that researchers need to engage themselves in a collaborative learning process with stakeholders and actors. Transdisciplinary knowledge production[1] involves societal engagement both before and after the parts in the knowledge production process where researchers by tradition have had their place.

My PhD thesis does indeed cover a broad subject, and draws in several scientific disciplines. There are scholars who hold the view that works across several disciplines is not manageable by one person. I do not claim that I did all this research completely alone. Rather I worked with many colleagues from different research disciplines, as can be seen in the author lists of my scientific papers in this thesis. All these colleagues are members of my own continuously growing network of researchers that together can solve tasks too complex for a single researcher, and which require the inclusion of several different scientific disciplines. I see my role as an integrative, inter- and transdisciplinary bridging researcher, or knowledge producer, with the aim to find solutions needed for the shift to sustainable development and sustainability. In accordance with policies at multiple levels, and despite advice against my integrative approach, I have taken steps away from being disciplinary only. Thus, in addition to relying on my natural science roots, also having developed sufficient understanding of other necessary research disciplines. My aim is that this thesis could contribute in a constructive discussion about what an integrative researcher[2] is. The thesis also means that I have started a journey that will eventually and hopefully allow me to master integrative research.

[1] Transdisciplinary research refers to an integrative process were researchers from different scientific disciplines, end-users and other stakeholders in an integrated way produce new knowledge that go beyond their respective disciplines together.

[2] Here an integrative researcher means a researcher that on his own bridges different research disciplines with the aim to understand the non-disciplinary reality better.

1 Introduction

It is evident that the human stewardship of planet Earth has more to wish for when it comes to sustainable development (SD) and long-term sustainability. Presently the human ecological footprint (Wackernagel and Rees 1996) exceeds the carrying capacity of our planet, and is increasing year by year (Anon. 2008a, Smith 2008, Rockström et al. 2009). However, sustainability problems have been observed even in early civilisations (Bogucki 1996, Tainter 2000). The term sustainability, and SD as the process to reach it, first came in focus when early industries used more raw materials than the local landscape could provide. Forests are a good example (Carlowitz 1713, Hartig 1804, 1805, Ström 1830, Wieslander 1936). Whereby, local communities suffered from problems to secure protective functions, and to extract or produce enough food and other necessary products locally (Hunter 1996, Ramakrishnan 2001). This lies behind early forest regulations in some mountain regions such as Swiss and Austrian forest laws (c.f. Schuler 1998). The focus was mainly on socio- economic aspects of SD, or to provide people and industries with their needs.

During the 20th century a global understanding of sustainability developed with the emerging environmental movement. It accelerated in the 1960s and 1970s when several environmental problems surfaced (Carson 1962, Palmstierna 1967, Gillberg 1969, 1973, Molina and Rowland 1974). In the 1980s and 1990s SD was agreed on as an aim for most nations and the principle to base further development on (WCED 1987, UN 1992a,b). As a part of a process to implement SD different more specific and targeted concepts, like sustainable forest management (SFM) have been developed (MCPFE 1993, Burton et al. 2003, Rametsteiner and Mayer 2004). SFM refers to the management, conservation and use of all types of forests globally following SD principles and is accordingly defined as having economic, environmental and the socio-cultural dimensions. Nevertheless,

despite a multitude of policies, work with SD in general, SFM and other efforts by different sectors using natural resources, humankind is still far away from ecological sustainability and a sustainable stewardship of planet Earth. However, as Hans Rosling shows in his pedagogic presentations of sustainability statistics, the world has become more socially sustainable and this development continues (Rosling et al. 2004, www.gapminder.org).

As a response to the need to implement and bring the SD concept into operation different guiding principles and approaches have been introduced, such as the precautionary principle, the polluter pays principle and the use of best available technology, etc. (EC 1997). Furthermore, the ecosystem approach was developed as a result of the meetings of the Conference of the parties of the Convention on Biological Diversity, after the convention was agreed on and signed in 2003 (FAO 2003). The principle was not a part of any of the convention texts after the Rio World Summit (UN 1992b). Its development was, however, a direct result of the agreements made during and after the summit. The ecosystem approach was gradually introduced and took shape during multiple meetings after the Rio World Summit. In 1998 it was defined, and twelve principles (the Malawi principles) were developed (CBD 1998). The ecosystem approach was further influenced by concepts such as the systemic approach used by the UNESCO Man and the Biosphere programme, the ecosystem management approach (Gauthier et al. 2009), and work done by the World Conservation Union (IUCN), World Wide Fund for nature (WWF) and other environmental non-government organisations (FAO 2003). In year 2000 the ecosystem approach was adopted by the signatories of the convention of biological diversity (CBD 2000). It was described as follows "The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way." The ecosystem approach has twelve principles (Table 3) and five operational guidance points (CBD 2000); (1) Focus on the relationships and processes within ecosystem, (2) Enhance benefit-sharing, (3) Use adaptive management practices, (4) Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate and (5) Ensure intersectoral cooperation.

The ecosystem approach implies that people are important actors in the SD process. In most parts of the world social activities and ecosystems are integrated. Thus, a division into independent social and ecological systems does not describe reality well (Folke et al. 2005). Scholars like Berkes, Folke, Walker, Hollings and others therefore use the term social- ecological system (Berkes and Folke 1998, Berkes et al. 2000, Berkes at al. 2003, Walker et al.

2004). This is consistent with the landscape concept as described by geographers (e.g., Sauer 1925, Grodzinski 2005). Further, new research present different dimensions of social-ecological systems' as strongly interdependent feedback systems and acting as complex adaptive systems (Gunderson and Holling 2002, Waltner-Toews and Kay 2005, Costanza et al. 2001). Thus, because landscapes are seen and treated as social-ecological systems it is not enough to address only ecological issues in work with SD and sustainability. It is not easy to understand how different parts are connected in complex systems. Soft systems methodology has developed as a way to manage sustainability issues in complex social systems (Checkland 1989, Checkland and Scholes 1990, Checkland and Poulter 2006). Similarly, landscape ecology is an attempt to support sustainability in landscapes (Liu and Taylor 2002, Wu 2006, Wu and Hobbs 2007, Wiens et al. 2007), and resilience science is an attempt to navigate social-ecological systems (Holling 1973, 2001, Berkes et al. 2000, 2003).

As a practical development of the ecosystem approach, the landscape approach is described as a way to address sustainability in a larger area and includes the understanding of a landscape as a social and ecological system and where success requires work and/or interventions in both the social and ecological part of the system (Borrini-Feyerabend 2004, Dudley et al. 2006, Singer 2007). It is a participatory approach where stakeholder collaboration is demanded (Singer 2007). When a landscape approach is implemented and used in a local landscape the term landscape approach initiative is used in this thesis.

There are several national and international concepts that promote work with SD in practice in landscapes. Examples of these concepts are Agenda 21, Biosphere Reserve (BR)(UNESCO 1996, 2002), Model Forest (MF)(IMFN 2008), Ramsar Wetland (UNESCO 1971), World Heritage Site (UNESCO 1972), EU Leader (Moseley 2003, Bryden and Hart 2004), the Canadian Forest Community program, the Swedish LEKO (Landscape Ecological Core Areas), the Polish Forest Promotional Complex (Rykowski 1997), and among others Joint Forest Management in India (Vania and Taneja 2004, Saigal et al. 2005). There are also numerous examples of local development groups that might not be influenced by or belong to any particular concept (Pretty 2003). Some of these concepts might qualify as landscape approach initiatives and some might not.

The aim of this thesis is to contribute to the understanding of how the landscape approach, and especially collaboration among actors and stakeholders, can contribute to the process of SD in landscapes viewed as social-ecological systems. Reality is not disciplinary (Daly and Farley 2004,

Farley et al. 2005). This requires that researchers from different fields collaborate. To undertake research about landscapes from a social-ecological systems point of view requires understanding of the ecological system, and the involvement of different stakeholders and actors in the knowledge production process in the social system (Gibbons 1994, Folke et al. 2005). In an effort to produce new knowledge needed to address SD in landscapes several frameworks were used in this thesis. First, based on a synthesis of literature, the collected data and practical experiences I developed a model for implementation of the landscape approach (see Figure 1 and 5). Second, the term multi-level governance was used as a complement to government to understand human multi-level interactions and decision-making processes. Third, I used the collaborative learning approach as a process-oriented way to deal with change, conflicts and uncertainty. Fourth, a model for transdisciplinary knowledge production and a framework for different modes of knowledge production were used. Finally, I used the concept of socially robust knowledge, i.e. knowledge that both solves problems technically, and is acceptable and feasible in the society (Gibbons 1999). My research is based on empirical studies related to the landscape approach and its different features (see Figure 1 and 5). Four papers based on work in places that have been treated as in-depth case studies of landscapes as social-ecological systems are used to shed light on the core questions in this thesis. In addition, one of the case studies is made up by an applied participatory research project with the aim to include natural and cultural landscape values in the planning and management of landscapes.

2 Background and research process

There are four sources of inspiration behind this PhD thesis. Since to a large extent I have been the instrument used for data collection and analysis (S. Kvale pers. comm.) in this thesis, the following text also contains information about myself, my approach and my learning process in line with the idea of self-scrutiny and policy-oriented professionalism of Clark (2002). Following Clark policy-oriented professionals have an interest in explicit gaining of knowledge and insight into the decision making process and they see themselves as both a participants and an "anthropological" observers. They see projects as open learning processes compared to conventional professionals that often uses and follows a specific plan or project design. The policy-oriented professional uses the tools that are needed to solve problems, which in a natural resource management context often means an integrative or interdisciplinary approach with a combined natural and social science methodology. In addition they understand that different stakeholders have differing understandings and perspectives and make efforts to understand these. They often use problem-oriented approaches including empowerment and enabling of stakeholders and take the context into account in integrative processes to find solutions, solve problems, and handle conflicts or to continuously improve natural resource management.

(1) First, in 2004 I started to collect data about BRs and MFs globally using a questionnaire about landscape approach initiatives where the areas a seen as socio-ecological systems, or landscapes, the reasons for initiation of the landscape approach initiative, and what aspects of SD and sustainability the initiatives were focusing on. This was initially a three-week course project at the end of my BSc education. However, the data collected were so interesting that I just continued to send reminders and had some interesting email conversations with people from BRs and MFs in different countries.

(2) Secondly, my first efforts towards applied integrative research including qualitative and quantitative methods were my MSc and Licentiate thesis (Axelsson 2008). It resulted in a simple model for forest management adapted to site type with the aim to emulate natural and cultural disturbance regimes. The thesis also showed that forest managers did not use site adapted forest management systems in two large study areas representing the Swedish boreal forest. This model based on forest disturbance dynamics could potentially provide guidelines that would support ecologically sustainable forest management. However, almost no one was interested in my results, and some even got angry with me. One person, a former employee at the Swedish Forest Agency said that this is proof that we have failed with parts of our aims to implement sustainable forest management in Sweden. I then asked myself the question "How to make research useful?"

(3) The third part was when I learned about the landscape approach. This came step by step as a part of my research process by reading literature, participation in workshops, during field work in mainly Canada, Russia, Ukraine and Sweden and my parallel practical work experience. Here I noted that many actors talked about the landscape approach, but that few understood all its parts and its implementation.

(4) Finally, I believe in people and their willingness to do well. Also the concepts SD and SFM have convinced me as very promising approaches that potentially could guide people to act and work in a different way. I felt that what was needed were new approaches to be developed to make these concepts operational and easier to follow.

Before I started my post-graduate studies I worked professionally with natural resource management. This was in the context of environmental consulting, monitoring, oceanography and air quality management in large cities. My working area was mainly Western and Eastern Europe, and Southeast Asia. How to use my previous experiences in the work with this thesis was initially a big challenge to me. For long I thought I could not use them at all. It was during a PhD course in qualitative analysis that I learned about grounded theory (Glaser and Strauss 1967). They described how sociologists could extend their data with what they called new sources of qualitative data (Glaser and Strauss 1967, chapter VII), and how insights could be developed to theory through systematic comparative analyses (Glaser and Strauss 1967, chapter XI). They provided an example about a researcher, Fred Davis, who wrote a scientific article titled "the cabdriver and his fare: facets of a fleeting relationship" (Davis 1959) based on his own prior experience as a cabdriver while still in graduate school. Sources of qualitative data could thus be anything that is useful to the research question

including different texts, library searches, films, magazines, newspapers as well as different kinds of earlier observations ranging from well documented to personal memories.

An example from my own experience was the Puerto Galera BR in the Philippines, located at the northern tip of Mindoro Island. Puerto Galera is a city and tourist resort area that I visited about 25 times during 1999 to 2004 without knowing it was a BR. I spent time scuba-diving, riding a motorcycle, trekking in the forest and bought on several occasions handicrafts made by and directly from the local Mangyan tribe. In 2004 I met with the local head of an international conservation Non Government Organisation (NGO) in Manila that presented his view about the contemporary conservation situation in Puerto Galera and Mindoro Island. Later the same year I studied the BR concept and collected data from designated areas globally. As a part of this work I found the Puerto Galera BR at the UNESCO MAB programme homepage and read about it . These three independent sources of information formed for me valuable data.

When writing the thesis my effort has been to communicate my findings to practitioners and stakeholders working with SD. I discuss potential applications to be applied in practice, and include some practical references in an effort to make the knowledge produced and documented in this thesis socially robust and useful for practitioners, forestry and sustainable development education. This is also why I try to write the thesis in a more popular and understandable way. My efforts to make my research useful could be exemplified with my participation in the practical implementation of landscape approach initiatives. In 2006 and 2007 I participated in Baltic Forest, an EU-funded development project that aimed to implement ideas in line with the landscape approach in the Baltic Sea region. Since my first day of work at the School for Forest Engineers I have been involved in the development of a local landscape approach initiative named Sustainable Bergslagen with the aim to develop a a collaborative learning process among stakeholders involved and interested in landscape governance, SD, sustainable forest management and rural development in Bergslagen.

These experiences have provided me with important comparative data that have been used to confirm empirical observations during the field work for my PhD, and have contributed to a good foundation and real-world practical context for my research. Based on the paradigm of natural sciences some scholars may oppose and say that these "old observations, memories and not properly analysed information" are not data! What if you remember wrong? My response to this is that it is one kind of data with its advantages and disadvantages just as any kind of data. I am aware of the limitations and

would at my present development stage as a researcher not use only this kind of data for a research study. However, these experiences have been very important for me in providing a solid foundation and context for and to relate my more formal research to. It has also provided me with different experiences that have made theories and concepts easier to understand as it is always easier to understand a theory or concept if you can relate it to your own practical experiences. I have used the practical experiences as references for comparisons, and to provide me with a general understanding of different phenomena that together with other data sources such as books, peer-reviewed articles, official reports and my own collected and analysed data have guided me while identifying interesting areas and issues to study in this thesis. For each of my studies more specific data collection efforts have been made and have been the main data source for the analysis. Figure 1 is an effort to present my previous life experience, my previous work experience and the practical experience during my PhD studies in relation to the 5 studies in this thesis. In Figure 2 the amounts of data from the different sources is illustrated.

In addition to these experiential data I have collected large amounts of not yet transcribed and/or analysed data materials from several landscape approach initiatives, local champions and concept champions, i.e. people that formed, further developed or work with the concepts at national and international levels. These data materials are very large, much larger than what would be feasible to transcribe and analyse for a PhD thesis.

However, I have chosen to not include my practical work and experiences during my PhD studies as a concrete part of this thesis (Figure 2). During my work with my PhD education the effort has been to produce research papers of good quality based on; 1) carefully collected and analysed empirical data, 2) official data and statistics and 3) literature reviews.

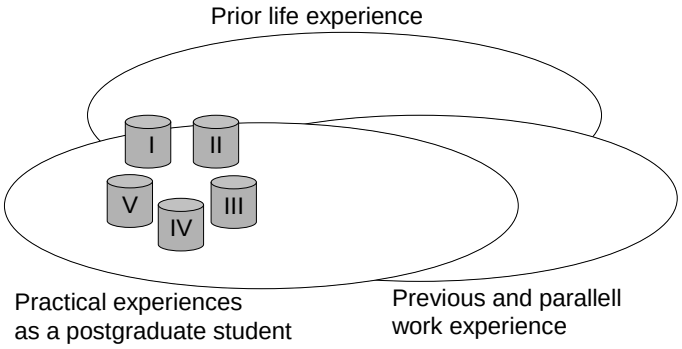

Figure 1. Reflecting on the role of the researcher. Life experiences, prior and parallel work, and postgraduate student practical experiences in relation to the work with my thesis (after Clark 2002).

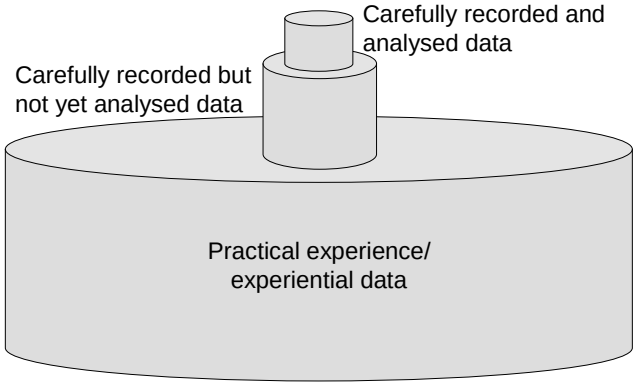

Figure 2. An effort to present the three different data sources used in this thesis and the relative amount of data from the different sources. All specific data collection used as the main data source in the papers of this thesis is represented by the smallest cylinder.

The research process started with two different tracks that I at the time did not know would merge to one. The first was the natural science track that I was well prepared for because of my prior and recent undergraduate exams in biology. The second was an interdisciplinary track which I discovered when I collected data from landscape approach initiatives world-wide using a questionnaire. I understood the necessity of studying both the social and ecological systems also from my own prior field experience, and from

literature. This was further emphasized when I presented my Licentiate thesis including the results from a natural science study that provided a simple model for site adapted forest harvesting that could potentially contribute to more sustainable forestry practices. However, this was not very appreciated by foresters, and some got really irritated. Still, from a research point of view both tracks proceeded well, even if in the beginning of the research process I was working with influences from my undergraduate natural science background only. My interest was to include also the social system in the research and with the aim to develop solutions that would be good enough to solve or manage SD issues and improve governance and management of natural resources in forest landscapes, and at the same time being acceptable among stakeholders. Together with my main supervisor a three step approach was developed. The steps were developed as the research process proceeded. It should also be noted the steps were not isolated from each other, instead they were woven together and I went back and forth between them. The three steps were (1) basic understanding, (2) research design and data collection, and (3) analysis and writing.

Basic understanding was gained through practical work and participation in landscape approach initiative work on the ground, extended field work in landscape approach initiatives, travelling workshops, meetings with local stakeholders in the different case studies, participation in conferences, seminars and meetings, and a review of relevant literature. During this phase I took some PhD courses and started to collect data. Data at this point was written documents from and about landscape approach initiatives. One important PhD training course was with Steinar Kvale about qualitative research interviews. After this course I started to make interviews. At this point neither my research questions nor the analytic framework for my thesis was in place. The interviews were inspired by case study research (Yin 1994) and explored the area, economical activities, background, sustainability issues, initiation, values, development, participants, activities, approaches and results of the landscape approach initiatives. My aim was to learn more about the landscape approach and to collect data.

Early in the process I wrote some essays and participated in work lead by colleagues. This work and discussions with colleagues and further reading gave me ideas about design of new studies. New ideas were described briefly and discussed with colleagues. The process of developing these ideas was really stepwise, iterative and long. My and our ideas evolved over time. Ideas that came up early, rarely followed through in the same shape as they appeared. Instead the ideas developed, were adapted, matured, in some cases were rejected, and then finally were realised. For these studies specific data

collection efforts were made. The design and data collection for paper IV aimed to use several data sources and analysing methods that together would present a strong result.

The analysis and writing for paper IV was quite straightforward from a natural science perspective, even if the multiple methods used made it very complex. For the interdisciplinary studies the analysis became more and more influenced by grounded theory (Glasser and Strauss 1967). My stepwise and iterative approach was to (1) thoroughly go through and work with my data, (2) evaluate the validity of the data, (3) write down my understanding of the case which often resulted in large amounts of unstructured text, (4) structure the text, (5) go back to the data for comparisons and confirmation, and (6) to compare, confirm and relate with mainly scholarly work. The writing and analysis process went through much iteration, back and forth between these six points. Results were repeatedly scrutinized by iterative comparison with data and other scientific writings (Glasser and Strauss 1969, Alvesson and Sköldberg 1994, Starrin and Svensson 1994). My aim was to reach a point where all my results were grounded in my data. In addition I went through a process where I tried to falsify my writings by trying to find and evaluate data that would speak against my results. Grounded theory helped me to structure my work, improve the quality of the work, and put names on and use terms for what I was doing. In the same way my research questions and analytic frameworks for the research have developed step-wise during with the iterative research process, as I was going back and forth between the three main steps basic understanding, research design and data collection, and analysis and writing.

The papers included in the thesis satisfy my aim to carry out research about both the social and the ecological systems of landscapes, with a final paper looking into knowledge production in general. The collection of data about BRs and MFs was my first attempt to describe implementations of the landscape approach (paper I), and the start of my postgraduate studies. Paper I describes the landscape approach, presents a model for evaluating its implementation in local and regional landscape approach initiatives, and compares two international landscape concepts (BR and MF) with the model using empirical data from 62 different landscape approach initiatives globally. The data provides a basic understanding of both the social and ecological systems in these landscape approach initiatives. Also in paper II both the social and ecological systems were studied. The aim was to explore in depth a landscape approach initiative on the ground (paper II). In this case one landscape approach initiative in north-western Russia, the Kovdozersky MF in Murmansk region, was studied to support its development by

development through evaluation (sensu Tranquist 2008). In paper III the social system in four landscape approach initiatives in northwest Russia and Sweden were studied with the aim to understand the reasons for initiation and the opportunities for adaptive governance, i.e. the partnership and the collaboration toward sustainable forest management. In contrast, paper IV is an example of applied biophysical research with the aim to improve the understanding and ecological management of boreal forests, thus providing evidence that implementation of sustainable forest management requires some sort of landscape approach (see also Axelsson 2008). Finally, paper V is about the core of knowledge production for SD in socio-ecological systems in general (see Table 1 for an overview). This study is an effort to dig deeper into different modes of knowledge production and especially transdisciplinary knowledge production. All five papers and the thesis itself represent the aim to produce socially robust knowledge. The sectors in focus in this thesis are those involved with the use of forest wood and non-wood goods, ecosystem services and landscape values (e.g. Daily 1997, Merlo and Croiteru 2005).

Table 1. *An overview of the papers in this thesis in relation to their focus on social or ecological systems in forest landscapes.*

Paper	Content of paper	Social system	Ecological system
I	The landscape approach, two landscape concepts, and their implementations in a large sample.	X	X
II	Landscape approach initiative development case study.	X	X
III	Mapping and analyses of the social systems in four landscape approach initiatives.	X	
IV	Applied research to assist landscape sustainability by analysing tangible policy outcomes in the ground.		X
V	Knowledge production for sustainable development in socio- ecological systems in general.	X	

The suite of methods used in this thesis has been chosen to match my different research questions (see discussion on methods in Moses and Knutsen 2007). The methods thus range from natural and human science (sensu Myrdal 2005) to integrative research methods (Svensson et al. 2002, Tress et al. 2006), and include quantitative to qualitative approaches.

My interest is in transdisciplinary research, i.e. to produce knowledge that can solve problems and support change to more sustainable practice in close collaboration with other researchers, end-users and stakeholder

developed during the work with the thesis. I am by formal education a natural scientist but have tried to learn about and understand inter- and transdisciplinary knowledge production based on the ideas of integrative research as described by Tress et al. (2006, Figure 3). However, transdisciplinary knowledge production takes a long time to arrive at. Hence, the research in this thesis has more a character of participatory and interdisciplinary research (see Figure 3, Table 8 and Table 9). The interdisciplinarity has been as a development process for myself, and to a lesser extent as collaboration with researchers from different research disciplines, except for Papers III and V.

Usefulness to and collaboration with the end-users has nevertheless been a high priority for me. In the same way as interdisciplinary research with participants from different research fields means that the researchers need to let go of their own ground and together develop a common framework that is acceptable to all the participators I have tried to take steps towards social and human sciences (as described by Myrdal 2003). My aim is not to become a social or human scientist, but to contribute to bridging of the gap between natural and social/human sciences because all are needed to support sustainable development in general and sustainable forest management in particular. The subject area of this thesis is natural science (forest management) even if it is described as interdisciplinary by my university: "The objectives of SLU research are to gain a better understanding of the different functions of the forests and to make best possible use of the opportunities it offers, when it comes to economical, social and ecological aspects" (SLU 2009a). Further the description of SLU research in general also emphasize this, "A comprehensive view, interdisciplinary studies and applicability are the ethos of SLU's research and education, and in our contacts with industry and society" (SLU 2009b).

During the work with my thesis I have made efforts to write also popular texts, and I have been involved in practical efforts to collaborative learning, conflict resolution, partnership development, international networking with different landscape concepts and dissemination of results from my own and my colleagues' research.

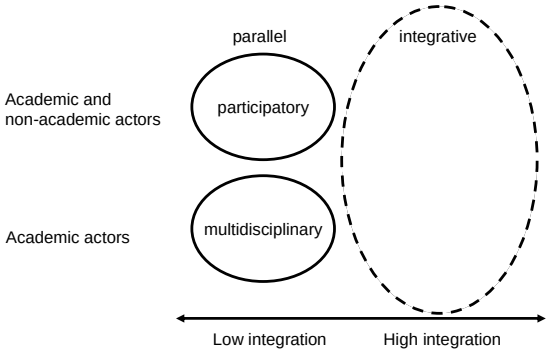

Figure 3. A model for integrative research (Tress et al. 2006).

The relationship between the papers included in my thesis on the one hand, and work with other research, development and implementation on the other is summarised in Figure 4. The five papers in this thesis and my parallel work experience could be seen as pieces that I have used to explore the main framework of the thesis, i.e. a model for implementation of the landscape approach (see Figure 5). The development of the model have been a stepwise or iterative process and the five features; (1) an area, (2) collaboration, (3) sustainable development/sustainability, (4) knowledge production and (5) sharing, have emerged during and as a part of the research process. An analysis of multiple regulatory frameworks for different landscape concepts (UNESCO 1996, 2002, Moseley 2003, Bryden and Hart 2004, Anon. 2006, IMFN 2008 among others), sustainability policy, related research, practical experiences from local and international implementations of the landscape approach and the three sources of inspiration mentioned above provided me with the insight that these five features are the corners stones of the landscape approach.

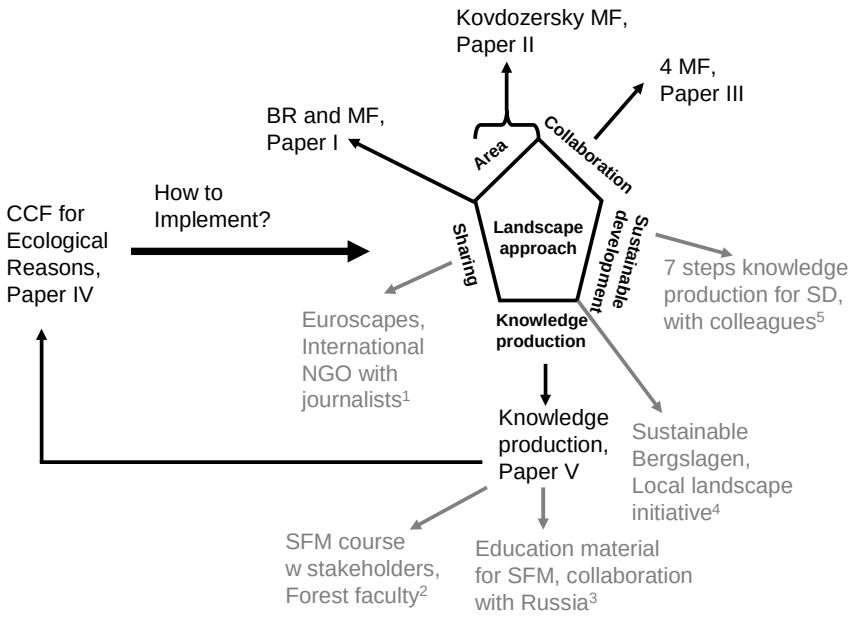

Figure 4. The evolution and working context of this thesis.
[1] Euroscapes is an international Non Government Organisation started by researchers and journalists in Sweden, Russia and Ukraine with the aim of communicating sustainability research and connecting landscape approach initiatives in Europe.
[2] In 2009 a new course named "infrastructures for a sustainable forest landscape" was introduced at the School for Forest Engineers. The course builds on the participation of forest stakeholders from Bergslagen, Sweden and internationally.
[3] As a part of a Swedish development co-operation with Russia, funding for mobility between Sweden and Eastern Europe, and applied research the School for Forest Engineers develops a course and study materials about sustainable forest management with Moscow State Forest University and other stakeholders from Russia and Ukraine.
[4] Sustainable Bergslagen is a regional initiative in Bergslagen and I have acted as the chairman of the board since its formal creation as a NGO in January 2009.
[5] Seven steps knowledge production for SD is an approach to wisely choose landscape case studies, to learn about them, to identify sustainability gaps and to extract new general knowledge from a series of landscape case studies. The seven steps were developed together with my colleagues (Angelstam et al. 2007, Axelsson et al. 2008).

The work with this thesis has been an attempt to strike the balance between human and natural science research rigour on one hand, and usefulness to people working with landscape approach initiatives, practitioners and landscape stakeholders on the other. I feel that research often will result in knowledge that is hard to use and understand for the average actor and stakeholder involved with the use and conservation of natural resources in forest landscapes. This is what some scholars have called the "knowing –

doing gap" (Pfeffer and Sutton 1999, Molnar 2009), i.e. there is knowledge to manage many sustainability problems, but it is ineffectively or not at all transformed into practice. Others call for socially robust knowledge (Gibbons 1999) and integrative PhD educations (EUA 2009). To support the SD process researchers involved with governance and management of natural resources, such as forest wood and non-wood goods, ecosystem services and landscape values, must integrate their work better with the rest of the society and learn two-way communication skills.

3 Methodology and methods

This thesis is an effort towards integrative research, i.e. an effort to understand interconnected social and ecological systems better by drawing from more than one research discipline. This necessitates the use of multiple methods. There is a need for at least; natural science methods and social science methods. Since a landscape seen as a combined social and ecological system is a complex study object, just using one method might not result in a correct picture of the studied phenomena. My methodology was to apply multiple natural science and social science methods to answer the complex research questions. The choice of methods has been pretty much straightforward due to what data was needed. A main method for data collection was used, which was complemented with additional data (i.e. triangulation). This is in line with Flood and Romm (1997) even if it was further extended by the usage of also multiple natural science methods. For each paper specific methods were applied, but as a whole the analysis of empirical data was conducted by the means of both quantitative and qualitative approaches. The strength of using a multi-methodological approach is that it enables a stronger validation of empirical data and specific research findings by triangulation. By using different methods when studying complex phenomena the possibility to interpret and contextualise data increase. It was the problem and question which guided what method that was used, implying that the study of ecological systems, social systems, and social-ecological systems demand different research approaches.

Furthermore, all studies included in this thesis are case studies of different landscapes (Table 2). The author does not claim that the research is case study research (Yin 1994) even if it partly draws on ideas from this discipline. This is the result of studying reality with the aim to produce knowledge that could support natural resource management, SD and the process of knowledge production. Regardless of the ambition of producing

useful information, this thesis does not claim to be participatory in the sense of involving participants and informants in the inner knowledge production process (i.e., it does not qualify as inter- or transdisciplinary research or knowledge production (Table 8)). Instead, the research sees the participants as actively participating in a nexus of practice in the field of SD of forest landscapes.

Table 2. *The different case studies of the papers in this thesis..*

Paper	Case studies
I	Multiple landscape approach initiatives globally.
II	One landscape approach initiative in Murmansk, Russia.
III	Four landscape approach initiatives in Western Russia and Sweden.
IV	Two case study regions that represent the boreal forest in Sweden.
V	The social landscape of a transdisciplinary research project.

The specific methods used for the studies of ecological systems range from a questionnaire sent to multiple landscape initiatives globally (paper I), to multiple methods including the use of ecological theory, several different spatial datasets, forest inventory data and other data sources, and spatial analysis using Geographical Information Systems (paper IV) as well as the use of forest inventory data, official documents, records and interviews (paper II). The data in paper I was compared with a model for the landscape approach initiative, tables, figures, multivariate statistics and analyses of texts. The work for papers II and IV were done in collaboration with end-users with the aim to assist their work toward SD in forest landscapes. For paper IV the Swedish Forest Agency was the end-user and customer. Paper II was an outcome of work within an EU-funded project named Baltic Forest, and was an effort to assist the Kovdozersky MF in northwest Russia in their development to become a MF according to the International Model Forest Network criteria (IMFN 2008).

The methods used to study the social systems include a questionnaire sent to multiple landscape initiatives globally (paper I), qualitative interviews, as well as analyses of socio-economic data, official documents and records (paper II and III). Data collection for paper V was mainly done through qualitative interviews, and analysis of official and unofficial documents. Several frameworks or models where developed and used for comparisons and analysis (Table 4, 6, 8, 9, 11, Figure 5, 9). Data collected through qualitative interviews followed Kvale (1996), Kvale and Brinkman (2008) and Ryen (2004), were transcribed and analysed with qualitative methods (Kvale 1996, Ryen 2004, Glasser and Strauss 1967). The specific methods

are described in detail in the respective paper (paper I-V and Axelsson 2008).

4 Theoretical framework

I used several theoretical and practical concepts. The first one is "sustainable development", the preferred kind of development and supported by governments, businesses and civil sector stakeholders world-wide. Sustainable development includes ecological, economical, social and cultural aspects of development and is thus seen as an interwoven framework for all development and human activity globally. The second, "government versus multi-level governance" describes the ongoing shift from few decision-makers to present decision-making processes that are affected by many stakeholders. Governments are still a key stakeholder, but as a part of the development of democracy and technical specialisation more stakeholders representing different groups, organisations and different levels are involved. These two first concepts describes what is preferred, i.e. "sustainable development", and the complexity of the social system. The third concept, "landscape approach" offers a framework to consider large enough areas for management of natural and cultural values, natural resources, and to include people in the sustainable development process. Large enough means that the size of the area is decided depending on management issues and thus the size is required to manage the values and natural resources at hand. The fourth concept, the "collaborative learning" approach offer a hands-on model for handling complex management situations with multiple actors. It builds on adult learning, conflict management and soft systems methodology and in this case could potentially provide a process oriented and stepwise guide towards sustainable development and sustainability in landscapes. The fifth concept, "socially robust knowledge" describes properties of and what kind of knowledge producing processes are needed to produce knowledge that can solve sustainability issues technically, and is socially acceptable. Finally, as a synthesis a normative model for process oriented transdisciplinary knowledge production and collaborative processes were developed.

4.1 Sustainable development

The development of the term "Sustainable Development" has its roots long back in time with the first signs that natural resources of our planet were not endless (e.g., Hunter 1996, Ramakrishnan 2001). During the 20th century a global understanding of sustainability developed with the emerging environmental movement. It accelerated in the 1960s and 1970s when several environmental problems surfaced (Carson 1962, Molina and Rowland, 1974). This was further emphasized by a series of publications and reports that described environmental degradation (e.g. Carson 1962, Ehrlich 1968, Ward and Dubos 1971, Meadows et al. 1972, Molina and Rowland 1974). In the 1980s the development of relevant policies, governance and action plans took off. The SD concept gained world-wide acceptance with the Brundtland report (WCED 1987). The Brundtland report defined what SD is: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". SD involves the recognition of resources as limited and equity within the present generation and with future generations as important features. The concept is a vision of progress that integrates present and long-term needs, locally, regionally and globally, and includes socio-cultural, economic and environmental needs (UN 1992a, UN 2004, Adams 2006 and others) as inseparable and interdependent components of human progress (WCED 1987). SD is commonly understood as having three dimensions i.e. an ecological, an economical and a socio-cultural (Adams 2006). Definitions of SD thus see and treat the earth as a system in space and time (Folke et al. 1994, Clayton and Radcliffe 1996). Later, in 1992 at the World Summit in Rio, governments globally committed themselves to make development sustainable (UN 1992a,b). Accordingly, governments today have SD as a priority and have developed national policies for different sectors.

Definitions of SD see and treat the earth as a system in space and time (Folke et al. 1994, Clayton and Radcliffe 1996). There is a need to improve the performance of all of the three dimensions and to find a sustainable balance. Regarding the ecological dimension there is appearing empirical evidence showing that performance targets can be formulated (e.g., Angelstam et al. 2004a). SD is seen by some as process where we decrease our ecological footprints (Wackernagel and Rees 1996) to sustainable levels. At the same time, to reach sustainability there is a need to address inequalities among people locally as well as globally. A decent life for all people in all countries is a corner stone of the SD concept. The socio-cultural dimension of SD includes issues like 1) social justice: equal opportunities and progress towards achieving all human rights, 2) solidarity:

empathy, cooperation, understanding and associational life, 3) participation: opportunities for people to play a meaningful role in development, 4) security: livelihood and safety from physical threats (Thin 2002). Coherent with ecological and economical SD social-cultural SD could be seen as sustainable management and development of social capital (Putnam 1993, Forsberg et al. 2002), and to link social capital within levels and between different levels of our society (Hansen 1998, Woolcock 1998). In the same way culturally SD could be seen as sustainable management of cultural values and capital, 1) landscape values, buildings/constructions, cultural and historical remains and points of interest and 2) the local way of life as the system through which a social order exists, is communicated, reproduced, experienced and explored (Williams 1983, Serrageldin and Martin-Brown 1999, Nurse 2006).

International policies on SD have been strongly influenced by the Brandt Commission's report in 1980 and the Brundtland report in 1987. These reports established a causal relationship between environmental degradation, population growth, loss of cultural identity, social inequities and the fact that unsustainable use of natural resources will sooner or later deplete the resources that we depend on. The Millennium Development Goals (MDGs) has lately provided a framework of quantifiable targets and thus allow the measurement of performance of the SD process (Anon. 2005).

The origins of sustainable forest management (SFM) can be traced back to early forest management literature (e.g., Carlowitz 1713, Hartig 1804, 1805, Ström 1830) while the present view originates from the Forest principles (UN 1992a) and Agenda 21 (UN 1992b) of the World Summit in 1992 (UN 1992a). SFM refers to the management, conservation and SD of all types of forests globally. In principle it means to manage forests in line with SD principles and accordingly defined as having economic, environmental and the socio-cultural dimensions. The concept has been brought further by the Montreal, the Helsinki processes and collaboration among international actors (MCPFE 1993, 2006, Anon. 1999a). Forest certification and the landscape concept MF are attempts to implement and elaborate sustainable forest management locally (Auld et al. 2008, IMFN 2008).

It is commonly agreed that SD and sustainable forest management requires collaboration among stakeholders (Lee 1993, Grumbine 1994, Berkes and Folke 1998, Gunderson and Holling 2002, Berkes et al. 2003, Dietz et al. 2003, Dudley et al. 2006) and policies have thus adapted accordingly (UN 1992a,b, Anon. 2000, Anon. 2008b, MOA 2008). In this thesis sustainability is treated as a social construct, i.e. something that is

preferred by people and decided by democratically elected decision-makers. This preference on what is thought to be sustainable is clearly visible in policies. Sustainable development, by contrast, is understood as the process of moving towards sustainability.

4.2 Government versus multi-level governance

In European and North American political theory the term government has been used to refer to the formal institutions of states and their monopoly of power. Characteristics of government have been its capacity to make and enforce decisions (Stoker 1998). Over time society has evolved to become more and more specialised, which has made societal functions and institutions more fragmented. The decision-making power is today divided among several specialised functions, and the government has lost parts of its monopoly. This is a result of a further development of European and North American democracies, the deregulation in different societal sectors and appearance of new actors in the national and international arena (Fry 1998). Many states are shrinking in size because societal functions are deregulated and taken over by the private sector. Governments are today affected by more international agreements and actors and have thus lost parts of the traditional capacity to govern. Scholars describe this as a required shift from government to governance. Governance includes multiple actors at multiple levels and is thus often referred to and described as multi-level governance (Bache and Flinders 2004). All the way from local, regional, national, international to global there are today different actors present that make decisions and enforce them. At the same time democracy has developed and made the civil society more active in the decision making process. Consequently, there are today different actors, interest groups and NGOs present on all decision levels. This does not mean that government has lost all of its power only that it is more fragmented and that other actors in society have increased influence on its decisions. Governance could thus be described as decision-making processes and networks (Sundström, 2005).

Other scholars describe the duality of governance; from one perspective it refers to government's adaptation to a new context that appeared in the late 20th century while from another perspective it is about a conceptual representation of co-ordination of social systems, most often the role of government (Pierre 2000). The role of the government is interpreted in two different ways, as the way the government steers the society and as co-ordination, formal and informal collaboration between the public and private sectors (Peters 2000). Research on governance is concentrated on

two different main fields; (1) dealing with the states capacity to steer and (2) different modes of co-ordination and self-governance (Rhodes 1997). The governance concept is applicable in more or less all societal sectors and many different contexts (e.g., Foss and Mahnke 2002). Generally it is about the shift from a single or few persons making all decisions in a less complex context to the same person or a small steering group making more informed and influenced decisions to meet the demands in a more complex world (Rhodes 2003).

When discussing issues like rural development, natural resource management, cultural heritage, biodiversity conservation and the environment in general it is clear that many governance levels affect policies and outcomes in terms of SD on the ground i.e. it is an example of multi-level governance. This means that the process of SD with many actors at different levels could be seen as a multi-level governance system. In the same way a transdisciplinary research project dealing with SD and with the many involved actors at different levels could be seen as a multi-level governance system. To assist SD in multi-level governance systems the development of adaptive governance has been proposed (Folke et al. 2005). Multi-level governance also implies that the management of local to regional SD issues often involves actors from higher levels. Adaptive governance is by scholars viewed as the combination of learning by continuous evaluation, reflection and the present system of decision making that includes integration of specialist functions and influence from different actors at multiple levels (Folke et al. 2005, Olsson et al. 2007, Armitage et al. 2007). It is a way for the social part of a social- ecological system to develop resilience or capability to resist disturbances by the capacity to re-organising itself when needed (Folke et al. 2005).

4.3 The landscape approach

To consider a larger geographical area when addressing sustainability, and to include both social and ecological systems and their interactions is called the landscape approach (Dudley et al. 2006, Singer 2007, Borrini-Feyerabend et al. 2004). This concept to support SD and sustainability originates from conservation of biodiversity, and the understanding that to find sustainable solutions to conservation issues there is a need to involve people living in the area in a development and learning process and thus for the implementation of management solutions. This understanding has grown to a paradigm shift in conservation (Singer 2007) and the landscape approach is thus today a widely accepted and used way to address mainly environmental

and ecological sustainability issues. Presently the landscape approach has affected many national and international sustainability policies. Singer (2007) describes the landscape approach as an approach that "enables stakeholders to come together in order to better understand and preserve their environment". The landscape approach is to consider sustainability with a holistic approach, to consider social and ecological interactions as well as interactions between the social and ecological system, the history and development trajectories in landscapes. Its origin has resulted in the landscape approach often being implemented in areas with high natural and/or cultural values. The landscape approach might however be useful in many different settings.

The geographical landscape of the landscape approach is a limited continuous area that is larger than a forest stand and smaller than a biome. Its ecological, economical, social and cultural sustainability dimensions include features that make it stand out from neighbouring land (Dudley et al. 2006). A landscape can be natural, a result of long time and natural disturbance dynamics, or cultural and created by humans in the form of settlements and/or land use, or a combination of both (e.g., Angelstam 2006). The properties of a landscape give rise to a local identity and sense of place (Lucas 1992, Pollock 2004). This is similar to the Malawi principles of the ecosystem approach (Table 3) and the implementation of sustainable forest management in a landscape (FAO 2003, Angelstam et al. 2004b, MCPFE 2005).

Table 3. *The twelve principles of the ecosystem approach (CBD 2000).*

1	The objectives of management of land, water and living resources are a matter of societal choices.
2	Management should be decentralized to the lowest appropriate level.
3	Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4	Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context.
5	Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6	Ecosystem must be managed within the limits of their functioning.
7	The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8	Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9	Management must recognize that change is inevitable.
10	The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11	The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12	The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

4.4 Collaborative learning

In the early 1990s collaborative learning approach or framework originated as a way to deal with natural resource management controversies in the US Pacific Northwest. Approaches, frameworks and practices from negotiation, conflict management, adult learning and soft systems theory were adapted and put together into a quite complete framework for development, change and learning processes (Cheng and Fiero 2005). Collaborative learning offers a framework for facilitation and handling of potential conflict situations that are complex, include many stakeholders and are thus hard to fully grasp and understand (Daniels and Walker 2001). Collaborative learning is as a way to work through or manage conflicts by the means of learning and the development of understanding, acceptance and agreement. The framework include identification of the collaborative potential among stakeholders, to set up a series of events to promote learning and creative thinking, to arrange constructive debates to support the stakeholders in the production of

new knowledge, to find solutions and to generate ideas to address natural resource management issues. Collaborative learning also includes the implementation of these ideas, assessment of the outcome and thoughtful reflections (Daniels and Walker 2001). Instead of focusing on solving the sustainability problem or conflict situation collaborative learning is an approach that tries to improve the situation (Cheng and Fiero 2005). When complemented with peer-review publication to document the problem, the process and the result in support of producing explicit rather than tacit knowledge the collaborative learning approach can be used as a methodology to achieve socially robust knowledge both in different settings like natural resource management, inter- and transdisciplinary research but is not limited to these (Nonaka and Konno 1998, Gibbons 1999). Collaborative learning rests on three main theoretical frameworks.

The first is practice-oriented adult learning theory (e.g., Kolb 1984, Vella 2002). To create a learning process with adults is different from in young people. It is important to treat them as experienced individuals and to work with problem-based, experiential, adaptive learning or related methods in groups of stakeholder from different sectors and levels. The learning and collaboration is very much about making different perspectives and experiences to create a creative space for new ideas and innovation to develop. This is in line with hybrid space as described by Nowotny (1999). The whole learning process is dealt with as a structured and step-wise process even if the situation is complex with stakeholders having differing opinions and perspectives.

The second framework is conflict management and builds on the works by Susskind and Cruikshank (1987) together with inspiration from empirical work in a broad range of social sciences. The production of new knowledge is often positive for some stakeholders and negative for others. Different stakeholders understanding of new knowledge and its usefulness are strongly correlated with their interest, openness and power relations within the group of stakeholders. With society's aim to make research useful in solving sustainability problems in reality researchers are forced to approach areas outside their main expertise like conflict management. Although perceiving the produced knowledge as objective per se, its consequences if and when applied are not.

The third framework is to see and understand complex natural resource management situations as systems, i.e. to use ideas and methodology from soft systems methodology (Checkland 1989, Checkland and Scholes 1990), critical systems thinking by Flood and Jackson (1991) and works by Midgely (2000) and Checkland and Poulter (2006). To use a systems approach for the

natural resource management situation and the collaborative learning processes will assist in handling the complexity of the situation and aims to make the connected knowledge production socially robust. Hence, this approach is likely to assist the stakeholders in developing and implement sustainable solution for the natural resource management issue at hand. The collaborative learning approach thus aims to both build on and develop established theories, and support natural resource managers and stakeholders to adapt more sustainable practices (Ljung 2001).

Collaborative learning is well in line with society's wish to make research more useful in the field, and as a support to the SD process. It presents a natural and inviting space for researchers to interact with stakeholders in an integrative knowledge production process and thus supports the development towards science-based natural resource management. Collaborative learning is a transdisciplinary approach to work through complex situations (Daniels and Walker 2001). The approach gives the added value of integration among stakeholders, researchers and between the two groups.

Working with a collaborative learning approach in research takes the challenge of creating new knowledge in the interface between science and society seriously. It does this by accepting the inherent complexity of the issues, while at the same time having the pragmatic ambition of making improvements of the situations at hand. Ideally a participatory approach should provide a space where researchers, the public and involved government agencies can be integrated in a common process to make decisions accepted and desirable by a broad part of the society (Daniels and Walker 2001). This requires a shared responsibility, and/or authority for the management of the process and the outcome. To make this process possible all actors must have an open mind, be ready to learn and listen and respect others. Actors should not learn from or teach others but should be a part of a collaborative learning process (e.g., Flood 1999). I argue that this is a successful approach to handle transdisciplinary research processes and to bridge the knowing-doing gap (Pfeffer and Sutton 1999, Molnar 2009).

4.5 Socially robust knowledge

Knowledge that is socially acceptable and understandable is called socially robust knowledge (Gibbons 1999). The opposite would be knowledge that is technically of high quality but might miss the intended target, i.e. it does not solve exactly the issue at hand, or the result is not appreciated or accepted in society. To solve real world problems, and to influences policy

and practice to become more effective in assisting the process of SD, knowledge need to be both of high quality and socially robust. Researchers are responsible for the production of knowledge in order to make it relevant, by collaboration with end-users, and to consider the context they act in (Nowotny et al. 2001). There are three characteristics of socially robust knowledge, (1) it is valid both in and outside of the laboratory (the research community), (2) this validity is a result of involving an extended group of experts i.e. stakeholders that in one way or another can contribute with knowledge and experience, and (3) the involvement of society in the knowledge production process that makes the results going from being only technically of good enough quality to solve sustainability issues to in addition being broadly accepted (Gibbons 1999). A part of this recognition and acceptance comes from the acknowledgement of the knowledge having been produced by a collaborative interaction between experts, stakeholders and other actors. Still having said all this, researchers have a special role in the knowledge producing process by safeguarding a proper research process, performing a lot of traditional research activities and by being responsible for the documentation and quality assurance (peer review publishing). As a result, socially robust knowledge is reliable and accepted both in the society and in the research community. In addition it meets the need that started the knowledge production process, the local context and the situation.

The shift from government to governance means that natural resource managers no longer can work and act isolated from the society. They need to develop relations with representative stakeholders. The same is valid for researchers that need to integrate better with stakeholders. This situation is clearly visible in policies related to both natural resource management (UN 1992b., Anon. 2000, UN 2004, Anon. 2008b, Anon. 2008c.) and research (Anon. 2008d, EUA 2009).

Researchers should thus no longer be considered the sole producers of new knowledge that only informs society of their results. To develop the bi-directional communication between research and the society is a fundamental part of producing socially robust knowledge (Gibbons 1999). Socially robust knowledge can be produced in a hybrid space (Nowotny 1999) where stakeholders, researchers, practitioners and other actors meet and collaborate. This means that science and society have invaded each others domains, and that this has resulted in a new relation between them. Society cannot just order research to solve sustainability problems but must be a part of the agenda-setting to the knowledge production process that develops the solution to make them socially robust (Anon. 2008d, FORMAS 2008, VR 2008, Mistra 2009, EUA 2009).

An important aim of socially robust knowledge is to contribute to policy development and policy adaptations. Policy development is often described as a cycle, the policy cycle or several nested policy cycles (Mayers and Bass 2004). In short this means that a policy is developed, implemented, assessed and adapted. A policy that has been developed or assessed with a transdisciplinary approach resulting in socially robust knowledge could potentially become more accepted in society.

4.6 Synthesis: a normative model for integrative transdisciplinary research and collaborative processes

Parts of the research community, funding agencies and politicians often emphasize interdisciplinary and transdisciplinary research to produce new knowledge needed to support SD on the ground (e.g., Meppem and Gill 1998, Hirsch Hadorn et al. 2006, EUA 2009). However, despite many attempts to clarify the meaning of terms and concepts there is still considerable confusion about the terminology for integrative research (Tress et al. 2006, see Figure 2). A normative or "ideal model" for integrative transdisciplinary research and collaboration was developed. For this model (Table 4) work by Fry (2001), Stokols et al. (2003) and Tress et al. (2006) on definitions of integrative and collaborative approaches to knowledge production were used and adapted. The modifications to the frameworks (Table 8) was not an attempt to increase the diversity of different kinds of research approaches, instead it should be seen as a gradient that could be used to assess the level of integration and outcome of a given transdisciplinary research programme or collaborative process. The aim was to use this gradient in the degree of transdisciplinarity as a framework for a comparative assessment of integrative research projects.

The inspiration for the normative model came also from ideas on processes to establish good governance for management of natural resources, the collaborative learning approach, ideas on socially robust knowledge, and existing frameworks for inter- and transdisciplinary research projects as well as for the evaluation of such projects. The ideas on a collaborative transdisciplinary research process were developed from and inspired by the works of Daniels and Walker (2001), Barbour et al. (2004:53), Blagovidov et al. (2006), Borrini-Feyerabend et al. (2004:139) and others. Those researchers describe processes for the development of governance systems for conflict situations and landscape approaches (e.g., Singer 2007, Dudley et al. 2006) such as MF (IMFN 2008), BR (UNESCO 1996, 2002, Axelsson and Angelstam 2006), IUCN Livelihoods and landscapes (Fisher et al. 2005) and

EU Leader (Moseley 2003, Bryden and Hart 2004), the collaborative learning approach (Daniels and Walker 2001, Cheng and Fiero 2005) and research on integrative research processes (Svensson et al. 2002, Stokols et al. 2003, Stokols 2006, Tress et al. 2006).

Daniels and Walker (2001) describe five distinct phases in a collaborative learning process; (1) Assessment - where an evaluation of the context and the potential for collaboration takes place, (2) Training - where stakeholders build an appreciation for collaboration and learn some specific techniques of collaborative learning, (3) Design - development of a context-specific strategy for involving stakeholders in a meaningful process, (4) Implementation/facilitation - to conduct project activities and decision making, (5) Evaluation - data gathering and reflection to learn from participating stakeholders with the aim to assess different approaches and their result to assist project adaptation and to learn for future projects.

Also Tress et al. (2006) emphasized five steps in order to achieve a successful integrative interdisciplinary and transdisciplinary processes. They emphasized the importance of (1) preparing an integration implementation plan that identifies the aim of integration, the necessary steps to realize integration of the expected integrative outputs and a clear time schedule, (2) planning for smaller rather than larger projects, (3) allowing additional time to develop a common language, a common aim and common outputs, (4) arranging regular meetings and events to help project participants get to know one another, trust each other and develop a common understanding of the research process, (5) planning realistic outputs that can be delivered on time and avoid setting expectations too high in order to please funding agencies and stakeholders (Tress et al. 2006).

Table 4. *A normative model for transdisciplinary knowledge production and other collaborative processes, based on the works of several scholars (see text above and paper V).*

Step	Activities
1	Assessment of the context and the potential for collaboration, identification of gaps.
2	To plan and work with the prerequisites for a successful transdisciplinary research process, identification of actors.
3	Integration and partnership building, among academic actors, non-academic actors and integration of the two groups, learn collaboration, start small and develop the skills step by step.
4	Development of a common framework for collaboration. This includes researchers and end-users.
5	Planning for the implementation of the project.
6	Implementation and facilitation of the project.
7	Continuous evaluation, reflection and adaptation. This includes researchers and end-users.

In an attempt to provide guidelines for and to support comparisons and evaluations a normative model for transdisciplinary knowledge production and other collaborative processes that includes seven steps was developed (Table 4). These seven steps are not a fail-safe step by step approach to transdisciplinary knowledge production. However, these steps can be used as a guide or frame and be adapted for a specific context when transdisciplinary research programmes and projects are planned for. In paper V and this thesis the purpose was to use this model for comparisons with the aim to understand and analyse the knowledge production process in a transdisciplinary research programme i.e. to identify correlations and deviations in comparison with the model.

5 Results and discussion

5.1 An interpretation of the landscape approach

As described above, the landscape approach is an approach to sustainable land management that considers a larger geographical area with its social and ecological systems and their interactions (Dudley et al. 2006, Singer 2007, Borrini-Feyerabend et al. 2004). In this thesis I have interpreted the landscape approach as a concept with five core features (Figure 5). The five constitutive features are, (1) an area or a landscape, (2) collaboration among partners, (3) sustainable development, (4) knowledge production and (5) sharing of knowledge and experiences. These five features have been used to divide my results in a way that make sense to actors and stakeholders.

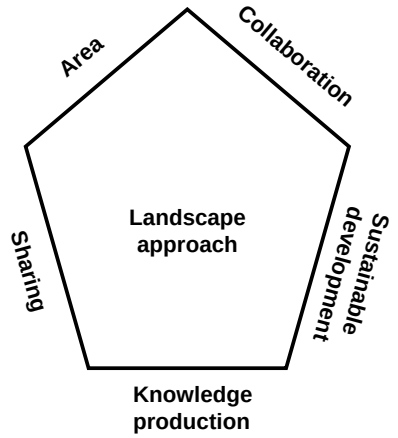

Figure 5. Illustration of the landscape approach and its five core features.

5.2 The geographical area

Implementation of the landscape approach requires a defined geographical area that is appropriate for addressing local to regional sustainability problems. The area is treated as a socio- ecological system and both parts are of equal importance when addressing sustainability issues. There are different approaches to the spatial extent of the area that the policy implementation initiative takes place in. Experiences from around the globe include administrative borders, a natural border like a forested area, a watershed, a landscape with its unique cultural or natural properties, or to just mark a large area on a map. The border of a landscape is often seen as fuzzy by the actors in the initiative. For example, not the entire area extent may be covered by implementation activities, and some activities can reach outside the border. Important properties for all landscape approach initiatives are that the area includes and is understood and handled as a combined social and ecological system. This is important since both parts are important when addressing sustainability issues and to develop solutions that can contribute in the sustainable development process towards sustainability in general (Berkes et al. 2003).

Table 5. *The size of BRs and MFs (paper I). All areas in 1000 hectares (ha).*

	Average	**Median**	**Std. dev.**	**Min**	**Max**
Biosphere Reserve	882	129	2,723	5	14,761
Model Forest	1,089	463	1,679	86	7,700

Both the MF and BR concepts recommend two main approaches to define the area of an initiative on the map. The first is to use a well defined area where the owner or holder of user rights is the main landscape approach initiative champion, and the second to use an integrated area with a large and diverse set of land owners and land use. For MF there are some implementations with very large areas that could be seen as a line on the map that limits the area of project activities and where the landscape approach initiative would like to support SD. The average size of the studied BRs was about 850,000 ha, which was less than for the MFs at about 1,100,000 ha. The variation in size was larger for BRs with both smaller and larger areas designated (Table 5). These area extents are well suited for management of viable populations of many species (Angelstam et al. 2009) and thus planning for biodiversity conservation (Angelstam et al. 2004c). For land cover the pattern was quite similar with large amounts of forest and lesser of the other land covers. BRs held about 40% forest compared to about 70% for MFs. In BRs there were a larger percentage of water,

mountain and farmland as well as other kinds of land covers (Figure 6). The land ownership pattern was similar in BR and MF, with largest part (50-60%) government owned, a large part (35-45%) privately owned and less than 10% for the other categories Figure 7).

For the BR concept a model with an often protected core area, a buffer zone and a transition zone was developed. This was a result of the origin of the concept with a more systematic conservation of the world's ecosystems and thus often already established protected areas to be designated (UN 1996). With the development of the concept to become more balanced in regards to SD and since the reality in a landscape often does not fit with this zonation designated BRs have started to use an integrated approach. Some have developed this further towards an ecologically functional landscape approach (Magnusson et al. 2004, S. Magnusson pers. comm., UNESCO 2008). A similar approach to the BR zonation is the spheres of influence concept developed in the Eastern Ontario MF. It includes a (1) sphere of concentration that is the core area delineated by the MF border where processes, products and tools are developed and tested, (2) sphere of adoptation and extension, where results and experiences from the sphere of concentration will be adopted by MF partners and others in relation to local needs, (3) sphere of adaptation, where results from the MF can be adapted for use, (4) sphere of collaboration, with a focus on the Canadian Model Forest Network and the Forest Communities program, and (5) Sphere of exchange, focused on exchange with international MFs to enhance and develop their activities (EOMF 2007). A general understanding of the area is as a multi-level construction with (1) an area for implementation, testing and evaluation, (2) an area to influence i.e. scaling up, (3) a larger area for dissemination, sharing and networking. These three dimensions of the area do share common spaces and are thus not strictly delimited.

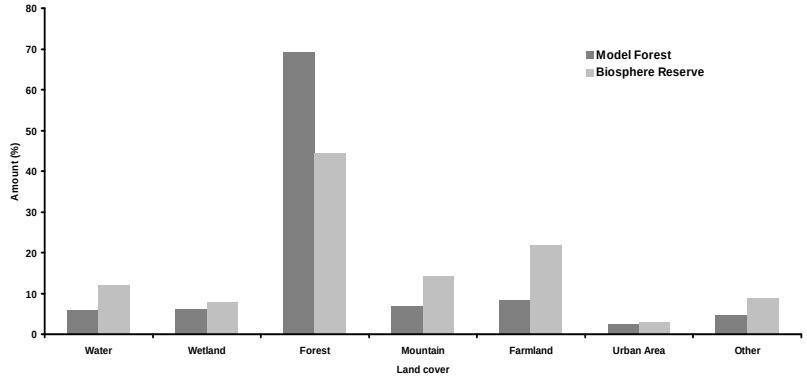

Figure 6. Average land cover in BRs and MFs in percent. Please note that categories are overlapping and thus amount to more than 100% (BR n=32, MF n=28).

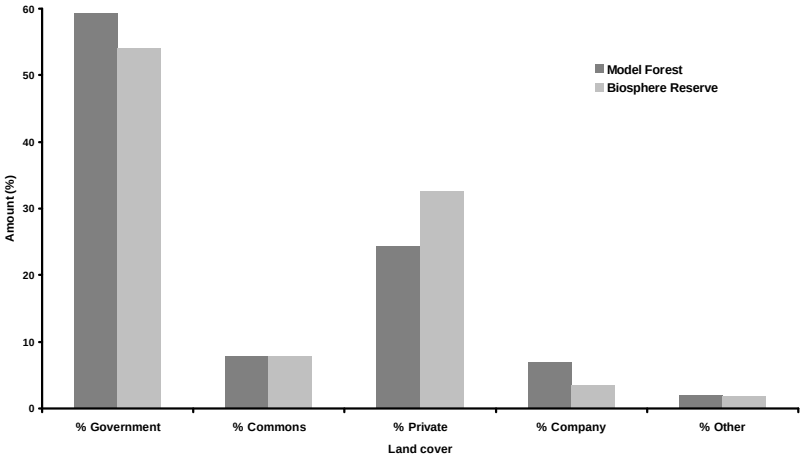

Figure 7. Land ownership pattern in BRs and MFs (BR n=32, MF n=31).

An important part of a landscape approach initiative is to learn about the area, both about the ecological systems (paper III and IV) and the social systems (paper II, III and V). In addition, there is a need to understand the social landscape with its actors and stakeholders to be able to develop a representative partnership (paper II) with representatives from different levels from local to national and international and that represents the different societal sectors, i.e. the public, civil and business sectors. Knowledge about the state and trends of different parts of the landscape seen as a combined social and ecological system is vital to be able to identify and address sustainability issues at hand (e.g., Lee 1993, Bell and Morse 2003, Angelstam

et al. 2004, Rockström et al. 2009, Josefsson 2009). Transdisciplinary knowledge production and collaboration as proposed in this paper are important ways to identify and learn about these issues.

5.3 Collaboration

To develop collaboration to a higher level to promote mutual understanding (cf. Arnstein 1969, Table 6), i.e. partnership, participation must be meaningful to all involved. As described above stakeholders and actors from different sectors that represent the landscape should be partners. This however, depends on the issue or activity at hand. For general activities like working with SD a more or less complete representativeness is preferred. For more limited issues the representativeness can range from a few stakeholders to large parts or the full partnership.

As soon as the partnership starts to develop there is a need to build trust among partners and to develop a collaborative learning process. Initially, the aim is to learn about each other, to build respect for each others perspectives and interests. To do this there is often a need to work with and handle inequalities in power and capacity, i.e. equity and empowerment (Lickers and Story 1997, Holmes et al. 2002, Pollock 2004). The process of developing a partnership is often tedious and takes a long time, often several years (Borrini-Feyerabend 2004). Partners are suspicious and do not feel secure. To overcome this one approach is to start with small steps. Small steps could mean to start with an easy to solve task and then step by step as the confidence grows address harder to solve issues. Collaboration is something open-minded partners will learn over time. The process of developing collaboration benefits if a neutral facilitator leads the activities, identifies the collaborative potential and gaps, assists communication and develops a plan for the procedure.

Data from paper I on the initial partner categories from concepts BR and MF shows that quite few partner categories was involved at initiation (paper I and Figure 8). There were at an average more categories involved in the development of a MF than in the development of a BR (paper I). This is probably a result of the higher emphasis of partnership and even support to partnership building for the MF concept (IMFN 2008). Paper I does not say anything about the further development of the partnership/collaboration among partners. In paper III a quite thorough analysis of the partners in two Swedish and two Russian MF initiatives was done. It showed that the partnerships had developed and after about ten years included many more partners. Two of the studied landscape approach initiatives had more than

50 partners; one had about 40, and one about ten. For all four this is a large increase from the partners involved in the initiation of the initiative (paper III). It should however be noted that these partners are from several collaborative levels (Figure 9).

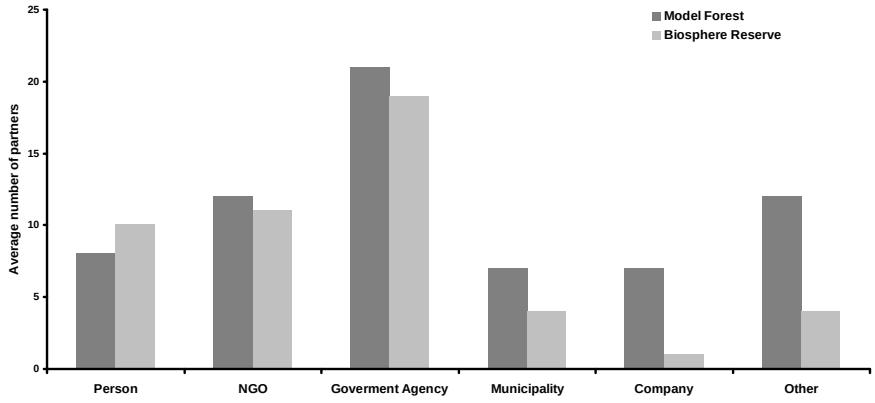

Figure 8. Number of initial partners from different categories for all BRs and MFs (BR n=32, MF n=32).

A key issue in addressing SD in large socio-ecological systems is to engage stakeholders and actors from different sectors and levels (see paper III). To build a solid partnership partners from the public, civil and business sectors from local to national level are required. Several national to international policies demands participatory approaches (UN 1992b, Anon. 2000, Moseley 2003, Bryden and Hart 2004, Anon. 2008c) to address sustainability issues. Words like partnership, participation, bottom-up approach and similar have increased in usage in natural resource management contexts. Still, however, few actors seem to know what these words mean in this context. To analyse the level of collaboration the original ladder of Arnstein (1969) was adapted (Paper III). To analyse several aspects relating to the partners of a landscape approach initiative a new framework was developed (Paper III, Figure 9).

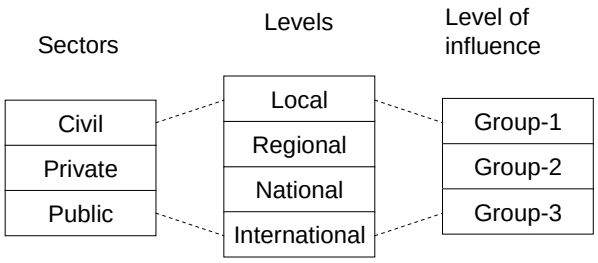

Figure 9. A framework to group stakeholders in landscape approach initiatives was developed. A stakeholder; (1) belongs to a sector, (2) that is mainly organized at a certain societal level, and (3) the level of influence defines the collaborative relation between the landscape approach initiative and the stakeholder (adapted after paper III).

The analysis of MF initiatives in Sweden and NW Russia showed well-developed stakeholder/actor profiles for all four landscape approach initiatives. All had representatives from all sectors (Figure 10) and from all levels (Figure 11). However, it is important to understand that these profiles need to be evaluated towards the social landscape of the landscape approach initiatives to learn how representative and inclusive they are. The analysis also builds on data from the landscape approach initiative champions as how they perceive the grouping of the stakeholders. This is a start were the structure of the partnerships were analysed. To gain a fuller understanding of the landscape approach initiatives ability to develop adaptive capacity there is a need for additional approaches. To study the potential for development of social capital (Putnam 1993, Forsberg et al. 2002) and adaptive capacity (Folke et al. 2005) I propose the following four steps; (1) to analyse the stakeholder structure in the landscape approach initiative following Figure 9 and paper III, (2) to map the stakeholders that are potential partners for the landscape approach initiative locally to internationally, (3) to compare the stakeholder structure with the structure of the mapped stakeholders, and (4) to analyse the involved stakeholders relations i.e. bridging, bonding and nestedness (paper III, Grafton 2005, Folke et al. 2005, Dale and Newman 2008). Step one to four represent an effort to study the social system and its features. In addition to this it is important to evaluate the efficiency of social system, i.e. the extent to which it delivers on the ground in terms of sustainable development as a process and sustainability as a goal. To evaluate outcomes on the ground, at least three approaches should be applied; (1) to study stakeholders' perceived results (Schultz 2009), (2) to analyse how the landscape approach initiatives work to achieve these results, and (3) to

compare the perceived results with empirical field data, official statistics and historical record s as a measure of actual change in the landscape (paper III).

Table 6. *Framework to categorize the level of collaboration with stakeholders in landscape approach initiatives. The framework is compared with similar frameworks developed by different scholars.*

Stakeholder category	**Type of participation**	**Type of participation (Pretty 1995)**	**Ladder of community participation (Guaraldo Choguill 1996)**	**Ladder of citizen participation (Arnstein 1969)**
Group-1	Formalised participation through foundation or society	Self-mobilization Interactive	Empowerment Partnership	Partnership Joint mgmt board
Group-2	Participation in projects or activities managed or co-managed by the MF initiative	Functional Material incentives	Conciliation	Co-operation
Group-3	Collaboration in stakeholder projects (active or passive) to continuous communication and information	Consultation Information giving Passive	Dissimulation Diplomacy Informing Conspiracy Self management	Advisory committee Communication Consultation Information

The development of the Kovdozersky MF (paper II) shows clearly that the development was driven by the forest sector (the Natural Resources Ministry/Russian Federal Forest Service and the local forest management unit). A model for local participation is under development and will be something new for the involved stakeholders. A NGO was established that is open to all local stakeholders. The forest sector is the main and most powerful actor and it is doubtful if they are ready to share some over their power in the newly developed NGO. It is often a long process to build capacity among local stakeholders to enable them to participate fully in a landscape approach initiative (Borrini-Feyerabend 2004, Barbour et al. 2004). It might also be a long process for the stronger actors to change from a traditional kind of management to a more participatory approach and to see and understand the advantages with this (Daniels and Walker 2001, Hemmati 2002).

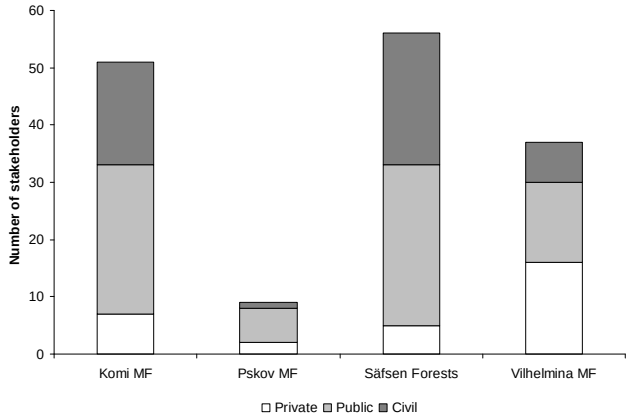

Figure 10. Number and distribution of stakeholders from three societal sectors involved with multi-stakeholder collaboration in Russian and Swedish Model Forest initiatives (paper III).

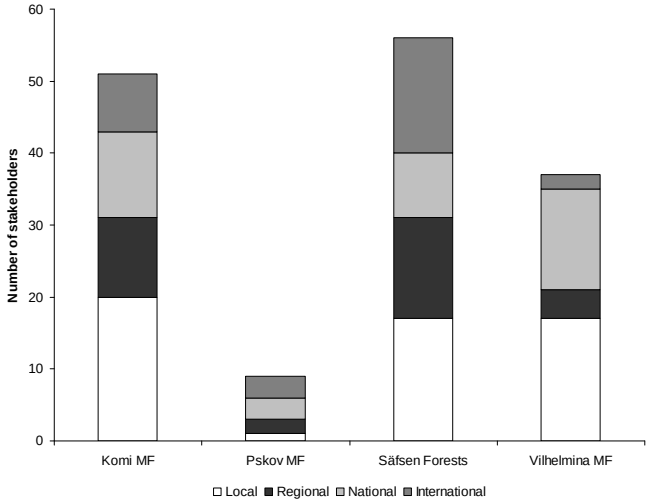

Figure 11. Number and distribution of stakeholders involved with the Model Forests' development in NW Russia and Sweden and at different levels of organization (paper III).

In paper V a model for transdisciplinary knowledge production (Table 7, first column, paper V) was used to analyse activities and results in the evaluated research sub-programme. The evaluation showed that the INCLUDE management did not understand and manage the research sub-programme as a collaborative learning process (Daniels and Walker 2001). Instead of creating a creative or learning organisation the INCLUDE research sub-programme was managed by a command and control

management style (Woodman et al. 1993, Buckler 1998) despite its integrative aim (Emanuelsson et al. 2005). The project was managed more like a conventional research project and no or few efforts were made to integrate researchers, end-users and the two groups.

Table 7. *Comparison between the normative model for transdisciplinary knowledge production and the INCLUDE research sub-programme a part of the TransportMistra research programme.*

Step	**Activities/results**
1. Assessment of the context and the potential for collaboration, identification of gaps, questions and problems.	-Initial assessment to assist the application
	-Assessment focused on the needs of end-users
	-Potential for collaboration was identified
	-No agreement among actors on gaps, questions or problems
2. To plan and work with the prerequisites for a successful transdisciplinary research process, identification of actors.	-No understanding of a transdisciplinary research process
	-No plan for a transdisciplinary research process
	-Successful identification of actors
3. Integration and partnership building, among academic actors, non-academic actors and integration of the two groups, learn collaboration, start small and develop the skills step by step.	-Poor programme level understanding of integrative research
	-No integration among researchers
	-No matching end-user project
	-No integration with end-users
	-Some integration within the INCLUDE sub-projects (A-E)
4. Development of a common framework for collaboration among researchers and with end-users.	-No common research framework was developed
	-No framework developed with end-users
	-Some integration started within the INCLUDE sub-projects (A-E)
	-Some conflicts with end-users instead of a constructive process
5. Planning for the implementation of the project.	-Plan as list of deliverables was developed
	-No plan for further integration and development of a common framework
6. Implementation and facilitation of the project.	-Command and control style of implementation
	-No facilitation
	-Perceived focus on administration
	-Failed in development of creative research environment
7. Continuous evaluation, reflection and adaptation for the research and with end-users.	-No common process
	-Some external reviews and criticism

The aim of a transdisciplinary research process, and one of the aims of a landscape approach initiative, is to create a new common space for actors that normally do not meet and collaborate. This is called hybrid space. If the context and situation is right this could be a space for new ideas to emerge and knowledge production to occur (paper V, Nowotny 1999). The normative model for transdisciplinary knowledge production fits well for different kinds of transdisciplinary collaboration (paper V, Table 4) and thus as a model for landscape approach initiatives.

5.4 Sustainable development and sustainability dimensions

The concept of SD was briefly described earlier in this thesis. Under the paragraph about area above it was described how important it is to know your area, to learn about the status and trends of ecological, economic and socio-cultural dimensions in the local landscape to be able to address sustainability issues through an ongoing dialogue about what SD is and how it might be achieved. Here the sustainability profiles of the studied landscape approach initiatives will be described i.e. an analysis will identify sustainability gaps that can be addressed. This section is about what has been identified as issues or gaps and is being addressed by the landscape approach initiative.

When asked about what values that was in focus when the landscape approach initiatives were initiated, both BRs and MFs responded with data that shows that both landscape concepts are quite balanced, i.e. they addressed all dimensions of sustainability. For BRs the origin with a main focus on ecological sustainability is noticeable (Figure 12 and 13). The BR concept originated in the 1970s and has developed a lot since then and in relation to different international sustainability treaties. In comparison MF originated as a concept in the late 1980s and the first implementations were launched in 1990 (Armstrong et al. 2000, LaPierre 2002, Besseaue 2002, Axelsson and Angelstam 2006, F. Pollett, pers. comm.). The concept thus was influenced by the recent Brundtland report (WCED 1987) that conceptualized the SD. If asked about the present values the difference would definitely be much smaller since the two concepts have had a convergent development conceptually to presently emphasize all sustainability dimensions in a balanced way. Still there are large differences among implementations of the same concept in different contexts and depending on when the area was designated.

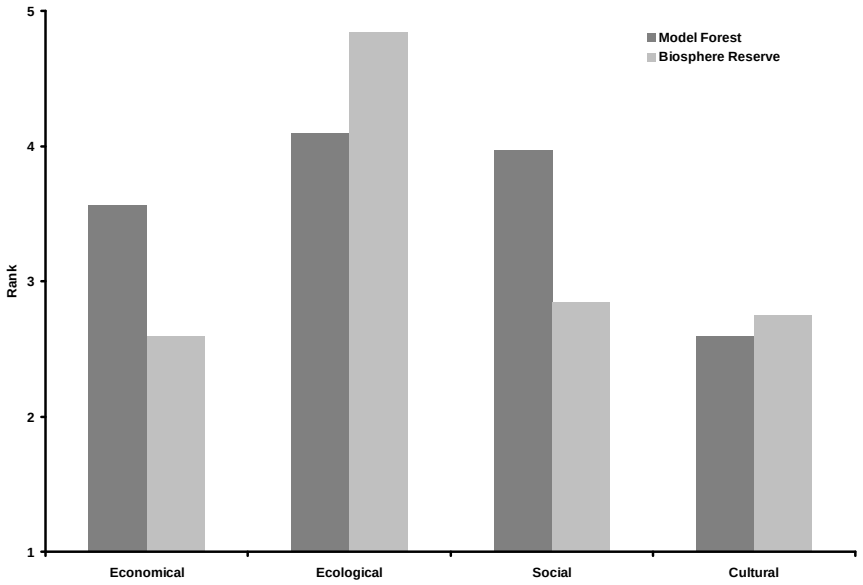

Figure 12. Sustainability dimensions that were in focus when the initiatives started, average values (BR n=32, MF n=32).

Paper II identified the main goals of the Kovdozersky MF as to implement Sustainable Forest Management by carrying out four steps. These were, 1) to implement landscape ecological planning based on Finnish practices and experiences, 2) to develop and implement regional regulations for forest management based on Finnish regulations, 3) to develop wood processing industries and a bio-energy fuelled central heating plant, and 4) to develop eco-tourism in the area. This reflects the needs and the status of the area well. The main cause of the present situation was the over-harvesting during the Soviet era.

During this era the forest industry was the dominant industrial sector in this case study area. The fall of the Soviet empire and the previous over harvesting and poor forest management in the area means that there are large areas that would benefit a lot from Scandinavian forest management approaches from a annual volume growth point of view. To make the next harvesting period into a continuous harvesting or sustained yield a landscape ecological plan is needed. In an effort to support local people and to improve their lives the idea about livelihoods in the forest sector and to replace the old central heating system with a new and modern bio-energy

fuelled system are interesting options. Severe obstacles are, however, that; 1) the approaches are imported from Scandinavia and thought to solve sustainability problems locally despite the fact that the context is completely different, 2) the area is remote in relation to national and international markets for bio fuel and wood, 3) the ecological component is weak, and 4) plans for rural development and non-wood forest products based on local knowledge and experience have not yet been developed. This means that strategic decisions must be supported by a thorough analysis of the local landscape and potential markets locally and internationally.

The four MFs studied in paper III had different sustainability profiles. In Komi MF the key aim was to protect pristine forests from logging by supporting the local forest industry with large scale plans and maps that identifies the most valuable and lesser valuable forests. The initialisation of Komi MF was supported by the WWF and the Swiss Agency for Development and Cooperation. By contrast the main aim in Pskov MF was to test and demonstrate intensive forest management inspired by the Nordic intensive sustained wood yield approach. The project was supported by StoraEnso and the Swedish Forest Agency with funding from the Swedish International Development Cooperation Agency. For the Foundation Säfsen Forests the initial driver was to create new livelihoods for local people since a lot of job opportunities had been lost in the area. In Vilhelmina MF the initial driver was to balance the traditional industrial forestry operations with conservation and other uses of the forest landscape. In all four MF initiatives the vision for the work has developed to become more balanced, reflecting more or less all dimensions of SD even if the initial goal still is a high priority.

A key priority for all studied landscape approach initiatives has also been to build capacity among stakeholders to strengthen stakeholder involvement at the local level, by empowering them to have a say in management decisions locally and to make their voice heard on the national level. The level of ambition might, however, differ between different landscape approach initiatives. This process is a result of careful facilitation in the studied MFs and includes capacity building and efforts to involve local people in decisions related to their area and natural resource management. The aim of the social learning process is that the community should learn how to manage sustainability issues (Leeuwis and Pyburn 2002, Keen et al. 2005, Wals 2009) and the building of capacity building among partners to allow their participation and contribution with the landscape approach initiative. An interesting example is the local champion in the Foundation Säfsen Forests, who except from stakeholder collaboration in different

projects arranges open meetings 2-4 times per year to reinforce the local support for the activities. The meetings are open to anyone, results from different projects are presented and local people are asked if they support the activities of the foundation and if they have ideas about new issues. A key challenge to all MFs is to take the step from being driven by one or few local champions to being partnership driven. When the highest level of collaboration, i.e. partnership, has been reached including people and their organisations there is a good opportunity that the achieved results are long lasting and can stand on their own also without the facilitation from the MFs.

5.5 Knowledge production

The relative importance of social learning is visible in the goals of both landscape concepts (Figure 13). Here issues like human development, scientific research and education received high scores. In this study a sample of landscape approach initiatives were asked about the initial goals of their work.

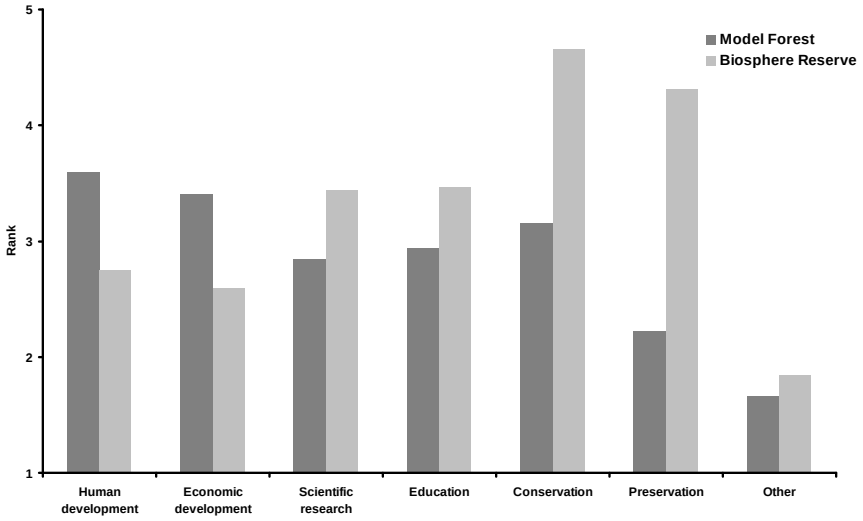

Figure 13. Main goals of the initiatives at initiation, average values (BR n=32, MF n=32).

A key feature of a landscape approach initiative is to create a space where different stakeholders can meet, learn about each other, build trust and to

facilitate a new kind of knowledge production (Gibbons et al. 1994). This is in line with the hybrid space concept (Nowotny 1999). The concept of knowledge production includes both the production of new knowledge and local capacity building i.e. to make sure the capacity is available where it is needed in the local landscape. Knowledge production is tightly connected to the process of learning about the area and to different stakeholders' needs and wishes. To identify gaps in knowledge, ability to act and attitudes (Sabatier 1986), and sustainability issues there is a need to learn about the local socio-ecological landscape.

There are different kinds of research from disciplinary to integrative (Table 8). All of them can solve different kinds of problems. A landscape or reality is however not disciplinary (Farley et al. 2005, EUA 2009) and landscape approach initiatives are efforts towards SD and sustainability in landscapes. In addition there is a need for knowledge production processes to result in socially robust knowledge (Gibbons 1999).

Table 8. *From disciplinary to integrative research. Terms and their meaning (adapted after Tress et al. 2006). By different disciplines we mean human, social and natural sciences (e.g. Myrdal 2005) as well as different disciplines within the main scientific disciplines.*

Term	**Explanation/properties**
Disciplinary research	-Only one academic discipline represented
	-Disciplinary aim of research project
	-No exchange or cooperation with other academic disciplines
	-Development of disciplinary knowledge and theory
Multidisciplinary research	-Two or more academic disciplines
	-Work from disciplinary perspectives with a common theme
	-Loose cooperation between researchers from different disciplines
	-Development of disciplinary knowledge and theory
Interdisciplinary research	-Two or more integrated academic disciplines
	-The development of a common scientific framework and goal among participants from different academic disciplines and for the whole research project
	-Delopment of integrated knowledge and theory
Participatory research	-Academic and non-academic actors
	-Exchange of knowledge and research results as information or dialogue between researchers and non-academic actors
	-Disciplinary or multi-disciplinary
	-Development of disciplinary theories and knowledge
Participatory research collaboration	-Academic and non-academic actors
	-Exchange of knowledge and research results as information or dialogue between researchers and non-academic actors
	-Disciplinary or multi-disciplinary
	-Non scientific or scientific aim to solve real world problems and to develop disciplinary theory
Transdisciplinary research	-Multiple academic and non-academic actors
	-Development of a common framework and goal among all actors
	-Integration of academic and non-academic actors
	-Development of integrated knowledge and theory
Transdisciplinary knowledge production	-Multiple academic and non-academic actors
	-Development of a common framework and goal among all actors
	-Integration of academic and non-academic actors
	-Non-scientific or scientific aim to solve real world problems and to develop transdisciplinary theory

This calls for research and knowledge production with stakeholders involved (Table 8 and 9). Any kind of integrative research or knowledge production means the integration of stakeholders. In an interdisciplinary research project researchers from different disciplines need to integrate. For transdisciplinary research and knowledge production end-users and other stakeholders need to be a part of the knowledge producing process. This means that everyone will bring in their expertise and through a collaborative learning process (Daniels and Walker 2001, Cheng and Fiero 2005) will define a framework for the research or knowledge production process. Some partners in the process will contribute with their disciplinary expertise as pieces of a larger puzzle. Others will need to take an inter- or transdisciplinary perspective to be able to facilitate the production of socially robust knowledge that meets earlier identified needs. Here socially robust knowledge means knowledge that simultaneously is a technical solution to a sustainability issue in the landscape and socially acceptable solution.

The study of a transdisciplinary research project (paper V) showed that few of the stakeholders knew the difference between different kinds of knowledge production and the implications to the research process. This resulted in a careless usage of "buzzwords" with the aim to attract funding and impress end-users and with the researchers despite all nice words by and large "just doing business as usual". Hence, my efforts to adapt the works of Tress et al. (2006) to cover different kinds of research, non-academic knowledge production and different integrative knowledge production processes. To facilitate discussion and improve the understanding of the different modes of knowledge production and their requirements they were sorted and characterized (Table 9).

As has been discussed above, integrative research and knowledge production requires integration. The highest level of integration could be called a partnership. A partnership is a group of equal stakeholders that have learned about each other, that respect each other and where potentially weaker stakeholders has been empowered to enable them to participate in the process (Lickers and Story 1997, Pollock 2004). This will take time to achieve both for pure research or knowledge production processes and landscape approach initiatives (Borrini-Feyerabend 2004, Tress et al 2006). A consequence is that these kinds of processes often require a different kind of implementation process compared to a traditional research or development project. In a traditional research or implementation project funding is often evenly or almost evenly spread over the implementation period. For an integrative knowledge producing process there is a need for

quite a long period of building the partnership, learning about each other and the task or area, defining the task and doing common small easy to solve projects (paper V). Then there is time to solve the main task. In a pure knowledge producing process the work might end here. In a landscape approach initiative there is now time to facilitate collaboration and the usage of the integrative approach among the partners i.e. to make it a part of their common business. This requires much less of efforts and funding than the implementation phase.

Table 9. *Different modes of producing knowledge in natural resource management, research and education.*

Level of integration	**No integration**	**Some integration**	**High integration, true partnership**
Actors involved			
Non-academic	-knowledge production -consulting -one actor or actors from one sector -reports or no written documentation	-local collaboration -development projects -actors from different sectors -reports or no written documentation	-collaborative learning -problem based learning -the new production of knowledge -for issue representative actors -reports or no written documentation
Non-academic and academic	-consult-based research -consulting -customer-producer relation -reports	-participatory research -participatory research collaboration -scientific publications	-landscape approach, initiative, concept -transdisciplinary research -transdisciplinary knowledge production -for issue representative actors -reports and scientific publications
Academic	-disciplinary research -scientific publications	-multidisciplinary research -scientific publications	-interdisciplinary research -scientific publications

The applied ecological study (paper IV) in this thesis is an example of research that potentially could contribute to ecological sustainability of landscapes, but need a way to be recognized and implemented. In the study forest site types where alternatives to clear-felling potentially could contribute to ecological sustainability were identified and quantified (Table 11). The work resulted in an ecologically based definition of continuous tree

cover (CTC) forest (Swe: kontinuitetsskog). Empirical work on natural forest disturbance regimes (Pickett and White 1985, Falinski 1986, Oliver and Larsson 1996, Attiwill 1994, Rülcker et al. 1994, Fries et al. 1997, Bergeron et al. 1998, Engelmark 1999, Hunter 1999, Angelstam and Kuuluvainen 2004), the applied ASIO model (Rülcker et al. 1994, Angelstam 1998) and site adapted forest management (Lundmark 1987) were used as inspirations. The main natural and cultural disturbance regimes in Swedens boreal forest are gap phase dynamics, succession, cohort and cultural use (Table 10).

Table 10. *The naturalness and cultural landscape visions and their disturbance dynamics regimes.*

Vision	**Dynamic**	**Description**
Naturalness	gap	Wet sites, humid climate or landscape configuration that protects with small-scale disturbances, but as a rule not fire. Typically, Norway spruce (Picea abies L.) and other shade-tolerant species dominate, and trees die of old age or from biotic and abiotic stress, thus forming small gaps where regeneration takes place.
	succession	Mesic sites with large-scale disturbance regimes, resulting in largely even-aged stands with successions of young to old-growth deciduous, coniferous and mixed stands.
	cohort	Dry sites, normally dominated by Scots pine (Pinus sylvestris L.) or oak (Quercus robur L.) in several age classes, where low-intensity ground fires often kill younger trees and leave most of the older and larger trees.
Cultural landscape	cultural use	Wooded grasslands that were either grazed or mown for winter fodder. The trees were often pollarded, which resulted in landscapes with large and old slow-growing deciduous trees.

CTC forest was defined as forests belonging to the multi-cohort and gap phase dynamics groups (Falinski 1986, Rülcker et al. 1994, Fries et al., 1997, Angelstam and Kuuluvainen, 2004). These are site types that rarely experienced stand replacing events in a landscape with intact natural disturbance regimes. In a naturally dynamic landscape the multi-cohort and gap phase dynamics groups could mainly be found on wet and dry sites. Cultural CTC forests were defined as wooded grasslands, which is the main cultural woodland type in Sweden (Ihse 1995) with a minimum of 10% tree cover (Anon. 1999b). Swedish forestry has over time successfully developed systems for sustained yield production of wood (Hagner 2005). Silvicultural

techniques are today completely dominated (96%) by clear felling methods (Anon. 2002) with no or little only consideration to the forest site type (paper IV). By contrast, Swedish natural forests and pre-industrial cultural woodlands were ecologically and culturally diverse, with a substantial proportion having a CTC as a response to natural disturbance dynamics and pre-industrial agricultural land management (paper IV). CTC forests were important for the maintenance of species, habitats and processes in the naturally dynamic and pre-industrial cultural landscapes (Angelstam 2006). All CTC forests varied a lot in age distribution, density and tree species both in time and space. CTC forests and wooded grasslands thus maintain structures and habitats that are rare in our present landscape. In table 11 the amounts of different site types in the present landscape is presented.

Table 11. *The amounts of dry, mesic and wet site types, and area with mountain climate, in the two study areas. These site types include all forest land (100%) and are based on the National Forest Inventory variable "ground moisture" while "mountain climate" (Västerbotten only) include dry, mesic and wet land. Humid mountain climate was defined as areas at an altitude of 550 meters and above*

	Amount site type						
	Southern area			**Northern area**			
Site type	dry	mesic	wet	dry	mesic	wet	mountain climate
%	5.5	91	3.8	5.8	90	3.8	3.2*

* *This number is the part of the study areas used for the estimate of age distribution i.e. this is not an estimate of the amount of climate caused CTC forest.*

If forest management systems do not mimic this diversity of disturbance regimes sufficiently well, the aim of the present forest policy and sustainable forest management to include biodiversity and socio-cultural values will not be met (paper IV, Axelsson 2008). An estimate of past and present amounts of one cultural and two natural disturbance regimes known to result in a CTC in two study areas showed a steep decline in CTC forests around two important biophysical and socio-cultural transition zones in northern and southern Sweden, respectively. Several approaches were used to estimate the amount of remaining CTC forests. The results indicate that 9 to 10% of the study areas are made up by site types that historically would have held a large proportion of CTC forests (Table 11). The estimates for CTC forest site types showed that only 1-2% (98-99% were lost) of these sites remained in southern Sweden and 10-20% in northern Sweden now has CTC forest (Table 12). The data indicated that present management in both study areas was similar. Thus, the differences between the regions will disappear in a few decades.

Table 12. *Percent of the study areas with no old forest (>140 years) on potential CTC forest sites with different analyses, scales and data sets.*

	Proportion without old forest (%)					
	Southern area			**Northern area**		
Site type	dry	wet	cultural	dry	wet	mountain climate
National Forest Inventory	94	96	-	90	88	68
Remote sensing	100	100	-	100	100	98
Agricultural statistics	-	-	81	-	-	-
Stand scale	98	99	-	84	82	53

Knowledge production is thus about producing applied new or extracting existing scientific, experiential or traditional knowledge and to bring this knowledge to stakeholders that need it i.e. to produce people with the needed knowledge. The study presented above is an effort of an applied ecological study that could potentially support sustainable forest management.

5.6 Sharing

This final core feature is about three things 1) scaling up of the results and experiences in the landscape approach initiative, 2) to network for two way sharing of results and experiences among landscape approach initiatives nationally and globally, and 3) documentation of results and experiences from the landscape approach initiative. For both BR and MF all these three points matches their conceptual criteria's well (paper I, UNESCO 1996, IMFN 2008). In fact sharing and the three bullets above is a property of almost all landscape concepts.

Landscape approach initiatives and other similar initiatives could be seen as islands of sustainability (Wallner et al. 1996). A main challenge is to go from islands to higher area coverage. The idea of islands of sustainability has been criticized because the islands often remain islands. Dissemination of the results, scaling up of practices and influencing natural resource management policy are key tasks. The main tool for scaling up results and experiences is a multi-level landscape approach. Extending from the local to national and international levels, collaboration and partnerships should be developed to secure two-way communication to feed the SD process and prepare receivers of the results and experiences. This means that the landscape approach should inspire similar approaches with relevant stakeholders and actors on all levels from local to national and international. Still this is hard.

It is much easier to produce good results in a local test area only as a part of a local project. To succeed this requires an understanding of collaboration, partners and to recognize the importance of the multi-level landscape approach initiative. Collaboration need to reach the higher partnership level. Partners need to be understood. Are they representing themselves as persons, as persons from organisations, or as organisations? Do these partners practise their experiences from the landscape approach initiative also outside this setting? Many landscape approach initiatives claim that they identify persons in organisations (P. Majewski, Komi MF, B. Barkley, Eastern Ontario MF, pers. comm.) as partners. This might be a first good step but efforts must be put in to get acceptance for the landscape approach initiative in the rest of the partner organisation. Even if the organisation is a partner the representative might not be interested enough to inform his own organisation (L. Myhrman, Foundation Säfsen Forests, pers. comm.). Partners representing different societal sectors, levels and influence should gradually develop an understanding of the philosophy behind the landscape approach and be a part of the scaling up process by emphasising collaboration with Landscape approach initiative partners and others also externally (see paper III).

There are different kinds of networks for most landscape concepts. To contribute to SD locally and globally are criteria of both Bioshere Reserve and MF (paper I) and for most other landscape concepts. Networking is often emphasized but rarely and despite efforts have forms for successful networking been developed. There are promising approaches (UNESCO 1995, UNESCO 2008, IMFN 2009, BR) but a problem is that people in a landscape approach initiative on the one hand have limited amounts of time and on the other hand enormous amounts of information available. A common approach is to hire consultants that together with local landscape approach initiative champions report important experiences as printed reports and/or books. Often researchers are involved in this. Another approach is to form closer relations with a few other landscape approach initiatives that share whole or parts of sustainability issues or are located in similar landscapes. The networking requires pretty much the same approach as partnership building to be successful. There is a need to build trust, to recognise all involved as equal partners and to support with experiences the weaker partners to enable them. Very few, if any, landscape approach initiatives have reached this far in their networking efforts. Still, even on the lower levels of networking a lot of benefits could be gained. It is often a good help to be able to call or e-mail a colleague in another landscape approach initiative to ask about their experiences of knowledge regarding

different issues. Experiences related to general issues like collaboration and social learning also seem to be similar in many different contexts. A weakness or gap is that all landscape concepts tend to build their own families and keep with them. Often landscape concepts are more similar within a country than between countries (Axelsson and Angelstam 2006). Development would thus benefit from international collaboration.

To facilitate scaling-up, dissemination and networking it is important to document experiences and new knowledge that has been produced. This is guided by the multi-level area-based approach that is used by both BR and MF. Different kinds of documentation have different properties. Examples of documentation from landscape approach initiatives include different kinds of reports (from local to international), popular writings, web pages, films, books (popular or scientific) to scientific publications. It is important for landscape approach initiatives and their networks to understand the properties of different kinds of documentation to be able to reach their aims to disseminate and to scale-up their results. In general I argue that it is important to a landscape approach initiative to produce a wide variety of documentation to be able to reach its goals, and contribute to sharing locally, nationally and globally. It will be easier to reach out with publications if the partnership reflects all societal sectors and several different levels (paper III) since no single actor is good in producing all these outputs on his own.

However, this form of information output is only one kind of dissemination. This needs to be complemented by different kinds of human interaction, and face to face sharing. The latter ranges from collaboration with partners, development of demonstration objects/areas, involvement of stakeholders in activities, involvement in other stakeholders activities, participation in network initiatives to addressing specific sustainability issues, and different kinds of oral information such as interviews in TV, radio and different kinds of local to international oral presentations at meetings, seminars, training courses and conferences. A promising approach is to design face to face sharing as a collaborative learning process. This means that no one should act as a teacher or student but that the group should use their common experience and knowledge as a starting point for learning. A collaborative learning process requires careful facilitation that could also be seen as a way to disseminate knowledge and learning about SD (Daniels and Walker 2001). When knowledge production is integrated with and in collaboration with stakeholder's dissemination, evaluation of the relevance and usefulness occurs as a part of the research process. This means that socially robust knowledge can be produced (Nowotny 1999).

Effective sharing and communication requires the development of a strategic plan assisted by different analyses to make sure the aim of the landscape approach initiative will be supported. An interesting step wise approach is to; 1) define systemic aim, 2) learn what behaviour that need to be changed, 3) contextual analysis, 4) understand the targeted actors, 5) define a communicative strategy, 6) chose a media that fits, 7) planning and implementation, and 8) evaluation and adaptation (adapted after Palm 2006a,b, IDRC 2009). Here one have to keep in mind that landscape approach initiatives in general often have a very broad goal of supporting and implementing SD locally, nationally and globally which requires multiple communication strategies or a very broad strategy. Still many landscape approach initiatives are much narrower in their work concentrating on a specific sustainability profile that meet their local needs.

6 General discussion

6.1 Can the landscape approach contribute to sustainable development?

The purpose of landscape approach initiatives is to implement SD policies in practice. Are they successful? The key to evaluate the extent to which this is the case is to (1) support and steer the activities towards the desired direction through evaluations, and (2) to go from being isolated islands of sustainability to also influence areas outside the landscape approach initiative. This requires that local and regional initiatives are well integrated, and with stakeholders from different sectors on different levels that collaborate. There are examples of collaborative efforts that have succeeded in finding solutions to local sustainability issues (see for example Flora and Flora 1993, Daniels and Walker 2001, Aden Wily 2002, Pretty 2003, Petheram et al. 2004, Olsson et al. 2004). In contrast there are no or few well documented cases that shows how the landscape approach have supported sustainable development on the ground in the long term. Still there is a lot of circumstantial evidence that shows that collaborative efforts and the landscape approach are very promising ways to address these issues (Lee 1993, Berkes et al. 1998, 2000, 2003, Borrini-Feyerabend 2004, Folke et al. 2005). It is, however, important that the initiatives on the ground reflect a sincere will (1) to work with SD locally or regionally, and (2) to be committed to contribute to sustainability also outside their own area and globally. There are cases were landscape approach initiatives have other agendas, such as making their own area, or project, more attractive and well known. This could indeed be effective, by only if they in addition satisfy these two criteria. When local and regional initiatives implement landscape

concepts according to the conceptual frameworks and agree with them they can contribute in the SD process.

6.2 Competition or collaboration?

A problem for landscape approach initiatives is to get the mandate to be a central hub for SD efforts in a landscape. This could also be seen as a problem with legitimacy (Dowling and Pfeffer 1975, Hedquist 2002). How can a partnership build legitimacy to become the central hub for work with SD in an area? There are many local government units and agencies that are responsible for the implementation of SD policy. In addition there are many companies (Utting 2000), projects (Hovik and Sandström 2008), and other actors that claim to work with SD. One actor in one of my case studies once said "we do not like to be coordinated by that landscape approach initiative". Here it is important to understand the meaning of partnership and collaborative learning. No one should coordinate someone else. The key word is collaboration with the aim to find synergy effects (Gilbert 2007) and to do things together as a partnership. Collaborative learning means that no one should teach, no one should be taught but partners should be a part of a collaborative learning process (Daniels and Walker 2001). In an actual landscape this is hard since there are already actors with a mandate that think of themselves as legitimate SD agents. It is about getting credit for their work and about letting others in to share parts of the responsibilities. In one case study area I was involved as a facilitator in a dispute over a protected area with the aim to find a solution for visitors that did not disturb the local population. The person from the responsible government agency stated several times during a meeting with stakeholders that "you are allowed to support this process but we are the ones to decide". It clearly showed that this government officer was not yet ready to give up some of power to develop a collaborative learning process. At the same time it is important to be clear about both the decision space and decision power, that is, who at the end decides what based on the outcome of the process. Others claim that it takes too long time and is thus too costly with collaborative processes when acute environmental problems are to be managed (McCloskey 1996, Kenney 2000). This might actually be true! The way around this is to learn about collaborative learning and other participative approaches and to early in a process evaluate if a collaborative process is needed. This is done by an assessment of the collaborative potential with the goal to identify the potential for an open, constructive, and respectful interactions and mutual gain results among stakeholders. In complex and uncertain decisison-making

processes that could easily lead to conflicts, the more attention given to initial preparations of the process, the better the chances for a successful outcome (Carpenter and Kennedy 1988). An assessment of the collaborative potential typically include issues like: (1) rough mapping of actors, are they easy or hard to identify?; (2) how long time there has been an issue, history of the situation; (3) complexity of the situation, (4) level of trust and respect among actors; (5) drivers of the present situation, specific identifiable interests or deeper held values and norms; (6) number of alternative scenarios, including non-collaborative solutions, few or several possible; (7) how clearly problems could be defined; (8) how controversial the problems are; (9) uncertainty of research related to the situation and problem at hand; (10) availability of relevant information about the issue; (11) how easy information related to the problem is to understand, interpret and apply: (12) involvement of local to national decision-makers; and (13) availability of resources for collaboration. The analysis will show if a collaborative effort is needed and if it is a feasible way to handle the situation (Daniels and Walker 1996, 2001).

6.3 Development through evaluation

Nobody will do everything right all the time in complex natural resource management situations and SD efforts. If one does not get help by external evaluations and reflective self-evaluations there is even a large risk that many efforts will miss the target. A main challenge is that people by nature feel an aversion against being evaluated. It feels like the tax authority is checking us. These feelings are problematic! This is probably both a problem with the evaluator, and the actors to be evaluated. Evaluators need to emphasize the parts that are working well, the parts that could be improved the parts that are not worth putting efforts in and the general aim with the evaluation to support improvements and adaptations to facilitate the SD and specifically sustainable natural resource management. A common agreement among stakeholders and actors that evaluations and adaptations is the only way forward towards the goal must be made. The persons and initiatives to be evaluated must learn the benefits of evaluations. There is a need for reflective self-evaluations, evaluations made by other landscape approach initiatives (evaluate your colleagues in the neighbouring landscape approach initiative) and evaluations by external evaluators. Evaluations can be made and are needed on project level, landscape approach initiative level, network level and for example country level across different landscape concepts.

6.4 Knowledge production for sustainable landscapes

The concept of site-adapted forest management was developed as an approach to make forestry more sustainable (Lundmark 1987), and reflected the forest policy of that time. Swedish forest policy has developed further since then. Today production and ecological goals are equally important. In addition social and cultural sustainability is emphasised (Anon. 2008b, MOA 2008). Paper IV could be seen as a further development of the site adapted forest management concept that reflects the present forest policy. Alternatives to clear-felling, which dominates to 96% in Sweden, have a poor reputation for historical reasons, and due to poor knowledge about the methods (paper IV, Axelsson 2008). As a result there are forest sector lobbyists fighting continuous cover forestry hard by presenting numbers of how much money would be lost if it would replace traditional clear-felling methods completely (see Karlsson and Lönnstedt 2006a,b for reports that present these calculations). There are also similar arguments from conservationists that like continuous cover forestry to be used more and in forests of a certain age on any site type to promote biodiversity (SSNC 2007). Both these arguments and claims are in my view a result of limited knowledge about basic forest ecology, cultural history, and the role of different forest ecosystems to satisfy policies about biodiversity and social forestry.

In addition to such arguments there is confusion of what a CTC forest is. Both researchers and the Swedish Forest Agency have pointed out any moderately biologically old forest as CTC forest. In Sweden, with its intensive forest management and with a forest policy that has supported it for a long time; all remaining old forest may have a value at the local scale. Still, however, a landscape approach to ecological sustainability in terms of securing functional habitat networks (Angelstam et al. 2004c), and ecological integrity (Törnblom 2008) requires that we look at the whole landscape, understand what has been lost, and identify levels of different landscape elements that are needed to maintain biodiversity. This kind of gap analysis clearly indicates that restoration of CTC forest sites is needed (e.g., Angelstam and Andersson 2001). The amount of CTC forest sites was less than 10% in the present Swedish landscape (paper IV). A rough estimate is that out of the less than 10% CTC forest types about half is needed to maintain biodiversity (less than 5%). This includes the wettest and the driest sites that are already exempted from forest operations due to poor productivity and poor carriage capacity (makes forestry operations harder).Out of these 5% about half is probably already exempted from forestry operations due to these reasons. This ends up to somewhere

between 2 and 3% of the Swedish boreal forest that would be a candidate for continuous cover forestry for ecological reasons. Here it is also important to point out that continuous cover forestry does not per definition result in more ecologically more sustainable forests. Continuous cover forestry systems range from intensive production to close to nature. To benefit ecological sustainability close to nature systems must be used. There are naturally also other incentives to use continuous cover forestry, for example for social sustainability, forest resilience, adaptation to and mitigation of climate change. These are, however, outside the scope of this thesis and more knowledge is needed in these areas.

Paper IV is an example of how the production of new knowledge and syntheses could contribute in the SD process. The results from this study could be used in a collaborative learning process with the aim to find common ground among stakeholders and actors about what CTC forests are and where and what kind of continuous cover forestry could contribute to ecological sustainability.

7 Conclusions

For SD, sustainable forest management, rural development and supporting transdisciplinary knowledge production a well-developed collaboration among stakeholders is necessary. A key gap in implementation of SD policy and transdisciplinary knowledge production is lacking or poorly developed collaboration among stakeholders. Actors, be they decision-makers, government officers, natural resource managers or researchers are not willing or capable of handling process oriented collaboration (paper I, II, III, V, Carpenter and Kennedy 1988, Depoe at al. 2004, Sinclair and Lobe 2005, Currie-Alder 2005, Gilbert 2007, Sandström et al. 2008). The landscape approach to SD can contribute to sustainable forest management, rural development and transdisciplinary knowledge production if implementations in local landscape approach initiatives are designed to consider; 1) an area that fits with the main sustainability gaps or task at hand, 2) collaboration among actors and stakeholders 3) a commitment to SD and sustainability profiles as a result of analysis, 4) knowledge production to learn about the area, to solve sustainability issues and to improve practices, and 5) a systematic approach to sharing including networking (see Figure 5). To handle conflicts and make development sustainable there is a need for collaboration and learning, which both require careful facilitation to be successful. A similar approach is needed on all levels from local, regional, national, international and global. On all levels well planned and facilitated processes are needed (Table 4). These processes needs to be implemented by actors in real landscapes bottom up with top-down overview, and with support from actors at higher levels of governance. Local and regional landscape approach initiatives are actors that can contribute a lot in the SD process on the national and higher levels.

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