Future Forests

Sustainable Strategies under Uncertainty and Risk

Program Plan 2009

Disposition

Program title

Future Forests – Sustainable Strategies under Uncertainty and Risk.

Program Board

The Program Board will be constituted of the following persons:

- Maria Norrfalk (Chair), County Governor of Dalarna
- Wilhelm Agrell, Professor in Intelligence Analysis, Research Policy Institute, Lund University
- Ann-Britt Edfast, Manager of Research and Development, Sveaskog.
- Pelle Gemmel, Chief Forester, SCA
- Linda Hedlund, Forest Director, LRF Skogsägarna
- Ulf Silvander, Secretary General, Svenskt Friluftsliv

Program director

Professor Tomas Lundmark will serve as Managing Director, and Professor Stig Larsson as Research Director.

Period for which funding awarded by Mistra

By a decision the 9th of June 2008, Mistra awarded Future Forests funding for the period 1 January 2009 to 31 December 2012. An evaluation of organization will be done in late 2010 to ensure that the program follows the intention of the call. If the evaluation is positive, the Executive Director of Mistra will execute continued financing for the first phase of the program.

Summary

Climate change, globalization, and increased consumption of materials and energy leads to higher pressure on forest resources. The task of intensifying forestry to produce more timber, paper, and energy, while at the same time ensuring ecosystem services, such as biodiversity and recreation, is a complex one. Difficult decisions have to be made if we are to strike a balance between these demands. These decisions have to be supported by scientifically-based land-use strategies to deal with trade-offs on different scales.

The vision of Future Forests is to take a significant step forward in this complicated task. The Program has a long-term perspective (50-100 years) and will consider changes in climate, as well as global and market development as major factors likely to have a strong influence on forest management and forest landscapes in the future. In this context, uncertainties, vulnerability, and the adaptive capacity of social-ecological systems must also be considered.

The Program's promise to society is: *Future Forests will create knowledge and tools to enable sustainable decisions for the future of one of our most important resources - our forests.* To fulfill this promise, the Program has the ambition to constitute a platform where researchers from different disciplines, and practitioners from several sectors, can interact. The program will combine empirical research with modeling, scenario analysis, and synthesis work in order to produce excellent science and applications.

Much of the multidisciplinary research performed in the Program will be done in the Component Projects. These research groups will be responsible for producing detailed, high-quality scientific results that can both be incorporated into the scenarios and be directly relevant for our stakeholders.

The Center for Forest System Analyses and Synthesis (ForSA) will form a unifying force in Future Forests. The main goal for this center is to develop skills in scenario analyses and to perform such analyses from a social-ecological perspective. A Core Team from within the program will be responsible for this. The composition of ForSA will be flexible. When analyzing certain problem areas, necessary competences will join in Thematic Working Groups for shorter or longer time periods. These competences may come from the Program's Component Projects. Scientific and practical competences may also be recruited externally.

When fully developed, ForSA will be a unique institution with an explicit mission to foster synthesis and analysis, turn information into understanding and through effective collaboration, alter how science and forest management are conducted.

Future Forests is a strategic investment to broaden the traditional approach to forest research. The interaction among individuals from different, but complementary, backgrounds has the potential to form a new generation of researchers with a novel perspective on forest science that will benefit industry and society in general.

The program is a joint research effort of the Swedish University of Agricultural Sciences, Umeå University, and the Forestry Research Institute of Sweden. It is organized directly under the Vice Chancellorship of the Swedish University of Agricultural Sciences and is led by a Program Board, a Managing Director and a Research Director.

Sammanfattning

Klimatförändringen, globaliseringen och en allt större konsumtion av energi och råvaror ökar efterfrågan på våra skogliga resurser. Utmaningen är att få skogen att räcka till och dessutom att räcka till för många olika behov. Att intensifiera skogsbruket för att utvinna mer timmer, papper och energi och samtidigt säkra biodiversitet, rekreation och andra ekosystemtjänster kommer att vara en nödvändighet. Det är en komplex uppgift som kräver svåra beslut. För att nå en balans mellan olika anspråk behövs vetenskapligt underbyggda markanvändningsstrategier som kan ge ”mer av allt”.

Future Forests vision innebär att programmet tar sig an denna komplexa uppgift. Forskningsprogrammet har ett långsiktigt perspektiv (50-100 år). Det kommer att beakta förändringar i klimat, globalisering och marknadsutveckling, som sannolikt är avgörande faktorer för framtida skogsförvaltning och skogslandskap. I detta sammanhang måste också osäkerhet och risk, sårbarhet och adaptiv förmåga hos social-ekologiska system vägas in.

Programmets löfte till omvärlden är: *Future Forests skapar kunskap och utvecklar verktyg som möjliggör långsiktigt hållbara beslut om en av våra mest värdefulla naturresurser - våra skogar.* För att uppfylla detta löfte är det programmets ambition att vara en mötesplats för forskare från olika vetenskapliga discipliner och avnämare från olika samhällssektorer. Programmet kommer att kombinera empirisk forskning med modellering, scenario analys och syntesarbete med målet att utveckla excellent vetenskap och tillämpning.

En stor del av det multidisciplinära vetenskapliga arbetet kommer att utföras i delprojekt. Forskargrupperna i dessa delprojekt är ansvariga för att ta fram resultat av hög vetenskaplig kvalité som både kan förstärka Future Forests scenarioanalyser och vara direkt användbara för programmets avnämare.

Ett centrum för analys och syntes av skogliga system (ForSA) utgör den sammanhållande kraften i programmet. Huvudmålet för ForSA är att utveckla kunskaper i scenarioanalys och att genomföra scenarioanalyser utifrån ett social-ekologiskt perspektiv. Programmets ledningsgrupp kommer att vara ansvarig för verksamheten. ForSA kommer att vara flexibelt i sin karaktär. När en speciell frågeställning ska analyseras kommer nödvändiga kompetenser från ForSA och Future Forests delprojekt att samverka med extern kompetens (både vetenskaplig och praktisk) i så kallade Tematiska arbetsgrupper under kortare eller längre perioder.

När ForSA är fullt utvecklat är det en unik institution med en uttalad mission att fostra avancerad syntes- och analysverksamhet, att omvandla information till kunskap, och att genom effektiv samverkan förändra vårt förhållningssätt till både vetenskap och praktik.

Future Forests är en strategisk investering för att bredda den traditionella synen på skogsvetenskap. Mötet mellan individer med olika och kompletterande bakgrunder har potentialen att forma en ny generation forskare vilket både gynnar industrin och samhället i övrigt.

Programmet är en gemensam forskningssatsning av Sveriges Lantbruksuniversitet, Umeå Universitet och Skogforsk. Det kommer att vara organiserat direkt under rektor på Sveriges Lantbruksuniversitet och ledas av en programstyrelse, en operativ programchef och en vetenskaplig programchef.

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Part A

1. Vision and objectives

1.1. Background

1.1.1. Multiple uses and global drivers

Forest systems are impacted by multiple uses, and influenced by global drivers (Fig. 1).

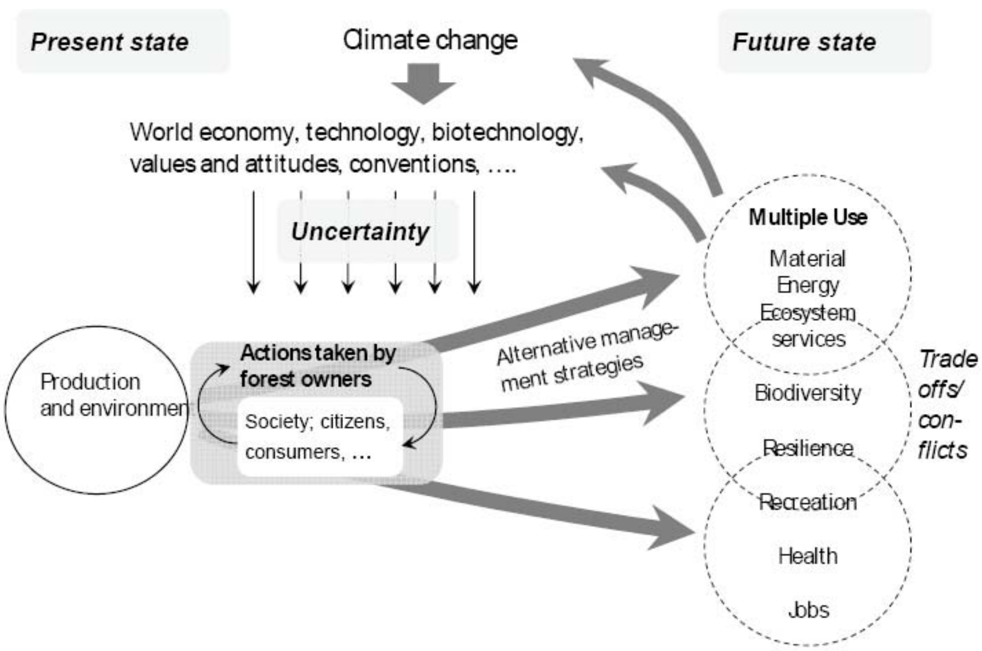

Figure 1. The multiple impacts that influence forest use over time.

Forests provide services for the individual land owner, the general public, and for society. In addition, forest communities are fundamental life-support systems in the biosphere. The multiple-use character of the forest means that many different, and sometimes conflicting, goals exist for its management. Conflicts can arise among timber-producing forest owners (raw material), reindeer husbandry (grazing), environmentalists (biodiversity), as well as among tourists and the local communities (recreational experiences, berry picking, hunting and fishing). To respect common values, and to achieve a balance among these values and users, forest management is subject to restrictions formulated in laws and international conventions.

In addition to producing raw materials of immediate use to society, a well-managed, productive forest can sequester substantial amounts of carbon, as well as producing biomass, which can substitute fossil fuel and oil-based products. The potential for forest management to make a significant contribution to Sweden’s efforts reduce greenhouse gas emissions will be a recurring theme in the work of Future Forests.

Wide-ranging effects on the condition of the forest ecosystem and its services are to be expected based on factors such as market changes, increasing per capita income, demographic change, changes in consumption patterns, urbanization, globalization of the economy, and new technology. Materials and energy use are expected to increase over time resulting in increased market prices and changed structures in the forest industry, with consequent changes in the demands on production of raw materials and energy from Swedish forests. Climate change will influence all driving forces, including people’s attitudes toward forests and forestry. This change poses a serious problem for the environment and for society. Among other things, climate change will lead to an increased risk for extreme weather events and pest outbreaks.

The combined society-forest system is under continuous change and development. The attitudes and values of forest owners, the general public, and politicians with respect to forests and forest management have changed in historic times and will continue to do so with global change. Forest ownership patterns are also changing, with impacts not only on gender structures and the economic significance of forest ownership where fewer and fewer small private forest owners are dependent on forestry for their living but also the world-wide structure of forestry where forest-based companies are global actors.

The need to understand the interplay between sectors and the complex patterns of cooperation and conflict pose challenges for sustainable management of individual forest holdings as well as for national forest policy. Sustainable forest management must adapt to all drivers of change by balancing these different goals while accounting for uncertainty and risk, and also taking advantage of new opportunities in technology and biotechnology.

1.1.2. Forestry in Sweden

Swedish forests have been utilized since prehistoric times. Initially, agriculture and mining industries, and later lumber and pulp industries, have shaped almost all of the Swedish forest landscape. After the Second World War, Swedish forestry developed towards a uniform system for the utilization of forests as a natural resource with a centrally-directed choice of silvicultural methods. Clear-cutting, followed by scarification, planting, and early pre-commercial thinning, became the dominant method of regeneration, and this method was applied in virtually all Swedish forest landscapes. Thinning measures were directed towards the production of coniferous wood with large-diameter growth in order to achieve fast rotation in the forest. The standing volume has more than doubled during the last 100 years and the annual increment has never been higher than it is today.

In the revised Swedish Forestry Act from 1994, production goals and conservation goals were given equal importance. Forest owners have considerable responsibility for fulfilling these goals, and the Forestry Act sets out the demands placed on forest owners by society. These include the minimum levels of wood production that must be attained, and the considerations that must be given to nature conservation and cultural heritage. Multi-use forest landscapes that take into account different user values are confronted with conflicting aims, some of which are far from being resolved at present. A few decades ago, the forestry sector was a concern mainly for those who owned the production resources and those who worked in the same enterprise. Future forestry, however, will work in a fundamentally different way by taking into account conditions dictated by the market and by society.

1.1.3. Prioritizing important forest research issues

Recently, forest industry and researchers have jointly prioritized important forest research issues. The present program builds on the same global and long-term perspectives as these initiatives, among which are the EU Forest-Based Sector Technology Platform (FTP), the associated National Research Agenda (NRA), the KSLA report, ”Klimatet och skogen-underlag för nationell forskning” (Climate and Forest – basis for national research), and planning documents used by MISTRA, “Framtidens skog – hållbara strategier under osäkerhet” (Future Forests - Sustainable strategies under uncertainty).

To further prioritize among important forest research issues, an active dialogue with stakeholder groups took place during the preparation of this program.

1.2. Vision

The Future Forests program will:

- Greatly improve the understanding for a sustained provision of ecosystem services from the forest landscape – timber, paper, and bioenergy, as well as biodiversity, recreation, water resources, and climate change mitigation;
- Improve the capacity of forest owners, managers, and decision-makers to adapt to unforeseen changes, apply new technology, and develop new markets;
- Provide a framework for the discussion of the forest’s future in Sweden for the coming generation and make that discussion an inspiration for other countries;
- Develop new knowledge about the forest system that will strengthen Sweden’s international competitiveness.

1.3. Objectives

The goal of Future Forests is to develop adaptive strategies for managing forests towards sustainability in a future characterized by change.

Specifically, the research program aims to:

- Develop and evaluate new forest management methods and strategies to meet increased, unpredictable, and conflicting demands on forest production and ecosystem services by current and future societies;
- Develop an understanding to support strategies and methods for improved and more effective governance within the forestry sector;
- Create a world-leading and long-lasting Center for Forest Systems Analysis and Synthesis (hereafter ForSA) where interdisciplinary research questions can be successfully analyzed and synthesized.

1.4. Strategy

The program intends to create a vital and powerful platform where researchers from different disciplines, and practitioners from several sectors, will interact to address fundamental questions concerning our future forests. This overarching strategy is based on four sub-strategies: 1) excellent science, 2) effective organization, 3) strong leadership, and 4) well-planned communication.

1.5. Significance of the program in terms of solving major environmental problems

The program will produce two major types of output. Firstly, we will generate new knowledge within several important areas where critical information for a sustainable development of forests and forestry in Sweden is missing or incomplete. These areas include adaptations and mitigations to climate change, water quality, nutrient cycling, and biodiversity. Secondly, the program will address several large and complicated environmental problems through interdisciplinary syntheses and scenario analyses. Our ambition is that these decision-support tools will make it easier for our stakeholder groups to address these issues.

The largest significance of the program is perhaps the focused effort at creating a research team where complex environmental issues can be addressed. This is not a trivial task. There is a large need in society for more integrated and interdisciplinary research, together with more comprehensive analyses of problems and decisions-support tools and models. We will establish the necessary competence, methods, and facilities for doing so. We believe that this will constitute a large step towards a sustainable use of forests in Sweden and elsewhere.

1.6. Significance of the program in terms of promoting Sweden's competitiveness

Future Forests will develop methods of addressing and analyzing conflicting goals of land use in forests in Sweden. This is very important for the international competiveness of Swedish forest companies. The knowledge generated in our Component Projects can also be used to produce more forest goods and services under changing climatic and societal pressures in a sustainable way. The establishment of an attractive and leading research center for forest system analyses will also increase the competitiveness of Swedish forest research.

1.7. Significance of the program in terms of creating strong research environments

Forest research in Sweden is strong. However, no attempt of integrating different research disciplines within forest research has previous been done at this scale. We foresee that the program activities will lead to increased interactions among disciplines and leading scientists, and to the recruitment of a new cohort of future scientific leaders within forest research. Further ForSA will be a unique research resource in Sweden.

2. Scientific value

2.1. The theoretical framework

As all other ecosystems, the long-term functioning of the northern forest depends on certain system states and key processes. Whether or not the forest ecosystem can be considered sustainable is partly a matter of definition. A natural forest ecosystem can be seen as a system that, over the normal cycle of disturbance events, maintains its characteristic diversity of functional groups, productivity, soil fertility, and rates of biogeochemical cycling. For the most part, Swedish forest stands are not “natural”, but for centuries have been managed to various degrees. Sustainability as a concept is clearly relevant also in a managed system, but here it becomes an integrated aspect of the management itself. For example, intensive harvesting may require that managers return nutrients in order to compensate for those removed at harvest. Similarly, in intensively managed forests, damage from insect pests or diseases might exceed the economic threshold and thus call for intervention measures. In these and similar cases, sustainability has different implications as compared with those for natural forests, and management actions are a crucial part in determining the states and sensitivities of the systems. In the managed forest, sustainability is an overarching goal that includes assumptions or preferences about the desirable states.

The concept of resilience is often referred to in the context of sustainability science. Resilience can be defined as the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity. To experience shocks, in a forest ecosystem perspective, could, for example, be to experience major natural disturbances, such as wind storms and subsequent bark beetle attacks, or major disturbances related to forest management, such as clear cuttings. Whether or not the Swedish forest will retain key functions after such disturbances is difficult to predict, and might depend on which scale, temporal or spatial, one considers and which processes are of interest. In general, a resilient ecosystem is assumed to host high diversity with potentially many negative feedback interactions. Recently, resilience has become as much, or more, a social concept.

Organism diversity is commonly assumed to be important in order to maintain high resilience. More specifically, the diversity of functional groups is assumed to influence ecosystem properties. However, what exactly it is that constitutes functional groups, or functional traits of the species involved, is unknown for most organism communities. An important question, with management implications, is if there is a correlation between species diversity, often expressed as species richness, and functional diversity. In general, this is not known, but it is reasonable to assume that a forest with high species richness, say of soil organisms, can better withstand variation in abiotic conditions, or disturbances, than a forest with fewer species. A common explanation for this is that certain combinations of species are complementary in their patterns of resource use or services provided in the ecosystem. Although scientists now agree on these general principles there is still little experimental evidence available for building predictive models over diversity and ecosystem functioning. Biodiversity research in Fennoscandia has for the most part been focused on conservation of species. This is another way of looking at forest biodiversity that can indeed have implications for forest ecosystems, but it is virtually unknown whether or not management practices aimed at conserving species also contribute to enhanced ecosystem functioning. A potential concern in ecosystems is the possibility of regime shifts that lead to threshold effects and thus changes in ecosystem properties. In forest ecosystems, so called dominant and keystone species of soil organisms may contribute disproportionately much to the dynamics of soil resources relative to their abundance. It is quite possible that in these systems functional diversity of soil organisms is a key to sustained nutrient dynamics.

The concept of vulnerability is closely related to resilience, but has its roots in the social sciences, including environmental risk, and health and food security research. Vulnerability has been broadly defined as the capacity to be wounded; it is a measure of a system's sensitivity to change minus the capacity of adaption to this change. This definition draws attention to an external side of vulnerability (exposure to risk) and an internal side (a system's capacity to cope and adapt when exposed). Vulnerability is thus crucially related to the sensitivity of systems and their adaptive capacity which, from a social perspective, draws attention to how different groups, institutions, and places may be impacted and what they can do to avoid adverse impacts. Social vulnerability can be seen as the ability, or inability, of individuals and social groupings to respond to, in the sense of coping with, recovering from or adapting to, any external stress placed on their livelihoods and wellbeing. "Social systems", in this respect, thereby include all non-ecological parts of the world: economic market, political structure, social and cultural value conceptions, and social organization. The focus in social vulnerability is based on the way this complex social system is structured, including the relevant decision-making or governance networks, and accordingly, the economic and political capacity of the entities to respond to risk. Actors that influence this system in a forest context may include all levels - from individual actors, such as local forest owners, to regional implementation agencies, the national decision-making system and international markets, together with NGOs.

The concept of adaptive capacity – the possibility to respond to change and undertake certain adaptations in the process – is thus crucial, as it describes the extent to which a system may decrease its vulnerability by learning and applying new economic, social or political approaches to limit risks. Within the context of Future Forests, this may include adaptations in forest management, such as new tree varieties or fertilization regimes, but may also include adaptations that include changes in laws or regulation. Consequently, important determinants of adaptive capacity include institutional multi-level capacities for communication and how well institutions are linked in multi-level governance systems, as well as an understanding of the patterns of influence within these networks.

2.2. Adaptive capacity and resilience in a Future Forests perspective

Adaptive capacity and resilience are both terms that target broad spectrums of impacts on social-ecological systems. The terms are sometimes used interchangeably when referring to integrated social-ecological systems, and a number of bridges have been developed between the two concepts in order to make an integrative treatment possible. In this sense, resilience provides the adaptive capacity to allow not only for system stability and buffering change, but also for development in the face of change. Managing change is thereby a balancing act between maintaining a system in its present state and developing or supporting beneficial development paths. Adaptive capacity may accordingly refer to capacities to respond within the social domain, but also to possibilities to shape ecosystem dynamics, for instance by retaining sufficient functional biodiversity as to maintain adaptive capacity in the system and buffer ecosystems. Goals in managing or governing such systems are often defined as increasing the possibilities in the future by choosing development paths that increase the general adaptive capacity in the system to perturbations. This reflects the general aim in Future Forests: to develop adaptive strategies for managing forests towards sustainability in a future characterized by change. The aim is consequently to decrease the vulnerability to stresses – which may exceed previous levels – through increasing adaptive capacity.

In order to understand, assess, and ultimately limit vulnerability in a social-ecological system, it is important to assess the exposures that affect the system and sensitivities to the systems as well as the factors that impact adaptive capacity. Such vulnerability assessments should integrate knowledge from various disciplines, be place-based with an awareness of the nesting of scales, recognize multiple and interacting drivers, allow for differential adaptive capacity, and use prospective as well as historical information. Such assessments can support development of adaptive governance, which extends conventional resource management by focusing on feedbacks between ecosystem dynamics and institutions to increase the adaptive capacity of the system. Developing such understanding is a fundamental aim of integrative social-ecological systems research within Future Forests.

There are a number of potential challenges to understanding, assessing, and supporting adaptive-capacity developments in social-ecological forest systems. One is the limited understanding that currently exists about northern social-ecological forest systems. Another challenge to integrated social-ecological systems understanding is the time scale of changes and their diverging effects on social and ecological systems; the ecological sub-system may not respond to the same external factors or on the same time scale as the social sub-system. An example is when economic decision-makers and individual entrepreneurs may be concerned about very short-term time scales while ecological systems may require long-term planning. Other challenges come from the changing concurrent pressures on society and forests through globalization and climate change that may reduce the room for adaptation over time, while new adaptive possibilities may emerge. Decision-makers may also be removed from immediate experiences with forest systems that could support their understanding of challenges in renewable resource management.

2.3. Dealing with complex problems

The multiple-use character of the forest means that many different, and sometimes conflicting, goals exist for its management. Throughout the 20th century, the forest landscape has been an arena for value conflicts, political struggles, and scientific controversies. All these debates have contributed to shaping the way forestry is now regulated and managed. Thus, many of the debates and problems of today are not new. All problem-solving is based on a particular understanding that makes it possible to imagine a problem, diagnose it, and propose a relevant solution. Inability to reach a general understanding of the problem – defining a problem and spreading the definition to a wider circle of stakeholders and decision makers – constitutes a central obstacle for problem solving. If no general definition is agreed upon, then there is rarely any opportunity to formulate a joint plan for concerted action. Future Forests will pay particular attention to this phenomenon and throughout the program period address the issue in workshops and during the development of the scenarios.

A particular challenge for reaching understanding is that problems are handled in a context of uncertainty. Uncertainty can be seen in at least four dimensions: cognitive, strategic, institutional, and normative. Cognitive uncertainty concerns inadequate or contingent knowledge about causes and effects of a particular problem. What ecological, social, and economical consequences may a certain action or inaction result in? Cognitive uncertainty means that the causal relations are not firmly established and that actors disagree on the roots of a problem, and its potential solutions.

Strategic uncertainty means that it is not possible to foresee what action the actors involved in the problem-solving efforts will take. Actors' strategies are partly based on their understanding of the problem at hand, and accordingly, to cognitive uncertainty. Approaching the issue from different interests in a situation of cognitive uncertainty often results in diverging and conflicting strategies that, in turn, can lead to stagnation and deadlocks in problem-solving efforts.

Institutional uncertainty arises from the fact that decisions are often made in different places and at different levels. The institutional setting for decision making is highly fragmented, resulting in difficulties to coordinate decision making and actions undertaken. In addition, many environmental problems are cross-cutting and wide in scope, and can not be handled by a solitary actor at a single societal level.

Normative uncertainty means that there is no set of shared values and norms that could guide the choice among societal goals such as material prosperity, human health, or biodiversity. Even if there exists a shared understanding of the issue at stake, and an institutional setting that fosters collective decision-making, it may be hard to develop effective regulation and deliver concerted action because there is no guidance on how to prioritize between different objectives. This may result in dilemmas where there exist different perceptions and values, sometimes between groups and sometimes existing within a single person, that may result in inaction.

These dimensions should not be understood as isolated from each other, but instead in dynamic interaction; one dimension of uncertainty may give rise to or moderate another dimension of uncertainty. As research within the field of science and technology studies has shown, uncertainty could be used as a "boundary-ordering device" that facilitates communication, interaction, and even decision-making. Actors may use uncertainty as a means to reconcile different interests, or to escalate the conflict between them, which, for instance, may be a result of diverging goals resulting in goal conflicts. Conflicts may also be a result of divergent norms, resulting in social dilemmas where one single correct solution cannot be found. Developing ways of pricing different values (for instance, ecosystem services) can here be one way of comparing different aims, thereby supporting decision-making. Rather than only causing problems, however, conflict can under conditions of successful conflict management, work as a catalyst for change.

2.4. The complexity of social-ecological system

A main aim of research on social-ecological systems is to identify ways in which the capacity of the system to provide goods and services – or retain social, environmental and economic sustainability – can be maintained and thereby decrease the vulnerability in the system. Seeing vulnerability as a property of a coupled social-ecological system and not as a separate social or ecological system represents an advance in the analysis. Otherwise, human adaptation may be at the expense of ecosystem capacities to sustain that adaptation, or vice versa, choices based on ecological criteria without consideration of the social system may not be socially manageable.

It has become increasingly clear that future environmental changes, such as climate change, pollution, and globalization, will have profound effects on natural resources. It is also clear that the effect on the natural resources not only concerns the biophysical component but also the human dimension of resource use. Ecological communities need to be considered as an integrated part of human communities to form social-ecological systems (Fig. 2). Any situation where natural resources are extracted can be seen as a complex adaptive social-ecological system (the box in Fig. 2) where changes in one component affect the other component in non-linear ways. Such a system is also affected by external factors, or drivers, that need to be understood. For instance, a change in the ecosystem due to a changing climate will feed back to the possibilities of the social system to continue extracting resources. This adaptation of the social system will, in turn, affect the ecosystem. When external and internal drivers operate on many spatial and temporal scales, and the feedbacks between the system components are non-linear, the system as a whole becomes very complex and needs to be studied as a whole. This is a main challenge for Future Forests.

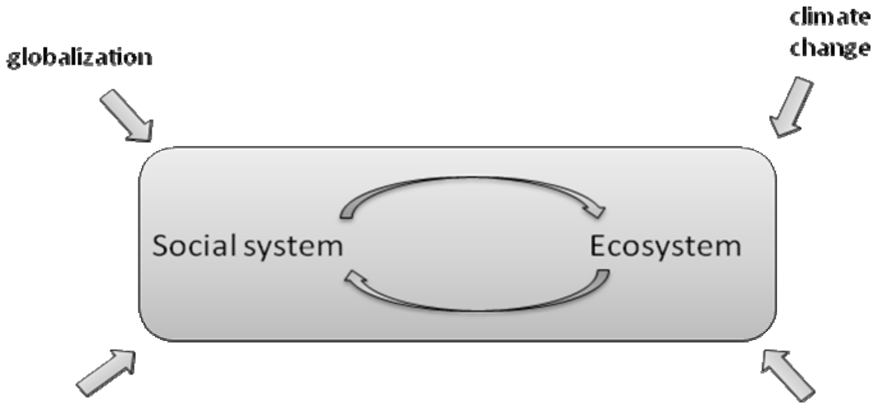

Figure 2. A conceptual view of a social-ecological system with external drivers.

A multitude of conceptual models have been developed during the last two decades in order to analyze the dynamics of social-ecological systems. Future Forests will build on, and further develop, the conceptual models used in analyses of social-ecological systems for application on forests systems, in particular Swedish forests. In so doing, the program will develop the theoretical basis necessary to bridge natural sciences and social sciences; this will enable us to develop novel insights applicable to management and governance of the forest system in an uncertain future.

2.5. Scenario analyses – alternative ways to use future forest landscapes

The future cannot be studied empirically. It is possible, however, to systematically explore, create, and test both possible and desirable futures to improve decisions. This includes analysis of how conditions might change as a result of the implementation of policies and actions, and the consequences of those actions. The value of such an exercise lies not so much in the accuracy of the forecasts, but in its usefulness in setting strategies and informing decisions today by emphasizing opportunities and threats and ways of addressing them.

One method of studying possible futures is through scenario analysis. In short, a scenario is a logically developed storyline regarding the development towards a potential future. One advantage of scenario analyses over other futures methodologies is the potential of combining qualitative (narrative) information with quantitative modeling (Fig. 3). Qualitative storylines provide an understandable way of communicating complex information, have considerable depth, describe comprehensive feedback effects, and incorporate a wide range of views on the future. Quantitative modeling may be used to check the consistency of the storylines, to provide relevant numerical information, and to enrich the qualitative stories by showing trends and dynamics not anticipated by the storylines alone.

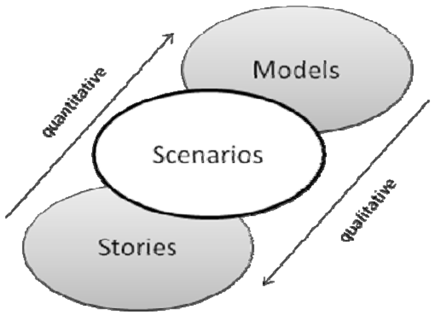

Figure 3. Qualitative and quantitative information are preferentially combined when developing scenarios. From Millennium Ecosystem Assessment: Scenarios

Scenarios are based on identified driving forces and on a defined understanding of conflicting aims. The scenarios should be judged on their ability to help decision-makers make policy now, and should be plausible (a rational route from here to there that makes causal processes and decisions explicit), internally consistent (alternative scenarios should address similar issues so they can be compared), and sufficiently interesting and exciting to make the future “real” enough to affect decision-making. Scenarios can be of different types that answer dissimilar questions. Predictive scenarios answer the question “what is most likely to happen?” and are most useful for short-time ranges and in situations with low uncertainty about drivers. Explorative or descriptive scenarios answer the question “what may happen?”, and may be most useful in complex situations over a mid- long range. Finally, normative scenarios answer the question “what would we like to happen?”, and may be most useful when there is a consensus of goals. Combinations of these approaches are also possible; IPCC, for instance, uses a combination of explorative scenarios in the sense of different emission strategies, but also normative scenarios in the sense of emission levels that should be reached.

Future Forests will focus on explorative scenarios that will act as decision-support tools for stakeholders. Explorative scenarios are constructed by identifying driving forces, defining critical uncertainties, describing scenario characteristics, and developing logical paths to these scenarios. This should be seen as an iterative process where the construction of scenarios identify key issues that are unknown and need to be studied, and the generation of new knowledge feeds into the process and may change the view of, for instance, drivers and uncertainties.

2.5. Deliverables of the program

Generally, we view Future Forests as a strategic investment in forest-related science. The science that we envision growing and developing during the course of the program period will, if successful, broaden the traditional way we look at forest research. The interaction among individuals from the natural sciences, social sciences, and the humanities will have the potential to form a new generation of researchers with a novel view on forest science that will benefit industry and society in general.

Specifically, the following assets will come out from Future Forests at the program level:

- Conceptual developments of the social-ecological system;
- Integration across natural sciences, social sciences, and humanities;
- A Center for Forest Systems Analysis and Synthesis (ForSA);
- Two generations of scenario analyses (2010 and 2016);
- Futures research methodology related to forest issues.

3. Value of the research to intended users

Future Forests has the ambition to be recognized for its novel research that will help solving environmental problems related to the long-term utilization of forest landscapes. Results generated will support forest owners and society to make informed choices about how to mitigate, adapt to, and benefit from foreseen and unforeseen changes and thereby promote Sweden's competitiveness.

Adaptive forest management strategies will be developed through the integration of results from scenario analyses, Thematic Working Groups, and research in Component Projects. Scenarios create potential pictures of the future that differ depending on what is assumed about the drivers of change. Scenario analyses thus facilitate an ongoing process of assessment and reassessment that increases the ability to perceive important developments early on. Future Forests will focus on explorative scenarios that will act as decision-support tools for stakeholders. In that way they provide a basis for decisions made now. This also contributes to preparedness for change, which increases the possibilities for moving in a desired direction. For an efficient use of the forest resource – from the view point of society or the forest owner – adequate management planning tools and more effective governance within the forest sector will also be developed. We see forest management plans as platforms where new decision-support tools can be applied to handle a variety of objectives and management strategies. In addition Future Forests will develop knowledge to support strategies and methods to improve governance within the forest sector.

3.1. User groups involved in the program

The target groups of the research program are those who manage the forest, including non-industrial private owners, forest owner associations, and forest companies. Other target groups are governmental authorities such as the Swedish Forest Agency, the Swedish Environmental Protection Agency, County Administrative Boards, and other national and local authorities. We also target the general public; this includes private citizens, consumers, politicians, and interest groups.

A Panel of Practitioners, consisting of approximately 25 persons representing a wide variety of interests, will be a vital and valued part of the program. To make this happen, the relationship between the members of the Panel and the management of the Future Forests will be described in a mutual letter of intent. This letter will be formulated in collaboration with the Panel. The work of forming the Panel and formulating a mutual letter of intent will be an ongoing activity during late 2008 and also stretch into 2009.

This work started in February 2008 when the planning group of Future Forests met with a group of stakeholders (referred to as a preliminary Panel of Practitioners). The meeting gave us valuable views and advice both on focus of research and stakeholder participation. The following 17 persons participated: Linda Berglund (WWF), Torbjörn Carlsson (Bergvik), Jonas Enström (Hushållningssällskapet Värmland), Camilla Dopson (Biofuel Region), Ola Kårén (Holmen Skog), Magnus Larsson (SCA), Daniel Ligné (Jägareförbundet), Anna-Helena Lindahl (Naturvårdsverket), Anna Lundborg (Energimyndigheten), Martin Lundgren (Norra Skogsägarna), Seved Lycksell (Skellefteå Kraft), Jonas Rudberg (Naturskyddsföreningen), Ulf Silvander (Svenskt friluftsliv), Thomas Stenlund (Malå sameby), Herman Sundqvist (Sveaskog), Johan Wester (Skogsstyrelsen), Jonas Ölund (Sveaskog), and Göran Örlander (Södra Skogsägarna).

In November 2008, 18 organizations will be invited to propose one representative each to the Panel of Practitioners. Organizations that will be invited are: SCA, Holmen skog, Sveaskog, Bergvik, LRF skogsägarna, Fastighetsverket, Energimyndigheten, Naturvårdsverket, Skogsstyrelsen, Riksdagens Miljö- och jordbruksutskott, Biofuel Region, EON, Samernas riksförbund, World Wildlife Found (WWF), Naturskyddsföreningen, Jägareförbundet, Ekoturismföreningen and Svenska turistföreningen.

The Panel formed out of this invitation will be asked to choose an additional number (5-10) of organizations that they think ought to be represented in the Panel to make it a legitimate, efficient, and exciting part of Future Forests.

3.1.1. Representation in Panel

As the panel will consist of about 25 persons, not all organizations or interest groups that have a stake in forest use or preservation can be offered a place. The following are criteria that will be used when choosing organizations:

- roughly 1/3 forest owners, 1/3 decision makers and authorities, and 1/3 other interests;
- as many different interests as possible should be represented;
- when the choice is between two organizations with similar missions, the one with most members in Sweden will be chosen.

The ambition shall be that the Panel is representative for all of Sweden (in terms of geography, age, gender and ethnicity). We foresee that invited organizations will suggest members who are open-minded, creative, social, and respected within as well as outside their own organization.

3.1.2. Role of Panel

The members of the Panel have three main roles: 1) to bring their personal/practical knowledge and perspectives into Future Forests, 2) to discuss new scientific results generated in Future Forests with researchers and college members of the Panel and in that way develop own understanding of results, and 3) to bring this self-acquired knowledge into practice. The Panel is advisory to Future Forests management and researchers; it does not have decision-making powers.

3.1.3. Interactions with the Panel

In order to facilitate for the Panel to fulfill the role given, the management of Future Forests will strive to enhance the preconditions for constructive interactions among the members of the Panel, as well as between the Panel and the researchers of Future Forests. The members will be:

- given first-hand information about new results from, and ongoing activities in, the program through internal newsletter, homepage, popular articles, personal meetings, lectures, and seminars;
- invited to the yearly Future Forests week;
- invited to a yearly Panel of Practitioners meeting;
- invited to electronic meetings and electronic workplaces;
- offered the opportunity to propose initiatives and contribute to the Thematic Working Groups under the framework of ForSA;
- offered opportunities to take part in some work in the Future Forests Component Projects.

To further facilitate the Panel's responsibility with dissemination of new knowledge from Future Forests into their own organizations and their target groups, Future Forests scientific communicator will collaborate with communication experts of key organizations. Each member of the Panel is expected to commit a minimum of 5 days per year in the framework of the Panel/Future Forests (this includes attendance at one Panel meeting per year, attendance at the annual Future Forests week, and additional collaborations).

3.2. User deliverables at the program level

3.2.1. Scenario analyses

At the program level, scenario analyses will be a major delivery. The scenarios will consider the most important drivers of change, include the major components of the forest system (social as well as ecological), and have a national relevance. The first-generation analysis will be available in late 2010, and the second-generation analysis in late 2016.

3.2.2. Decision support

Several different decision-support tools and recommendations will be developed during the program period. By having all research groups involved in developing the decision-support tools, it is possible not only to take biomass production into consideration but also to describe, e.g., effects on biodiversity, water quality, and risk for damage from pests. The decision-support tools will be able to function both as stand-alone applications and be included in larger applications.

3.2.3. Popular articles/press releases

The communicator will continuously produce and distribute popular articles and press releases covering new results, ongoing research and practice. The text format will be narrative, supplemented with facts in short, pictures, maps, and graphics. These popular articles and press releases will be distributed for free use to media and different organisations within the programs´ main stakeholder groups.

3.2.4. Yearly reports

After each year in operation a yearly report for the program will be produced. This product will summarize research findings and activities, as well as giving an account of the program's organization and budget.

3.2.5. Scientific and popular science books

At the end of the program, one scientific peer-reviewed book or special issue of a scientific journal, as well as one popular-science book that summarizes the programs findings will be published.

3.2.6. Summaries of Thematic Working Groups

Within one month of completion of a Thematic Working Group, an exit summary written for the educated public should be provided by the group.

3.2.7. Webpage

The program webpage will be established during the first year. It will begin with basic information about the program and points of contact (in both English and Swedish). Gradually, the webpage will evolve to be one of our most important internal and external communication channels. The fully developed webpage will contain all necessary information about the program and its research, the latest developments in the field, and PDFs of every publication that results from the program.

3.2.8. Conferences

The researchers in Future Forests attend a number of high-level conferences every year, often invited as key-note speakers. Future Forests will also arrange one large scientific international conference during the program period, as well as one end-conference for stakeholders. In addition to this the program will hitch-hike with a number of national conferences for both researchers and practitioners arranged by our collaborating partners.

3.2.9. Seminars and hearings

Researchers will continuously be giving and attending seminaries and hearings related to the program's issues of interests.

3.2.10. Advisory roles

The researchers in Future Forests are already engaged in a number of key global, regional, and national processes related to forests. These activities will be encouraged and we foresee that Future Forests advisory roles will grow larger over time.

3.2.11. Courses/education

Researchers engaged in Future Forests will give lectures and presentations at their universities, as well as in various situations and occasions outside the university.

3.2.12. Exhibition

If successful in raising funds, the Forest Museum in Lycksele intends to rebuild and expand. In their plans, an essential part of the 2000 m^2 new building will be devoted to an exhibition that in different interactive ways will show how future forests might look. Already, the Board and Director of the museum have expressed enthusiasm for collaboration with Future Forests. The ambition with such an exhibition would also include showing it at other Swedish and international museums and exhibition centres.

4. Program structure

4.1. Leadership

SLU will be the official host of the program. The Vice Chancellor appoints the Board of Directors for the program in cooperation with MISTRA (see Ch.1 for the composition of the Board). The Board will be responsible for the program, and thus for assuring that the program activities proceed according to plan, as well as for the fulfilment of the program's goals (see fig 4.1 for a schematics of the program structure).

The leadership position of Managing Director will be held by Professor Tomas Lundmark, and the position of Research Director will be held by Professor Stig Larsson. The Managing Director is responsible for the overall daily running of the program, and also for presenting the agenda to the Board and for executing the Board's decisions. The Research Director is responsible for maintaining a high research quality in the program.

Professor Lundmark is currently in charge of SLU's Field-based Unit of Forestry Research, employing 50 people working on eight experimental forests spread across Sweden. He is also the Associate Dean of SLU's Forestry Faculty.

Stig Larsson is Professor in Forest Entomology at SLU in Uppsala and has a scientific career focused on the ecology of tree-herbivore interactions. He is also the Associate Dean at SLU's Faculty of Natural Resources and Agricultural Sciences.

4.2. Scientific Advisory Board

The members of the Scientific Advisory Board are highly ranked and respected scientists in their respective fields, chosen to cover the interdisciplinary breadth of the program. The Advisory Board will function as a resource for the scientific management of Future Forests in the planning and assessment of the program. Their main role is to advise the Managing and Research Directors on strategic scientific decisions during the program period. Board members will also be invited to main meetings of the program, and interact with the program and program members in other ways. The Board members and their networks will add further scientific strength to activities in the ForSA, in particular to the development of novel ideas to be analyzed in the Thematic Working Groups.

The board consists of the following members:

- Prof. Lauri Hetemäki, Finnish Forest Research Institute, Finland
- Prof. Rik Leemans, Wageningen University, the Netherlands.
- Prof. Rolf Lidskog, Örebro University, Sweden
- Prof. Sune Linder, SLU, Sweden
- Prof. Pekka Niemelä, University of Joensuu, Finland
- Prof. Maureen G. Reed, University of Saskatchewan, Canada

4.3. Core Team

The leaders of the Component Projects form a Core Team in the program. The main responsibility of the Core Team, together with the Program Management, is to develop and evaluate the forest scenarios in ForSA. The members of the Core Team will bring their collective expertise to the scenario analyses, and will thus be a guarantee for analyzing scenarios that are both scientifically valid and of relevance to the stakeholders. Furthermore, the Core Team will regularly have an active discussion and contribute the scientific knowledge in order for the program to be operational. The Core Team, together with the Center Director, will secure the integration among disciplines in the program.

4.4. Panel of Practitioners

The Panel of Practitioners, which will consist of about 25 persons representing main stakeholder groups, will be the core of the stakeholder participation in Future Forests (see Ch. 3.1 and Ch. 8).

4.5. The Center for Forest Systems Analysis and Synthesis (ForSA)

ForSA will be the cornerstone of Future Forests. It will form a unifying force, a creative and intellectually stimulating environment, where different scientific disciplines will merge to address problem areas in a multi-faceted setting. When fully developed, we foresee that ForSA is a unique institution with an explicit mission to foster synthesis and analysis, turn information into understanding and, through effective collaboration, alter how science and forest management is conducted. We also expect that the understanding gained through ForSA activities will influence people's attitudes and governance at different levels.

ForSA will have a research infrastructure with access to key databases about forests and will develop key analysis tools. It will also host the program management and make up a vital hub in the communication with stakeholders and external actors in general as well as internal communication. In addition to a fundamental base of resources and competences, the composition of the ForSA will be flexible. When analyzing a certain problem area, necessary competences from within ForSA, from the Future Forests´ Component Projects, and external competence will work jointly for shorter or longer time periods. Competence and resources will be well beyond the critical mass needed to attract leading scientists/policy makers, and for performing the tasks expected of ForSA.

A combination of data sources (e.g., National Forest Inventory, remote sensing data, demographic databases, interview data, historical documents and texts) and tools, such as micro-simulation and a close collaboration with the SLU Heureka team, has a great potential to serve as a focal point for integration. Further, ForSA will provide desktop and technical support, maintain a modern technology infrastructure (including online collaboration services for working groups), assist residents and visitors, and assist outreach and communication, incl. the program website.

4.5.1. Organisation of ForSA

ForSA will be run by a Director. The program management has appointed Professor Jon Moen, Umeå University, in that position. His research background is in ecology, with a particular focus on plant-animal interactions and plant community dynamics.

The ForSA will also house the program communicator and the program administration. We will also add expertise on qualitative scenario building through a post doc with Prof Duinker, and expertise on quantitative data bases and tools (e.g., NFI, Heureka, GIS) from within the program to the ForSA. In a few years time, ForSA will also be the home for the program's post docs and sabbatical fellows. Members of the Core team will also have part of their research time connected to ForSA (see section 6.1.2. for details).

One to two post docs will be appointed annually for 6-12 months. The Postdoctoral Associates are expected to conduct scholarly research, to spend the vast majority of their time in residence at ForSA, and to interact with other residents and visitors. Post docs will be recruited via an international search. Priority will be given to projects that contribute to our scenario- or syntheses approaches and to the integration of the program.

Sabbatical Fellows will come to ForSA for a few months to up to a year. ForSA will support approximately two Fellows per year. Fellows may propose a creative mix of Thematic Working Group activities as part of their proposals. They are expected to spend their time at ForSA and interact with other residents and visitors. Important prerequisites when engaging Sabbatical Fellows (as well as post docs) will be their motivation and ability to support integration, aid in bridge-building, and thereby their capacity to promote the interdisciplinary approach of the program. The Fellows will be provided a housing allowance and up to 50% salary support for every month in residence, depending on the arrangements with their home institutions.

4.6. Component Projects

Much of the multidisciplinary research performed in the program will be done in the Component Projects. These research groups will be responsible for producing detailed, high-quality scientific results that can both be incorporated into the scenarios and be directly relevant for our stakeholders. The leader for each group will also be a part of the Core Team to ensure that the competence in each group and the results produced will be available to the program as a whole. Each group will have their own research plan, time plan, list of deliverables, and budget (see Ch. 6 for a detailed plan for each group).

The groups are (with group leader in parentheses):

- Forest management and planning (Urban Nilsson)
- Swedish forestry sector in a global context (not finalized)
- Pests and diseases (Jan Stenlid)
- Soils and Water (Hjalmar Laudon)
- Forestry at the crossroads – global markets and rural development (Erik Westholm)
- Forest use over time: ideas, values and interests (Christer Nordlund)

- Forest governance among public and market actors (Carina Keskitalo)
- Collaboration and conflict in future forests (Camilla Sandström)
- Values and attitudes (Kerstin Westin)
- Biodiversity (Lena Gustafsson)

The Forest management and planning project differs somewhat from the others. The project is already running and it has its own steering group that will work closely with the Board (Fig. 4). Being the largest Component Project it is represented also by Ola Rosvall in the core team. The activities planned under Future Forests will expand and complement the activities that are ongoing (see Ch. 6 for a detailed description).

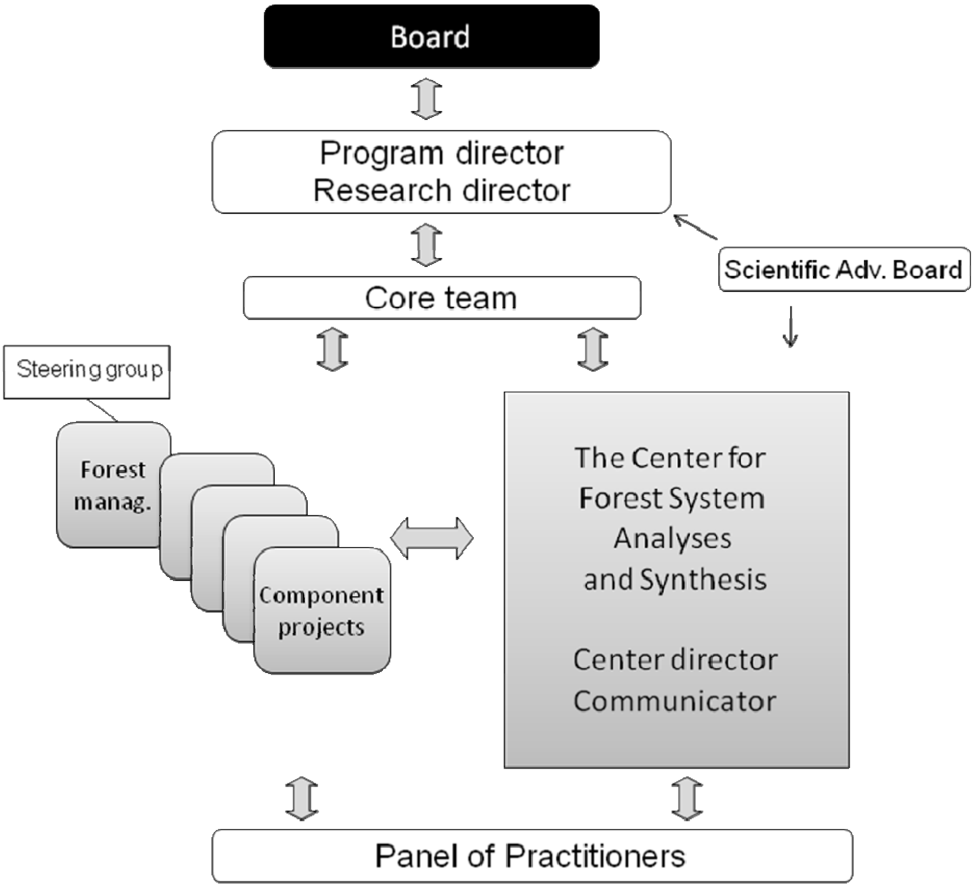

Fig. 4. Schematic overview of the program structure.

5. Skills and networks

5.1 The Consortium

The program builds on formal cooperation among the Swedish University of Agricultural Sciences (SLU), Umeå University (UmU), and the Forestry Research Institute of Sweden (Skogforsk). Individually, the three are leading Swedish academic institutions providing excellent research in the area of natural resources in forest landscapes. The two universities have a more basic research approach, where UmU adds a social-science perspective to the natural-science focused work of SLU, while Skogforsk has a more applied focus in research and development, with close affiliation to practical forest management. Thus the institutions complement each other, and have an established history of cooperation to build on.

5.1.1. UmU

At UmU, research includes theoretical and empirical studies of resource dynamics under uncertainty, climate- and environmental policy, resource conflicts and social change, as well as the effects of governance and awareness-raising mechanisms. UmU researchers are involved in large-scale EU, International Polar Year, and national projects with relevance for forest systems, for instance regarding biofuel, adaptation to climate change and cost-benefit analysis. Both broad and deep interdisciplinary research linkages exist, especially in areas such as resource conflict and governance, valuation and attitude shifts, and resilience theory. Relevant research areas host more than 15 professors, 40 researchers, and over 40 PhD students engaged in environmental and natural resource research. In addition, a larger number of other scholars have methods and interests of relevance to environmental and resource issues.

5.1.2. SLU

SLU is Sweden´s main centre for research and higher education in forestry and natural resource management. Research activities cover fundamental research in e.g. genetics, physiology, ecology, and soil science, as well as problem-oriented research, e.g. forest resource management, forest products, and economics. The academic staff in subjects relating to forests and forestry includes ca. 65 professors and over 200 PhD students, with an annual output of ca. 40 PhD degrees. Researchers in this field are among the university’s most productive in terms of scientific publication and competition for external funding from both national and international sources. Available infrastructure includes a number of state-of-the-art specialist laboratories, as well as a wide range of experimental sites all over Sweden. SLU is responsible for several educational programs at graduate level in e.g. forestry and natural resource management. Collaboration with the forest sector has a strong tradition at SLU and is regarded as a cornerstone for both research and education. SLU is the only Swedish university that acts as a national data host for environmental monitoring and assessment programs, such as the National Forest Inventory (NFI) and the Forest Soil Inventory (MI). Environmental monitoring contributes to the official Swedish statistics about changes in the environment and is the basis for evaluating progress towards the national goals for environmental quality. Researchers at SLU benefit from the easy access to unique sets of long-term data, and a closer integration between research and environmental monitoring is currently being developed.

5.1.3. Skogforsk

The Forestry Institute of Sweden, Skogforsk, plays a unique and vital role in satisfying the forest sector's needs for operational research and efficient dissemination of new knowledge concerning the sustainable management of forests. Skogforsk is supported by the forest sector and the Swedish government through a Framework Program, financed 50% by the Swedish government (via Formas) and 50% by the ca 100 forest sector members of Skogforsk. Overall, the forestry sector finances about 70% and government or other public funds about 30% of Skogforsk's activities. This has direct implications for the way Skogforsk works. The organization is responsive to the demands from the stakeholders of Skogforsk who collectively define Skogforsk's role and the expectations it must meet. Research areas span forest production including tree breeding, silviculture, conservation of nature and the environment, as well as forest operations including wood utilization, logging, logistics and forest bio-energy. Through its research efforts Skogforsk supplies an important public good to the forest sector and the Swedish society. There are two features of the research efforts done by Skogforsk that are of particular relevance to Future Forests. One is tree improvement programs being the most prominent manifestation of the overall public-good functions. The other is the highly skilled and efficient work with dissemination and extension that enables Skogforsk to make a large contribution to the efficiency and sustainability of the Swedish forest sector and hence society as such. The ambitions of the Future Forests Program are fully in line with the vision and goals of Skogforsk, and this research proposal will impact the Skogforsk Framework Program currently being drafted for the period 2009-2012.

5.2. The research team

The program is built upon expertise that spans the breadth of the issues for Future Forests. The research team is committed to working for the aims of Future Forests in an interdisciplinary spirit through both the ForSA activities and the Component Projects. The participation of these researchers secures links to significant national and international research networks.

5.3. International networks

SLU, Umeå University, and Skogforsk will together develop and extend existing contacts with a large number of research organisations within the proposed area of research, of which just a few are mentioned below. Networks will be extended and utilized both within Component Projects and within Thematic Working Groups. The networks cited below will also function as a start for recruiting sabbatical fellows and in some instances postdocs to the ForSA.

- University of California, Dept. of Agricultural and Resource Economics, performing prominent research in economic and policy questions related to natural resources.

- Centre National de la Recherche Scientifique, France. The centre has done major work on demographic modeling.
- Canberra University, Australia. The university has experience of highly sophisticated socioeconomic micro simulation models and databases.
- Colorado Forest Restoration Institute, Warner College of Natural Resources, Colorado State University, Fort Collins, USA. Collaboration within the field of experimental evaluation and synthesis of forest ecosystem biogeochemistry
- Environmental Change Institute at Oxford University, and the Tyndall Centre, both Great Britain. Interdisciplinary units performing research with relevance for adaptation to climate change.
- The European Forest Institute (EFI), Finland. EFI has a number of models of certain interest, EFISCEN for large scale, but also the European level forest analyses and the global trade model EFI-GTM. EFI has seven projects centres of which some performs risk analyses related to e.g. fires in the Mediterranean region.
- Global Observation of Forest Cover – Global Observation of Land Dynamics (GOFC-GOLD), Land cover implementation Team
- European Biodiversity Observation Network (EBONE), a granted EC FP 7 4 years research program, starting April 1, 2008
- Alterra, Holland. The institute is developing the EFISCEN model to a spatial model, EFISCEN-SPACE. The institute also has wide experience in ecosystem modelling.
- IIASA, Austria. The institute has great experience of regional modelling concerning forest resource, trade, and demography.
- University of Natural Resources and Applied Life Sciences, (BOKU) Vienna Austria. BOKU has an outstanding group with expertise in MCA, multi-critera analysis.
- The UK Centre for Ecology and Hydrology shares a concern for the effects of forestry on both water quality and biodiversity at the landscape scale.
- Institut National de la Recherche Agronomique, INRA France. One of the leading European Institutes in Forest Research. Several important collaborative projects are active, including projects in forest health, tree breeding, silviculture etc.
- Forest Nutrition Cooperative, Department of Forestry and Environmental Resources, North Carolina State University Raleigh, USA

Research programs of certain interest:

- The Integrated project in FP6 “Tools for Sustainability Impact Assessment of the Forestry Wood-Chain” (EFORWOOD). The aim is to develop tools for sustainability impact assessment of complete forestry-wood chains i.e. forest – industry – consumer interactions. SLU and Skogforsk are both partners.
- The research program Coastal Landscape Analysis and Modelling Study (CLAMS), USA, carried out by Oregon State University and USDA Forest Service. The aim is to analyse the aggregate ecological, economic, and social consequences of different forest policies in the Oregon region.
- IUFRO Unit on Forest Operations Ecology (Division 3.05) dealing with evaluation of environmental performance, with an emphasis on management of impacts on stands and watersheds in operational forestry.
- The collaborative research project in FP7 NovelTREE in which Skogforsk take part. The objective is to mobilise and integrate scientific research and forest tree genetics resources in Europe to develop genetic tools for forest tree breeding and optimized management of genetic resources for adaptive and productivity-related traits of

interest, and to demonstrate novel/improved methods to breed trees with improved quality and productivity.

- The Coordination action in the FP6 ” European Network on Emerging Diseases and Invasive Species” (FORTHREATS). This action coordinates the work of 23 partners on new and emerging threats to European forests. The focus is primarily on Fungaldiseases and insect pests. SLU is coordinating the action.

5.4. Additional assets

The sustainability of forests and forest landscapes has to be studied through integrated modeling of the biophysical, socioeconomic, and political systems from an historical perspective. It has also to be given a geographical context, e.g., in relation to human populations, or other land-use forms. Described in the following are valuable assets to the program, i.e. databases, tools and infrastructure.

5.4.1. The Astrid database

Demographic data are provided by the ASTRID database, which contains a large subset of available longitudinal, individual register information 1985–2005, including certain information about real estate ownership. The database is a part of a project with the aim of developing a geographical micro-simulation model regarding the population. It contains annual socio-economic data on all residents in Sweden during a 20-year period, including location of residence and work (to 100 m^2).

The database is located in the sheltered environment of Spatial Modeling Centre (SMC) at the department of social and economic geography. The integrity conditions for using ASTRID includes use only in situ within SMC and its closed network. Each user is responsible for not revealing individual data outside the laboratory and not connecting to other sources of individual personal data. The purpose of ASTRID is to enable research giving support (directly or indirectly) to the construction of spatial micro-simulation models of population and labor market developments.

5.4.2. The National Forest Inventory

Forest ecosystem data are provided by the National Forest Inventory (NFI), the Soil Survey, the Swedish Species Information Centre, and other environmental monitoring and assessment programs at SLU. Wall-to-wall forest information on individual holdings and forest landscapes are provided by combinations of field survey (NFI) and remote sensing techniques for the whole of Sweden (kNN Sweden, raster elements 25 m^2) from the SLU Remote Sensing Lab. By the use of digitized land ownership boundaries, it is technically possible to link the actual geographical forest data to the different categories of owners. Thus, the landscape development can be simulated as a function of actions made by a mix of owner categories. The models are also possible to validate by additional remote-sensing analysis of changes in the landscape.

5.4.3. Heureka

Heureka provides both a system and specific tools for integrated analyses of multi-purpose forestry in different geographical scales; stands, forest holdings, landscapes and regions. The core of the system is made up of models for detailed and long-term projections of trees and tree cover development. By including models for ecosystem services and forest products – depicting their relation to the tree cover development – the output of different goods and services can be analyzed using different approaches. Different tools need to be used. Rule-based simulation – answering "what if" questions – are often used in small-scale (stand) as well as in large-scale (region) forest analyses. The forest is supposed to be managed, i.e. thinned, final felled, according to certain schedules depending on, e.g., tree species, and soil fertility. Optimization techniques are typically used for forest-management planning at estate and company levels. At a regional level it provides benchmarks of maximum production potentials given certain restrictions or (theoretical) answers on what happens if all forest owners act like "the economic man". It is also a tool for identifying specific solutions, such as how to achieve a high economic turnover given restrictions based on nature conservation and environmental objectives. A third approach in Heureka is to mimic the actions taken by the forest owner. The activity of forest owners can be modelled given information such as sex, age, residence, and income, and the state of the forest of their holdings. All three approaches are available in Heureka. Methods supporting the decision maker in balancing tradeoffs (multi-criteria decision analyses) are also being implemented.

The models mimicking forest-owner activities elaborated in Heureka have to be viewed as a first attempt. Here the knowledge of micro-simulation/agent-based modeling techniques at UmU and the ASTRID database provides an excellent base for further development and refinement. Combined with the Heureka system, ASTRID provides powerful tools for integrated analyses of the biophysical and socio-economic systems. Applied to a sample of landscapes in a region the approach serves not only as case studies but also provides regional level estimates of forest goods and service production, as well as socio-economic factors, including indicators of sustainability. As the analyses have a geographical context, GIS has a natural role in the analysis and in conveying the results. Time sequences of maps, time graphs, and 3D visualization of forest landscapes are other tools to support analysts and to enable stakeholders to interpret data provided by the analyses.

5.4.4. Field-based research infrastructure

A defining feature of forests is their great extent in space and time. Adaptive capacity for managing forests is built on our understanding of forests. In the task of building this knowledge foundation, the Future Forests consortium will be well-served by its partners' portfolio of long-term experiments, field stations and institutional commitment to these facilities. This research infrastructure turns the daunting spatial and temporal extent of the forest into a resource for achieving the goals of Future Forests because there are extensive records and ongoing studies of how different regions, stands, species, soils and waters respond to combinations of silviculture and climate.

The landscape scale perspective on alternative forest management strategies that Future Forests is seeking is something relatively new for forestry research. To meet this challenge, SLU has recently negotiated with Sveaskog AB to establish a "production park" in the north of Sweden of 2980 hectares where the different aspects of the response of the landscape (forest, biodiversity and water) to innovative silvicultural approaches to achieve a sustainable provision of ecosystem services ("more of everything") can be studied. Also in the south one such "park" is currently in the process of being crated through agreements with Södra. These new parks will be useful arenas for the Future Forests project. The insights that these landscapes will provide for future generations will also be shaped by the vision of the Future Forests project that will help set the research agenda for these new parks.

6. Program integration and Component Projects

6.1. The Center for Forest System Analysis and Synthesis (ForSA) as an arena for integration

ForSA will develop a platform for systems analysis and synthesis that will employ both a driving and an *ad hoc* approach. This platform will be open not only for researchers from within Future Forests, but an active effort will be made to attract leading scientists from around the world. We expect such inputs to be highly significant for the development of the program, and for the successful implementation of the results that come from the research. In particular, we believe that the platform can be the workshop where scientists from different disciplines are encouraged to contribute to real interdisciplinary models.

6.1.1. Scenario Analyses

The main goal for ForSA is to develop skills in scenario analyses and to perform such analyses from a social-ecological systems perspective. To achieve this, several steps will be taken. We will start by analyzing the null model ('zero-generation scenarios') used in the planning of the program, applying climate change and forest utilization (driven by global markets) as drivers (Fig. 5). This gives us four scenarios, ranging from small climate changes and low forest utilization (scenario C; e.g., protected forests today) to large climate changes and high forest utilization (scenario B; e.g., a fertilized high-productive forest in the future). We include intensification of forest use as a driver of uncertainty because conflicting demands on forest use will probably be more common in the future. For instance, an increased intensity of the use of the resource is likely due to a continued interest in wood for timber and pulp, while at the same time increasing bioenergy extraction from the forest can be expected. Such intensification of the use of the forest land will have ramifications for the preservation of biodiversity and the use of the forest for other land users. We realize that the zero-generation scenarios are simplistic, however, they do capture some of what we believe are important forest states. These scenarios will serve as a starting point for building competence on how to analyze such scenarios, and as a pedagogical tool to unite the Future Forests researchers at the start of the period around a common approach.

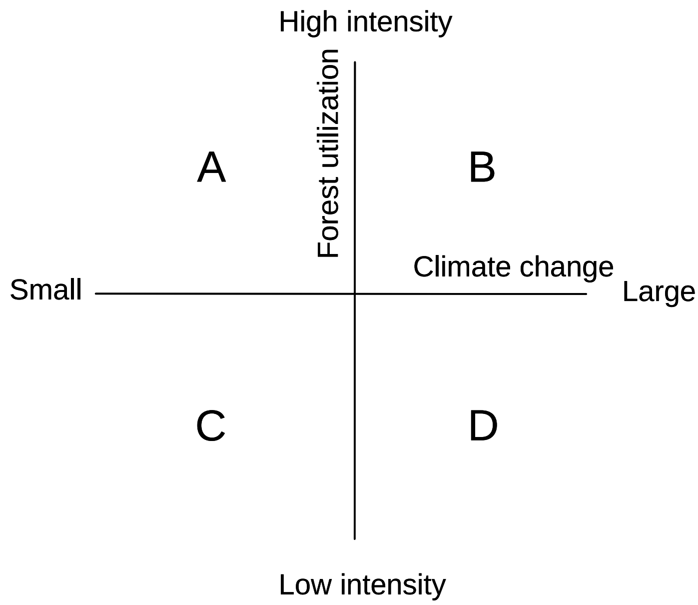

Figure 5. The ‘zero-generation’ scenarios that will be the starting point for the program.

It will be the responsibility of the Core team to critically question and develop these scenarios. We will start by having each research group leader produce a, so called, driving paper. These driving papers focus on suggested strong drivers in both a short and long time perspective, and they will be used as a starting point for discussions within the Core team on refining the scenarios. From these discussions, we will identify the major uncertainties, and develop drivers. We will then characterize each scenario and describe responses of various components in each scenario. We will also invite the panel of practitioners to participate at various stages of the process in order to produce a state-of-the art development in the planning of adaptive forest management strategies. We may also deepen our collaboration with Mistra-SWECIA (SWEdish research program on Climate, Impacts and Adaptation) to further examine the strength of climate change as a driver of future forests in Sweden. We expect that the activities in the Core Team will result in the production of first-generation scenarios at the end of year two in the first program period.

To further strengthen the ability to work with scenarios, we have appointed Prof. Peter Duinker, Dalhouise University, Halifax, Canada to take a lead in the early phase of scenario development within Future Forests. We have started the process to recruit a post-doctoral fellow to initially work in Prof Duinker’s team, and then successively be responsible for the scenario development and analysis within Future Forests.

6.1.2. Thematic Working Groups

Some of the knowledge that we need in order to critically analyze and develop scenarios within Future Forests is currently lacking. To remedy this, ForSA will initiate and run Thematic Working Groups. This means that researchers within Future Forests will collaborate with Postdoctoral Associates, Sabbatical Fellows and other invited world-recognized experts from outside the program, as well as with stakeholders, to analyze and synthesize complex research questions. These research questions can be initiated by the Program Board, the Panel of Practitioners, the program management, or by researchers in the program. The complexity of the research questions will demand that interdisciplinary groups are formed to solve them. These groups will be formed on an ad hoc basis and ultimately engage 5–15 persons who will work intensely in ForSA for repeated visits of a few days to a few weeks during a period of a few months to no longer than two years, depending on the nature of the problem.

Approximately two to five new Working Groups will be supported annually after approval by the Board. If a proposal is approved, the projects will be given a total budget. ForSA will facilitate the meetings by making local arrangements. Support includes reimbursement for actual travel and lodging. Proposals may involve activities with partial support from matching funds or one or more other institutions or agencies. Each approved Working Group will have their own research plan, including a detailed budget, time plan, and deliverables before commencing work.

The Research Director, together with the Center Director, will have a special responsibility for the identification of urgent questions, knowledge gaps, and appropriate issues to analyze in Working Groups. During the first year of the program, one or two Working Groups will be suggested by the Research Director. However, we envision that in a few years time, initiation of Working Groups may instead take the form of open calls. The Center Director will gather and present proposals from the open calls for the board, and the Director will also be responsible for the organization and follow-up of each group.

Examples (from our application) of Thematic Working Groups include Carbon sequestration and forest management, Invasive species, Biopaucity and conservation, Biodiversity and ecosystem services, Swedish forest policy in a comparative perspective, Methods for assessing vulnerability, Domestication of forests, and Effects of an increased use of exotic tree species. However, these should be seen as examples of interdisciplinary questions and not as definitely approved themes.

6.1.3. Integration Projects

It is always a challenge in such a large research program as Future Forests to achieve integration among disciplines. Through the scenario work we have created a structure for integration in the Core Team, and through the Thematic Working Groups we will also include other researchers from both within the program and from the rest of the world. We also see, however, that there is a need to further encourage and increase integration and bridge-building among disciplines in the program. New and exciting research is often developed when the theoretical and empirical basis in one discipline meets research questions in another discipline. Such integration can sometimes have difficulties in finding a departmental home because departments are primarily single-disciplinary. A suitable venue for these projects is thus ForSA, and to give an incentive for developing these projects we will set aside funds for specific Integration Projects.

Integration Projects will address cross-cutting research questions aimed at developing interfaces between the different component groups. Examples of such interfaces are described in Ch. 6 for each Component Project, and include questions such as Public valuation of ecosystem services, Economics of pests and diseases, Conflict management in multi-use forests, and The role of history in constraining forest management. The Integration Projects will often run for a longer time period than the Thematic Working Groups, and be specifically aimed at developing interdisciplinary interfaces between two or more research groups within the program. Each project will have its own research plan, budget, time plan and list of deliverables. The projects will be approved by the program management, and it will be the responsibility of the Director of the Center to organize and follow-up the projects.

During the autumn of 2009, we will initiate a simulation experiment of two model landscapes as the first Integration Project. This experiment will serve as a first attempt of bridge-building in the program, and we anticipate that all or most of the Component Projects will participate in the study. The model landscapes (Strömsjöliden in the north and Christinehof in the south) will be studied from a multiple-use aspect. In the simulation experiment, stand-level forest management strategies will be combined to maximize both wood production and other values (such as biodiversity). These strategies will be compared to business-as-usual strategies using the Heureka system. The results of the simulations will be analyzed with regards to, for instance, exotic tree species, fertilization and leaching to ground water, and responses of pests and pathogens.

6.1.4. Education and seminars

Education and seminars for students, researchers, various stakeholder groups, and the general public will be natural and regular activities in ForSA. In particular, the exceptional scientific expertise in forest-related subjects that will be associated with ForSA will offer excellent opportunities for PhD training to be organized by the two universities.

6.1.5. Time plan

During the first two years of the Program, ForSA will focus on producing the first-generation scenarios (Fig. 6). We will also initiate the work with the Thematic Working Groups and Integration Projects. During year 3-6, a higher proportion of the activities will go to Thematic Working Groups, post docs, and sabbatical fellows. During the last two years of the second program period, we will focus again on the scenario analyses to produce the second-generation scenarios. We will also focus on establishing ForSA as an independent unit with a continued life after the Future Forests program.

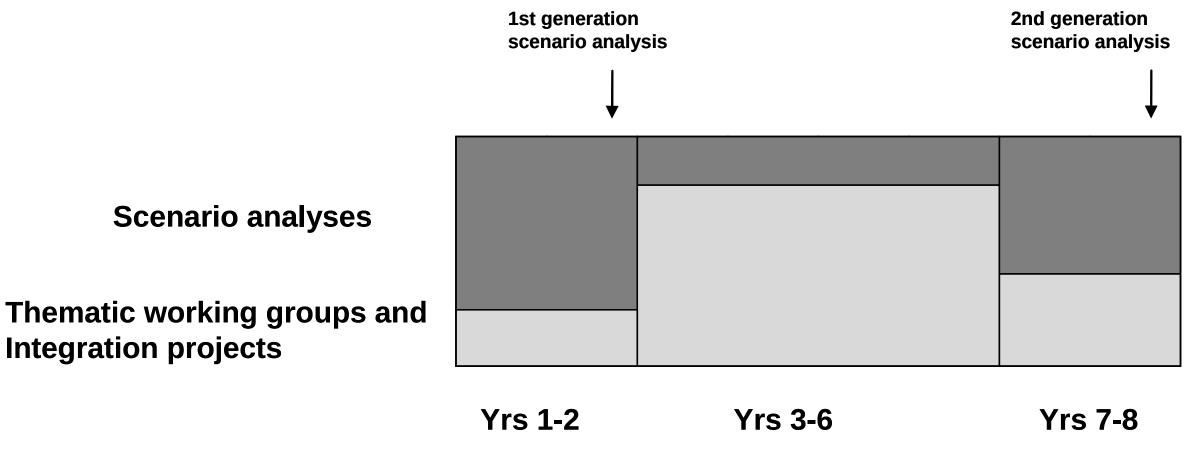

Figure 6. Schematic timeline of ForSA activities.

6.2. Forest management and planning

6.2.1. The significance for the Program as a whole

Future Forests will initially consider climate change and varying intensity of forest land use as external drivers in scenario analyses. In order to do so land use must be defined on the basis of stand- and landscape-level forest management programs. Therefore, an ongoing research program at SLU (Tema Tillväxt, TT, http://tematillvaxt.slu.se/) addressing forest management has for that reason been amalgamated in Future Forests. TT focuses on stand-level forest management programs that have the potential to increase the productivity and the economy of Swedish forestry. In young forest stands, current recommendations for pre-commercial thinning are investigated with respect to spacing after thinning, and the timing of the thinning. Data from old field experiments that have been conducted on several occasions between 1950 and today will be used, as well as data from current field experiments (Pettersson 1992). In mature forests, the thinning programs in Scots pine and Norway spruce of today are compared with data from a series of thinning experiments that were laid out between 1965 and 1980 (Eriksson & Karlsson 1997). Data from this series of experiments are unique, both with respect to the amount of data and to the long series of measurements that were done. Furthermore, stand management of lodgepole pine (*Pinus contorta*) is investigated based on data from several old experiments and compared with data from experiments that have been recently established (Agestam 1990). Silviculture in mixed stands of Norway spruce, Scots pine and birch, and in pure stands of birch, are studied with simulation models (Agestam et al. 2005). The importance of root-rot infection on production and economy of Norway spruce, and methods to decrease its negative effects are investigated (Rönnberg et al; http://www-gran.slu.se/Webbok/PDFdokument/Rötbok%20fullständig%201%2020060626.pdf). Lastly, methods for, and effects of, fertilization in young stands of Norway spruce are investigated; several field experiments have been established in order to investigate operational use of the novel method of intensive fertilization in planted Norway spruce stands that have low, or no, biodiversity value (Bergh 2006; http://www-gran.slu.se/Webbok/PDFdokument/Ungskogsgodsling.pdf).

The additional projects described below will complement TT. Here, questions related to climate change will be given higher priority, i.e., choice of tree species, genetic material, multiple use aspects (in particular the relation between increased production and environmental aspects).

Activities under the umbrella of TT have two general aims. i) Results will be used in order to improve current forest management with respect to biomass production and production of other values, from a land owner perspective. ii) TT will also define forest management programs that will serve as input to scenario analyses, other Component Projects, and Thematic Working Groups within Future Forests.

All forest management methods need to be assessed for sustainability, including their economical, ecological and social consequences. Sustainability is not a well defined concept and will vary due to, e.g., intensity of management and extension in the landscape, and people’s values and attitudes. Furthermore, the adaptive capacity of different management strategies, in relation to climate change and globalization, has to be included in the assessment. Therefore, methods for assessment will be developed and defined in close collaboration with the other Component Projects, and through Thematic Working Groups.

The methods developed will be used for assessment of sustainability, and the findings will be incorporated into various decision-support tools. This should be seen as a new generation of decision-support tools that consider uncertainty and risk about changes in future climate and market. The decision-support tools will be implemented in the Heureka system.

6.2.2. Research issues addressed

Expansion of TT

Choice of seed source with respect to future changing climate
Optimal selection of seed sources and tree species in forest regeneration is of utmost importance for sustainable maintenance and use of the forest ecosystem under climate change (Rosvall et al. 2001). To fulfill user requirements on adaptive management we will involve forest owners, forest managers, as well as forest and environmental authorities in this activity.

Variation in climatic adaptation and adaptability could be further understood by studying internal growth and growth rhythm on the cell level by cytometric methods and cell hardiness by freeze tests in designed seedling, or tree, experiments with diverse seed sources and climates.

One hypothesis is that selected trees that perform best over environment gradients, like spatially different climate sites, are also more adapted to climate change over time. This can be investigated by field-testing species, provenances, and tree progeny in diverse environments by a factorial lay-out sites considering photoperiod (latitude) and temperature (elevation and aspect). In this way the potential gain in selection for adaptability can be predicted.

During the first two years of Future Forests we will develop a model for how to change the target area for use of a given, existing or future, seed source under changing climate conditions. This includes optimal deployment strategies that consider different degree and rate of climate change relative to the rotation age of a seed orchard and a forest stand. We will also consider how to deal with uncertainty about the degree of climate change in terms of when to act as well as the extent of action. During model development, input data will come from existing knowledge and the large dataset on provenance and progeny tests, including hundreds of test sites and millions of trees from the Swedish breeding programs and from the SLU databases. These databases include records of frost injury, damage by pests and diseases, as well as tree growth and quality characteristics.

Continuous-cover forestry
Continuous-cover forestry has been extensively investigated in Europe during the last 20-30 years, and experiences from these studies will form the base to further investigate various aspects when using this silvicultural system (Cedergren 2008). A post doc will be appointed to investigate methods and possibilities to make use of the already present heterogeneity in Swedish forests. Researchers from central Europe will be invited to participate in assessing different aspects of continuous-cover forestry.

The use of continuous-cover forestry has been put forward as an environmentally friendly alternative to the clearfelling system (Larsen 2005). Before continuous-cover forestry can be used extensively, forest managers need to know what production levels that can be expected.

Furthermore, it is necessary to better understand how to convert ordinary forest stands, or how to make use of heterogeneity already present, in order to make a shift to continuous-cover forest management.

A limited amount of data is available about production in continuous-cover stands. Therefore, this project will initially compare growth in the clearfelling system with growth in stands managed without clearcuts. A large experiment that was established during the 1980s will be evaluated, and growth will be compared with modeled growth in planted Scots pine and Norway spruce stands. Furthermore, the possibility for sustainable management of forest stands with various degree of heterogeneity without clearcut will be investigated by analyzing a number of stands and model future development with existing growth models. A literature study will be done in the beginning of the study period and researchers from central Europe will be invited to take part in the simulation experiments. This evaluation of existing literature and Swedish field data will serve as a first decision-support tool for this kind of practices. As described above, existing experiments and stands with various degree of heterogeneity are however limited. Therefore, a large silvicultural system experiment, including continuous cover system and management of mixed species stands will be initiated during the first two years of Future Forests to be completed during coming years.

Fertilization in mature Scots pine stands
Nitrogen enrichment of various ecosystems is a global concern, and therefore, future large-scale forest fertilization must not only be cost effective but also environmentally effective. Fertilization in mature Scots pine stands has been extensively investigated in Sweden during the 1970s and 1980s. Based on data collected at SkogForsk, models of growth increase after fertilization have been developed, but large variation in growth response to fertilization is included in the models. In this context, it has been documented that trees only capture a fraction of the nitrogen added as fertilizer while a major fraction is retained in the soil (Jacobson 2001). Development of forest fertilization practices should focus on this low and variable recovery of added nitrogen in trees. We will, together with Component Project Soils and Water, study the functional background of the distribution of added fertilizer nitrogen in forests. Data from fertilization experiments at both SLU and SkogForsk will be used. Data from new and existing experiments will be used for enlargement and refinement of a pilot version of a growth model for intensive fertilization in young Norway spruce stands (Nilsson & Fahlvik 2005) to include also fertilization in Scots pine stands. Targeting fertilization to forest stands with high growth response to fertilization will give more volume per unit fertilization added, which of course will increase the economical return. However, an additional environmental benefit may also be achieved because less area need to be affected to attain the same increase in growth. The new fertilization practices will be tested in close collaboration with Sveaskog and other forest companies and forest-owner associations.

Exotic tree species
Taking into account a possible climate change, the use of exotic tree species may be considered in the future forests of Sweden. Douglas fir, Sitka spruce, and hybrid and Siberian larch are probably the most interesting tree species for a large-scale introduction in Swedish forestry (Larsson-Stern 2003; Karlsson 2008). Douglas fir and Sitka spruce are two of the most investigated tree species in the world, and they have been introduced into a number of countries. The introduction of Douglas fir in Scotland, Germany, and France will be specifically studied in order to gain experience for a possible large-scale introduction into Sweden. This literature study will be conducted during the first two years. Existing knowledge about management of Douglas fir in Sweden will be summarized and the need for

new knowledge will be identified. It is generally accepted that knowledge about regeneration of Douglas fir in Sweden is lacking, and a regeneration experiment will thus be established at the start of the project. The experiment will be designed to study effects of shelter-trees, site preparation, and protection against damage by the pine weevil. Furthermore, the experience from introduction of lodgepole pine in northern Sweden will be analyzed in order to learn from both wise and not so wise decisions that were made when the first large-scale introduction of an exotic tree species were made in Sweden during the 1970s and 1980s. In the coming years, a possible introduction of Sitka spruce and larch will also be analysed. Risks related to introduction of new pests and diseases with these new tree species will be considered.

6.2.3. Value to users and user groups involved

Several different decision-support tools and new silvicultural recommendations will be developed during the program period. The development of recommendations and decision support will be done in close collaboration with other Component Projects. By having all Component Projects involved in the development of decision- support tools it will be possible not only to take biomass production into account but also to describe effects on, e.g., biodiversity, water quality, and risk for damage.

The decision-support tools aim at assisting forest managers when choosing among forest management treatments in a specific forest stand; the tools may both be in the form of computer programs and printed brochures. Decision-support tools may be a valuable complement to popular research articles and excursions in order to deliver research results to the practical forestry.

6.2.4. Planned scientific and user deliverables

To facilitate dissemination of optimal seed transfer rules, a web-based decision-support system will be developed by 2010 based on the existing "Plantval" system (Choice of Regeneration Material, http://www.skogforsk.se/kunskap/valskog/ValSkog.htm). For a given seed source, the system will inform the user about geographic area for best utilization, i.e., effects of seed source transfer on survival and productivity under various climate change scenarios. The development will put emphasis on user friendliness and visualization of effects in maps and graphs. The system will be freely accessible for forest owners.

Results from the comparison of growth between the clearfelling and continuous-cover systems will be available for publication in scientific journals within two years after the start of the project. Results from this study will thereafter be made available in a more popular form and thus available to forest managers in Sweden. Conversion of heterogenic stands into continuous-cover forests and long-term forest management of these stands will also be available for publication in scientific and popular form within two years of the start of the project.

The existing model for response of mature Scots pine stands to fertilization will be adjusted in such a way that it allows site-specific estimations to be done. The new model will be available to be included in the Heureka system in the autumn of 2010, and available to forest managers by early 2011. Site-specific responses to fertilization will be published in scientific journals before the models are made available for use in practical forestry.

Recommendations for regeneration of Douglas fir in Sweden will be available from literature studies within one year after the project commenced. Results from the field experiments will be used to adjust these recommendations, but data from the field experiments will not be available before year three-four. Results from the regeneration experiments and results from the comparison with introduction of lodgepole pine will be published in scientific journals.

Decision-support tools will be developed when new results are available. For example, choice of genetic material with respect to future climate change is planned to 2012 and decision support tool for site specific fertilization in mature Scots pine is planned to 2011. Several of the decision support tools will be developed in close collaboration with other Component Projects. E.g. the decision support tool in order to decrease the negative effect of root-rot will be developed in collaboration with Pest and diseases.

The following decision-support tools and silvicultural recommendations will be developed later during the program period (2011--):

- Decision support tool in order to decrease the negative effect of root-rot.
- Decision support tool in order to decrease the risk for wind-throw.
- Decision support tool for choice of tree species and provenances with consideration of climate change
- Decision support tool for prioritizing stands for final harvest.
- Decision support tool for choice of regeneration treatments.
- Decision support tool for choice of sites for fertilization in young and mature stands of Scots pine, Norway spruce and lodgepole pine.
- Recommendations for management of mixed species stands.
- Recommendations for thinning in Norway spruce and Scots pine.
- Recommendations for regeneration and management of lodgepole pine, sitka spruce, Douglas fir, Siberian larch, hybrid larch and hybrid aspen.
- Recommendations for restoration of old drainage systems.
- Recommendations for choice of sites for continuous cover forestry
- Recommendations of stand management without clearfelling.

6.2.5. International collaboration

The research will be done in close cooperation with the EU-program Noveltree, METLA and BC Ministry of Forests Research Branch. Professor Lee Allen (Raleigh, NC, USA) will be invited to supervise the fertilization project. Researchers from central Europe will be invited to participate in scenario analyses on continuous cover forestry. The introduction of Douglas fir in Scotland, Germany and France will be studied in close collaboration with researchers in those countries.

6.2.6. Project leaders and participants

Professor Urban Nilsson will be project leader. Furthermore, an additional 20 researchers will be involved in the project (http://tematillvaxt.slu.se).

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6.3. Forestry at the crossroads
- a futures study on global markets and rural development in Sweden

6.3.1. The significance for the Program as a whole

The Future Forest program is focusing the demands on forestry that are generated by a number of changes in the global environment and also in the Swedish society. The first part of the study (year 1-4) will concentrate on a synthesis of the “big picture” of trends in global forestry. It aims at capturing 1) main drivers for change and 2) the primary adaption strategies that are implemented at various political levels and by market actors in various regions and segments of the forestry. In a second phase (year 5-8) these changes in global forestry will be linked to the future of rural Sweden. In this second phase, forestry and other land use activities such as agricultural production and bio energy supplies will be investigated in a common framework.

The drivers for change in forestry will be examined in an effort to broadly capture the spectrum of changes that may have important implications for the Swedish forest sector: demographic transition and economic growth, climate change, energy issues, land use competition, and society value changes. This part of the study assumes that a critical demand growth on forest products will take place during the coming decades.

The analysis of adaption strategies to these changes will be more precise and concentrate on climate change as a driver and on responses/strategies related to increased intensity in forestry. These may be institutional changes as well as changing practices like de-forestation, increased/decreased use of land for forest production, intensified management, exchange of natural forests for forest plantations, etc. This second part of the study will be based on the presumption that climate change and climate politics will become highly influential on global forestry. Political strategies in relation to climate change can follow various paths from conservation measures, sequestration and storage practices or substitution practices, in which there is an increased use of forest products replacing fossil fuels etc. Changing nature conservation policies, demands on biodiversity and efforts to increase resilience will be equally important to investigate. Market strategies may be directed towards increasing production on the supply side and securing the access to forest products on the demand side.

The project is an effort to synthesize from the wealth of existing knowledge which is scattered in the world of literature on global trends in forestry. It is based on literature and on communication within the broad field of global forestry research. The study must succeed to present the principal drivers and strategies in an analytically informed way and also provide examples, cases, from various regions and markets. It is a futures study insofar that it aims at increasing the understanding of possible forest futures on various time scales.

The project can be seen as a general and necessary input for the program as a whole. It will require a continuing exchange of information with both the other research projects in the program and with the various user groups and stakeholders.

6.3.2. Research issues addressed

A critical demand growth?
In April 2007 the Swedish Environment Advisory Council (SEAC) (Miljövårdsberedningen) finalized a study on issues of long term environmental concern. The study is based on a penetration of existing forecasts for population growth and economic growth in the world up to 2050. The SEAC studied how the expected growth would affect the demand for biological resources such as food, bio energy and forest products. The study foresees growth in the global economy of three to four times and a dramatically increased competition over land resources and fresh water on a global scale.

This is a picture that departs sharply from the understanding of the situation that has dominated in Europe and in Sweden. The rural policies of the EU (for instance in 2006/144/EC) are mainly based on a worry for the weak competitiveness of farming in Europe as a result of falling prices on agricultural products on the world market and the liberalisation of food trade that may follow from the WTO negotiations. Abandonment of land and less intensive production is expected rather than an increased pressure on land resources (Scenar 2020; European Commission, 2007).

Taken together, the SEAC and the Scenar 2000 highlight the formative character of the discussion on the future of biological resources. Depending on the chosen time scale and geographical level they provide radically different pictures of the resource demand in the future, globally as well as in Europe and in Sweden. The SEAC results suggest a paradigmatic shift towards a critical demand growth of biological resources. The scenario indicates that there will be a competition not only over biological resources in general but also between various ways of land use; between forestry and food, forestry and bio energy, water resources etc. Also, the relation between forest production and nature conservation, biodiversity and resilience will be an issue.

The global forest industry provides already pregnant examples of an increasing competition for biological resources, in many ways similar to the demand for minerals that took off in the beginning of the 2000´s. In many parts of the world illegal de-forestation in favor of increasing intensive farming is a major problem. Tropical areas of Africa and South America experience a declining forest production. In total, deforestation is estimated to explain 20 % of the increased CO2 emissions (CEAC 2007). Europe, Russia and China have successfully increased production by re-planting of lumbered areas, conservation measures and increased land used for forestry. Countries with scarce land resources for forest production are buying land in northern Africa to secure a future demand etc.

Climate change and forestry

Besides the expected critical demand growth, the climate change scenarios as presented by the IPCC indicate further disturbances on forestry production and also changing policies in relation to forestry. Forests constitute both a sink and a source of atmospheric CO_2. Forests absorb carbon through photosynthesis, but emit carbon through decomposition and when trees are burned due to either anthropogenic or natural causes. The management of forests in order to retain and increase their stored carbon may be important to reduce the rate of increase in atmospheric CO_2 and stabilize atmospheric concentrations. The IPCC have estimated a considerable potential for mitigation through improved management of forest lands for carbon conservation, storage, and substitution, in balance with other objectives (SAR II, Chapter 24, Management of Forests for Mitigation of Greenhouse Gas Emissions). Still, the uncertainties on the extent to which forestry can actually mitigate climate change are the concern of various interpretations and estimations.

The ICCP have also produced scenarios for the climate change process indicating that the possibilities for forest production may undergo substantial changes in various parts of the world due to changing temperatures, hydro conditions, storms, etc.

One of the strategies concerning forestry and climate change has been the establishment of market based reduction schemes. In the Kyoto Protocol, forestry activities such as afforestation, reforestation and deforestation are included, but are still limited in importance within carbon accounting. The main focus of most climate change schemes has been on market based solutions such as trade in reduction credits, so called baseline- and credits systems (Westholm, L 2008). Still, the difficulties seems to have overshadowed the potential in the greatest regulated based scheme; the Clean Development Mechanism (CDM). The voluntary market for emission reduction credits (VER) has been more successful but is still a very limited market which has certain credibility problems: problems to define a baseline scenario, asymmetric information (the buyer knows little about the climate effect), permanence (for how long will the forest sequester carbon), additionally (would this forest have been managed the same way without this effort?), leakage etc. It is an open question to what extent these policies for carbon sequestration will develop and affect forestry over a longer period.

Is critical demand growth the most probable future?
Obviously, the picture of land use in the future is different depending on the chosen time scale and geographical scale. In the short and medium term land abandonment of at least arable land seems to be a reality in Sweden, and in the rest of Europe. In a longer perspective and on a global scale, the problem appears to be a lack of land resources. The global economy is expected to grow three to four times during the next 50 years (SEAC 2007:1, Malmberg 2007).

Growth of GDP and population trends throughout the world means that increases in the demand for food, bio energy and forests products are inevitable. The expected economic growth can only take place with a successful de-coupling of income growth from resource use. Even if today's production and consumption patterns are radically transformed, the effects of climate change and increased population will cause considerable strain on biological resources. The background report to the SEAC study also contains a thorough discussion on possible effects on the eco-systems, resilience and biodiversity (Background report to the SEAC Memorandum 2007:1).

Even if reduction of losses and improvements in agricultural and water productivity are accounted for, meeting the future food demand will most likely require an additional new cropland of 20 to 45% (Lundqvist et al. 2007). Production of biomass for energy and expansion of commercial non-food production is likely to affect food production considerably. If everyone were to have the same living standards as the industrial countries using bio energy from plantations as their energy source it is estimated that a total of 10 billions of hectares would be required. The earth's total land area amounts to 13 billions of hectares and the total amount of arable land in the world is about 1, 5 billions of hectares (Azar & Berndes 2007). For industrial round wood, Hedenius and Johansson (2007) estimate a 100% demand increase in the next 50 years with expected continuing increase in the recycling of paper. The last 50 years have seen a doubling of the demand for forest products and the last ten years a further increase in demand growth is expected.

Demographic research progress - the basis for resource growth estimations
One possible objection against the SEAC picture is that the scarcity of resources has been predicted before with no success. The most well-known forecast in this direction is the Rome Club which Limits to Growth (1972) produced a modeling of the consequences of a rapidly growing world population and finite resource supplies. The model goes back to ideas of Malthus who already 1798 introduced the theory that increased population would create a food demand crisis (Malthus 1798).

The basis for the SEAC report though, is the developments of demographic research during the last decades. The use of demographics for forecasting is empowered by exploring the links between socio-economic age dependent variables and the actual age structure in the past. According to the UN (1998), five phases of age transition can be identified on a global scale. On the basis of the correlation between these phases and economic growth, forecasts of economic growth have been made for all parts of the world (Lindh & Malmberg 2004).

The demographic structure has proved to be a powerful tool for forecasting the future also in more specific contexts. The key factor to open this field has been the recognition of the age structure as a determinant of a number of socio-economic indicators. While an increasing share of the population being adults in working ages increases the productive capacity, a rising number of children and senior citizens expose the economy to economic stress. Going into details, every cohort has its own patterns of production and consumption and these patterns are in a general sense fairly stable and similar over time and also in various economies. Even if there are variations in the age of starting school, entering the labour market, moving away from home or retiring from work, over time and from one society to the other, a fundamental stability in the life cycle pattern remains (Malmberg & Sommestad 2000). Also the UN climate panel IPCC explores these kinds of projections and come to a similar result. The demographic change in the s o called BRICS-countries (Brazil, Russia, India and China and South Africa is expected to drive the economic growth on a global scale.

Drivers and strategies - case studies from regions in the world
In the first part of this project these general long term outlooks, based on expected climate change and demand growth on forest products must be further investigated. The long term scenarios must be related to more specific contexts and a shorter time perspective in which drivers and strategies are investigated. Thus, the study should proceed from the SEAC overview and the IPCC scenarios into details of different regions of the world. The study is operating over the two fields of a) main drivers for changes affecting forestry and b) adaption strategies in politics and markets. The study will be presented as cases from various regions of the world, covering a variety of forest environments as well as political, economic and demographic environments. Special attention will be paid to the forest producers and the main markets for forest products.

The importance of Swedish forestry for rural development
In the second part of the Future Forest project, carried out during the years 5-8, the study on global trends would be related to the situation in rural Sweden. The “rural discourse” since long dominating policies and planning in Sweden is based on a view on the primary sectors and the agrarian society as something pre-industrial, a past history. The scenario given by the SEAC points at a transformation of land use driven by price increases on productive land and a competition between both users of land and uses of land. The sparse population, which today is mainly a disadvantage with expensive infrastructures and weak labor markets could become a major national asset with many hectares per capita. The new situation, with a growing global demand for biological products, would bring issues of productive capacity, biodiversity and resilience to the top of the political agenda.

The communities in rural Sweden could find themselves in a basically new situation and scenario works on various outcomes would facilitate for all actors to take on a long term perspective. The land use situation in Sweden is different from the situation in many other parts of Europe in a few fundamental ways. Forestry is deeply rooted and institutionalized. Farmers are normally also producers of forest products and all land is seen as productive space. The exchange of land from food production to forest production or bio energy has occurred for many decades. The forestry has long traditions of operating on a world market and Swedish forest companies are producing and trading worldwide since many decades. Yet, in rural Sweden, the land resource is still to 50% privately owned and often in the hands of farmers living on the land. These structural conditions explain the vitality of Swedish forestry which has succeeded to operate in global competition, yet embedded in the local communities.

A futures study on the effects of the changing global environment on rural Sweden seems to be an urgent way of renewing the rural research agenda. This is something that the national rural research strategy, adopted by Formas and the Rural Development Committee during 2006 calls for (SOU 2006:104).

The aim of the study and the procedure
The aim of this research based futures study is to further investigate early warnings on critical demand growth on forest products and the adaption strategies among major global actors (year 1-4). During a second phase (year 5-8) these results shall be used as the basis for a futures study on rural Sweden.

1. World Forest Futures (year 1-4). A study on drivers for changing structures on a global scale; tracing key activities in the global markets for forest products. This study should proceed from the SEAC overview and the IPCC scenarios into details of different regions of the world. The study is operating over the two fields of, a) main drivers for changes affecting forestry, and b) adaption strategies in politics and markets. The study is based on the concept of early warnings in which a trend shift can be traced and discovered by a search for changing values and behaviour of key actors in various geographical scales that are linked together. Special attention will be given to production and consumption patterns of the BRICS countries in general.

The projects must rely on secondary sources, mainly a literature study combined with conference participation and interviews with leading figures at research institutes, university departments and organisations such as World Bank and FAO. Among research organisations are the IIASA, which has been researching forest futures on a global scale since decades and also School for Resource and Environmental Studies Dalhhousie University in Halifax Canada, where Professor Peter Duinker provides a link to the Future Forest program.

The first year of this project is a planning and preparation phase; literature work in order to make a general overiview of the situation and selecting and planning the various cases as well as establishing the research contacts that each case will need. Year 2-3 are used for the various case studies and year 4 is mainly spent on the synthesis. The outcome of the study should be a book “World Forest Futures” and a number of popular articles in Swedish press and magazines.

2. Forestry and Rural Sweden (year 5-8). This study should provide a comprehensive work on linking the global trends to the future of rural Sweden. The aim is to develop Swedish rural research towards a higher recognition of global drivers for change by using the Word Forest Futures project as a basis for scenarios, linking the local to the global and to re-connect the natural resources to the future of rural communities in general. This study will further investigate actions taken in all parts of the Swedish forestry to prepare for long term demand increase. Interviews will be carried out with main stakeholders in the industry, representatives for the small scale private landowners and producers of forest products. Also, the approach to the sector within the public sector will be analyzed in search for adaption strategies from the state in order to promote the sector to be competitive or to restrict its activity to protect interests of conservation or biodiversity etc that may be threatened. Conflicting interests will be scrutinized, also in trealtion to other land use activities such as agricultural production and bio energy supplies will be investigated in a common framework. The study will be planned more in detail when the global trends study has proceeded for 2-3 years.

6.3.3. Value to users and user groups involved

The project should interact with the forest community and rural interests in Sweden throughout the study.

6.3.4. Planned scientific and user deliverables

The results will be published in Swedish and in English. In Swedish it should be a book of interest to the Swedish rural community, actors in the Swedish forestry and forest industry, as well as politics and planning. The English publication should focus on the parts of the study concerned with the global futures supply and demand of forest products and address a broad audience both within forestry and rural development and a broader international readership.

6.3.5. International collaboration

See above (6.3.2).

6.3.6. Project leaders and participants

The project will be carried out by professor and research director Erik Westholm and a post doc research assistant at the Institute for Futures Studies, Stockholm as an integrated part of the MISTRA-program Future Forests.

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6.4. Swedish forestry sector in a global context

Forecasts of future supply and demand for wood and wood products are essential parts of the planning and decision making in the forestry sector, and thus for Future Forests. This Component Project aims at contributing to this. The project is closely associated with the project Forestry at the Crossroads (see Ch. 6.3.) and the initiative to develop long-term scenarios (see Ch. 2.5. and 6.1.1.). The present project differs from these, however, by focusing on international trade and policy issues, and makes predictions for a shorter time period (5-10 years).

Assessing and analyzing the status, trends and outlook for forestry is an integrated part of Future Forests. This project will describe recent trends in forest products markets in Sweden and Europe and highlight some of the main features of these trends. It will also present a more qualitative analysis of the trends and projections and discuss their implications for the forestry sector in Sweden. Tentatively, the project will present an outlook study by the end of 2010 that puts the Swedish forestry sector into an international perspective.

Outlook studies highlight trends in the sector and identify emerging opportunities and challenges. Drawing on the inputs from various initiatives, they examine the impact of key internal and external forces acting on the sector. By taking into account economic, social, institutional and technological changes, outlook studies support policy reviews and strategic planning, and depict the range of choices available to forestry policy makers.

This project will interact closely with the group that develops the scenarios. Because the scenario development and the outlook study have different time perspectives they must operate partly in parallel. The synergetic gains however, are obvious. The outlook study will benefit from including understanding of a qualitative nature that has been achieved in the scenario analyses; the quantitative models that traditionally have dominated outlook studies can thus be given an additional dimension. The scenario development will similarly benefit from the association with the outlook work because it will make possible quantitative predictions in the scenario development which is largely qualitative.

This project will also have close collaboration with the project Forestry at the Crossroads. While the present project deals mainly with economic outlooks for the sector, Forestry at the Crossroads will investigate the main drivers and strategies for a changing global forestry and the possible impact they may have on the rural areas in Sweden. The outlook study will benefit from the Forestry at the Crossroads' project in that it will provide essential information on the specifics of the future Swedish rural landscape.

The project organization will to be further discussed. It should be emphasized that economic outlooks need to be well integrated in Future Forests. The general structure of the project, as outlined above, has been discussed with Peter Duinker, Erik Westholm and Runar Brännlund. In addition, we have seriously considered ways to link Future Forests to international organizations. Specifically, during a visit to the Forestry Department at FAO in Rome we discussed the interesting possibility to formally establish collaboration with FAO. This and other issues concerning research agenda, organizational structure, and appointment of PI will be worked out during the next six months.

6.5. Collaboration and conflict in future forests
- exploring the impacts of intensified production in a changing climate

6.5.1. The significance for the Program as a whole

Conflicts over natural resources have always played a significant role in societies worldwide. Recent conditions have however led to a boost in their strength, public profile and complexity. The Swedish forest sector, characterized by its many stakeholders with diverging or conflicting interests, is not an exception to this situation. The conflict between production and biodiversity conservation is central (Sundström 2005), but the complex, fragmented and unclear property rights structure in Sweden further complicates the relationship between different stakeholders (Sandström et.al. 2008; Sandström & Widmark, 2007). Due to more intensively used forests and climate change in combination with increasing demands on the forest resources from a number of stakeholders we foresee new conflicts arising in the future. Policies and in particular forest policies have however paid relatively little attention to these conflicts and how they can be managed. It is thus increasingly important to sort out new methods and institutions adapted to future challenges to manage these conflicts and resolve them productively in the interest of short term economic and long-term sustainability goals.

Conflicts of natural resources can take place vertically on different levels, from local to global, but also horizontally cut across these levels. The intensity of conflicts may also vary from frustration to conflicts involving violent behaviour. They may however also vary due to context, e.g. different parts of a country, and how many actors that are involved in the use of the forests. These different conflict situations may be categorised in terms of whether they occur at the micro-micro or the micro-macro-levels (Grimble & Wellard 1997).

Table 1. Examples of conflict situations with varying degree of complexity.

	Few interests	Multiple interest
Small-scale (micro)	Conflict situation I	Conflict situation II
Large-scale (makro)	Conflict situation III	Conflict situation IV

- The first conflict situation (I) takes place on a micro level and involves few conflicting interests. A typical example of such a situation is a conflict about biodiversity protection on privately owned forest.
- In the second conflict situation (II), the number of conflicting interests is increased but the conflict is still on a micro level. The conflict could e.g. be between recreation, biodiversity and forest production in urban forests.
- When we move from the micro to macro level the conflicts concern not only a single stand but a whole landscape. The situations will here be complicated by a more fragmented property-right structure. Examples of conflicts could be between forestry and reindeer husbandry or between forestry and recreational fishing (conflict situation III).
- When multiple interests are included at the macro level (conflict situation IV) the conflict situations are often very complicated but on the other hand there are also many possibilities for collaboration. Examples of such complex situations are when

there are several ongoing and related conflicts involving for example forestry, biodiversity protection, energy production (biomass and wind mills) as well as recreational interest.

To be able to handle the varying degree of complex conflict situations an important initial step is to identify how a future situation with e.g. intensified forestry in combination with change in climate will affect the occurrence, but also the variation of conflicts and the possibilities to handle these conflicts.

Furthermore, the Swedish forest policy is characterized by the concept of freedom-within-frames in combination with steering through environmental objectives why planning processes and decision making is increasingly influenced by the users or forest stakeholders. There is thus a need to develop governance e.g. participatory planning methods that may facilitate cooperation instead of conflict. One problem with conflict and participatory methods is that experts are too dominant in such processes or that the public is not given fully insights. For the forest managers the outcome from the process is often too broad to be useful in their ordinary planning routines. Methods that may handle a variety of conflicts and involve stakeholders efficiently to handle future forest conflicts is thus necessary. In the Future Forests project we will combine meta-analysis of existing literature on natural resource conflicts and conflict management and expert and stakeholder analysis of current and future forest related conflicts.

The development of this conflict management will be linked to several of the other sub-projects. We foresee collaboration with the Component Project Forest use over time (Ch. 6.10), as well as with Values and attitudes (Ch. 6.11). on the mapping of present values related to the forest sector. The project will also benefit from cooperation with Forest governance among public and market actors (Ch. 6.6) to identify correspondence and conflicts between existing legislative and political governance mechanisms.

To be able to identify conflicts between actors or specific interest with relevance for the forest we need collaboration with the Component Projects Forest Management and Planning, Biodiversity, and Soils and Water. Knowledge developed in this project will support the development of scenarios in ForSA with regard to future forests related conflicts between users of the forest.

6.5.2. Research issues addressed

The overarching aim is to offer answers to questions about the role of conflicts in sustainable forest management. More specifically we will answer the following questions:

- How will intensified forest production affect the use of forest resources among different stakeholders?
- To what extent will intensified forest production contribute to conflicts in the forested landscapes?
- To what degree will climate change amplify/reduce these conflicts?
- What kind of conflict management methods is suitable to solve these conflicts and how can these methods be implemented in established management arenas in the forested landscape?

Many authors claim that the problem of collective action is the most fundamental problem (Ostrom 1998; Taylor 1996) and that many other forms of social dilemmas (e.g environmental degradation) are generated through failures of addressing, collective action problems on various levels (North 2005; Ostrom 2005; Rothstein 2005; Sandler 2004). Lack of collective action and thus the emergence of conflicts, i.e. "fundamental and underlying incompatibilities that divide parties" (Putnam & Wondolleck 2003:37), should however not automatically be regarded as a problem. Conflicts might instead be constructive and work as catalysts for social change, if they bring to the fore, important political concerns, and encourage innovative planning, adaptive capacity building and problem-solving (Deloges & Gauthier 1997; Hellström 2001; Jensen 2002). Extreme conflicts may however create vulnerability and uncontrollable changes in a society. The establishment of successful governance mechanisms that may ensure collective action is thus a fundamental part of the performance of democratic societies (Ostrom 2005; Kyllönen et al. 2006; Raitio 2008).This includes e.g. the development of institutional arrangements that are inclusive of different stakeholder interests as well as adequate methods to help the actors value and chose among different policy alternatives. As such, governance mechanism that includes successful conflict management also serves as an important indicator of the adaptive capacity of, in this case the forest sector.

Conflicts often derive from the demographic change, natural resource competitions, development pressure and structural injustices. A promising conflict management tool to analyse and structure these conflicts is Multiple Criteria Decision Analysis (MCDA). MCDA refers both to a set of mathematical techniques that can be used in decision making situations to evaluate different alternatives with respect to a range of conflicting interests but also to the whole process of structuring and solving multiple criteria problems, see figure 7 (Belton & Stewart 2002).

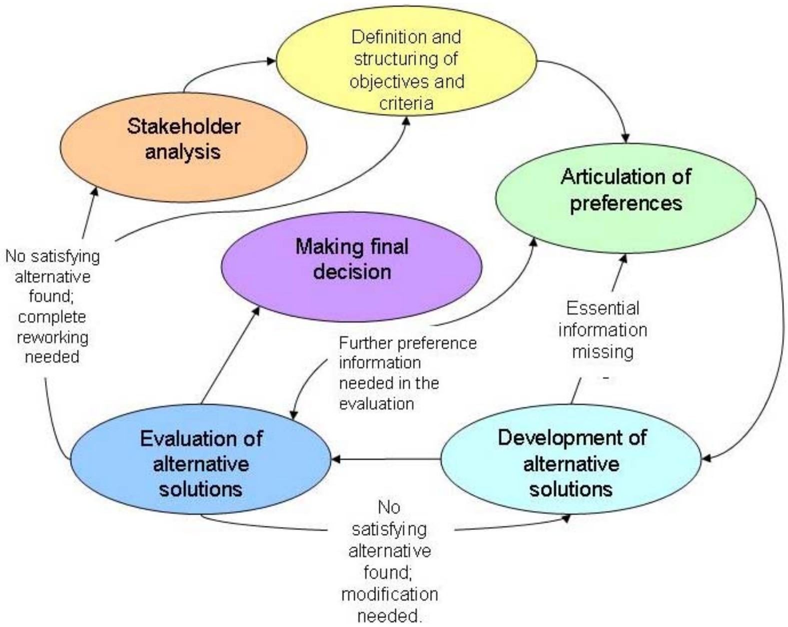

Figure 7. A schematic description of the MCDA process

The principal benefit of MCDA, compared to other conflict management tools, is that it facilitate collaborative learning about and understanding of the conflict, about their own and others values and objectives and through exploring these in the context of the problem, guide them in identifying a preferred course of future action in the forest planning context (Daniels & Walkers 1999).

In this project we will make an extensive analysis of current and potential future forest-related conflicts and conflicts management. This work will be divided into three phases:

Phase 1. Providing input to scenario analysis (year 1-2)

- In depth analysis of the interaction of drivers and different interests linked to the forest sector to develop an understanding of why and how conflicts (past and present) arise in the forest sector under different scenarios, what the common factors of these conflicts are and how the different conflicts affect the interest of involved stakeholders.
- Expert assessment (FF researchers) of current and future conflicts to identify and evaluate drivers of particular importance to conflicts with intensified forest production in a changing climate.
- User assessment (FF Panels of practitioners) to identify drivers of particular importance to future forest conflicts and analyse a number of different management plans, developed with the Heureka system, using MCDA techniques. The objective with this is to provide a structured collaborative process for combining multidisciplinary expert evaluations with stakeholder input and develop preliminary versions of conflict management methods to be assessed and evaluated in phase two and three of the program.

Phase 2. Conflict management in forested landscapes (year 3-4)

- Refined version of a set of conflict management methods developed and tested under phase 1 will be tested in conflict situations at a landscape level. The object here is to investigate in detail how conflict management could be performed in different scenarios (A-D) and different conflict situations (see table 1), to increase the awareness of how drivers interact in Future Forests scenarios..
- Evaluation of experienced conflicts management methods and participatory planning processes in work-shops with stakeholders. An expected outcome of the workshops is an application of MCDA processes in combination with proposals on how conflicts among different stakeholders might be solved and thus to what extent their adaptive capacity might increase.

Phase 3. Governing future forests (Year 4-8)

- During phase three we will link the outcome of year 1-4 to available governance mechanisms (Model Forests, Biosphere Reserves, Ecoparks, voluntary protection etc.) to reveal if and when they are successful in handling conflicts and to what extent such mechanisms can work as a supplement to the traditional planning processes in a future characterised by climate change as well as a more intensively managed forests.
- The available arena concepts and MCDA techniques (e.g. voting procedures, AHP) will be categorised according to their adaptive capacity to manage the conflict situations. To what extent is the need to mange conflicts recognized, what is the actual willingness to undertake conflict management, what are the available resources and constraints for implementation of conflict management?
- The quality of the developed conflict management methods during phase 1-2 will, in terms of the usefulness and their possibility to produce a relevant outcome to the stakeholders involved be assured trough the testing of the methods in real situations and in established arenas.

6.5.3. Value to users and user groups involved

The project will result in a better understanding of the nature of forest conflicts, offer methods for conflict management that could be used to prevent conflicts to escalate and finally contribute to the enrichment of the existing body of knowledge on governance and multi criteria decision analysis.

The collaborative learning approach used in this project take its departure in concrete societal problem situations, and refers to a quality of research processes in regard to the integration of practice and interplay of natural and social scientific research activities, with the goal to generate new knowledge. Conventional processes of disciplinary evaluation and quality assurance will thus be complemented with research processes where experts from the involved disciplines Future Forests and from the realm of practice (including the Panel of Practitioners) that will be involved to treat the defined research issues. As such the users will thus play an important part in the project by defining important drivers, articulate preferences, evaluate different alternative solutions and finally give recommendations on how mechanism to solve conflicts. Users groups and interests are identified in the actual landscape that is studied. The number of groups may thus vary depending on where the actual landscape is situated and degree of abstraction. The value to users will thus be direct and the results will be applicable in real life situations.

6.5.4. Planned scientific and user deliverables

The project foresees several papers in international peer-reviewed journals, co-authored both within the sub-project and within the centre, as well as popular science reports and popular science papers in cooperation with the communication strategy of the program. The project will contribute to an improved understanding of the role of conflicts and conflict management to the sustainable use of forests, which will feed into the scenario analysis. Additionally the project will provide knowledge of the opportunities and scope for action and recommendations on conflicts management methods that can be used by the forest sector, environmental authorities and other forest related stakeholders to manage conflicts successfully.

6.5.5. International collaboration

The project will benefit from cooperation with forest research at Joensuu university, Finland in particular on issues of legitimacy of the forest sector and management of wildlife in relation to forestry. Project synergies on aspects of biodiversity and hunting will be developed with in particular the Macaulay Institute, Scotland but also other research centres in other parts of Europe and Africa under the EU FP7 program “HUNTing for Biodiversity”. On governance issues and climate change the project will benefit from existing research network with in particular the Saskatchewan Research Institute in Saskatoon, Canada.

6.5.6. Project leaders and participants

The work will during the first two year be divided between Camilla Sandström and Karin Öhman. During year 3 and 4 extra competence is need in MCDA and participatory planning

As a result the group will during year 3 and 4 be increased with Eva Maria Nordström Cost for travels, interview studies, publications costs as well as the cost for several collaborative work shops are to be covered.

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6.6. Forest governance among public and market actors

6.6.1. The significance for the Program as a whole

Adaptation to climate change and globalization are crucial aims in the Future Forests research program. This project views governance –decision-making by public and private actors (mainly the EU, states, NGOs, and companies) on forest use – as largely a result of the way economic and political globalization is changing the decision-making landscape. EU directives such as the Water Directive, private regulation systems such as the forest certification system and an increasingly globalised wood product market are here changing the possibilities for a single state and interests in it to govern national forest use. Climate change will here constitute an additional stressor on decision-making systems. As climate change adaptation and mitigation requires large steering capacities in terms of well-organized and strong decision-making, climate change constitutes a crucial test for governance systems. The fragmentation of decision-making in terms of super national (EU) decision-making and numerous private bodies and NGOs means that adaptation and mitigation to climate change may be piecemeal and impeded by the increasingly limited decision-making capacities of the state and the quick changes in market demands on forest products. Conflicting aims for biodiversity preservation in different regulation, for production and for the trade-off between different stakeholders, as well as different ownership and user rights are ultimately given their expression in regulation and governance, where the legal framework sets a limit for utilization.

Given changes in intensity of forest use – often due to globalizing pressures – and climate change, the existing system will need to embody a large capacity to adapt to change (both globalization and climate change). As a result, the governance network to a large extent has an influence on all four areas of the quadrant, both situations of low and high intensity and combinations with low and high climate change. The requirements for adaptation and the demands on the systems will be much higher given situations of high intensity.

6.6.2. Research issues addressed

- What are the existing legislative and political governance mechanisms with relevance for forests, and what are the correspondences and conflicts between these mechanisms? (Year 1 - 2)
- How would requirements for “more of everything” impact this system? (Year 2 - 4)
- How could existing institutions deal with risks specifically to forest systems, such as forest pests and storms? (Year 5-8)

To take an overarching perspective on the governance system – understood as the public and private decision-making system, including both state and market characteristics – that impact forestry, and the points at which this system is well or badly functioning is a crucial aim (Walker et al. 2002). Work by Ostrom (e.g., 2005) and Berkes (e.g., 2003) on co-management, by Young (e.g., 2002) on the fit and interplay of governance systems, and Smit on local community vulnerability (e.g., Smit & Wandel 2006) attempt to take in diverse levels and sectors, such as multi-use conflicts, but seldom embrace the full multi-level context from international to local level. To answer the first two research questions above, the project will undertake four steps. These are:

1. A system description (Walker et al. 2002): a literature survey of the existing legislation and policy with relevance to forest use with respect to the international level (UN Forum on Forests, ILO Convention No. 169, Biodiversity Convention, and others), EU level (Forest Action Plans/Forest Strategy, Natura 2000 biodiversity conservation network, Water Directive, and others), and national legislation and policy (forest, biodiversity, and reindeer husbandry legislation, among others). The study will also include a clarification of the role of different levels within the national system (such as the power of local municipalities to develop land use planning) and an identification of the institutions – understood as

the norms encased in legislation and with particular actors – that are determining for forest use in international and national cases. This inclusive focus on the forest-relevant policy and legislative system with the basis in a systems perspective (e.g., Berkes et al. 2003; Walker et al. 2002) is ultimately that which determines land use at local level.

2. The study will further undertake a literature review of the known conflicts between existing legislation and policy, including policy implementation, such as the conflicts the EU Natura 2000 implementation has led to in Sweden and Finland or the problems with implementing the Water Directive. In assessing correspondence and conflicts between the existing policy, legislation and regulation, the study will be based in recent work in the global environmental change field. The study judges that a well-functioning system would be well adjusted to environmental management (have a good "fit"), integrated with related constituencies on other levels (have well developed "interplay") and have developed communication and knowledge dispersion structures in place, thereby being more easily able to adapt than less integrated or less communication-intensive systems (Young 2002; Staber & Sydow 2002). The concept of *institutional adaptive capacity in response to change* will thus be central in the study.

3. Based on the identification of areas where legislation or regulation conflicts, the project will undertake *semi-structured interviews* with the identified actors on the different levels regarding possibilities for integration and problems with institutional functioning or interplay that may limit adaptive capacity. In other studies, problems in the legislative and broader governance framework have been seen to include limited integration between different departments, lacking integration and short time frames with regard (for instance to Natura 2000 implementation, e.g., Korhonen 2004) or different legal requirements providing for different long- or short-term incentives (Pettersson 2006). Such problems may play out differently in different cases. The project here aims to identify potentials for changes or adaptations in governance networks in response to different stresses – both as a result of ongoing globalization and of adaptive actions that may be required by different stakeholders. The study will thereby show upon the nature of obstacles in the political and legislative processes and interplay, and upon the institutional logics that govern and constrain change.

4. Finally, specific studies will be undertaken to answer the second research question listed above. With the basis in an understanding of the current governance system and potential correspondences and conflicts in the legislative and policy frameworks, the program calls for an understanding of how this current system, investigated both on local and higher levels, would be impacted and able to deal with requirements posed by a "more of everything" scenario. Within such a scenario, use of forest fertilization or biodiversity management in specific local/regional areas could potentially require more possibilities for differentiated treatments of different areas in order to achieve an overarching goal. Such potential for differentiated treatments would potentially need to exist in legislation, regulation and policy; at the same time, a differentiated treatment in order to attain national aims for conflicting goals could potentially provoke local conflicts in areas where one land use is given preference before another (such as seen in areas with large biodiversity protection areas, with, for instance implications on local

forestry and recreation). *Focus groups*, among other methodologies, will be used to investigate conceptions (among for instance small scale forest holders, forest companies and conflicting land uses) of how such a differentiated land use would impact stakeholders on different levels, including local stakeholders as well as governance; what means local stakeholders could identify that would support them in the light of any such development; and what means to support such adaptations exist or could be extended within current frameworks or as a result of policy changes. All of the above tasks will be undertaken during years 1-2 of the project, although point 3 may not be analysed until in year 3. Point 4 will be initialized during year 2 and empirical studies and analyses will continue into years 3-4.

In later years of the program (5-8), the third research question in particular will be embarked upon, in order to research way in which institutions and processes dealing with responses to forests pests and storms as likely risks to forest management, and within the context of globalization and invasive species will be researched, together with additional case studies to be defined on the basis of preceding work.

6.6.3. Value to users and user groups involved

This research holds implications for the policy level and policy level stakeholders, and is crucial in identifying steering mechanisms at large that influence the forest owner and will determine adaptation to increased intensification of forest use, climate change and globalization. The identification of aims and targets that different societal actors see for their own forest use is intended to serve as a basis for program modeling and scenario work (for instance, actor-based models, or for further development of Heureka).

6.6.4. Planned scientific and user deliverables

The project foresees several papers in international peer-reviewed journals, co-authored both within the sub-project and within the centre, as well as popular science reports and popular science papers in cooperation with the communication strategy of the program. In cooperation with international projects (such as CAVIAR), internationally co-authored comparison papers will be developed. Specific deliverables include: a literature review (basis for a journal paper) in year 1, which can be presented to stakeholders in a popular format; a description of conflicts between legislative frameworks (for instance, conflicting priorities on EU and national levels) in the beginning of year 2; and an empirical material of interviews and focus groups (from end of year 2).

6.6.5. International collaboration

The studies in general draw upon synergies with and extend ongoing and previous work funded by Swedish funding agencies (VR and Formas), thereby creating a value added for the program and extending this sub-project beyond what could otherwise have been managed funding-wise. An existing VR project including the research leader, a postdoc and a research assistant is in the process of defining climate change adaptation measures in Sweden, the UK, Finland and Italy, and the institutional barriers and enablers for adaptation to climate change specifically (but not with specific regard to forests). This project will provide an understanding of mechanisms governing climate change adaptation, that may support this project in identifying different institutional logics. Existing Formas projects support an understanding of the policy framework for forest use in Sweden, to the extent that 30% of Carina Keskitalo's working time, beyond that funded by Mistra, can be seen as used directly to support Future Forests. Formas projects do not include specific studies of EU and international policy or the overlap between policy areas, which Carina Keskitalo will lead a political science postdoc in undertaking, or the legislative features and the legislative multi-level governance study in the Future Forests project, for which a 50% postdoc with legal expertise will be recruited. Other projects listed below are networking projects that mainly support international research interaction and publication; one doctoral study in the area is also listed.

- 2008 –2011. *Adaptation to climate change in Europe: can models and premises for increased adaptive capacity be identified?* Carina Keskitalo, Vetenskapsrådet (VR). (2 200 000 SEK).
- 2007 –2010, *Vulnerability and resilience of coupled socio-ecological systems in multi-use forests.* Carina Keskitalo, FORMAS 2007-2009 (3 240 000 SEK).
- 2008 –2011. *Adaptation to climate change in multiple-use forest systems*. Carina Keskitalo, FORMAS (1 640 000 SEK).
- 2007 –2008, *An Interdisciplinary Network for the Study of Multi-Level and Multi-Stakeholder Forest Governance in Russia and Sweden.* Carina Keskitalo, Swedish Institute (SI), 2007-2008 (475 000 SEK), continuation applied for 2008-2009.
- 2006 –2008. International Polar Year (IPY) Status Project *Community Adaptation and Vulnerability in Arctic Regions (CAVIAR).* Led by Research Director Grete Hovelsrud-Broda, Norwegian Centre for Climate Research and Professor Barry Smit, Canada Research Chair in Human Dimensions of Global Change, University of Guelph, Canada.
- 2008 –2011. *Legitimacy in environmental resource management – the role of forest certification.* Carina Keskitalo (Johanna Johansson PhD project), Centre for Environmental Research (CMF), Umeå University (1 600 000 SEK).

Within these projects, cooperation exists with leading social science and especially political science-focused climate change adaptation research, including at the Environmental Change Institute (ECI), Oxford University, UK; Joint Research Centre (JRC), Ispra, Italy; Norwegian Centre for Climate Research (CICERO), Oslo; and Global Change Group, Guelph University, Canada.

6.6.6. Project leaders and participants

The project is led by Carina Keskitalo, Associate Professor of Political Science at the Department of Social and Economic Geography, Umeå University. The project will recruit two postdoctoral level researchers, one with legal expertise who will work 50% from October 2009 –December 2010 (Maria Petterson), and one with political science expertise who will work 100% 2009-2010 especially on conflicts and overlaps between policy areas (to be sought).

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6.7. Biodiversity

6.7.1. The significance for the Program as a whole

In future forest landscapes the composition of the flora and fauna is likely to differ strongly depending on the degree to which climate and forestry intensity will change, and also their combined effects. For the four main combinations of these drivers the following responses of biodiversity can be postulated, on a large scale level (Fig. 8): 1) Decreasing forestry intensity and low degree of climate change will cause a RECOVERY into more natural forest habitats, and promote plants and animals favoured by such conditions. 2) Increasing forestry intensity and low degree of climate change will cause a decrease in the populations of species connected to natural forests and thus a general DEPLETION of biodiversity. 3) Decreasing forestry intensity and increasing climate change will mean that species that belong to natural forests will be promoted. There will also be an immigration of a number of exotic species, and thus a DIVERSIFICATION is expected. 4) Increasing climate change as well as forestry intensity will have profound effects on the flora and fauna. Numerous new species will reach Sweden and there will be parallel extinctions of cold-adapted species. Thus a SHIFT in the species composition can be predicted.

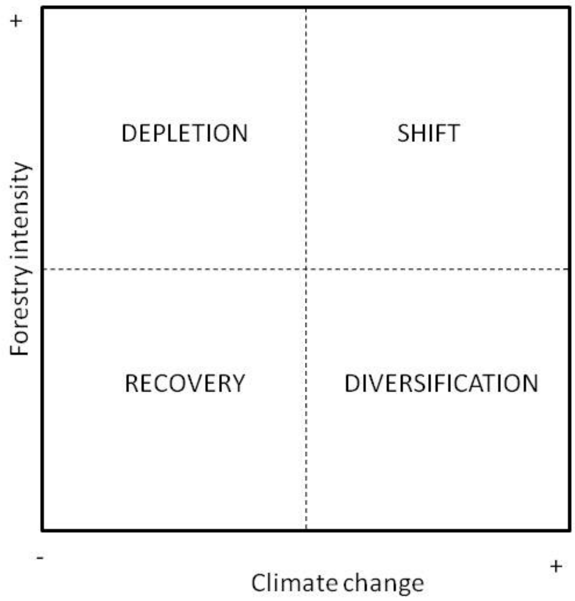

Figure 8. Postulated response of biodiversity in a 50-year perspective in relation to the two main drivers of change: forestry intensity and climate change.

6.7.2. Research issues addressed

Our research will be divided into two broad tasks:

- Predictions of biodiversity at different spatial scales in relation to degree of forestry intensity and climate change, in a long-time perspective (at least 50 years). Different modelling approaches as well as evaluation of expert opinions will be used. All postulated responses in Fig. 1 will be addressed (Sub-projects 3.2.1, workshop (4.); for years 3-8 see 3.3.).
- Assessment of the impacts on biodiversity of present and near-future forestry methods including both methods for increased production and novel restoration measures. This more short-term task, embraces the DEPLETION and RECOVERY hypotheses in Fig. 1 (Sub-projects 3.2.2. (years 1-2), for years 3-8 see 3.3).

Habitat fragmentation and change of landscape composition greatly affect biodiversity in most ecosystems worldwide (Lindenmayer & Fischer 2006). Current applied research on forest biodiversity in boreal and temperate countries is to a large extent directed towards the impact of forestry methods and to the evaluation of conservation measures (e.g. Larsson & Danell 2001; Rosenvald & Lõhmus 2008). Forestry has continuously decreased the area of old forest, and the structure of new forest differs significantly from that of natural successions. How sensitive a certain species is to fragmentation is dependent on its life history (Fahrig 2002). The dynamics of many forest species could be described as local extinctions and colonizations of habitat patches (Hanski 1999). The matrix (areas outside habitat islands) can offer suitable habitat conditions, although often sub-optimal (Lindenmayer & Franklin 2002).

In recent years there has been a rapid increase in the number of studies on the effects of climate change on biodiversity (e.g. Parmesan 2006). Under a scenario of natural development, many southern tree species will migrate rather quickly northwards (Koca 2006), but in reality it is likely that forest management will continue to shape the forest composition (Sonesson et al. 2004). Bioclimatic envelope modeling that predicts future distribution areas and number of species are common (e.g. Thuiller et al. 2003). These models, however, are static and do not account for species colonization and dispersal, as is considered in, metapopulation modeling (Hanski & Gaggiotti 2004) which will be used in this project.

Systems with high biodiversity are predicted to be more resilient to change than species-poor systems (Pimm 1984; Carpenter et al. 2001). Thus, maintaining biodiversity is expected to make systems more likely to maintain basic functions even after disturbance. The role of disturbance for plant and animal diversity has been a central theme in ecology for several decades (e.g. Connell; 1978; Sheil & Burslem 2003). Successions after a major disturbance (e.g., fire, storms) are known to result in succession patterns of different species composition and richness as stands develop and mature (Connell 1978; Cordonnier et al. 2006). Hence, both forest diversity and conservation can only be understood in terms of several decade long succession patterns or whole stand rotations. More intensified forestry and climate change will change succession as well as community patterns.

Research design and methods years 1-2

Biodiversity in relation to degree of forestry intensity and climate change:

- Analysing the effects on biodiversity of different conservation efforts and management regimes using a spatially realistic landscape model. We will predict the local extinction risk of species for the following 100 years by using a model that simulates colonization-extinction dynamics and habitat dynamics. We will work with a range of species that represent the dominant taxa on the Swedish Red List, as well as different climate regions, and for which there are satisfactory data, e.g., three-toad woodpecker, an epiphytic lichen (*Lobaria pulmonaria*), saproxylic fungi (*Fomitopsis rosea* and *Phlebia centrifuga*), and saproxylic beetles (*Peltis grossa*, *Harminius undulatus*, and *Elater ferrugineus*). We will work with real forest landscapes that currently exist in Sweden, and predict the landscape dynamic given different conservation strategies (setting aside larger or smaller areas of different quality).
- Modelling vegetation changes from forest, species and climate databases. We will use databases (National Forest Inventory NFI, National Survey of Forest Soils and Vegetation NSFSV, Ecological Flora of the British Isles EEBI) to predict changes in vegetation due to climate change as well as intensified forestry. We will analyze a subset of species with ecological characteristics and life history traits that relate to climate and succession. Existing models of climate migration will be used to estimate a climate change variable by present-day climate in different geographic locations. Scenarios with different forestry intensity (rotation length) and degree of climate change will be examined by statistically analyzing species occurrence in present-day stands of different geographic location and age (NFI and NSFSV databases), and by extrapolating distribution ranges in a future climate based on species temperature requirements (EEBI database).

Impacts on biodiversity of present and near-future forestry methods:

- Baseline data for the production park Strömsjöliden. The unique, large-scale experimental park at Strömsjöliden will be used to describe spatial patterns of different organism groups (vascular plants, bryophytes, lichens, fungi, insects and birds) over the forest landscape. We will also investigate how they respond to the conversion to a high yield production park in a replicated experiment with 3 different management levels: intense, conventional and control. In the short-term perspective, we expect changes in assemblages composition and biodiversity of vascular plants, bryophytes (reduced) and ground living insects (increased) in respose to high yield production. The project will generate empiric knowledge on the short-term ecological effects of intensified forestry and constitute a baseline for future long term studies. These data can also provide input to the metapopulation modelling of 3.2.1.1.

- Cost-efficient restoration measures in protected areas. We will design and evaluate restoration experiments, e.g. removal of some trees to open up gaps in the canopy and prescribed burning of smaller areas, together with forest companies (e.g. Holmen, Sveaskog). The experiments will be conducted in 6-8 localities with the same number of untreated localities as controls. The evaluation will involve assessment of conservation values related to forest characteristics according to “skogsbiologernas metod” (Drakenberg & Lindhe 1999), but also measurement of volume and quality of dead wood, measurement of the occurrence of insects per ha (species richness and abundance), and inventories of birds, fungi, and lichens. Furthermore, this will provide a baseline for long-term studies, and an initial evaluation of cost-efficiency will be conducted in collaboration with the Heureka team.

Research year 3-8

The aim will be 1) to present more accurate predictions for biodiversity in future forest landscapes under different intensities of forestry and climate change, and also to evaluate future possible conservation models, 2) to further increase the knowledge on the effects of novel forestry methods on biodiversity, and 3) to evaluate the efficiency of restoration measures through cost-benefit analyses. The modeling approaches will be extended and refined through adding more management regimes, forest landscape types and regions, partly with the help of Heureka data on stands and landscapes, as well as their modeling tools. Links among models of habitats, landscapes, and climates will be strengthened. Validation of models will be performed using existing databases and by new field surveys. The studies in the production park and restoration areas will include assessments of the effect of intensified forestry/restoration measures on early colonizers of vascular plants, bryophytes, wood fungi and insects. Cost-benefit analyses of different restoration measures will be extended.

6.7.3. Value to users and user groups involved

The users of our results will, broadly speaking, be of two types. The modelling results from “biodiversity in relation to degree of forestry intensity and climate change” will be of interest to decision makers in policy work on different levels (forest-owners, administrators, governmental bodies, representatives in international bodies) on future adaptation strategies, regarding forestry as well as conservation. The empirical studies on the description of biodiversity in different forest landscapes, and on how biodiversity is affected by different forestry and conservation measures will be valuable to practitioners of forestry and conservation.

6.7.4. Planned scientific and user deliverables

After two years:

- Knowledge of the efficiency of different conservation strategies, in terms of predicted persistence probability for representative care-demanding forest species. The conservation strategies include only different types of set-asides.
- Broad predictions on vegetation composition in a low number of different types of future forest landscapes (in relation to management intensity as well as climate change), and for a small number of species and species types
- Predictions of the effect of climate change and changes in forest practise on biodiversity using BII (expert-based evaluations from workshop)
- Description of the distribution of vascular plants, bryophytes, lichens, fungi, insects, birds in different forest types and ages and in relation to forestry intensity and landscape composition in the experimental forest park Strömsjöliden. This will also serve as base line data for long term studies on changes in forest intensity/practise will effect biodiversity
- Information on species number and composition of old set-aside forest areas in the restoration experiments of Holmen and Sveaskog
- Two scientific publications on species' extinction risks and vegetation changes, one on biodiversity changes based on expert opinions, and two on biodiversity in managed forest landscapes and the effect of restorations measures

After eight years:

- Evaluation of the efficiency of different conservation strategies, in terms of predicted persistence probability for representative care-demanding forest species. The conservation strategies include both setting aside forests and different management operations in managed forests.
- Predictions on vegetation composition for a large number of different types of future forest landscapes (in relation to management intensity as well as climate change), and for a large number of species and species types
- Predictions of species persistence probability in relation to climate change. Both indirect (e.g. changed habitat availability) and direct effects on colonisation-extinction processes will be considered for some representative care-demanding forest species.
- Knowledge on short term effects of different types of intensified forestry management on species richness, abundance and community composition of vascular plants, bryophytes, lichens, fungi, insects, birds in different forest types and ages in the experimental forest park Strömsjöliden
- Assessment of the biodiversity in unmanaged forest stands/landscapes and stands/landscapes managed with varying degrees of intensity (production park of Sveaskog).
- Assessment of the cost-efficiency of different restoration measures for different species and overall biodiversity.
- Six scientific publications and three popular articles on species' extinction risks and vegetation changes under different future forestry and climate scenarios
- Three scientific publications and two popular articles on effects of intensified forestry and restoration measures on biodiversity, including cost-efficiency analyses

6.7.5. International collaboration

We plan to collaborate (i.e., publish papers) with the following researchers: Terry Chapin, University of Alaska, USA, (Biodiversity Intactness Index), Heloise Gibb, CSIRO, Australia, (changes in forestry intensity/practise on biodiversity and communities), Mikko Mönkkönen et al., University of Jyväskylä, Finland (metapopulation and landscape modeling).

6.7.6. Project leaders and participants

Joakim Hjältén will mainly be responsible for the new experimental sites on the properties of Holmen and Sveaskog, and also for the BII workshop. Thomas Ranius will do the metapopulation and landscape modelling. Olof Widenfalk will perform the analyses of biodiversity on existing large databases on changes due to climate change as well as intensified forestry based. Lena Gustafsson and Jan Weslien will take part in the planning of the projects, in the discussions of results, and in the initiation of new activities. Therese Johansson, will be involved in the research in the production parks (financed by other sources than Mistra).

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6.8. Pest and diseases

6.8.1. The significance for the Program as a whole

One of the main factors affecting the ecological and economic status of the forests is their susceptibility to stress, pests, and diseases. Pest and disease outbreaks can have a major influence on the structure and composition of forests, the supply of timber, the use of forests for recreation. Outbreaks can in addition affect legislation and international trade. Recent examples include the mountain pine beetle in British Columbia and the sudden oak death in California and elsewhere. In Sweden, we recently, in 2000-2001, experienced an outbreak of *Gremmeniella abietina*, as well as one of *Ips typographus* following the storm Gudrun 2005. These and similar disturbances result in substantial economical losses and drastic transformations of the forests.

It is therefore important to include pests and pathogens when predicting the fate of future forests, especially when considering effects of climate change and globalisation (Ayres & Lombardero 2000; Kirilenko & Sedjo 2007; Desprez-Loustau et al. 2007 a). Increased summer temperatures are likely to accelerate the development rate for insects and influence sporulation in fungi. Milder winter conditions may lead to higher survival rates in insects and increased activity in fungal populations. Humidity is a major factor controlling sporulation and spore germination in fungi and therefore a key environmental variable for infection. Not only the pests and pathogens but also the trees that they attack, and their natural enemies, are likely affected by changes in the climate (Harrington et al. 1999). Tree stresses are key factors determining the resistance of trees to biotic attacks, although interactions are likely to differ among the particular systems studied. More or less complex interactive effects are thereby likely to occur. In addition to climatic changes, globalisation of trade and travel are facilitating movement of pest and diseases and increase the risk for new pest and disease outbreaks (Desprez-Loustau et al 2007b).

Also changes in forest management will affect pests and pathogens. Under the high-producing scenarios, intensive silviculture may lead to unwanted side effects of increased risks for insect and fungal attacks. For instance, both the root rot fungi *Heterobasidion* and the pine weevil *Hylobius abietis* use tree stumps as substrate for reproduction in managed forest stands. Fertilizing and watering stands will affect the nutritional status of trees, and their patterns of resource allocation to growth and defence could thereby change the susceptibility to pests and pathogens.

Forest management is a key to actively counteract the effects of pests and diseases, and prepare for anticipated environmental changes. Important aspects are, e.g., avoiding stress caused by overstocking, planning for selection of suitable tree species and provenances, and appropriate timing of silvicultural activities.

The overall aim of this project is to provide predictions on how pests and diseases will impact the forests in Sweden in the future, in particular with regard to the influence of climate change and changed forest management.

The general approach will be to synthesize existing knowledge and to use models to explore possible future scenarios. We will build on existing data bases and compile new ones, but also, if additional funding can be secured, collect field data and conduct experiments in the lab.

6.8.2. Research issues addressed

Scenario predictions year 1-2

The two major axes in the null scenario are mainly influenced by climatic change and increased intensity in forestry. Both these envisaged impact gradients will most certainly affect the risk for problems associated with pests and diseases in future forests. We will support these and other scenarios by producing predictions of pest population dynamics and disease levels under different selected scenario regimes. Already known pest and disease problems will be the starting point, and chosen to represent different main categories of pests and diseases. Predictions will initially be based on existing models, and published and otherwise available records. Models will continuously be validated and refined. Primary targets for the first predictions will be:

A. *Heterobasidion* root rot of conifers is causing economic losses in the range of SEK 500-1000 million yearly to Swedish forest owners. It is known to respond to temperature increase and intensified management by increased infection levels. We will use a published mathematical model to predict root rot levels in Sweden under the scenario conditions. This work will be in close connection with the silvicultural management and planning part of the program.
B. *Gremmeniella* dieback of conifers. *Gremmeniella abietina* has caused shoot dieback and canker of Scots pine (and to a minor extent *Pinus contorta* and Norway spruce) with severe loses to forestry during its epidemic outbreaks. The fungus is present throughout the country but epidemic outbreaks are initiated by rainfall and low temperature during summer and mild winter conditions. We will model the likelihood of disease outbreaks in different geographic regions of Sweden under the scenario conditions.
C. *Mycosphaerella pini* needle cast in pine. This fungal disease is present in Sweden but to an unknown level. From the literature we know the weather conditions that are conducive for epidemic outbreaks in other countries. Predictions will illustrate the risk of getting a new severe fungal disease in Sweden as a consequence of changes in management and climate.
D. The spruce bark beetle *Ips typographus* regularly kills large quantities of mature spruce trees and is thus one of the most important insect pest species in Europe. The main factors initiating outbreaks are considered to be large-scale storm disturbances (allowing a rapid population increase in storm-felled trees) and summer drought (reducing tree vigour) (Christiansen & Bakke 1988). A warmer climate will result in a change from one to two generations per year in parts of the country which will affect the risk for damages. We will generate predictions of the likelihood of outbreaks under the scenario conditions chosen.
E. The pine weevil *Hylobius abietis* has constantly high population densities and is limited by the amount of available breeding resources (fresh conifer stumps) (Day K. et al. 2004). Pine weevil damage to planted seedlings cost several hundred million SEK per year in forest regenerations in Sweden. A changing climate will probably affect development time and generation time, leading to increased problems, especially in the north. We will generate nationwide predictions for the risk for seedling mortality in relation to the climate and forest management scenarios chosen.
F. Leaf- and needle-feeding insects Leaf- and needle-feeding insects sporadically reach defoliating outbreak levels resulting in growth reduction and occasionally to tree mortality. Currently several needle-feeding insects present in Sweden (e.g., nun moth

and pine sawflies) cause severe damage in continental Europe. A changing climate may increase the incidence of outbreaks in Sweden. Time series with density data and outbreak records are key elements in analyzing effects of climate change on insect population dynamics (Jepsen et al. 2008). Density data and historical outbreak records will be matched with climatic data to generate predictions of future outbreak risks under the selected climatic scenarios.

Specific work year 1-2

A. Validating the root rot model. Two mathematical models were recently developed, Thor, Ståhl and Stenlid (2005), and Pukkala et al (2005). The latter model is particularly well adopted to predict impact of climate change because it has a temperature-sensitive infection module based on large data sets. The models are functioning but can be improved by further validation and parameterization. Field experiments not previously included in the data base for model development will be sampled (partially already done) and data will be used to validate the model.
B. Building a model for *Gremmeniella* dynamics. The Gremmeniella life cycle has strong connections to weather conditions in several stages. Low temperature and moist weather have direct effects on the fungus as well as on the susceptibility of the host tree. The modeling is perceived as a life table model where transitions between various stages is modified by temperature and conditions in the tree. In data for the model has been collected over the recent epidemics that caused a massive death in more than 300 000 ha of Scots pine.
C. *Mycosphaerella pini* needle cast in pine. Based on published responses to temperature and moisture, predictions of potential areas for *Mycosphaerella* outbreaks in Sweden will be carried out under the scenario conditions chosen.
D. Building a model on *Ips typographus* dynamics. A review of spatial and temporal patterns in outbreak histories of the spruce bark beetle will be conducted. The main factors influencing the risk for outbreaks are considered to be large-scale storm disturbances, summer drought (reducing tree vigour), climate, and percentage of mature spruce trees in the landscape. Thus, a data base containing this information will be built.
E. Building a general risk model for pine weevil-caused seedling mortality in relation to generation time. We will synthesize present knowledge on development time and generation time (Bejer-Petersen 1962) in Sweden, and levels of seedling damage and mortality (results from an ongoing monitoring study, Nordlander et al. in prep.).
F. Building a general model for leaf- and needle-feeding insect dynamics. Literature studies will be initiated to start model building in order to identify characteristics of insect outbreaks and outbreak species among needle- and leaf-feeding insects. This will be a starting point for making more precise predictions about their outbreak species'response to changes in climate and management.
G. Suggested case studies /scenarios. In order to highlight aspects of pest and disease outbreaks, their consequences, and responses in the society, we propose, for the whole program, to study model case studies. This is thought to involve not only the pest and disease module but preferentially many of the research groups involved in the program. We suggest for the initial phase (2009-2010) two such case studies:
    - The spruce bark beetle outbreak following the 2005 storm. This case study will highlight processes involving forest management and organisation of the society to counteract a severe outbreak on a regional level in Sweden. The bark beetle case study could be used to investigate how the critical situation was handled by forest owners, authorities, researchers and media. On what base were decisions taken?

What actions were taken? How was the communication between forest owners, authorities and researchers? What was the impact on forest administration, organisation and legislation

- Eradication of Dutch Elm Disease on Gotland. An important aspect in pest and disease control is how society can organise itself in an effort to eradicate a disease. Dutch Elm Disease has recently been introduced into Gotland. The main purpose of this case study is to generate data and observations on how the society organise a large scale attempt to eradicate an invasive disease. This work will involve the local authorities ('Länsstyrelse') and management teams. The case study will highlight management problems and awareness and attitudes in the society with particular reference to nature conservation aspects ('lövängar').

H. Initiating field monitoring sites. Assuming that we can obtain additional funding from other sources, we will monitor insect pests and diseases along a latitudinal gradient at or in the vicinity of field stations and experimental plots run by SLU and SkogForsk. Pest insects will be surveyed by using pheromone traps and forest damage inventories. Diseases on leaves, shoots, and stems will be surveyed using traditional technology, and modern DNA-based detection methods. Particular care will be taken to search for species that have been indicated as likely to respond to milder climate conditions by expanding their geographic range (Desprez-Loustau et al 2007 a,b; Jeger & Pautasso 2008: Slippers et al. 2006). Results will be compared to the present knowledge and will also provide a base line for future follow up on any changes in distribution patterns. We will integrate this effort with existing and new environmental assessment programs (FOMA) at SLU.

Specific work year 3-4

A. Delivering predictions of pest and disease development in future scenarios. We will continue to use literature and field data to predict pest and disease outcome in the scenario work of the Future Forests program.
B. Refining the model for *Gremmeniella* dynamics. The model developed during year1-2 will be refined and validated using data from the literature and observation series not previously included in the model building.
C. Refining the *Ips typographus* model. The model will be refined and validated using data compiled during year 1-2. The explanatory power of suggested factors for explaining the historical outbreaks will be tested. Based on the results and other information a simple model for outbreak risk will be built.
D. Refining the *Hylobius abietis* model. The synthesis from year 1-2 together with new data (gathered to fill identified knowledge gaps), will be used for an improved model.
E. Refining the general model for leaf- and needle-feeding insect dynamics. The model developed during year1-2 will be refined and validated using data from literature and observation series not previously included in the model building.

Specific work for year 5-8

A. Delivering predictions of pest and disease development in future scenarios. We will continue to use literature and field data to predict pest and disease outcome in the scenario work of the Future Forests program.
B. Refining and validating the specific models for pests and disease dynamics. The models developed during year 1-4 will be refined and validated using data from literature and observation series not previously included in the model building.

Relevant to scenario predictions and other points of specific work: Identification of invasive forest pest and diseases is currently done in an EU-financed project “FORTHTHREATS” that is coordinated by Jan Stenlid. Impact assessment of climate change on the distribution and dynamics of forest pests and diseases is initiating in a EU-financed project “BACCARA” involving Jan Stenlid and Christer Björkman. The monitoring plots described under Specific work year 1-2.E will be partly included in that project. A SNS project “The potential impact of climate change on spruce bark beetle populations in Scandinavian countries”, involving Martin Schroeder, will be beneficial for the model development. Modeling of root rot (Specific work year 1-2.A) is currently carried out as a part of a post doc project by Jonas Oliva currently visiting Jan Stenlid. The suggested program will benefit from that work. Relevant to Specific work year 1-2.E is a recently introduced inventory at Dept. Forest Mycology and Pathology, SLU on endophytic and pathogenic fungi in pine.

6.8.3. Value to users and user groups involved

Predictions of future pest and disease levels are highly relevant to forestry. Established collaborations exist on root rot predictions with Bergvik AB, Södra skogsägarna, Holmen AB and other organizations. The results directly feed in on the decision-making process in terms of, e.g., when to thin, under what conditions protective stump treatment is necessary.

Continuous contacts and support with disease confirmation and management options are kept with the County administrative board of Gotland for Dutch Elm Disease. Spruce bark beetle damages are followed in a focus group organized by Skogsstyrelsen and with participation from major forest owners, relevant authorities (Skogsstyrelsen, Kemikalieinspektionen, Naturvårdsverket), and SLU. Predictions on insect population densities and damages are highly relevant to forestry and feed directly into decision making.

6.8.4. Planned scientific and user deliverables

Year 1-2

- Scenario predictions for *Heterobasidion* root rot, *Gremmeniella* shoot dieback, *Mycospherella* needle cast, the spruce bark beetle, the pine weevil, and leaf/needle-feeding insects.
- Validation of the root rot model
- Preliminary model for *Gremmeniella* dynamics
- Data compilation for outbreak history of *Ips typographus*
- Preliminary risk model for pine weevil *(Hylobius abietis*) damage in relation to development time and climate.
- Preliminary characterization of insect outbreak species and insect outbreaks
- Identified locations for monitoring plots
- Workshop on eradication of introduced disease

Year 3-4

- Time series data on variation in pest and disease distribution and abundance at different latitudes.
- Updated reports on current distribution of known and previously unknown pests and diseases in relation to biotic and climatic conditions.

- Validation of the *Gremmeniella* dynamic model
- Predictions of *Gremmeniella* in future forests, relevant to management scenarios.
- Risk assessment for pests and disease damage in future forests.
- Recommendations on how to reduce the risk for pest and disease damage through, e.g., changes in forest management methods.

6.8.5. International collaboration

For bark beetles there is an ongoing SNS-project, involving modellers from Norway (H Lange) and Lund (A-M Jönsson). Researchers from Norway (B Ökland and P Krokene) and Denmark (S Harding and HP Ravn) are also involved in this bark beetle project. For general effects of insects on forest structure there is a VR-project together with researchers in Lund (M Sykes) and Canada (D Kneeshaw) starting this year. Other ongoing projects include e.g. a general analytical modelling of climate change effects on insects (M. Ayres, USA).

Particular important connections for the disease part are with Marie-Laure Desprez-Loustau INRA Bordeaux, and Benoit Marcais, INRA Nancy. The models are developed in collaboration with a European network (MOHIEF) and with Timo Pukkala, Joensuu Finland. Several Forest managers at the main Swedish forest companies have taken part as focus groups. International collaboration on Dutch Elm Disease exists with Alberto Santini, Firenze, Italy. General Forest pathology collaborations are established with Steve Woodward, UK, Halvor Solheim, Norway, Jarkko Hantula, Finland, Ottmar Holdenrieder, Switzerland, Tomas Kirisits, Austria among others.

6.8.6. Project leaders and participants

Project leaders are Jan Stenlid and Christer Björkman. Jan Stenlid will represent in the Core Team. Jonas Oliva (disease), Hanna Millberg (monitoring disease), Helena Bylund (insects) and Martin Schroeder (insects) will participate in the work.

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6.9. Soils and water

Exploring the effect of intensified production in a changing climate

6.9.1. The significance for the Program as a whole

The supply of nutrients in the soil limits tree growth and defines the basis for surface waters quality. It is well established that growth can be significantly increased in the Swedish forests by nutrient additions. There is thus a potential for more biomass production, especially when combined with other silvicultural strategies (e.g. thinning, drainage, genetic selection), but the sustainability of the soil resource and the impacts at the landscape scale on other ecosystem services, such as water quality, is largely unknown. Before any large scale efforts to increase forest production is put into action the long-term effects on forest sustainability and water quality needs to be properly investigated. Of particular concern is how the environmental impact of intensified biomass production will be exaggerated by the predicted climate change that will affect both temperature and precipitation patterns across Sweden.

The potential effect of both intensified forest production and climate change on the long-term sustainability of soils in Sweden is considerable. While intensive fertilization will result in changes in the soil ecosystem by changing the microbial and fungal communities an increased biomass growth will also result in an enhanced base cation uptake. As climate change will prolong the growing season in much of Sweden the effect on forest biomass production will most likely be further exaggerated which can further augment the negative effect on soil sustainability.

Soils and surface waters are closely linked by the groundwater which transports dissolved nutrients and other solutes from the terrestrial to aquatic ecosystem. A consequence of this strong linkage is that a change in the soil hydrology or biogeochemistry will ultimately affect water quality in the streams draining the catchments. Potential effects are increased leakage of nitrogen (because of loss of nitrogen retention capacity), increased flux of dissolved organic carbon (DOC) and metals (as the hydrology is affected by harvesting) and decreased concentration of base cations (which will lead to acidification of surface waters). These effects are likely further exaggerated by the expected increase in precipitation during summer and fall in the future. What the downstream effects of the combined effects of an intensified forestry and a change in climate will ultimately depend on how individual landscape elements or small catchments are affected by these drivers.

In order to foresee the impact of intensive silvicultural strategies in a changing climate on the long-term forest sustainability and water quality a more holistic ecosystem approach needs to be taken. In this Future Forests project we will combine meta-analysis of existing literature, experimental manipulation studies and state-of-the-art modeling. While the immediate output of the project will be an enhanced understanding of the sensitivity and environmental impact of an intensified biomass production which will feed into the scenario analyses, the long-term goal is to provide recommendations and decision support tools that can be used by the forest industry and environmental authorities to minimize environmental effects.

Trees, soils and water are at the center for understanding how our future forest will be affected by an intensified biomass production and climate change. The implications of a negative effect on the sustainability of soils or deterioration of our water quality will have immediate implications for many of the other Future Forests projects including Biodiversity, Values and attitudes, and Forest governance among public and market actors.

6.9.2. Research issues addressed

The major objective of this project is to provide answers to questions addressing the role of soils in sustainable forestry and the maintenance of water quality at a landscape scale. More specifically, we will provide answers to the following questions:

Tree-soil interaction and sustainable forestry:

A. How will an increase in forest growth through nitrogen fertilization affect functional mycorrhizal fungi and what are the consequences for long-term N retention in the soil?
B. Is intensive forestry involving nitrogen fertilization and/or whole-tree harvesting mining soil base captions at a rate that is exceeding the weathering of minerals?
C. How will a change in temperature and precipitation exaggerate/reduce these effects?
D. What are the long-term consequences of changes in upland soils chemistry on laterally moving water reaching the riparian soil and surface waters?

Soil-surface water interaction:

E. How will the potential long-term effect on upland soil chemistry translate into changes in surface water quality? And how are these effects buffered by the riparian soils?
F. What are the short-term influence on water quality from intensified forestry in a changing climate with respect to nitrogen, dissolved organic carbon (DOC) and associated metals such as mercury?
G. How will changes in soil and stream water chemistry affect water quality at a landscape scale? What is the role of organic soils, landscape heterogeneity and scale?

Additions of nitrogen to forests have the potential to greatly enhance their capacity as sinks for atmospheric CO_2. This is because nitrogen additions to nitrogen-limited forests increase their foliar biomass and the rate of photosynthesis per unit of foliage. This effect is further exaggerated because fertilized trees allocate less carbon down to its roots (and their symbiotic mycorrhizal fungi), while more carbon is used for production of wood. Simultaneously, the nitrogen added has a retarding effect on the decomposition of litter and soil organic matter at the soil surface (Berg & McClaugherty 2003). Altogether, this leads to a greatly enhanced carbon sink capacity of forests but also to an enhanced limitation of other nutrients such as base cations. Another consequence of the decrease in allocation of carbon to roots and their symbiotic mycorrhizal fungi, is that the capacity for nitrogen retention in the soil decreases.

During the last decades there has been an intensive debate about the sustainability of forestry and water quality in Sweden. The debate started because of model results indicating that forest growth would be affected by deficiencies in the supply of the plant macro-nutrients Ca^{2+}, Mg^{2+} and K^{+} (Sverdrup et al. 1992, 1994), the so called soil base cations. More recently, large-scale experimental manipulations suggest that a lack of base cations does not limit forest growth (Binkley & Högberg 1997) and that rates of soil weathering is higher than predicted by the models used in the past (Högberg et al. 2006). So while there is no immediate threat to a sustainable forest production in Sweden, little is known about how intensified silvicultural practice in combination with longer growing seasons will affect the soil nutrient availability.

Although the soil is the primary source for most chemical constituents in surface water, both forestry and climate exert powerful controls on the water quality of streams, rivers and lakes in the boreal landscape (e.g. Schindler, 1998; Buttle et al., 2000). It is well established that forest harvesting results in decreased transpiration, increased groundwater tables and hence an increased runoff (Andreassian 2004). These effects will probably be further exaggerated in a future climate because of increased temperatures and precipitation across Sweden. Although the effect of nitrogen leakage is well studied (Ring et al., 2006) it is not until recently that forest harvesting has been shown to increase both the concentration and total flux of dissolved organic carbon (DOC) in boreal regions (Cummins and Farrell 2003; Nieminen 2004). One reason for the increasing awareness of DOC is that it forms an important transport-vector for contaminants such as heavy metals (Porvari et al. 2003) and persistent organic pollutants (Persson, 2007). Although the role of base cations for controlling pH in surface water was established decades ago (Reuss and Johnson, 1986) the connection between the removal of base cations through harvesting and how this affects the concentration in the streams has not been properly resolved. If there is a connection, an intensification of forestry in the future could have detrimental effects on weakly-buffered streams in several regions of Sweden.

In this project we will make the most extensive analysis ever made in Sweden on forest growth, soil biogeochemistry and water quality and how these are interlinked and affected by forest management. This work can be described chronologically as;

Providing input to scenario analyses (Year 1-2)

1. In-depth meta-analyses on published results from the boreal region to identify gaps in the current knowledge on the questions pertaining to the question on sustainable forestry and water quality under intensified forest production and changing climate. The advantage of using meta-analyses compared to traditional literature reviews is that the former method provides more quantitative results that will be beneficial for both the scenario analyses and the biogeochemical modeling.
2. Initiate the biogeochemical modeling of soil and surface water chemistry. The purpose of modeling at this initial stage is both to provide inputs to the scenario analyses and to identify gaps for more informed empirical and experimental work.
3. Based on the meta-analysis and the modeling provide input to the scenario analyses.

Advanced modeling, experimental studies and empirical data collection (Year 2-6)

4. Using the findings in the meta-analysis and the first modeling to gather necessary available information and new empirical data from already ongoing field studies in

order to assess how an intensified biomass production in combination with climate change will affect the long-term sustainability of forest soils and water quality.

5. In the case where critical data cannot be provided from ongoing field studies we will conduct experimental manipulation studies. One example where this will most likely be necessary is in understanding the role of climate change. As the changes in precipitation and temperature will fall outside the natural variability we already have experienced we need to overcome this limitation by generating experimental data that better represent possible future climates. The purpose of the experimental work is to constrain models and illuminate non-linear process behavior.
6. Combine current knowledge and the generated empirical and experimental data using available biogeochemical models. In contrast to most traditionally modeling approaches where only single models are used, we will focus on an ensemble model approach and base our predictions on results from several different models (an approach that has been found to outperform the prediction of single models in climate models).

Combine generated knowledge to provide new recommendations and tools (Year 7-8)

7. The vision for the more long-term goal of the project is that we shall provide recommendations and decision support tools for sustainable forestry and water quality that can be used by environmental authorities and forest companies. One example of such output is to provide a simple tool that can be used to identify sensitive areas for water quality.

6.9.3. Value to users and user groups involved

While the short-term goal is to provide a stronger scientific base for the soils and water input into the scenario analyses, the long-term goal is to provide recommendations and decision support tools that can be used by the forest industry and environmental authorities to minimize environmental effects in the future. Due to national and international legal conventions that are now being implemented, forest enterprises could be forced to adopt new protection methods and management approaches to reduce forestry impacts on soils and waters. As such models presently are not available, there is a risk that forestry applies management strategies that do not meet stated water quality targets or do this at an unnecessarily high cost. This limited planning capacity of forest management with regards to the quality of water does not represent a tenable position given the new EU directive on water (RDV, 2000/60/EG). Furthermore, to achieve the targets of at least eight of the national environmental goals, among them Living Forests and Flourishing Lakes and Streams, forest management practices need to be elaborated with respect to soil and water quality in their planning.

6.9.4. Planned scientific and user deliverables

The overall purpose of this project is to provide a stronger scientific underpinning on what impact an intensified silvicultural strategies will have in a changing climate on the long-term forest sustainability and water quality. By combining meta-analysis of existing literature, experimental manipulation studies and state-of-the-art modeling we will enhance the understanding of the sensitivity and environmental impact of an intensified biomass production.

- In-depth meta-analyses pertaining to the questions on sustainable forestry and water quality under intensified forest production and changing climate.
- Provide scientifically based answers to
    - How will an increase in forest growth through nitrogen fertilization affect functional mycorrhizal fungi and what are the consequences for long-term N retention in the soil?
    - Is intensive forestry involving nitrogen fertilization and/or whole-tree harvesting mining soil base captions at a rate exceeding weathering of minerals?
    - How will a change in temperature and precipitation exaggerate/reduce the effect of base cation uptake on the soil supply?
    - What are the long-term consequences of changes in upland soils chemistry on laterally moving water reaching the riparian soil and surface waters?
    - How will the potential long-term effect on upland soil chemistry translate into changes in surface water quality? And how are these effects buffered by the riparian soils?
    - What is the short-term influence on water quality from intensified forestry in a changing climate with respect to nitrogen, dissolved organic carbon (DOC) and associated metals such as mercury?
    - How will changes in soil and stream water chemistry affect water quality at a landscape scale? What is the role of organic soils, landscape heterogeneity and scale?
- Recommendations and decision support tools for sustainable forestry and water quality that can be used by environmental authorities and forest companies.

6.9.5. International collaboration

The section on soils and water will benefit strongly by broadening the perspective outside the national boundaries. The question on how silvicultural strategies in a changing climate will affect the long-term sustainability of forest soils and water quality is a research issue that we share with several other leading forested nations, including USA, Canada and Finland. To secure the success of this program a tight link to this international scientific community will be maintained throughout the project. The three PI:s of the project all have a strong international network within their respective fields which will be utilized and strengthened in this program.

We also envisage that within the framework of the Future Forests program we can attract leading scientific members of the international soil and water community to spend substantial time with the groups.

6.9.6. Project leaders and participants

The soils and water section of the Future Forests program will be closely integrated with the already ongoing research conducted by the three PI's. The new recruitments (see below) will work closely as a group to reach the specific tasks set ahead and closely interlinked with the other members of the three PI:s research groups as well with other Future Forests projects. The constellation of the PI:s of this working group consists of Peter Högberg, Hjalmar

Laudon and Kevin Bishop which all are experienced and well respected scientist in their respective fields both nationally and internationally.

New recruitments for the project
For the success of the project three new full-time assistant professors (Forskarassistenter) and one part-time senior scientist (Docent) are required. These new recruitments will both be tightly interlinked within the group as well as to the PI:s other research activities. The main focus of the work of this team will be;

- Assistant professor 1: Uptake and allocation of nutrients, carbon and base captions at the tree/soil interface. This person will work both on the implication for nutrient additions for symbiotic mycorrhizal fungi and its biogeochemical consequences in the soil and will hence be responsible for objective A and B. He/she will also work on the long-term effects on the base cation supply in an intensified forestry and changing climate and on its influence on forest sustainability (objective C) in collaboration with Assistant professor 2.
- Assistant professor 2: What are the long- and short-term effects of intensive forestry in a changing climate on soil chemistry in upland and near stream soils and what are the implications for water quality. This person will work closely with Assistant professor 1 on the soil biogeochemistry modeling using an ensemble modeling approach that combines traditional weathering models with fully mechanistic soil chemistry models (objective C). He/she will also work closely with Associate professor 3 on the short and long-term effects of forestry on soil-surface water interaction (objective D and E).
- Assistant professor 3: What are the implications of intensive forestry in a changing climate on water quality at a landscape scale. This person will work on up-scaling biogeochemical and hydrological effects (objective F). He/she will also work in close conjunction with Associated professor 2 on how nitrogen and DOC and its associated metals will be affected by intensive forestry and climate change (objective D and E). In this work the role of mires, riparian soils and landscape heterogeneity will be a focal point.
- Associate professor (30%):Within the project there is a great need for an in-depth assessment of the many Fennoscandian field experiments on nutrient cycling, especially those concerned with the return of nutrients after forest harvests. This person should also have an effective network with companies and organizations dealing with the practical aspects of recycling nutrients. The need of this knowledge is greatest in the initial years of the project for the scenario analyses, but the networking and communication of results of the project will continue throughout. This person will also conduct and organize some of the field work, e.g. sampling of soils and other ecosystem components, and make nutrient budgets. Although fully funded from other funding, the person is expected to work 30% of full time and to interact with the three PI´s and the three assistant professors in this sub-project.”

6.9.7. References

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6.10. Forest use over time: ideas, values and interests

6.10.1. The significance for the Program as a whole

The purpose of this subproject is to create a historical framework for Future Forests by exploring the “intellectual background” (Sörlin & Öckerman 1999) to the current social-ecological forest system in Sweden. Historical research is often motivated on the basis that most of the experience of humanity belongs to the past, and that historical insight helps us to learn from earlier mistakes. Although that normative motive is important, the main significance of this project for the program as a whole is that it will contribute to an understanding of the intellectual drivers behind the present situation, such as ideas, values and interests.

In order to understand the scientific, political, economical and environmental views surrounding the forest and forestry in Sweden today – including the conceptual, theoretical and methodological points of departure for Future Forests itself – it is of utmost importance to have a solid understanding of the past. The reason is obvious. The way forests are treated today is a result of decisions made in the past, and the way we think about forests is shaped by our cultural and mental heritage. As William Faulkner once put it: “The past is not dead. In fact, it is not even past”.

The analysis of people’s values and attitudes in contemporary society, and of current and future controversies, is the responsibility of several of the present program’s component projects. But these projects may benefit from studies of shifts of values and attitudes in the past, as well as studies that localise stable values and attitudes as part of cultural traditions. Furthermore, history offers perspective; what is seen through contemporary eyes as abrupt and unpredictable events often become cyclic and comprehensible when viewed at appropriate time scales. History also matters for futures studies in so far as research is conducted through trend analysis and extrapolation methods. The past can be searched for analogies to current as well as future developments, and, although by no means precisely predictable, the potential pattern of future change can be explored. These statements are true for human societies but also for forests, simply because the modern forest is a mixture of nature and culture: it is a social-ecological system.

6.10.2. Research issues addressed

The social-ecological forest system in Sweden may be characterized in many ways, but one model is to interpret it as the result of two different types of forest management paradigms: ”the paradigm of sustained-yield forestry” (P1) on the one hand, and ”the paradigm of species-oriented nature conservation” (P2) on the other. Due to the existence of these two paradigms (and many other forces) the Swedish social-ecological forest system has become regulated and managed in a way that takes the interests of many stakeholders into consideration. Yet, since the paradigms are competing and more or less incommensurable the system is, at the same time, a highly contested area.

The debates and problems of today are, however, not new. Throughout the 20th century, the forest landscape has been an arena for value conflicts, political struggles and scientific controversies, and all these debates have contributed in shaping the way forestry is now regulated and managed (Öckerman 1996; Öckerman 1998; Nordlund 1999; Hagner 2005; Enander 2007a; Enander 2007b).

The aim of the project is to illuminate the present situation through a novel qualitative historical analysis of the development and establishment of ”the paradigm of sustained-yield forestry” and ”the paradigm of species-oriented nature conservation”, and to contribute to the ongoing debate about the possibility to merge P1 and P2 with the “paradigm of ecosystem service” (P3) – or other, not yet thought out, alternatives. The project’s main research questions can be stated as follows: What have been the main ideas and values within the paradigms P1 and P2? How have these ideas and values evolved, been negotiated and eventually institutionalised? How and why has the balance of power between P1 and P2 changed over time? Given the trajectories of these ideas and values, is it reasonable to suspect any radical paradigm shifts in the near future?

From an epistemological and institutional point of view this project is situated within the discipline of history of science and ideas. In short, it is a research field in which science, knowledge and other intellectual activities are analysed as components of a wider social and cultural context, and which tries not to take stand in favour of one or another way of thinking before the analyses are conduced (“the symmetry principle”). The goal is to understand how certain styles of thinking have developed and in what ways these styles have affected human practise, for example regarding the relationships between humans and nature. But the project also draws on other disciplines in the humanities and social sciences, such as environmental history, environmental philosophy, forest history, and science and technology studies (STS). One strength of the project is that it will combine concepts and methods from all these fields.

From the perspective of history of science and ideas, P1 and P2 are associated with two different intellectual traditions in environmental philosophy, known as conservationism and preservationism respectively. Conservationists point out the value of forests as a resource for human life; their view of nature is human-centered, or anthropocentric. They do argue that the forest should be exploited, but their aim is to do so without destroying the productive potential of the ecosystems (Worster 1994; Stenmark 2002). Ever since the second half of the 18th century, this view has dominated forestry (Lowood 1990). It has been articulated time and time again, notably by Gifford Pinchot, the founder of the conservation movement in the USA: "The central idea of the forester, in handling the forest, is to promote and perpetuate its greatest use to men. His purpose is to make it serve the greatest good of the greatest number for the longest time." (Pinchot 1914) While the conservationists intend to protect and, ultimately, improve nature for humans and societies, the preservationists intend to protect it against humans and societies. Preservationists point out that forests and their inhabitants have intrinsic values; their view of nature is nature-centred or ecocentric/biocentric (Stenmark 2002). Although this view is mainly associated with post-war ecological philosophy and the radical environmental movement, it is as old as the existence of extensive forestry, articulated already in the beginning of the 20th century (Haraldsson 1987).

Framed in this way, conservationism and preservationism are "ideal types" in a Weberian sense. In reality, there has always existed a great variety of ideas and values toward the forest and its use within the two traditions. The work to put the ideas and values into practice has created further trouble; to argue for one ethical view or another is one thing, but to translate the views into policies and regulations, and implement them in a predictable way, is another and much more complicated business (Stenmark 2002). Due to this complex situation, debates have occurred not only between but also *within* P1 and P2. It is reasonable to believe that some of these ideas and values (as well as their impact on society) have changed considerably over time, while others have taken the form as stable "thought figures" that continue to structure thinking. According to the environmental historian John R. McNeill (2001), one reason that the environment in the twentieth century changed so much is because prevailing ideas and politics changed so little. Thus, in order to properly analyse the development and establishment of P1 and P2, we need to focus on the actors who have articulated and negotiated the ideas and values, and the organisations that have been able to institutionalise them, thus creating "path dependence". In short, path dependence theory contends that decisions made in the past are likely to have long-term impacts by binding, limiting or postponing alternative options. According to North (1990) institutional change may also be understood as path dependent.

Changes in legislation are crucial for creating path dependence. Thus one part of this project – "Forest use and law" – will investigate ideas and arguments behind changes in the forestry law and its implementation during the 20th century, changes that in the end has been decisive for the physical shaping of the forest landscape in Sweden. Ideas and values, however, often remain silent within paradigms, typically because they are taken for granted, just as tacit knowledge. In official debates and controversies, on the other hand, ideas and values are spelled out and made clear both within and between paradigms. Another part of this project – "Controversial cases" – will therefore be designed as a series of case studies, focusing on a range of significant forest-related debates and controversies, from the beginning of the 20th century until today. Topics may include debates concerning devastating of forest resources, national parks and nature reserves, different harvest methods, spraying with phenoxy acids, fertilization, lodgepole pine plantation, the question of "forest death", clear cutting of the fjeld forest, and biotechnological innovations.

The material used for these studies will include Governmental reports and archive material and publications from important and powerful forest-related organizations, such as The Royal

Swedish Academy of Agriculture and Forestry, The Royal Swedish Academy of Science, The Swedish Society for Nature Conservation, The School of Forestry (later the Swedish University of Agricultural Sciences), the Swedish Forest Enterprise (Domänverket; later Sveaskog), and The Swedish Forest Agency. It is important, however, also to take into account the voices of less powerful organizations, such as NGOs and informal stakeholder-networks (Nordlund 1999). Mass media material will also be utilized as sources. Furthermore, in line with the program's overall aim, the project will pay special attention to the more than one hundred year old academic debate on the possible connections among climate changes, biogeography, and forest growth. One hypothesis is that scientific disagreements about these connections have always existed, and that "risk" and "uncertainty" have thus always been a part of forest management.

The two paradigms have, of course, evolved in a cultural, political and socio-economic context, both national and international, which always needs to be taken into account. Contextualisation is of importance not the least for understanding the gradual shifts of power between the paradigms, and for doing trajectory analysis of the main ideas and values. As is well known, the forest (and indeed nature in general) became a significant component in the nationalisation process of the late 19th century and early 20th century. In Sweden, the forest was first of all regarded as a key resource for modern industry and national welfare (Sörlin 1988; Eliasson 2002). But due to the many works of contemporary painters, poets, composers, architects and popular science writers, the forest was also linked to people's national pride and national (or sometimes regional) identity (Sörlin 1982; Schama 1995; Nordlund 2000; Ekman 2008). Since then people in general have appreciated forest use and taken a large interest in recreation – due to the legal right of access to private land ("allemansrätten") – or forest ownership, especially in rural areas. For some modern Swedes, the forest has almost replaced the church as a holy place (Uddenberg 1995; Ekman 2007). Such attitudes, together with the rise of "biodiversity research" and the post-Rio political goal to save and protect the "biological diversity" within single countries, certainly did much do strengthen P2 in Sweden in the 1990s.

Of certain interest for the present project is the hypothesis that this "romantic" period may be expected to come to a halt as demographic change and urbanization go further, and Sweden gains a large population that has neither grown up in rural areas nor have an attachment to Swedish forests (such as foreign nationals). This change may indeed affect people's understandings of the forest and on the legitimacy of different actions in areas of forest use. For example, people's support for P2 may decrease so that preservation of biodiversity will end up as a question of interest only for a tiny elite of biologists and environmentalists (as in the beginning of the 20th century). Due to climate change and other global environmental and economical crises it is, at the same time, likely that people's interest in P1 or perhaps new, not yet established, paradigms (such as P3) will evolve.

6.10.3. Value to users and user groups involved

Many different user groups – forest-related organizations, forest companies, forest scientists, environmental organizations, biodiversity researchers – will be involved in this project, both as informants and as objects of study. Since these various groups have different experiences, interests, and perspectives they will certainly have very different understandings of the historical development regarding the use of Swedish forest. For some, the history of forestry is an example of a gradual natural (and cultural) decline, while others would argue that it is a success story. The strength of the current project is that the history will be written by professional scholars in history, who (due to the symmetry principle) will be able to take many different views into consideration. By doing so, the project will deliver a deep understanding of how the valuation (from the standpoint of ecocentric versus anthropocentric values) of the forest has changed and been institutionalized over time, and how the differences in the valuation among groups of involved actors and institutions (forest-related organizations, societal stakeholders, environmental organizations, and the general public) have taken place. This is not only a history of ideas about forests and forestry but also a history of ideas about what forests and forestry should, or could, be. Such a history will be more complete, more compelling, more comprehensive, but also more complicated than previous histories. The research will also contribute to an understanding of the adaptive scope in organizations and generate knowledge for apt management and resolution, in order to handle potential conflicts that may be actual or implicit, among diverse actors in the forest sector and the public sector. Finally, the project will foster reflexivity among actors involved in forestry as well as in forest related science, including the Future Forests program.

6.10.4. Planned scientific and user deliverables

Research within part one ("Forest use and law") and part two ("Controversial cases") will be conducted in parallel during the first two + two years. The results will be regularly presented at local, national and international conferences, and published both in interdisciplinary journals and journals of the humanities and social sciences. Taken together our papers will comprise a unique history of ideas about forest use in different contexts, which will enable a deep understanding of the forest both as a natural resource and as a cultural phenomenon. Therefore, in addition to the scholarly articles, the project members will eventually gather their findings in two types of "syntheses": articles, published in general journals for environmental science and one textbook. These syntheses, which also should contain comparative elements (e.g. Finland, Russia, Canada), will be carried out as joint projects with the members of the research group during the second part of the program. Furthermore, the scholars in this project will contribute to working groups and, in order to foster reflexivity and inter- and transdisciplinarity within the program, run a seminar on common (and not common) theories and concepts.

6.10.5. International collaboration

Due to the work within the ongoing research program "The fuel of the future: The science, technology and selling of bio fuels in Sweden" (Formas) significant contacts regarding collaboration and comparative analyses in environmental history have already been established in Finland, Norway, Holland, UK and USA. Further contacts with distinguished international scholars will be established in 2010–2011, when the project leader have the opportunity to spend a year as a research fellow at one of the European centers for advanced study (SIAS).

6.10.6. Project leaders and participants

Leader: Associate Professor Christer Nordlund. Participants during the first two + two years: two postdoctoral students in history of science and ideas/environmental history. In year three and four, two senior scholars (Erland Mårald and Jenny Eklöf) will join the group as well.

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6.11. Values and attitudes

6.11.1. The significance for the Program as a whole

People’s values and attitudes towards how to manage the forest resource – be it an intensified or more extensive utilization of forests – is connected to how to behave and act in times of climate change. Values and attitudes may be directly linked to the forest as such, but also to other aspects of human life, i.e., the importance of clean water, the economy at large, or a cultural and historical heritage. The life we lead and the decisions we make are made in a dynamic context, in which the person may fulfill different needs with dissimilar decisions and actions. The dynamics referred to is the intricate interdependence between the individual choice and the choice of others (Liebrand & Messick 1996).

In times of climate change many of our decisions and actions as individuals within the realm of our relation to the forest and forest management may be defined as a social dilemma, in which there is a conflict between short-term personal interests and more long-term collective interests. To complicate the issue further, we may in addition find conflicts among different populations with a relation to the forest: the individual forest owner, the forest industry, the general public, and the regional and national government agencies. There are many interests associated with the forest, be it financial interests of cuttings, demand for the timber resource, recreational needs, ensured biodiversity, low degree of damage from pests, or good water quality in streams, just to give some examples. These interests may constitute short-term personal interests for some demographics and long-term collective interests for other, depending if you are a forest owner or part of the general public, if the forest owner lives at site of the forest or not, if the general public lives in proximity to the forest (rural) or not (urban), and what values and attitudes the persons hold, hence the potential conflicts.

Values and attitudes are drivers that certainly influence behavior. The private forest owners' decisions on how to manage the forest are influenced by their values and attitudes, and also by attitudes and norms in society. Values and attitudes of the large and heterogeneous group of non-forest owners are also influenced by norms. Such norms are a form of informal public consensus on a specific issue. In addition, the valuation of forest lands and perception of how to best utilize forest resources varies between different groups. Who one is, one's background, and one's values affect attitudes and behavior.

Another driver of interest is demographics, especially because there is a demographic change occurring in Sweden, as in most Western countries, which will impact the utilization of forest lands. The group of private forest owners is recognized as a heterogeneous group. These characteristics, e.g., whether or not residing on the property or live more or less far away from their forest land, if the forest is a major source of economy or if it gives an additional income, if forest property has been inherited and have emotional and cultural links with the land or if the property has been acquired, are essential parts in understanding, explaining, and predicting the attitudes and behavior. The general public shows the same heterogeneous qualities, e.g., strong link to the countryside and forest lands or not, being active in environmental work or not, spend a lot of time in forest lands or not.

6.11.2. Research issues addressed

This project focuses on how attitudes and values of both forest owners and non-forest owners affect utilization and demand of forest resources, and how attitudes and values also affect the decisions and behavior of these groups. The project focuses on the individual with his/her socio-demographic characteristics, values, and attitudes. The aim is to show how values and attitudes related to environmental issues are related to the choices that forests owners and non-forest owners are faced with in a world in which climate change, globalization, and higher consumption of materials and energy increase not only the demand of services but also the threats to the forest ecosystems. Further, the aim is to show how values and attitudes related to environmental issues change over time, and how these values and attitudes are related to demographical and geographical differences. Specifically, the following questions will be addressed:

- How do demographic change and population redistribution on the local level (in- and out-migration), occurring at the same time as climate change and globalization, affect attitudes and decisions related to environmental issues and the forest of different groups of forest owners' and non-forest owners, respectively?
- How do values and attitudes affect decision making in the dilemma of forest land use (for health and outdoor recreation versus traditional forest economics) for different groups of forest owners and non-forest owners (based on demographics and geography)?
- How do basic values and attitudes towards the forest change over time?
- How do values and attitudes, as well as different demographic factors (e.g., gender) and population redistribution, affect the balance of costs and benefits with different decision alternatives, such as presented in the scenarios?
- How do people's values and attitudes influence the perception of different scenes of forests?

Decisions, or choices between different decision alternatives, such as between different scenarios for management of forests are made by forest owners who try to balance the costs and benefits of different decision alternatives (Liebrand & Messick, 1996). Likewise, the general public is also in the situation of balancing different decision alternatives, e.g., the desire to increase bio fuel production and thus reducing burning fossil fuel versus preserving forest land for recreation and biodiversity purposes. Many of the currently occurring environmental changes may be defined as environmental dilemmas in which the individual is confronted with choices regarding the future ways of forestry; this often being a choice between acting in one's own short-term interest or in the collective long-term interest (Liebrand & Messick 1996). People are more prone to choose an alternative with known consequences rather than alternatives with unknown or uncertain consequences (Dawes 1988). This could point to a wish to continue as now ('more of the same'), neither increasing nor decreasing the level of forest production, but instead keeping it at the current level of production and continue to use current forest management systems. Because a change might be necessary, however, due to globalization, climate change, or competition for the forestry resource we need to gain more knowledge on attitudes and values.

Demographic change and an aging population can cause conflicts, not the least when a situation of scarcity of resources arises – for instance forest land (Goldstone 2002). Values, attitudes, and experiences differ among different age groups; however, to what extent this is an effect of cohorts or of changing time is disputed (Schwartz & Bilsky 1990). There are also implications of the ongoing demographic change on consumption patterns where, for instance, the perception of forest land and utilization may change as a result of changes in activities. Attitudes and behavior of different groups may thus have implications for competition over forest resources. The competition can be even harder if, e.g., clean water, wildlife, and uncut forests become scarcer in other parts of the world due to a climate change. The interest for management of Swedish forests may lead to increased ownership of non-Swedish citizens, and Swedish forests may well be exposed to increased "climate tourism". The European perspective, e.g. behavior, attitudes, and values of non-Swedish residents, will influence management and may also increase conflicts over land use (Goldstone 2002).

Age is closely linked to recreation preferences and aging will thus affect recreational use of the forest lands (Marcin 1993). Recreational use of the forest land is also significantly affected by socio-demographic factors, such as family, where one grew up, income, work, education level, and physical capacity. Previous generations, in general, had a stronger tie to rural areas and forest lands, either by having grown up in rural areas or having connections by parents or grandparents to rural areas (Borgegård et al. 1995). Half of the Swedish forest land is owned by 350 000 private owners, often non-residential, who often use forests not only for production but for fuel wood and timber for private use, recreation, and a possibility to uphold contacts with family, friends and heritage. A growing number of female forest owners also give ground for different use and valuation of the forest resource. In general, men and women have different values, as well as unequal influence and power over resources. At the same time, forest recreation has a strong tradition in Sweden. The "Right of Common Access" and the abundance of forest land often make access easy. A short distance to green areas, such as forests and parks, are important to people. A study of Swedish city residents revealed that living close to a natural setting was as important as having traditional services within walking distance (Hörnsten & Fredman 2000). These changes in how forest land is perceived, from being a source of production to being a resource for recreation, will affect forest management and utilization, but equally important it will also affect forest owners through societal norms to which forest owners are exposed to and also restricted by. If there is a norm, such as an informal public consensus to save primeval forests, it is likely that the individual forest owner will adapt rather than carry out an action that negatively provokes others.

Attitudes are not isolated within the mind but are linked to other attitudes (Eagly & Chaiken 1993). More abstract and general attitudes or values encompass more concrete and particular attitudes, which can be visualized as general attitudes about climate change on the one hand and influencing more concrete attitudes about forestry on the other hand. The beliefs assessed in the New Environmental Paradigm (NEP) are considered to tap such primitive beliefs or values about the nature of the earth and the human relationship with it (Dunlap et al. 2000). The NEP is a widely used scale that assesses beliefs about the human ability to upset the balance of nature. NEP relates to the costs and benefits of the human – environment relationship, the existence of limits to growth for human society, and the human right to rule over the rest of the world (Stern et al. 1995). NEP can shed light to the conflicts present, such as to view ones own profit as a forest owner as the core aspect of forestry today or, on the oterh hand, preserving biodiversity and neutralize climate effects.

The research will be conducted using both questionnaire and experimental scene preferences studies. The questionnaire study will be of a longitudinal design, following the same individuals in at least three data collections during eight years. This gives us the opportunity to track changes in values, attitudes, conflicts, and demographics over time within individuals but also among groups in a cross-sectional manner. In order to receive valid and reliable measures of changes in values and attitudes over time it is of utmost importance to attain a baseline on the concepts involved early in the Future Forests program. By combining questionnaire data on attitudes, preferences and decisions with the Astrid database a longitudinal perspective will be adopted.

Year 1-2
The baseline questionnaire, planned to be conducted during 2009, will involve items assessing demographics, core values, environmental awareness, attitudes, beliefs, and norms related to the forest, forest management, and environmental management. The questionnaire will also include different measures of forest-related behaviors (e.g., recreation, hunting,

berry picking, hiking), stated values and preferences for various forms of forest utilization, and related decision processes (the balancing of costs and benefits). The questionnaire will be administered as a mail-back paper-pencil survey, in two samples, with relevant under-samples. The first samples (N=2000) will be one of private forest owners, stratified such as containing owners residing on versus off their property, those who are large-scale owners and those who are small-scale owners, and private forest owners geographically spread in the southern and northern parts of Sweden. The second sample (N=2000) will comprise the general public (i.e., not private forest owners), stratified to contain those situated in an urban and rural setting and geographically spread in the southern and northern parts of Sweden. Both these samples will be screened to contain a representative distribution regarding gender and age groups.

In 2010, the data received from the baseline questionnaire will be analyzed in-depth and two articles/manuscripts will be produced, covering aspects of how demographics, values, attitudes, and conflicts are related to the views and beliefs of/about the forest in general, and also on the differences in values and attitudes between groups of forest owners and non-forest owners.

Year 3-4
Taking a departing point in the results from the questionnaire, the Future Forests program scenarios established after the second year and in collaboration with researcher of the ecology disciplines, a number of 'snapshots', or scenes, of natural forest environments will be developed. These scenes will represent different possible views of the future forest presented as photographs or through visualization software. The scenes will take into account possible effects of climate change, pests, forestry management and be used to assess scenic beauty, preferences, and also human restoration value in different samples of respondents. In addition to how people perceive the forest landscape, in terms of a scene for human recreation, it is of interest to measure how this perception is related and influenced by people's values and attitudes, and how these perceptions and related attitudinal factors influence behaviour, acceptance of conservation strategies, and preferences for different future forest scenarios. The scene preference study will tap the same samples/subsamples as in the questionnaire, conducted 2009, although in smaller numbers (N = 200) and be conducted in a controlled experimental setting.

In addition, we plan to conduct the second phase of the longitudinal study with a new questionnaire, in which some questions will be repeated and new questions based on the work of the centre for analysis and other project groups will be included. An ambition is further to carry out this second phase also in two or three other European countries (web survey) in order to capture concern over Swedish forests among European citizens.

Year 5-8
Because the design of this project is longitudinal, repeated measures of values, attitudes and conflicts will be assessed in a third phase of data collection during the last four years, alongside with repeated measures of scene preferences in a second phase. If possible, it would also be of interest to repeat the assessment of the chosen other European countries with a second web survey. The repeated data collection phases also give the opportunity to develop new research questions.

6.11.3. Value to users and user groups involved

The results from this project will be of value for private forest owners and the forest industry; it will lead to knowledge about the influencing factors related to the different interests and potential conflict present in forest management. These interests may constitute short-term personal interests for some demographics and long-term collective interests for others, depending if one is a forest owner or part of the general public, if the forest owner lives at site of the forest or not, if the general public lives in proximity to the forest (rural) or not (urban), and what values and attitudes the persons hold.

6.11.4. Planned scientific and user deliverables

- Knowledge about differences in forest consumption patterns and forest perceptions between different cohorts (young vs. old and urban vs. countryside) and among different actors (private forest owners and the general public) and changes over time.
- Present knowledge about values, attitudes and conflicts which is an important component in the scenario analyses, and a prerequisite for sustainable planning.
- Knowledge of the effects of demographic change occurring at times of climate change and globalization
- Understanding of how demographic change will affect demand and utilization of forest resources, which is an input to scenario analysis.
- Knowledge about how actors view the conflict between certain short-term consequences and uncertain long-term consequences in relation to the use of the forest, and the influence of values and attitudes on this decision process.
- Knowledge about how people’s values and attitudes influence the perception of different scenes of forests regarding scenic beauty, preferences, restoration value, and related risk perception, and how these changes over time.
- A deep understanding of how the valuation (from the standpoint of ecocentric values versus anthropocentric values) of the forest has changed and been institutionalized over time, and how the differences in the valuation between groups of involved actors and institutions (forest-related organizations, societal stakeholders, and the general public) have taken place. This is not only a history of ideas about forests and forestry but also a history of ideas about what forests and forestry should, or could, be;
- Understanding of how different actors behave, which will be an important input to the Heureka Team in its efforts for micro-scale modeling.
- Input to modeling and simulation of forest owner behavior (or actions).

6.11.5. International collaboration

Cooperation has been established with the Department of Geography at the University of Tartu. A group of geographers and climatologists working with impacts of climate change (Professor Rein Ahas and Dr Anto Aasa) will be involved in the project. They have indicated their interest in working within the project and we intend to recruit a post doc from this Tartu group, and also enable shorter (2 months) visits for one researcher.

There are established contacts with environmental psychologists on a European level. More specifically Dr. Linda Steg, University of Groningen, Dr. Christian Klöckner, University of Trondheim, and Brigitta Gattersleben, University of Surrey. They will participate in developing the European survey.

6.11.6. Project leaders and participants

Kerstin Westin and Annika Nordlund are the participants in the research project, in which Annika Nordlund will function as the project leader. A post doc will be recruited.

6.11.7. References

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Part B

7. Deliverables

Program level			
	Website available on the Internet	2009	
	First generation of Scenario Analysis	2010	
	Methods for assessing sustainability of forest land use	2012	
	Second generation of Scenario Analysis	2015	
	Thematic Working Groups	Annual	
	Conceptual developments of the social-ecological system	Annual	
	Integration projects	Annual	
	Methodology for futures research	Annual	
	Future Forests week	Annual	
	Yearly reports (eight issues, starting 2010)	Annual	
	Popular articles on new results and ongoing activities	Annual	
	Establishment of ForSA	2015	
	Popular science book summarizing Future Forests	2016	
	Scientific book/special issue summarizing Future Forests	2016	
	End-conference for stakeholders	2016	
	Scientific conference	2016	
Project level			
Forest Management and Planning	Literature review and data analysis on continuous-cover forestry	2009	
	Contribution to first generation program-level scenario analysis	2010	
	Growth model on fertilization effects, implemented in Heureka	2010	
	Literature review on productivity of exotic tree species	2010	
	Establishment experiment with Douglas fir	2010	
	Decision support tools for regeneration of forests in a changed climate	2010	
	Further decision support tools and recommendations	2011-	
	Contribution to second generation program-level scenario analysis	2015	
Forestry at the Crossroads	Seminar on World Forest Futures	2009	
	Contribution to first generation program-level scenario analysis	2010	
	A book and two articles on "World Forest Futures"	2012	
	Contribution to second generation program-level scenario analysis	2015	
	A book on forestry and rural development	2015	
Swedish Forestry in a Global Context	Detailed project description	June 2009	
	Contribution to first generation program-level scenario analysis	2010	
	Contribution to second generation program-level scenario analysis	2015	

Collaboration and Conflicts	Interview-based study identifying current and present forest related conflict situations to address future conflict scenarios (technical report)	2009	
	A synthesis on impact of climate change and intensive forest management on conflicts among stakeholders (scientific paper)	2009	
	In depth study involving Panel of Practitioners to assess future forest conflicts and the management of these conflicts (report).	2010	
	Syntheses of present knowledge (literature reviewed and interview-based) regarding: conflict management methods among forest sector interest	2010	
	Contribution to first generation program-level scenario analysis	2010	
	Participation at national and international conferences (targeted ISSRM 2010).	2010-	
	Evaluation of experienced conflicts management methods and participatory planning processes (1 scientific papers and 1 popular science paper)	2011	
	Evaluation of experienced conflicts management methods and participatory planning processes on micro and macro-levels (1 scientific papers and 1 popular science paper)	2012	
	Defining the adaptive capacity of new modes of forest related governance (2 scientific papers)	2013	
	Quality assurance of conflict management methods (2 scientific papers).	2014	
	Contribution to second generation program-level scenario analysis	2015	
Forest Governance	Literature review on existing governance mechanisms for forests	2009	
	Scientific publication on governance mechanisms for forests	2010	
	Contribution to first generation program-level scenario analysis	2010	
	Empirical case study material	2011	
	Scientific publication on case studies	2011-	
	Contribution to second generation program-level scenario analysis	2015	
Biodiversity	Contribution to first generation program-level scenario analysis	2010	
	Models on species' extinction risks in relation with nature conservation strategies	2010	
	Model of vegetation changes	2010	
	Assessment on the status of biodiversity in different parts of the managed forest landscape, including the experimental forest park Strömsjöliden	2010	
	One scientific publication on biodiversity changes based on expert opinions	2010	
	Contribution to second generation program-level scenario analysis	2015	
	Comparison of species' extinction risks under different future forestry and climate scenarios	2015	
	Forecasting vegetation changes in real forest landscapes	2015	
	Assessment of short-term effects on intensified forestry on biodiversity.	2015	
	Assessment of cost efficiency of restoration measures	2015	

Pests and Diseases	Contribution to first generation program-level scenario analysis	2010	
	Publication on the validation of the root rot model	2010	
	Preliminary model on *Greminiella* dynamics	2010	
	Data compilation on *Ips* dynamics	2010	
	Preliminary risk model on *Hylobius*	2010	
	Characterisation of insect outbreaks	2010	
	Case study on the spruce bark beetle infestation after Gudrun	2010	
	Case study of the eradication of the Dutch elm disease on Gotland	2010	
	Field monitoring sites initiated	2010	
	Review of time series	2012	
	Contribution to second generation program-level scenario analysis	2015	
Soils and Water	Provide meta-analyses on the sustainability of soils and water quality under intensified forest production and changing climate.	2009	
	Present results from initial biogeochemical modeling to identify drivers and gaps in understanding and data availability	2010	
	Contribution to first generation program-level scenario analysis	2010	
	Present improved assessments on how an intensified biomass production in combination with climate change will affect the long-term sustainability of forest soils and water quality by using new empirical and experimental data.	2011	
	Combine current knowledge and all available data into a more holistic ecosystem approach using an ensemble model approach.	2012	
	Contribution to second generation program-level scenario analysis	2015	
	Provide recommendations and decision support tools for sustainable forestry and water quality that can be used by environmental authorities and forest companies.	2016	
Forest Use over Time	Literature review on cultural factors shaping perceptions of forest use	2009	
	Contribution to first generation program-level scenario analysis	2010	
	Two publications on forest and the law (1900-1970)	2010	
	Two publications on controversial cases (1900-1970)	2010	
	Two publications on forest and the law (1970-2010)	2012	
	Two publications on controversial cases (1970-2010)	2012	
	Contribution to second generation program-level scenario analysis	2015	
	Organization of an international conference on “Forest use over time”	2015	
	Book on “Forest use over time”	2016	
Values and Attitudes	Literature study directed at attitude surveys connected to forest lands in order to make comparisons over time and space.	2009	
	Panel Study 1: Base line measure of individual values, attitudes and perception of conflicts in different samples (forest owners, different demographics)	2010	
	Contribution to first generation program-level scenario analysis	2010	
	Scene preference study 1	2011	

	Panel study 2 (Sweden, Germany, The Netherlands and Italy): 2nd wave of measure of values, attitudes and perception of conflicts in different samples (forest owners, different demographics)	2012	
	Analysis of panel studies 1 and 2 – dynamics of attitudes.	2013	
	Panel study 3	2014	
	Scene preference study 2	2014	
	Analysis of time series data	2015	
	Contribution to second generation program-level scenario analysis	2015	
	Articles on panel study 3, scene preference study 2 and longitudinal article	2016	

8. Communication strategy

8.1. Background

It is stated that a Mistra program is successful when research of high international class is put to practical use. We acknowledge that if the purpose is to initiate a change process where actions are taken based on the results generated, it is not only a matter of achieving results – how the results are achieved is of equal importance. Thus, the research process must by necessity be continuous, iterative, and include reciprocal exchange between science and practice.

Well-planned and structured communication throughout the program will aid bridge building between researchers and stakeholders as well as among researchers from different disciplines. In this way, communication will serve as a strategic tool to support and strengthen the research program in its efforts to reach vision and goals.

Specific communication plans will be developed and put into action for each individual Component Project and Thematic Working Group (see Ch. 4 and 6).

8.2. Analysis of current realities

8.2.1. Research behind the analysis

- Meetings and personal contacts with stakeholders;
- Meetings and personal contacts with researchers;
- Meetings and personal contacts with communication specialists at Mistra, supporting universities, and stakeholder organizations;
- Communication strategies and plans from other Mistra programs, and other organizations and projects;
- Literature;
- Anders Esselin personal experiences from the Mountain Mistra Program and the County Administrative Board of Västerbotten.

8.2.2. Interested parties and target groups

There is a range of stakeholders representing various claims on the forest landscape, for example:

- Forest industry;
- Forest managers (including non-industrial private owners, forest owner associations, and forest companies);
- International, national and regional governmental authorities (such as the Swedish Forest Agency, the Swedish Environmental Protection Agency, the Swedish Energy Agency, County Administrative Boards, other local authorities);
- National and international policymakers;

- Municipalities;
- Other businesses (e.g., reindeer husbandry, tourism, energy);
- NGOs (e.g., hunting, fishing, conservation, recreation);
- Other national and international research initiatives, groups and individuals working with related issues.

8.2.3. Motives and hindrances for collaboration

Each involved researcher and stakeholder has unique motives to be an element of a partnership. The phenomenon of participation or consultation “fatigue” tends not to be due to weariness about talking about important issues but to the lack of action that result from it. If nothing actually changes for them, then why should people spend precious time describing their experience and explaining their ideas? Consequently, it is important to recognize that the individuals make different priorities, have specific constraints, and need a variety of incentives to participate. To get up and get going, and after that gain and maintain a momentum in a collaborative process, it is necessary to constantly pay attention to motives and hindrances for collaboration.

- *Fundamental differences.* If we, at an early stage of the process, fall short of acknowledging and managing fundamental differences in scientific and practical paradigms and values, as well as discrepancies between benefits for individual persons, the research program and its funding bodies, there might be hinders for constructive dialog later on in the program.
- *Stakeholder involvement:* If stakeholders are not involved at an early stage of the research process the Program run the risk of lack of confidence. This can hinder stakeholders to feel that questions addressed are relevant and outputs are pragmatic (in terms of knowledge that is perceived as reliable, understandable, acceptable and implementable/useful). In the end this will surely diminish the chances of actions taken on knowledge generated.
- *Worth while:* If researchers and stakeholders experience information and communication activities as a time and resource consuming extra work, this will be a hinder for interest and engagement.
- *Feedback:* If researchers and stakeholders don’t get recognized for their engagement (initiatives taken, questions asked, etc) and don’t feel that they have a say in what is happening, this will be a hinder for further interest and engagement.
- *Dissemination of information:* More information can ad to already existing information over load. This in turn can lead to negligence to vital information sent out.
- *Empty words:* If the Board, Program management, researchers involved in the program and members of the Panel of Practitioners don’t feel that the communication strategy and communication plans
    - depart from their personal experiences and knowledge;
    - consider resources available (time, money, personnel);
    - secures a functional organization for communication;
    - are useful in a pragmatic way;

  ...the strategy and plans run the risk of being perceived as unattached to reality, rigid and difficult to apply. Thus, they will be neglected and even act as hinders for interest in, and engagement for, a continuous dialog.

8.2.3. Conclusions

Collaborative learning will be a cornerstone in the Future Forests´ communication strategy. This is a means of designing and implementing a series of events (e.g., meetings, field trips) to promote creative thought, constructive debate, and the effective implementation of proposals. Through facilitation, collaboration makes use of the different perspectives among researchers and stakeholders in order to find new ways to manage or solve problems, and tests the innovations in practice in a process of experimental learning (shifting between phases of action and reflection).

Through collaborative learning we will focus on enhancing preconditions for communication and integration between different research projects and organizational parts within Future Forests and make every individual researcher and member of the Panel of Practitioners an active and vital part of the program.

One of the basic principles of communication is to adjust communication channels and activities to each individual target group. Thus, for each project that develops a communication plan, depending on the issue at stake, the groups will be categorized into primary and secondary target groups. This will be done by the means of thorough target-group analysis.

To find the most effective way of communicating the program intends to hitch-hike (i.e. use already existing communication channels and arenas), lobby (i.e. equip key players - such as the Panel of Practitioners, the Board and the researchers - with information to help communicate the results), and roll-out (i.e. carry out own communication activities).

We recognize timing as crucial and will schedule many of the activities to coincide with important national and international meetings and political decisions in order to raise interest and make as big of an impact as possible.

8.4. Key message

The Program’s promise to society is: *Future Forests will create knowledge and tools to enable sustainable decisions for the future of one of our most important resources - our forests.*

This message will be adjusted according to objective of activity and target group.

8.5. Communication objectives

Communication shall be one of several means to help the program reach the over all objective. The overarching communication objective will thus be to optimize the learning potential of the individuals and groups involved, create constructive relations, and build both the individuals’ and groups’ capacities. Thus the knowledge generated by Future Forests will be perceived as reliable but also as socially robust (i.e. understandable, acceptable and applicable). In this way Future Forests will gain a high-profile reputation among a wide group of stakeholders, supply key stakeholders with demand-driven knowledge, and increase the use and implementation of tools and research findings from the program.

Communication objectives, target groups and efforts will change as the program evolves. We picture three phases. The focuses in each phase will naturally overlap (for instance roll out of results will be an ongoing activity through out the program, but will probably be most intense during the latter part of the program) but have a focus described in bullet points:

Year 1-2: Identification/involvement.

- Teambuilding including all organizational parts of the program;
- Production and dissemination of basic information materials that present and explain Future Forests internally and externally. This includes: design of a logotype and a graphic profile, a webpage in operation, PPTs, roll-ups, brochures, etc;
- Get all communication channels and activities refined, running and tuned in with other organizations channels and activities. In order to fulfill, develop and improve the program’s communication strategy, a meeting will elaborate on, and plan, possibilities to hitch-hike, lobby and roll-out. Information officers connected to major stakeholder organizations, as well as researchers and other experts in the field of communication, will be invited.

Year 3-6: Support/profile

- Support research with communication tools and techniques (i.e. different types of large and small groups interventions);
- Profile Future Forests externally.

Year 7-8: Conclude

- Roll out results.
- Media

(For details on objectives year 1, see Ch. 8.8.)

8.6. Chosen strategies

8.6.1. Strategy for branding

The brand Future Forests will stand for

- knowledge/science that is both reliable and socially robust (i.e. understandable, acceptable, and applicable);
- a truly interdisciplinary approach;
- a strong commitment for interacting with, and involving, stakeholders;
- rapidness, consistency, and openness.

To achieve this, information material produced in the context of Future Forests shall

- be tempting, tidy, and pedagogical;
- expose the program’s logotype, and build identification and profile;
- use the program’s graphic profile (still to be worked out);
- be gathered and catalogued both electronically and physically to raise availability.

8.6.2. Strategy for stakeholder participation

Stakeholders from a variety of organizations, companies, and authorities will be informed about the program's progress and results, and also invited to participate in the research process in a number of different ways. This has two main objectives: transparency and as a means to achieve something, i.e.:

- to inform and educate in order to raise common awareness and knowledge;
- to incorporate stakeholder knowledge, values, attitudes and doings in the research process;
- to legitimize the research initiative;
- to enhance chances for implementation of knowledge generated;
- to reduce conflicts.

The Panel of Practitioners, which will consist of about 25 persons representing main stakeholder groups, will be the core of stakeholder participation in Future Forests (described in chapter 3).

8.6.4. Strategy for channels and activities

The choice of which channels and activities to be used depends on the complexity of the issue. There is no "one size fits all" formula but there are a number of tools and techniques that can be applied to suit a given situation. Our ambition will be to connect different communication activities and channels in order to create synergies (for details on channels and activities, se Ch. 3).

8.6.5 Strategy for media

Interactions with the media are an important responsibility, and we will invest in highly strategic and active media work. This includes sending press releases and our external newsletter to media, give exclusive interviews and open press conferences, and writing debate articles. We will

- bee service minded towards journalists. Answer questions quick and objective, be available, and pass on relevant information;
- respect and accept medias independence;
- Be honest with who we are and who we represent;
- Be just as available when the news is bad as when they are good.

8.6.6. Strategy for language

Scientific working language in Future Forests is English. Communication with Swedish stakeholder groups and the public will be in Swedish.

8.6.7. Strategy for measurement and evaluation

We aim to evaluate our communication work periodically. The focus will be on process, outcome and impact. Every year we will evaluate how we have met stated operative objectives. We will also:

- Continuously measure hits on our webpage and record number of people on the distribution list for our popular science news letter and number of people attending meetings and conferences arranged by Future Forests;
- Evaluate all three aspects of our communication by sending out a survey two times during the program (forth year and eighth year). This survey will be complemented with qualitative measurements in forms of focus groups or in depth interviews;
- Use electronic media monitoring as a key tool. This enables us to not only evaluate media exposure and coverage of Future Forests´ findings and activities, but also to closely follow the news flow and current debates and strategically schedule our communication work.

8.7. Organization

Anders Esselin will be the scientific communicator who will lead the strategic and operative communication work in Future Forests.

A firm institutional support for outreach and communication is crucial for success. The Managing Director will thus be ultimately responsible for communication activities in the program.

The communication work will be done in close collaboration with the Managing and Research Director, staff in program management, the Board, engaged scientists, the Panel of Practitioners, and experienced information personnel at UmU, SLU and Skogforsk. In addition to this, we will tap synergies with our collaborative partners´ ongoing outreach and communication activities.

Every year the communication plan is to be revised and approved by the Board.

8.8. Communication plan 090101-091231

Target group	Communication objectives	Activities/channel	Budget	Responsible	Date
Board	*Know* • Program plan • Role and responsibility in FF *Feel* • Confidence in plan and management • Engagement *Do* • Take decisions • Contribute with knowledge and networks	• Future Forests week • Internal newsletter • Popular articles • Website on the Internet • Basic information materials • Scientific reports, articles and books	250 000 100 000 150 000	FF mgnt Anders Anders Anders Anders Stig/researchers	8-12/6 1/month Ongoing
Contracted researchers	*Know* • Program plan • Role and responsibility in FF *Feel* • Confidence in plan and management • Engagement *Do* • Research according to plan • Participate in, and contribute to, FF overall activities and development • Contribute with knowledge and networks	• Future Forests week • FF Research meetings • Thematic Working Groups • Internal newsletter • Popular articles • Website on the Internet • Basic information materials • Scientific reports, articles and books		FF mgnt Stig Jon Anders Anders Anders Anders Stig	8-12/6 2/year 4 1/month 4/year Ongoing
Panel of Practitioners	*Know* • Program plan • Role and responsibility in FF *Feel* • Confidence in plan and management • Engagement *Do* • Participate in FF overall activities and development • Contribute with knowledge and networks	• Future Forests week • PP meeting • Workshop on communication strategy • Thematic Working Groups • Internal newsletter • Popular articles • Website on the Internet • Basic information materials • Scientific reports, articles and books	100 000 100 000	FF mgnt Anders Anders Jon Anders Anders Anders Anders Stig	8-12/6 12-13/2 08 12/3 4 1/month Ongoing
Interested parties and target groups, as specified in 8.2.2.	*Know* • FF exist *Feel* • FF is a novel, creative, serious research initiative *Do* • Collaborate with FF • Seek info about FF and knowledge generated by FF	• Popular articles • Website on the Internet • Media • Basic information materials • Scientific reports, articles and books		Anders Anders Tomas/Anders Anders Stig	Ongoing

8.9. Communication activities, timetable 2009

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Okt	Nov	Dec
Peer-reviewed articles and books	Ongoing											
Working Groups´ project summaries	Ongoing											
Internal newsletter	1	1	1	1	1	1	1	1	1	1	1	1
Popular articles	Ongoing											
Yearly reports												
Scientific and popular science books												
Presentation material	Ongoing											
Webpage*	X	X	X	X	X	X	X	X	X	X	X	X
Internal meetings	21-22/1 Research meeting	12-13/2 PP-meeting	12/3 Workshop on communication strategy			8-12/6 FF week				6-7/10 Research meeting		
Board meetings	x					x					19/11	
Conferences												
Workshops												
Seminars and hearings												
Advisory roles												
Personal meetings**	Ongoing											
Courses/education												
Excursions												
Media												
Exhibition												

* Will be updated at least 2 times/months

9. Budget

INTÄKTER	2009	2010	2011-2012	Totalt
Mistra	15000	15000	30000	**60000**
Skogsbruket	12000	12000	24000	**48000**
Universitet	10000	10000	20000	**40000**
Summa intäkter	37000	37000	74000	**148000**

KOSTNADER				
personalkostnader	17035	19423	35978	**72436**
Resekostnader	1007	1180	2240	**4427**
Förbrukningsmaterial	1619	1744	3075	**6438**
Övriga driftskostnader	751	352	637	**1740**
OH inkl lokaler	5946	6747	12492	**25186**
Köpta tjänster	2850	3560	6212	**12622**
Högskolemoms 8%	2160	2160	4320	**8640**
Till styrelsens förfogande	5632	1833	9046	**16512**
Summa kostnader	**37000**	**37000**	**74000**	**148000**

	2009	2010	2011-2012
KOSTNADER			
Programledning			
Personalkostnader	1228	1253	2560
Tomas L 0,4	396	408	840
Stig L 0,4	432	445	920
ekonom	300	300	600
adm stöd	100	100	200
Resekostnader	150	125	250
Förbrukningsmaterial	50	50	100
Övriga driftskostnader	50	50	100
till direktörernas förfogande	50	50	100
OH inkl lokaler 35%	430	438	896
Köpta tjänster	200	300	450
Högskolemoms 8%			
Summa kostnader	2108	2216	4356

	2009	2010	2011-2012
KOSTNADER			
Centrumaktivitet syntes och analys			
Personalkostnader	2250	2550	1600
Scenarioanalyser	1650	1650	0
Tematiska workshops	600	900	1600
Resekostnader	100	300	600
Förbrukningsmaterial	200	200	400
Övriga driftskostnader	100	100	200
OH inkl lokaler 35%	788	893	560
Köpta tjänster	400	1000	2000
Högskolemoms 8%			
Summa kostnader	3838	5043	5360

	2009	2010	2011-2012
KOSTNADER			
Centrumaktivitet			
ledning och kommunikation			
Personalkostnader	2543	1898	2828
Jon Moen	619	638	1307
Anders Esselin	720	742	1520
Peter Duinker	200	200	
Postdoc nn	504	519	
Tematisk workshop	700	0	
Resekostnader	225	225	550
Förbrukningsmaterial	500	400	600
Övriga driftskostnader	150	75	225
OH inkl lokaler 35%	890	664	990
Köpta tjänster	100	100	200
Högskolemoms 8%			
Summa kostnader	4408	3363	5392

KOSTNADER	2009	2010	2011-2012
Tematiska samverkansprojekt			
Personalkostnader	900	1400	2800
Belutsstöd skogl plan	400	400	800
Bryggprojekt	500	1000	2000
Resekostnader	50	50	100
Förbrukningsmaterial	200	400	800
Övriga driftskostnader			
OH inkl lokaler 35%	315	490	980
Köpta tjänster			
Högskolemoms 8%			
Summa kostnader	1465	2340	4680

KOSTNADER	2009	2010	2011-2012
Pest and diseases			
Personalkostnader	800	800	1600
Resekostnader	50	50	100
Förbrukningsmaterial	70	70	140
Övriga driftskostnader	0	0	0
OH inkl lokaler 35%	280	280	560
Köpta tjänster	0	0	0
Högskolemoms 8%			
Summa kostnader	1200	1200	2400

KOSTNADER	2009	2010	2011-2012
Forest management			
Personalkostnader	4550	4687	9300
Resekostnader	225	225	250
Förbrukningsmaterial	300	300	400
Övriga driftskostnader			
OH inkl lokaler 35%	1593	1640	3255
Köpta tjänster	1390	1390	2800
Högskolemoms 8%			
Summa kostnader	8058	8242	16005

KOSTNADER	2009	2010	2011-2012
Conflicts			
Personalkostnader	135	278	1290
Camilla Sandström	135	139	570
Karin Öhman	0	139	570
Eva Marie Nordström			150
Resekostnader	12	5	10
Förbrukningsmaterial	5	30	75
work-shops	5	30	75
Övriga driftskostnader	16	32	32
konferenser	16	32	32
OH inkl lokaler 35%	47	97	452
Köpta tjänster		10	12
Högskolemoms 8%			
Summa kostnader	215	452	1871

	2009	2010	2011-2012
KOSTNADER			
Values and attitudes			
Personalkostnader	680	603	1400
Annika Nordlund	270	278	550
Kerstin Westin	158	65	150
Post doc nn	252	260	
Resekostnader			
Förbrukningsmaterial			
Övriga driftskostnader	340		
OH inkl lokaler 35%	238	211	490
Köpta tjänster			
Högskolemoms 8%			
Summa kostnader	1257	813	1890

	2009	2010	2011-2012
KOSTNADER			
Forest use over time			
Personalkostnader	672	692	2400
Post doc nn	336	346	1200
Post doc nn	336	346	1200
Resekostnader	10	10	20
Förbrukningsmaterial	50	50	100
Övriga driftskostnader	25	25	50
OH inkl lokaler 35%	235	242	840
Köpta tjänster	20	20	50
Högskolemoms 8%			
Summa kostnader	1012	1039	3460

	2009	2010	2011-2012
KOSTNADER			
Forest sector in a global context			
Personalkostnader	252	520	1000
post doc nn	252	520	520
Resekostnader	5	10	20
Förbrukningsmaterial	5	5	10
Övriga driftskostnader	5	5	10
OH inkl lokaler 35%	88	182	350
Köpta tjänster	700	700	700
Högskolemoms 8%			
Summa kostnader	1055	1422	2090

	2009	2010	2011-2012
KOSTNADER			
Soils and water			
Personalkostnader	1352	1928	3900
Eva Ring	200	200	400
Foassar	1152	1728	3500
Resekostnader	20	20	40
Förbrukningsmaterial	100	100	200
Övriga driftskostnader			
OH inkl lokaler 35%	473	675	1365
Köpta tjänster			
Högskolemoms 8%			
Summa kostnader	1945	2723	5505

	2009	2010	2011-2012
KOSTNADER			
Biodiversity			
Personalkostnader	878	895	1800
Jocke Hjältén	210	210	
Thomas Ranius	312	320	
Olof Widenfalk	306	315	
Teknisk personal	50	50	
Resekostnader	10	10	
Förbrukningsmaterial	19	19	
Övriga driftskostnader	45	45	
OH inkl lokaler 35%	307	313	630
Köpta tjänster	40	40	
Högskolemoms 8%			
Summa kostnader	1299	1322	2430

	2009	2010	2011-2012
KOSTNADER			
Futures studies			
Personalkostnader	324	1014	2000
Erik W	324	667	1575
Post doc nn	0	346	726
Resekostnader	100	100	200
Förbrukningsmaterial	50	50	100
Övriga driftskostnader	20	20	20
OH inkl lokaler 35%	97	304	600
Köpta tjänster			
Högskolemoms 8%			
Summa kostnader	591	1488	2920

	2009	2010	2011-2012
KOSTNADER			
Governance			
Personalkostnader	471	906	1500
Post doc nn	336	510	180
Post doc nn	70	260	500
Carina K	65	66	140
Teknisk personal	0	70	70
Resekostnader	50	50	100
Förbrukningsmaterial	70	70	150
Övriga driftskostnader	0	0	
OH inkl lokaler 35%	165	317	525
Köpta tjänster			
Högskolemoms 8%			
Summa kostnader	756	1343	2275

10. Report on deviations from application

To meet recommendations posed by the two committees that evaluated Future Forests, and the Board of Mistra, in the spring of 2008 and to fulfil the intentions of Mistras initial research call, the application has now been revised and refined. The most important deviations from the application are as follow:

- The **structure** of the document has been changed to meet standards described by Mistra.
- The methods and underpinning science of **scenario analysis** are explored, elaborated and described in more detail (Ch. 2.5, 4.5, and 6.1.2.). Prof. Peter Duinker, Dalhouise University, Halifax, Canada, is appointed to take the lead in the early phase of the scenario development within Future Forests. More resources have been allocated to this part of the program, especially during year 1-2 and year 7-8.
- The **Center** for Forest Systems Analysis and Synthesis (ForSA) will not be hosted in a new building, as suggested in the application (Ch. 4.5 and 6.1). Instead, it will start out as an immaterial center. The ambition is still, however, that ForSA will be the cornerstone of Future Forests, with an explicit mission to foster integration among scientists from different disciplines as well as between science and society. To put more power into ForSA, organization and activities are now more clearly defined and resources have been allocated from Future Forests Component Projects into ForSA. Prof. Jon Moen, Umeå University, has been appointed Director of Center.
- The **international perspective** of the Program has been strengthened in several ways. Prof. Peter Duinker will take a leading role in the development and analysis of scenarios, as already mentioned. Prof. Lauri Hetemäki, Finnish Forest Research Institute has accepted our invitation to be a member of the Scientific Advisory Board (Ch. 4.2).
- The **budget** is now described in detail for all parts of the program (Ch. 9).
- The **communication strategy** (Ch. 8) is developed according to plan. During this process, communication officers from universities and collaborating partners have given valuable views, perspectives and advice. Further refinement will take place in collaboration with stakeholders and communication expertise during the first year of the program.
- The composition, role, and work of the **Panel of Practitioners** is updated and described in more detail (Ch. 3). 18 organizations have been invited to contribute with representatives. Those persons will then (in the beginning of 2009) suggest additional 5-10 organizations that ought to be represented in order to make the Panel a vital injection to the program.
- The Component Project **Future forests for all and everyone? An economic perspective** has been revised and renamed to **Swedish Forestry Sector in a Global Context** (Ch. 6.4). Although yet to be finalized, we feel confident that this Component Projetc will be a significant contribution to the Program. Valuable international contacts, potentially partners of the Project, have been established, and enlightening discussions have been undertaken with fellow Swedish economists. Thus, we foresee that this Component Project will be successfully described and in full operation by June 2009.

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Prof. Stig Larsson, Research Director