mistra–INCLUDE

Integration of ecological and cultural dimensions in transport infrastructure management

part of the Mistra research programme

SUSTAINABLE MOBILITY

Programme proposal

2005-04-01

Preface

We hereby deliver the proposal for component programme INCLUDE in the Mistra research programme "Sustainable Mobility" for the period 2006-2008.

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This programme proposal can be referred to as:

Emanuelsson, U., Seiler, A., Helldin, J-O., Folkeson, L., Lindström, M., Olsson, K., Wästfelt, A., Isaksson, K., Angelstam, P. 2005. Integration of ecological and cultural dimensions in transport infrastructure management (INCLUDE). – MISTRA Programme proposal, April 2005, Uppsala.

The main goal of our proposal is to support the development of a long-term strategy for achieving an environmentally sustainable transport system. Decoupling today's transportation from its adverse environmental and social impacts requires not only a wise management of mobility and transports; it needs as well a broad-scale adaptation of physical transport facilities and associated planning processes concerning land use and infrastructure. Our focus is on the integration of landscape ecological and socio-cultural landscape values in this latter task.

We envision a future infrastructure that is well adapted to the natural, social and cultural conditions of the embedding landscape and provides opportunities for creating new values and qualities that match national and international environmental quality objectives.

Summary

In June 2004, the Swedish council on strategic environmental research (MISTRA) called for research proposals addressing the topic of “Sustainable mobility”. We responded to this call with an application on “Land use for sustainable mobility”. Among all applicants, MISTRA invited four consortia to develop detailed program plans under the umbrella of Sustainable Mobility until April 2005. Our consortium represents the only group that focuses on how ecological and socio-cultural dimensions in landscapes and land use can be integrated in different levels of the planning towards a sustainable transport system. Our program is being developed in close cooperation with the Swedish Road Administration and the Swedish National Rail Administration, which also took the initiative together with landscape ecologists, physical- and human geographers, and civil-engineers from a range of relevant institutions (see annex 1). The present document comprises the detailed plan of the program now called “INCLUDE - Integration of ecological and cultural dimensions in transport infrastructure management”. In order to increase the thematic complementation among the possible programs within “Sustainable Mobility”, our programme is now more focused on the impact of the transport system on ecological and socio-cultural landscapes qualities than the original proposal in September 2004.

The main goal of our proposal is to support the development of a long-term strategy for achieving an environmentally sustainable transport system. Decoupling today’s transportation from its adverse environmental and social impacts requires not only a wise management of mobility and transports; it also needs a broad-scale adaptation of physical transport facilities and associated planning processes concerning land use and infrastructure. We envision a future infrastructure that is well adapted to the natural, social and cultural conditions of the embedding landscape and even provides opportunities for creating new values and qualities that match national and international environmental quality objectives.

Approaches to accomplish this high ambition must integrate environmental policy with best knowledge about dose-response relationships in the environmental cumulative impact. They must be based on present decision making processes, and yet prepare for a methodological and conceptual change in infrastructure management. Landscape systems and hence the impacts on landscapes are highly complex, involving a multitude of perspectives and interests that interfere with or depend on spatial and temporal dynamics. In order to support understanding and implementation of our work by the various stakeholders and end-users, we need to find simple but elegant, illustrative but robust means of communicating concepts and methods.

In INCLUDE, we seek to contribute to this vision by demonstrating, for a selected set of problems, how solutions can be found and implemented. Our approach is concentrated around four guiding questions:

- What is a sustainable landscape, which criteria relate to sustainable development of landscapes, which indicators can be used to measures and evaluate sustainability for biodiversity and cultural heritage?

- How does infrastructure and traffic affect ecological, social, cultural, and recreational values in landscapes? What is the critical impact on environmental qualities, functions and processes that relate to sustainability? Where are limits and thresholds in dose-response relationships of this impact?
- How can the impact and its consequences be assessed, predicted, evaluated and communicated to stake holders, planners and decision makers. What tools are needed to integrate this knowledge in planning processes as well as in the mind of people?
- What options do we have to improve the situation? What remedying measures can be implemented and how can we affect the planning process itself to provide for a greater consideration of landscape and sustainability values?

We will focus our efforts on the two most characteristic and yet least understood direct effects of infrastructure and traffic, i.e., barrier and disturbance effects. They relate to accessibility, connectivity, landscape perception, value and suitability for humans as well as for animals and plants. We intend to develop an interdisciplinary approach in joining tangible geographic information with intangible landscape values in a “toolbox” for use in spatial and infrastructure planning. Our work will be organised in international workshops, four component projects that address the above questions and which’s results are synthesized and combined to provide the necessary tools and applications. The latter will be accomplished mainly during the second phase of the programme, while the first phase will establish and develop knowledge and approaches. We will work at local, regional and (inter-)national spatial scales and use different case studies and study areas along a gradient of natural over rural to urban landscapes and equally, from East Europe to West Europe. Our results will be endorsed in Swedish spatial planning and infrastructure management through close collaboration with the related governmental authorities, non-governmental organisations and the private sector. Since the need to tackle the cumulative impact of transportation infrastructure on landscapes is ubiquitous, we believe that INCLUDE can also make an internationally significant contribution.

Sammanfattning

I juni 2004 utlyste Stiftelsen för miljöstrategisk forskning (MISTRA) forskningsmedel på temat “Sustainable mobility”.

Vårt konsortium ansökte med ett forskningsförslag kallat “Landuse for sustainable mobility”. Bland de sökande valde MISTRA ut fyra konsortier som inbjöds till att utveckla detaljerade programförslag till april 2005. Vårt konsortium var den enda grupp som behandlade hur ekologiska och socio-kulturella dimensioner skulle kunna integreras på olika nivåer i planeringen av ett uthålligt transportsystem.

Föreliggande program har utvecklats i sammarbete med Vägverket och Banverket, som tillsammans med ekologer, naturgeografer, kulturgeografer samt ingenjörer, ursprungligen tog intiativ till ansökan (se bilaga 1) vilka representerar olika institutioner. Föreliggande ansökan innehåller den detaljerade programbeskrivningen får vårt program som vi numera kallar “INCLUDE - Integration of ecological and cultural dimensions in transport infrastructure management”. För att tydliggöra hur vårt program kompletterar det andra under programmet och huvudprogrammet “Sustainable Mobility” har vi fokuserat vårt program tydligare mot transportsystemens inverkan på det ekologiska och socio-kulturella landskapskvaliteter än vilket var fallet i den ursprungliga ansökan i september 2004.

Målet för vårt förslag är att skapa förutsättningar för utvecklingen av långsiktiga strategier för att på sikt kunna uppnå ett miljömässigt uthålligt transportsystem. Separationen av transportsystemet från dess miljö- och samhälleliga effekter kräver inte bara en utvecklad teknisk hantering av själva transporterna, det kräver också en bred förståelse av hur transportsystemets fysiska egenskaper och dagens planeringsprocesserna påverkar markanvändning och infrastruktur. Vår vision är en framtida infrastruktur som är väl anpassad till inneboende miljö- och kulturmiljöegenskaper hos landskapet samt ger upphov till skapandet av nya värden och kvaliteter som harmoniserar med nationella och internationella miljömål.

För att nå denna höga ambitionsnivå krävs att en integrering åstadkoms där policy och kunskaper om samband mellan påverkan och respons relateras till den ackumulerade miljöpåverkan. Integreringen måste utgå ifrån aktuella beslutsprocesser och samtidigt lägga grunden för en begreppslig och metodiska förändringar i planeringen av infrastrukturen. Landskap funktionellt system är mycket komplext till sin natur. Därmed är påverkan på landskap svårt att enkelt studera, många olika perspektiv och intressen är alltid involverade och dessutom är landskapet dynamiskt i både tid och rum. För att skapa förståelse och göra det möjligt att nyttja våra resultat hos olika intressenter och slutanvändare kommer det att krävas enkla och eleganta, robusta och illustrativa grepp för att kommunicera begrepp och metoder.

Genom INCLUDE vill vi bidra till att denna vision förverkligas genom att demonstrera hur ett urval av problem kan identifieras och implementeras. Vårt program kommer att koncentreras och fokuseras på fyra frågor:

- Vad är ett uthålligt landskap, och vilka är kriterierna och de indikatorer som kan mäta och göra det möjligt att utvärdera en uthållig utveckling av biologisk mångfald och kulturmiljövärden i landskapet.
- Hur påverkar infrastruktur ekologiska, sociala, kulturella och rekreationsvärden i landskapet? Vilken är den kritiska påverkan på miljökvaliteter, funktioner och processer relaterade till uthållighet? Vilka är gränserna och trösklarna för påverkan?
- Hur kan påverkan och dess konsekvenser bedömas, förutses, värderas och kommuniceras till intressenter, planerare och beslutsfattare. Vilka verktyg behövs för att integrera våra kunskaper i såväl i planeringsprocessen som i allmänhetens medvetande?
- Vilka möjligheter har vi att förbättra dagens situation? Vilka mått kan implementeras och hur kommer det påverka planeringen att det blir möjligt att göra överväganden kring landskaps- och uthållighets värden?

Vi kommer att fokusera våra insatser på två karakteristiska effekter av infrastrukturen, barriäreffekter och störningseffekter. Dessa relaterar till tillgänglighet, konnektivitet, landskapsuppfattning och värden av olika slag för såväl människor, djur och växter. Vår intention är att utveckla ett tvärvetenskapligt angreppssätt där geografiska information och immateriella värden förenas i en verktygslåda som skall kunna användas i rumslig infrastrukturplanering. Vårt arbete kommer att organiseras genom internationella workshops, fyra projekt som var och ett tar upp ovanstående frågor och vars resultat kommer att syntetiseras och kombineras för att skapa de nödvändiga verktygen och applikationerna. Applikationerna kommer i huvudsak att arbetas fram under den andra fasen av programmet, medan fokus i den första fasen är att utveckla kunskapen och angreppssättet. Vi kommer att arbeta på lokal, regional och (inter-) nationell skalnivå i olika studieområden längs en gradient från natur via rurala till urbana landskap i såväl Västeuropa som Östeuropa. Implementering av våra resultat i den Svenska infrastruktur och samhällsplaneringen kommer att ske genom nära samarbeten med berörda myndigheter, intresseorganisationer och privata aktörer. Behovet av metoder för att hantera den kumulativa påverkan av transportinfrastrukturen på landskapet och landskapets uthållighet är allomfattande. Genom detta menar vi att INCLUDE kommer att kunna ge ett betydelsefull internationellt bidrag till kunskapsuppbyggnad och vidare forskning.

Contents

Part A

Program description

A1. The problem

Mobility is an essential requisite to our cultural, social and economic development; it is needed for our individual daily activities as well as for the society as a whole. Growth in motorized traffic is usually taken as a benchmark in the socio-economic development of a country. Increased traffic is usually met with an expansion of infrastructure, which, in turn, invites for further transport increase. Over the past decades, we have witnessed a steadily growing transport sector and the trend is yet unbroken.

Unfortunately, modern transport systems with their supporting infrastructure and the imbalance in the development of the means of transportation (favouring individual car travel and flight transport before public transport such as railways) entail substantial environmental impacts: they consume non-renewable natural resources, contribute to climate change and local air pollution; contaminate surrounding environments with noise, toxins, and particulate matter; degrade artefacts and monuments; trigger changes in microclimate, ground water flow and land use; and cause an increasing loss and fragmentation of natural and human living spaces with subsequent adverse effects on biodiversity and social life (Canters et al. 1997; Seiler 2003; Forman et al. 2003).

In many respects, today’s mobility is far from environmentally and socially sustainable. To achieve sustainability, we need to rethink transport systems, adapt decision processes, understand people’s behaviour and values, and decouple transportation from its environmental effects. Reducing overall mobility is certainly not feasible; instead, new transport strategies must be developed in concert with an adapted planning for land use and infrastructure at different spatial scales that organises the need of personal mobility and the access to goods, places, services, and information in a more efficient and socially inclusive way. However, regardless of whether vehicles can be made more efficient, energy restored or congestion problems prevented, land use for transport infrastructure (roads and parking, rail corridors, airports, and harbours) is likely to increase by 2030 due to the expected growth in transport activity. Transport infrastructure, mainly roads, already occupies about 25-30% of land in urban areas and almost 10% in rural areas in the OECD (OECD 2000). Between 1990 and 1998 some 33,000 ha, about 10 ha of land every day, were taken for motorway construction in the EU. Most areas in the EU are highly fragmented by transport infrastructure. The average size of contiguous land units that are not cut through by major transport infrastructure ranges from about 20 km^2 in Belgium to nearly 600 km^2 in Finland (EEA 2001). In Sweden, roads and railroads combined make up less than 1.5% of the total land surface, which nevertheless is almost the same area as is designated as national parks (Seiler 1996). However, the cumulative impacts on the landscape influence significantly larger areas. Forman (2000) assessed that road infrastructure in the USA directly affects an area that is about 19 times as large as the 1% of the USA land surface that is physically occupied by roads. The expansion of road infrastructure, in particular motorways, will add barriers to the migration of many species, reducing their viability and disrupting local ecosystems, and further increase the adverse effects on ecological and socio-cultural qualities in the landscape. This trend will be especially strong in the new EU member states.

Clearly, infrastructure and its effects on landscapes and land use are key criteria in a sustainable transport system (OECD 2000). Land use influences several other critical sustainability issues: it creates and canalises transport activity with the consecutive environmental effects, it generates transport demands, and it contributes directly to the increasing pressure on ecosystems and biodiversity in landscapes as well as on the natural and cultural heritage through expansion and intensification of infrastructure networks. Moreover, the interdependence between land use and infrastructure has a great influence on social and ecological sustainability. Transport infrastructure does not only have the potential to bring people or businesses together, or create access to natural resources, it can also counteract social interaction and deprive the natural resilience of the environment at local as well as at regional scale.

Sustainable transport systems and sustainable landscapes

Traditionally, the focus in developing environmentally sustainable transport systems (EST) has been either on global issues or on local issues. Strong efforts have been made to control and reduce effects on climate change and tropospheric ozone, as well as on local air pollution, acidification and eutrophication, on traffic noise and traffic safety related to congestion problems, mainly in urban areas. To tackle problems at intermediate scales, however, including the impact of infrastructure on landscapes and landscape qualities, further research is needed (Anonymous 1994, 2001c; OECD 2000).

The definition of EST by the OECD (2000) summarizes some of the key questions that need further elucidation. An Environmental Sustainable Transport System

- helps to preserve public health and the environmental quality,
- respects critical limit values for health and ecosystems,
- uses non-renewable and renewable resources in a sustainable manner,
- avoids global irreversible effects.

What is “environmental quality”, what are the “critical limit values”, what is “sustainable manner”, and what are “irreversible effects” if applied to landscapes? In other words, what are the ecological and socio-cultural qualities in landscapes that are affected by infrastructure and are essential for sustainability? Where are and who defines the limits for how much transport and infrastructure may affect these qualities? The limits certainly vary between natural, rural and urban landscapes, but these landscapes, on the other hand, are partly defined through the presence of infrastructure in the first place. Infrastructure and human settlement go hand in hand, except in areas that are exclusively used for resource extractions, such as managed forests. Infrastructure density in combination with traffic intensity may provide a crude but useful index of the overall effect of transportation on a landscape, although it is less the direct and immediate impact than the cumulative impact together with secondary effects caused by human activity, changes in land use, etc., that comprise the total footprint (Forman et al. 1997, Angelstam et al. 2004).

Natural space, and hence a landscape, is limited per se and thus a non-renewable resource. How can we use it in a sustainable manner? What is a sustainable landscape in the first place and how does modern transport infrastructure fit in? Historically, paths and roads were an integrated part of the landscape, built and maintained by local farmers for local purposes. Where roads were built, new settlements, farms, fields or other human facilities were likely to follow. Thus, an intimate relationship between roads and land use developed, making the roads an integrated part of the environmental and cultural context of the landscape (Castensson 1991). As a result, many of the older local roads in Sweden still carry significant cultural and ecological values (Almqvist & Syllner-Gustafsson 1994). It was first during the recent 70-80 years, that technical progress and modern engineering liberated road-planners from the natural constraints of the terrain (Jönsson 1991). Roads could be built broader, straighter and with less concern to topography and soil texture than in earlier times. The need of roads that could carry motorized vehicles of heavier weight and at greater speed led to a general improvement of practically all roads, especially those that serve long-distance communication. Motorways and highways are thus no longer embedded in the given context of the landscape; they do not serve local communication or give access to local resources, nor should they. Instead, they are rather superimposed on the existing land use pattern, they disrupt natural linkages and processes, and lead to a fragmentation of the landscape in a literal sense.

Yet, if seen from a broader perspective and on a longer time scale, even motorways may eventually become an integrated part of the environment as they shape and create a new landscape, new land use pattern and new processes and linkages. Landscape (cultural) value is thus not a continuum, but rather a variable that is defined from a number of independent factors. Sustainability, in this context, is difficult to define. It is not a conservation or preservation concept, but a rather dynamic property that allows changes and processes to occur, and eventually, alter the characteristics of the original landscape. Sustainable development should be based on knowledge of the processes that maintain the environment in a state of change; the processes need to be protected, not maintained in a particular state (Southwood 1995). In addition, landscapes are clearly multifunctional arenas for our live. Sustainability should thus result from a multidisciplinary and multileveled consensus among all actors and stakeholders involved, rather than being solely created upon expert opinions, political ideals, or economic constraints (e.g., Naveh & Lieberman 1994; Forman 1995).

Sustainability concept

Since the endorsement of the “Brundtland Report“ (World Commission on Environment and Development 1987), sustainability has become the key term in developing the relationship between the three basic dimensions of sustainability, i.e., the economic dimension, the social dimension, and the ecological dimension. Clearly, sustainable development has particular meanings in different disciplinary settings (Basiago 1995):

- In biology, sustainability is associated with the protection of biodiversity and natural “capital” on behalf of future generations.
- In economics, it addresses accounting for natural resources and examines how markets, as conventionally conceived, fail to protect the environment.
- In sociology, it involves environmental justice in situations where few make decisions over the use of natural resources that affect many in their daily lives.
- In planning, it relates to the process of urban revitalization that integrates urbanization and nature preservation.

- In environmental ethics, it means alternatively conservation or 'sustainable use' of natural resources and relates to the questions whether humans are part of, or apart from, nature, and how this should guide moral choice.

To address sustainability issues in the management of landscapes and infrastructure, we need strategic planning tools that integrate these different interests. We need a more process- and target-oriented approach towards a dynamic environmental management instead of the traditional static conservation approach (Seiler & Eriksson 1997). We need to understand which processes and functions are to be protected so that landscape dynamics can be maintained. To be able to assess the consequences of permanent impacts such as infrastructure development –or the efficacy of mitigation measures--on values and processes in "dynamic" landscapes, we need to develop methods for creating and comparing alternative scenarios. At the same time, however, our tools and methods must be robust enough, and their results simple enough, to be understood and implemented by the various stake-holders and decision makers involved in the planning process.

Swedish environmental policy and target-orientation

Target-orientation has become a leading theme in Swedish environmental work since the endorsement of the new environmental code in 1999. The Government's declared aim is to promote sustainable development that ensures a healthy environment for both the current and future generations. By 2020, the natural and cultural environment shall be flourishing; the transport system shall be economically, socially and environmentally sustainable, and land use planning shall be driven by programmes and strategies (Anonymous 2000b; 2000a; 2001a). This shall be achieved through a top-down implementation of 15 national environmental quality objectives such as "clean air", "green forests" or "good built environment", which reflect five fundamental principles of sustainability: promotion of human health, preservation of natural and cultural heritage, preservation of long-term production capacity of ecosystems, and wise management of natural resources. A 16th national objective with a exclusive focus on biodiversity has recently been proposed (SEPA 2003). These national quality objectives govern a system of sectorial, regional and local objectives, intermediate environmental goals and interim targets that integrate pro-environment efforts of authorities, organisations and individuals. It is the responsibility of each sector to develop intermediate goals and to set up a system of criteria and measures that shall help attaining these goals within a given time.

Most of the 15 environmental quality objectives relate either to specific sector responsibilities, i.e. land use forms (e.g., urban areas, agriculture, forestry, marine environment) or to well known environmental threats (e.g., air pollution, eutrophication, climate change). There is as yet no environmental objective, however, that considers properties, processes, and functions in entire landscapes, or cuts across sector responsibilities and develops a specific apprehension of natural (and cultural) assets in the landscape (Anonymous 1994; 2001c). Current practise in environmental impact assessment (EIA) has not been successful in evaluating and counteracting impacts on landscape perception, value, biodiversity, and social function (Anonymous 1996; Seiler & Eriksson 1997; DeJong et al. 2004). Social, cultural and ecological landscape values do not yet receive the same consideration in infrastructure planning as do other environmental issues such as air pollution or CO_2-emission that more easily can be described quantitatively and be converted to monetary values (Cedermark & von Koch 2000; Grudemo et al. 2003; Nilsson & Sjölund 2003).

Quality objectives and performance targets

Initial steps to integrate landscape ecological concepts in road management and impact assessment have already been taken (e.g., Eriksson & Skoog 1996; Seiler & Eriksson 1997). Development of goals, criteria, and quality requirements concerning natural and cultural assets is ongoing (Anonymous 1999; 2001b). A new target-oriented approach in transport management is currently being developed to direct activities from strategic planning at national level via infrastructure management and maintenance down to individual road or railway projects (Nilsson & Sjölund 2003, Seiler & Sjölund , submitted).

In this approach, one overarching quality objective concerning the cumulative impact of roads on natural and cultural landscape assets has been formulated:

> "The road network shall be aligned, designed, and maintained so that natural and cultural heritage assets in the landscape can persist and develop, be experienced and utilized."(Vägverket 2005)

Important to notice in this objective is the combination of the ecological focus on sustained ecological *functioning* with the anthropogenic view on a landscape that can be both *utilised* and *experienced*. This holism shall support a user-friendly and process-oriented, democratic management of the road transport system that is governed by the dialogue between developers and conservationists.

Based on this overarching objective, different quality goals specify the desired long-term state or quality of the road network with respect to those natural and cultural assets that shall be maintained or created through adaptation in road management. Examples of such goals (not yet endorsed) are:

> "Habitat connectivity in the landscape shall be maintained or improved at a level that ensures viability and/or sustainable management of local wildlife populations" or
>
> "Transport infrastructure shall support and not impede human access to areas important for recreation, natural and cultural experience".

For practical use in road management, these quality goals must be broken down into measurable *performance targets* that directly relate to the activity of the road administration or the condition of the road infrastructure. Condition targets concerning wildlife, for instance, may state that 'exclusion fences against large game species must be combined with wildlife passages at *regular* (not too large) intervals' or that 'road bridges over valleys or streams in urban green areas must be built *wide enough* to maintain the visual perception of the natural corridor'. Activity targets could imply requirements such as 'the distribution of black-spots in road-kills in wildlife must be mapped and monitored".

Obstacles and challenges

Nevertheless, there are still some fundamental obstacles that have hampered the implementation so far (Lisitzin & Ljung 2003; Nilsson & Sjölund 2003). Primarily, these obstacles relate to the lack of adequate methods for impact evaluation, to gaps in knowledge on effect-impact relationships; and to deficiencies in the planning process (Seiler & Sjölund , submitted):

1. As proposed as interim sustainability target by the Swedish Government (2001/02:20), planning of infrastructure and land use should be based on broad-scaled programmes and long-term strategies, rather than being driven by small individual development needs.
2. Concern for natural and cultural heritage assets in the landscape should enter the planning process already at a strategic level. This can be achieved if concern is presented as environmental quality objectives and strategies that refer to quantifiable landscape criteria and performance targets that provide a system for monitoring and evaluation.
3. Effective methods for landscape evaluation, impact assessment and mitigation should be developed for different spatial scales, and implemented at appropriate management and planning levels. This requires improved knowledge on dose-response relationships in the environmental impact of the transport system, especially with respect to the criteria and goals for sustainable development.
4. The traditional, rather static preservation paradigm in conservation biology and preservation of cultural heritage, with its focus on sites, species, and physical artefacts, should be complemented with a process-oriented and dynamic approach that integrates societal needs with a sustainable management of multifunctional landscapes.
5. The communication between scientists, planners, stake holders and decisions must be improved so that principles, methods and tools for sustainable development are understood and can be implemented in the practical work.

Main objective

It is from here, INCLUDE takes its departure.

We seek to overcome these obstacles, at least partly, and demonstrate for a selected set of problems how solutions can be found and implemented. Our main objective is to develop tools and methods that help identifying, evaluating, and communicating probable consequences of the impact of transport infrastructure on ecological and socio-cultural values in landscapes. Ultimately, we envision a transport infrastructure that is well adapted to the natural and cultural conditions in the embedding landscape and that creates new values and qualities that meets the needs and desires of our own and future generations in a sustainable manner.

Tools to accomplish this high ambition must integrate environmental policy with best knowledge about dose-response relationships in the environmental impact. They must be based on present decision making processes, and yet prepare for a methodological and conceptual change in infrastructure management. Landscape systems and hence the impacts on landscapes are highly complex, involving a multitude of perspectives and interests. In order to support understanding and implementation of our work by the various stakeholders and end-users, we need to find simple but elegant, illustrative but robust means of communicating concepts and methods. It is not our goal to make existing EIA techniques more complicated--instead we seek for efficient ways to help introduce a holistic view on the landscape in land use and infrastructure planning.

Among the various impacts of traffic and infrastructure on landscapes, we have chosen to focus on the two most characteristic and yet least understood direct effects, i.e., barrier and disturbance effects (e.g., Van der Zande et al. 1980; Seiler 2003; Forman et al. 2003). Barrier effects in particular receive a growing attention not only in ecology (e.g., Canters et al. 1997; Trocmé et al. 2003), but also in social sciences and with respect to recreation (e.g., Swedish Government Bill 2003/04:95). In ecology, quantification and parameterization of these direct effects have made considerable progress. Efforts have been made to integrate barrier and disturbance effects and their cumulative impact (i.e., habitat fragmentation) into Swedish road planning (Eriksson & Skoog 1996; Seiler & Eriksson 1997) and to develop GIS-based applications for the practical use in EIA (e.g., Lundgren et al. 1998; Lundgren 1999; Nordström et al. 2004), but still, there are no applicable tools and methods available so far.

It is here where we see possibilities to make a significant contribution to the achievement of an environmentally sustainable transport system within the frame that is set by the time schedule, our possible budget, and our competences and skills. We will focus on producing tools and methods (a toolbox) that enable planners and decision makers to grasp the cumulative impact of barrier and disturbance effects of transport infrastructure on ecological and cultural qualities in the landscape. These spatially explicit issues will be communicated through visualisations of GIS-based models that illustrate values as well as consequences to these values of anticipated (or simulated) changes in infrastructure, including mitigation measures. To accomplish this, we need to specify where, when and how such GIS applications, models and maps can be integrated in planning processes and what level of precision and information that can be communicated in the first place. To be realistic in our approach, we will focus only on barrier and disturbance effects for a few selected indicators of landscape sustainability. These indicators can be species, land cover properties, as well as perception values and attitudes related to certain landscape characteristics.

Of course, the INCLUDE programme will only provide answers within this outlined field, but through our international contact networks and collaboration, we can reach a greater audience. The need to tackle the cumulative impact of transportation on landscapes is a world-wide issue. Especially in countries with rapid expansion of infrastructure networks, such as in East-Europe, we believe that INCLUDE can make a significant contribution towards developing an environmentally sustainable infrastructure.

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A2. Scientific value

Today's transport system is not environmentally sustainable. The steady growth in traffic, with its constant need for new and upgraded transport infrastructure, continuously increases the pressure on our natural and cultural heritage and transforms landscapes at broad scale. The environmental footprint of the modern transportation system is considerably larger and more permanent than what it may seem from its physical imprint on the landscape (Forman et al. 2003). The questions are justified: what kind of landscape do we want to leave to our children and grand children? And how can we integrate our need for increasing mobility with the natural, social, cultural and recreational values and interests in our and our children's environment?

Four major questions

INCLUDE addresses these questions and seeks to demonstrate at selected problems how solutions can be found and implemented. Our research is concentrated around four guiding groups of questions:

1. What is landscape sustainability, which criteria relate to sustainable development of landscapes, which indicators can be used to measures and evaluate sustainability?
2. How does infrastructure and traffic affect ecological, social, cultural, and recreational values in landscapes? What is the critical impact on environmental qualities, functions and processes that relate to sustainability? Where are limits and thresholds in dose-response relationships of this impact?
3. How can the impact and its consequences be assessed, predicted, evaluated and communicated to stake holders, planners and decision makers. What tools are needed to integrate this knowledge in planning processes as well as in the mind of people?
4. What options do we have to improve the situation? What remedying measures are efficient and how can we affect the planning process itself to provide for a greater consideration of landscape and sustainability values?

What is a sustainable landscape?

The first question addresses the framework for evaluating the cumulative impact. Without knowledge about *what* exactly in a landscape we want or need to protect to achieve a sustainable development, it is difficult to find adequate solutions. Some answers can be found in the domain of landscape ecology providing the experts' view on sustainability which is often (e.g., Troll 1971, Naveh & Lieberman 1994, Forman 1995, Haines-Young 2000), while others must be obtained from the stakeholders and private people. A landscape is a complex multiple use area with intrinsic dynamics and processes that shape its structure and texture. In his textbook on land mosaics, for example, Richard Forman (1995) identified four structural patterns as indispensable in sustainable landscapes: 1) a few large patches of natural vegetation, 2) major stream or river corridor, 3) connectivity with corridors and stepping stones, 4) heterogeneous bits of nature across the matrix. These indispensables express (to some degree) functions, processes and, from a human perspective, also perception values such as recreation, familiarity, social identity, history (e.g., Olsson 2003; Kaplan and Kaplan 1989). Landscape perception is influenced by knowledge, profession, age and gender, but also by the wider landscape and historical context (Meinig 1979; Lindström 2003; Lindström, et al. submitted). To understand and tackle the impact of roads and railroads on this complex and dynamic system, we need a holistic approach that includes socio-cultural, ecological and economical interest in the landscape and reflects experts', public and planners' perspectives. Developing adequate assessment tools and mitigation measures against the impact of transportation on landscape function and values is an outspoken challenge to landscape ecologists (Forman 1998).

What is a critical impact?

The second question focuses on the actual impact of traffic, infrastructure and consecutive development on landscape sustainability. There is a vast literature on the effects of roads and railroads on fauna, flora and ecosystems (e.g., Bennett 1991, Reck & Kaule 1993, Spellerberg 1998, Forman et al. 2003, Seiler 2003), however most of these studies are rather small-scaled and provide only little help to evaluate whether an impact is significant at landscape level and requires counteraction. Knowledge about potential thresholds in the dose-response relationship of the impact of infrastructure is very limited, and critical limits for the maximum tolerable load on landscapes are not yet established. In contrast to traffic pollution problems or to the physical land take of infrastructure in private property or designated protection areas (such as Natura 2000), where strict limits and clear environmental quality objectives have been implemented and legally enforced, there is yet no such protective instruments for the entire landscape (e.g., Anonymous 1994; Anonymous 2001). If at all existing, landscape concern in Swedish road and rail planning has a strong aesthetic background (e.g., Nihlén 1966). On the other hand, landscape protection for a sustainable future, has become a leading theme in environmental policy in Europe (European Council 2000). For instance, the European Strategic Environmental Impact Assessment (SEA) Directive (2001/42/EC) enforces the integration of ecological aspects in future planning and programming of infrastructure. Recently, a new 'Code of Practice for the Incorporation of Landscape and Biodiversity in the Planning of Linear Transport Infrastructure' has been developed by the European Council that includes recommendations for integration of the Pan-European Biological and Landscape Diversity Strategy in environmental impact assessment (e.g., Jongman 1994; Jongman & Kristiansen 2000; Damard et al. 2003). In the European Conference of Ministers responsible for Regional Planning held in Hannover in 2000, guiding principles for sustainable spatial development of the European continent have been established (CEMAT 2000:7). These principles include recommendations on quality objectives for the enhancement of natural and cultural heritage, with special reference to ecological networks (to provide habitat connectivity) and landscape perception (to provide value to humans). Yet they do guide impact evaluation and decision making in practise.

Which planning tools are needed?

The third question deals with the urgent need to provide the planners and research community with functional tools to study, monitor an simulate the effects of infrastructure development on the landscape and its ecological and cultural content. Planning and decision-making today is very complex and complicated, and it is difficult to combine and balance ecological, economic and social sustainability-dimensions (Isaksson 2001, 2004, Storbjörk 2001, 2004, Boström and Sandstedt 2004, Macnaghten and Urry 1998, Owens and Cowell 2002). In general, only specific objects (monuments) and well-defined areas are considered in planning. Other natural and cultural values or functional linkages and processes in landscapes in particular, are often neglected or, at least, not handled systematically (e.g., Eriksson and Skog 1996, Seiler and Eriksson 1997, Olsson 2004).

The planning-process is in itself biased in a way that serves private perspectives and interests as it is strongly influenced by power relations (Fog et al. 1992, Healey 1997, Olsson 2003) and the communicative process in which various planning partners interact (Healey 1997, Dovlén 2005). Thus, we need to further develop common conceptual models and definitions that will facilitate the communication and sharing of knowledge between the sectors involved.

What remedying measures are efficient?

The fourth question, then, is typically asked by planners, decision makers and engineers. Also here, empirical studies are numerous as are the various measures taken (e.g., Romin & Bissonette 1996, Putman 1997, Iuell et al. 2003). Nevertheless, knowledge about the actual efficacy of the measures is often insufficient to advise planners, guidelines are often based on opinions and assumptions rather than being scientifically founded. Further, monitoring studies to validate the (positive) effect of mitigation measures are difficult to finance. These shortcomings partly stem from the common planning approach: Decisions about the implementation of mitigation measures concerning natural and cultural heritage values are seldom based on cost-benefit analyses in a broader meaning but often due to informal and private communications and interests. Cost-benefit analyses should be an integrated part in impact evaluation as they link back to the first question of what we want or need for obtaining a sustainable environment.

Finding answers

Clearly, there is no straightforward answer to these fundamental questions. Nevertheless, in INCLUDE, we need to assemble a set of landscape sustainability criteria on which our further work with assessment and evaluation can rely as “response” variables. To accomplish this, we will organise international workshops at the start of the programme to gather and synthesise existing knowledge on this topic.

We will attempt to identify ecological as well as social, cultural, and recreational landscape values related to sustainability, establish quantitative links between these values and landscape criteria and analyse and visualise these critera using GIS. This will allow us to merge ecological and socio-cultural values and put them in relation to the (spatial) impact of infrastructure and traffic. In ecology, translations of values to structural pattern and criteria are already commonly used in e.g., habitat suitability models (e.g., Scott et al. 1993; Scott et al. 2002). In human sciences, similar models have not yet been used in Sweden, although sociological landscape perception values, as for example in the green corridors in the city of Stockholm (Ståhle et al. 2003), or as perceived by a car driver from the road (Antonsson 2004) have been verbally defined and mapped.

Conceptual barriers

Value, however, does not automatically translate into sustainability, as sustainability implies a (long term) time component and (social, cultural, recreational) values do change over time. A sustainable use of landscapes is often translated as the protection of those values that we want to maintain for the future generations. This bears the risk that sustainability in landscapes can be misunderstood as a certain, static condition. Indeed, the planning of land use and infrastructure still rests on a spatially discrete and absolute notion of space, which suggests that landscapes could be dissected into discrete parts in which state and condition could be managed by different interests.

However, landscapes are dynamic in both time and space, changing both physically, ecologically and mentally due to natural forces and human activities (Hägerstrand 1995, Russell 1997, Skånes 1997, Wästfelt 2004). Sustaining landscapes translates therefore to maintaining processes and dynamics rather than conserving these processes at a particular state (Southwood 1995). These dynamics, however, obstruct our ability to predict and control the future development of a landscape (Bartel 2000). The awareness that the theoretical objectives and the practical response may not match should be taken into account when attempting to predict the effects of political and socio-economic decisions on the physical landscape (Antrop 1998, Haines-Young 2000). A common approach to study effects of possible or anticipated landscapes changes is to make scenarios built from existing knowledge and assumption about the likely change and the likely relationships between an impact and its effect (dose-response). Naturally, this kind of modelling entails several sources of error and uncertainty concerning parameter estimates, and dose-response assumptions.

Three important methods for assessing uncertainty propagation are sensitivity analysis, scenario modelling and uncertainty analysis. The latter refers to the propagation of uncertainties in source data sets and model parameters to the analysis results, whereas sensitivity analysis and scenario modelling refers to the relative importance that each source of uncertainty has on the analysis results (Crosetto and Tarantola 2001). The difference between sensitivity analysis and scenario modelling is that the first one is used for evaluation of existing plans and policies, and the last one for developing plans and policies (Olsson 2004, Wallace 2000, 2003).

Forecasting models used to identify possible significant effects on an action will likely become common practise in environmental impact assessment and spatial planning. This, however, requires a better education of planners and decision makers as these must understand the outcome of such models as well as evaluate the uncertainties and risks. On the other hand, scientists employing these methods must seek to communicate results in a pedagogic and illustrative way.

Our approach

We will address the complexity of landscapes and sustainability in different approaches and at different scales. We aim at developing interdisciplinary methods that combine ecological with human perspectives on infrastructure impacts. We will work at different spatial scales, considering long-term changeability of landscapes through using scenario modelling a tool to visualise and communicate eventual consequences on (sustainability) values, on functions and processes at landscape scale. In all this, our main focus is to produce applied and high quality science and to answer the questions raised initially. Since these questions are quite ubiquitous and answers urgently needed, not only in Sweden but especially in Eastern Europe and other developing countries abroad, our findings aim at significantly contribute to the solving of the problem. Inside the scientific community we will contribute with theoretical models, empirical findings and methods which are explicitly based on a trans-disciplinary approach (Skånes 1997, Naveh 2001). The analysis of landscape sustainability, values and functions will all be based on a spatial landscape perspective which we will develop in a way which make it possible to systematcally include ecological and socio-cultural dimensions into spatial planning.

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A3. Value to users

Value of the research to intended users

The work will provide planners and decision-makers with a toolbox consisting of tools and methods for EIA and SEA within the transport sector, especially the roads and railways. The tools will also be useful for spatial planning performed by, e.g., regional and municipal authorities. In addition to tools and methods, the work will also produce concepts, environmental objectives, threshold values and other decision bases for target-oriented spatial and infrastructure planning. In essence, the programme will contribute to a more efficient way for the decision-maker to handle the information necessary for taking decisions towards a sustainable transport system.

User groups involved in the programme

Governmental authorities and agencies

- BoV, National Board of Housing, Building and Planning (Marianne Lindström)
- SRA, Swedish Road Administration (Anders Sjölund, Michael Frisk)
- SNRA, Swedish National Rail Administration (Jan Skoog, Ulrika Lundin)
- NV, Swedish Environmental Protection Agency (Ebbe Adolfsson)
- RAÄ, National Heritage Board (Jerker Moström, Ann-Marie Westerlind, Lena Odeberg)
- FV, Board of Fisheries (Torbjörn Järvi, Erik Degerman)

Private sector: consultancy companies (in the EIA field and environmental analysis)

- Calluna AB (consulting company, contact: John Askling)
- Ramböll AB (consulting company, contact: Marie Jakobi, Tomas Grönlund)
- SWECO AB (consulting company, contact: Martin Ljungström)
- SwedPower AB (Department of Hydrology and GIS, contact: Laine Boresjö-Bronge)
- Metria Miljöanalys, Swedish National Land Survey (Kerstin Nordström)

Upon the decision of funding, we will extend our network to include transport and planning authorities and non-governmental associations at European and international level.

We will also involve additional institutes and non-governmental organisations in Sweden and Europe. Contacts have been made with e.g., The Swedish Institute for Ecological Sustainability (IEH), The Swedish Society for Nature Conservation (SSNC), The European Council for Nature Conservation (ECNC), The World Road Association (PIARC).

Collaboration with users

The development of tools and methods to handle ecological and socio-cultural dimensions in landscapes and infrastructure requires dialogue and cooperation between various academic, public and civic sectors. We ensure this through active involvement of authorities such as the Swedish Road Administration, the Swedish National Rail Administration, the Environmental Protection Agency, the National Heritage Board, the National Board of Housing, Building and Planning, the National Board of Fisheries, the National Board of Forestry. The private sector is represented by leading consultancy companies in infrastructure and environmental planning (Ramböll Sverige AB, SWECO AB, Calluna AB).

Intimate collaboration among the involved experts and end-users within the INCLUDE consortium will be ensured on several levels:

- through direct cooperation in the main research projects and multi-authorship of scientific papers;
- through cooperation in the synthesis projects (see component projects)
- through 2-4 annual internal workshops that focus on disciplinary and interdisciplinary research questions.
- through the joint organization of the international workshops.

Each participating expert contributes his own existing network to be used by the entire consortium. This will provide possibilities of trans-disciplinary cooperation between experts in Sweden and in foreign countries in a range of scientific fields. Inter-disciplinary work, especially if it integrates practitioners and end-users of the scientific research, requires a well developed communication and understanding across the traditional disciplinary boundaries. Not only that we “talk in different scientific languages”, also research approaches, conceptualizations, and needs are different and could obstruct the progress of the programme. To reduce this risk, we will facilitate interdisciplinary communication in the attempt to develop a “common language” for all INCLUDE members. For summer 2005, for example, we intend to organise a first INCLUDE workshop in order to introduce and update each other on the current level of knowledge in our respective disciplines. This includes researchers, practitioners from consulting companies as well as the involved authorities.

The common web-based workspace (hosted by SLU) which has already been established will be continuously developed to serve as an efficient means of communication among INCLUDE participants. An efficient workspace will help overcome the geographical and administrative distance between partners within Sweden as well as outside Sweden.

Planned user deliverables at the programme level

- Planning instruments for transport infrastructure planning and spatial planning
- Workshops and seminars
- Résumés and executive summaries from scientific papers and workshops.
- GIS-applications and routines (to be discussed in more detail)

A4. Programme structure

"Sustainable Mobility" and collaboration within it

In June 2004, Mistra called for research proposals addressing the topic of sustainable mobility. We responded to this call with the application "Land use for sustainable mobility". Among all applicants, Mistra invited four consortia to develop a detailed program plan until the first of April 2005. Two of these, including INCLUDE, are considered as "satellite programs" as they shall focus on selected parts of the call only, while the other two consortia compete for the core-program. Our consortium represents the only group that focuses on how ecological and cultural dimensions in landscapes and land use can be integrated on different levels in the planning towards a sustainable transport system. In that we comprise one third of the MISTRA umbrella program on "Sustainable mobility" and will co-operate with the other two consortia (Figure 1).

However, since it is not decided yet which of the two consortia competing for the core-program will be chosen and whether one or both satellite programmes will be included, details in the collaboration within "Sustainable Mobility" could not yet be outlined. We intend to develop this issue in depth as soon as possible, as this has strong influence on the design of our research projects (especially the choice of study areas). At present, after meeting with the potential partners, we have identified clear differences between our respective approaches (no or only little thematic overlap), but also clear linkages that offer possibilities of exchange and complementation. In general, we will attempt developing three levels of collaboration:

- centrally from Mistra and the corresponding program boards,
- at management level (organization of joint workshops, selection of joint research areas and case studies), and
- at project level (direct cooperation in research activities).

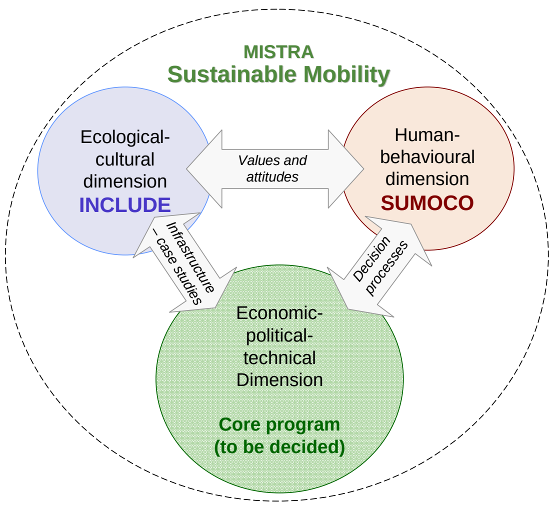

Figure 1. Possible constellation of main thematic linkages between the three sub-programs of the Mistra program "Sustainable mobility". Details in this cooperation must be developed after Mistra has decided upon the proposed programmes.

Organisation

In contrast to previous Mistra programmes, and to the two partner programmes in "Sustainable Mobility", INCLUDE will primarily be funded by governmental authorities. Even though the funding will be handled centrally through Mistra, we feel a strong responsibility towards the "external" financers in terms of meeting their need for applicable tools and knowledge. This is a benefit with respect to user involvement in and user orientation of our applied research, but it may also puts additional constraints on the organisation and administration of INCLUDE. Nevertheless, the authorities have agreed upon relying on Mistra's established programme organisation structure.

We suggest therefore, to organise INCLUDE accordingly (Figure 2). This implies that INCLUDE will be steered by a program board in which majority of the authorities and users will be represented. The program will be managed through cooperation between the program manager and a management group. This group, together with project leaders and other program members will be responsible for a number of synthesis projects that both summarize new findings from the component projects and provide new (synthesized) input to these. The synthesis projects will prepare for our work during phase 2 of the programme.

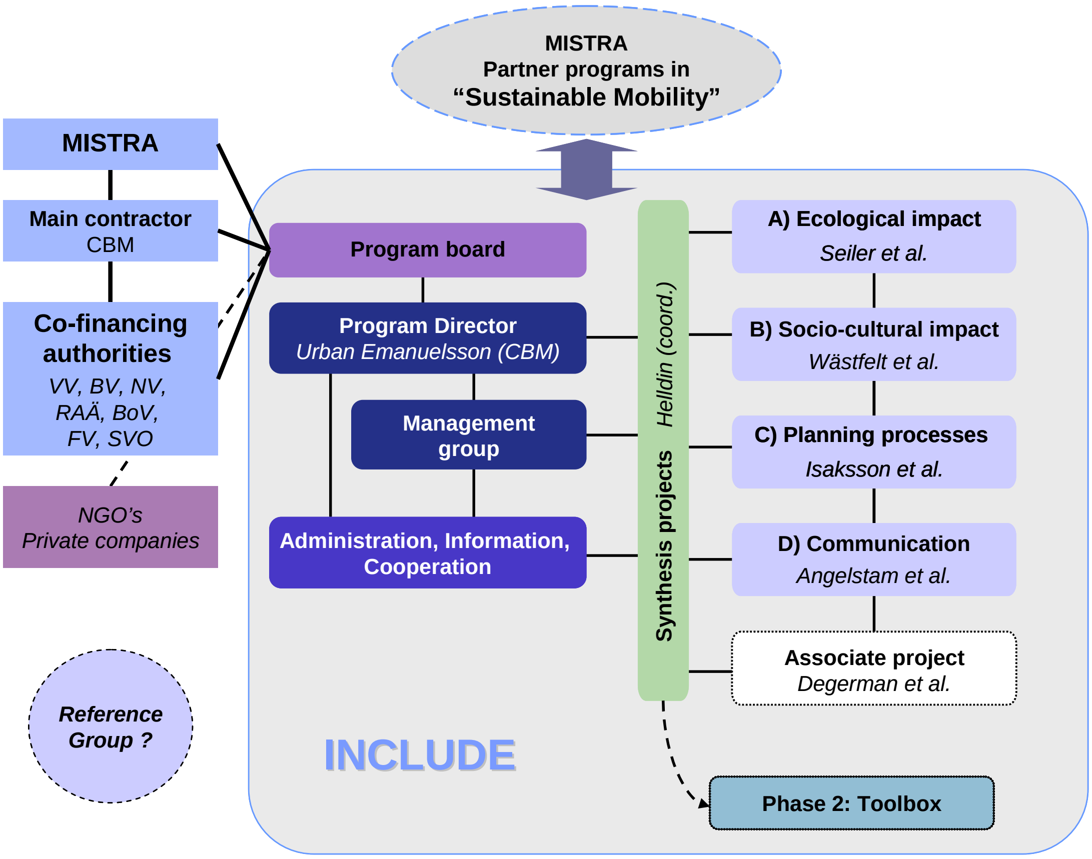

Figure 2. Structure of the proposed INCLUDE programme.

Program host

The Swedish Biodiversity Centre (CBM) has solid experience of multidisciplinary work containing natural and cultural aspects on the environment. The CBM is currently program host for another MISTRA-program, Hagmarks mistra, and a similar research program, Naturvårdskedjan, financed by the Swedish Environmental Protection Agency.

Program management

Program director

Dr. Urban Emanuelsson is proposed as program director and will work intimately with a management group representing the different scientific competencies. Emanuelsson is also head of the two programs mentioned above.

Proposed associate directors

Andreas Seiler (SLU), J-O Helldin (CBM)

Proposed management group

Lennart Folkeson (VTI), Marianne Lindström (HIK, BoV), Krister Olsson (KTH), Anders Wästfelt (SU), plus above directors

Reference groups

In addition, we intend to establish an ***international reference*** group in which both scientists and governmental and non-governmental organisations will be represented. The aim of this reference group is to 1) provide further input of knowledge (through participation at workshops or as referees for reports and publications) and 2) help to adopt our tools and methods for implementation in other countries.

Co-financing governmental agencies and authorities

- Swedish Road Administration (VV)
- Swedish National Rail Administration (BV)
- Environmental Protection Agency (NV)
- National Heritage Board (RAÄ)
- National Board of Housing, Building and Planning (BoV)
- (National Board of Fisheries, FV)
- (National Board of Forestry, SVO)

The relative contribution of these authorities to the total budget of INLCUDE will be decided at a meeting with all potential financers that is planned for late April or early May 2005. The decision about the definite budget of INCLUDE will be available to MISTRA by mid May.

Research projects

We identified five overarching fields of development, each focusing on specific needs in research and development (Figure 3). These needs will be addressed through a number of component projects, workshops, and synthesis tasks (Figure 4). Ultimately, the products of our actions intend to be implemented in legislation, planning procedures and guidelines, as well as provide for education of both practitioners and students. Implementation and education must be organised in close cooperation with and financed separately by the respective authorities. It is not an internal part of the research in INCLUDE.

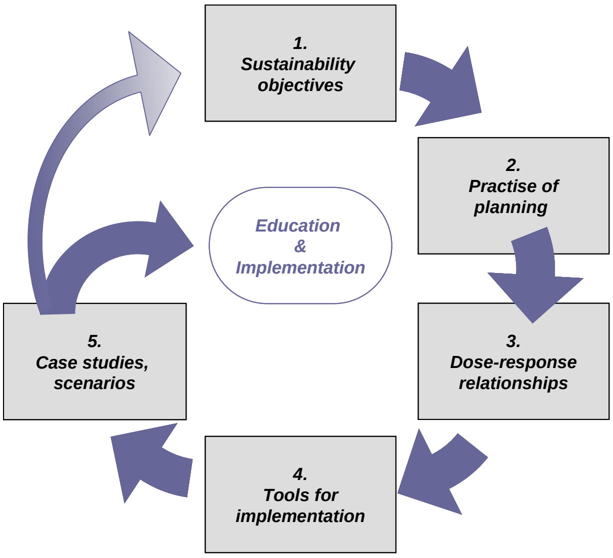

Figure 3. *Fields of research and development.*

Fields of development

Objectives for sustainability

The engagement in developing environmentally sustainable landscapes and achieving a sustainable use of natural resources is clearly stated in the Swedish national quality objectives. These national objectives are currently translated into various sector objectives, performance targets and criteria. However, objectives concerning landscape function and ecological and socio-cultural landscape qualities affected by the various sectorial activities have yet to be formulated. To accomplish this, we need improved knowledge on dose-effect relationships, thresholds and critical limit values, but also a better understanding of how these landscape qualities are perceived and evaluated by people, and what qualities or criteria are essential to the ecological, cultural and social sustainability of the landscape.

Practise of planning

Essential for the integration of ecological and socio-cultural dimensions in spatial planning and transport management is a deep understanding of how physical planning and infrastructure planning are organised and carried out today. We need to identify relevant gaps and needs, barriers and bridges in planning procedures in order to be able to affect the system towards a sustainable development. Typically, there is a lack of tools for integration and consideration of ecological and socio-cultural dimension in early planning stages. This is only partly a methodological problem; there is also a lack of mutual communication and understanding among scientists, experts, planners and stake holders.

Dose-response relationships

One of the most critical research tasks in our program is to increase our understanding of how infrastructure and traffic affects landscape qualities, especially those qualities that have been identified as essential for a sustainable development (in development field 1). Existing knowledge on the ecological impact is comprehensive but not congruent enough to allow immediate implementation in management practise. Knowledge on socio-cultural impacts, on the other hand, is still vague and needs further refinement. Above all, we need a better understanding how environmental qualities respond to changes in infrastructure and transportation at different spatial and temporal scales. We need to be able to assess possible short-term and long-term consequences of cumulative effects and evaluate when and where mitigation is needed.

Tools for implementation

The transport sector has clearly asked for adequate tools and methods to consider environmental issues in the planning and management of transport infrastructure. Similar needs have been identified also in other sectors. The Environmental Protection Agency, for example, currently supports a project on developing environmentally strategic tools, "MiSt". What kind of decision support, data and methods are needed to strengthen the landscape approach in strategic and project environmental impact assessment (SEA, EIA)? How can different (competing?) thresholds and limit values merge with environmental quality objectives into operative goals for use in a target-oriented planning process? What measures and criteria can be developed to direct the transport sector's environmental activities? How can these measures best be implemented in the planning process and in people's knowledge? How can science and research results be communicated in an understandable way?

Case studies and scenarios

How does the knowledge and tools we developed so far apply to reality? Does our work in the previous research fields match with real world situations and validity criteria? We intend to develop, test and validate the proposed tools in real-world case studies, through building alternative scenarios for spatial and infrastructure plans. Research focus will be on creating scenarios to study the outcome of alternative decisions based on our tools and recommendations. Special weight shall be put on applying these tools in countries that currently go through a phase of intense infrastructure development and with which we have long experience of research cooperation (e.g. Ireland, Poland, other East-European countries).

Component projects

Our research will be focused on selected ecological and socio-cultural issues in landscapes that can be assessed, evaluated and communicated using geographical information systems and thus visual (map) presentation. Since our thematic focus is on landscapes and land use, spatial explicit (geographical) information, including risk models and scenarios, will be expressed most efficiently by visual presentations.

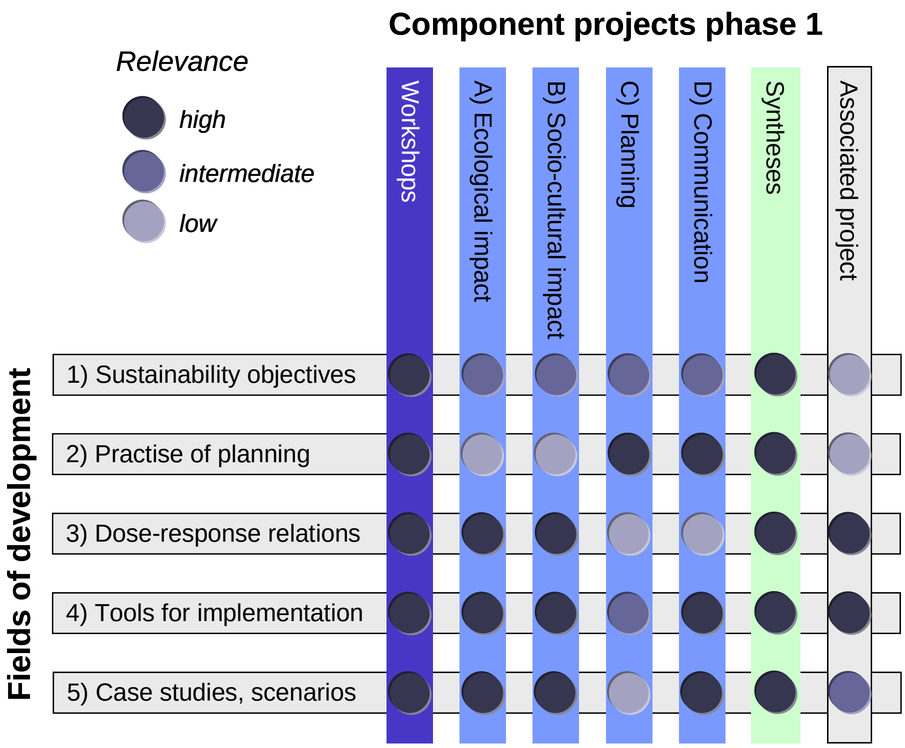

Figure 4. Thematic representation of the main fields of development within the proposed research activities (workshops, component projects, synthesis projects and an associated project).

There is a main thread that links the core component projects together: spatial explicit scenario modelling as a tool for impact evaluation and visualisation. In order to evaluate cumulative impacts on long term landscape sustainability, alternative scenarios of the future development must rely on simulations when empirical data can not be obtained. This scenario modelling, however, requires profound knowledge about dose-response relationships in the impact of infrastructure, knowledge about how people value the landscape (field of development 3), and an understanding of the likely changes in landscapes (besides infrastructure), as well as concern to barriers and bridges in planning processes (field of development 2). The impact must be evaluated with respect to environmental qualities or indicators that relate to landscape sustainability. These indicators are not yet established for ecological and socio-cultural landscape values (field of development 1). Modelling itself provides one of the tools required for assessing and evaluating the cumulative impact on sustainability indicators (field of development 4), other tools are interviews and questionnaires. Sustainability, finally, implies resilience and robustness over time, and relates to the protection of dynamics and processes rather than the preservation of a certain environmental state. Therefore the effects of future changes in infrastructure, traffic, landscape, and society should be included in the scenarios for impact evaluation (field of development 5).

Our research activity will be organised in five main component projects including a synthesis project that will prepare and initialise research and implementation activities during phase 2 (Figure 5). In addition, we will organise four international workshops during the first two years in order to gather and transform existing knowledge for work in the core component projects. The main component projects shall provide answers to questions raised in the previously discussed fields on development. We propose two core projects A) and B) with a focus on identification of landscape values, assessment of the cumulative impacts on these qualities, and evaluation of the long-term consequences to previously defined sustainability criteria. Core project C) will focus on barriers and bridges in the planning process, while core project D) addresses issues in the communication and understanding of the landscape ecological, sociological and psychological principles behind the impact evaluations in projects A) and B).

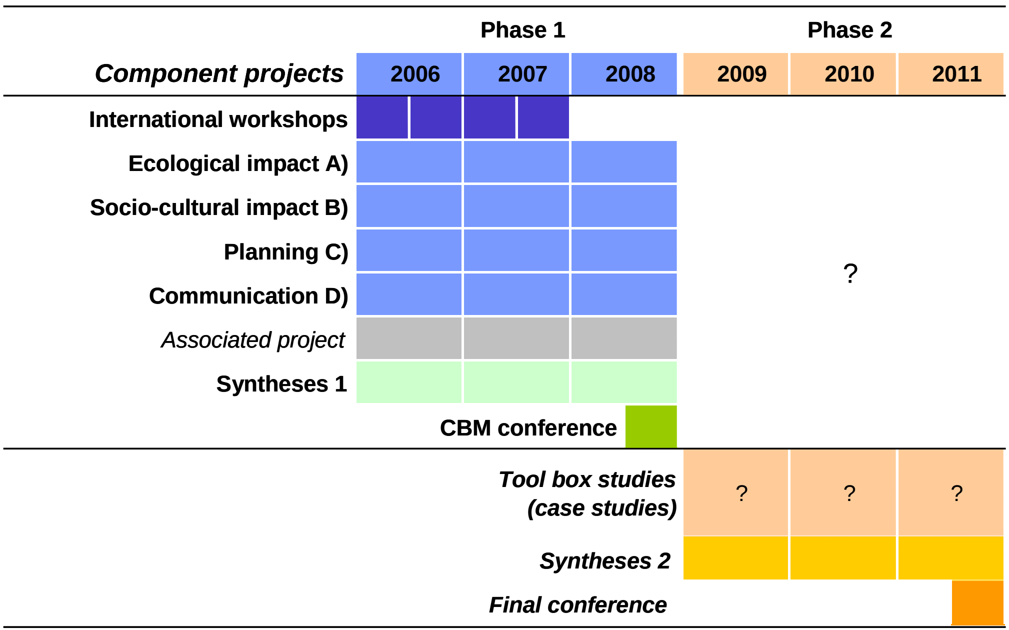

Figure 5. Approximate time schedule of the main activities during the first and second phase of the programme.

During the first phase of the program, we will develop a preliminary set of tools and approaches to deal with cumulative landscape impacts based on existing knowledge gathered in international workshops and literature reviews and through interview studies and GIS analysis. These tools and approaches shall then be applied to and developed further in real-world cases in close cooperation with the end-users during phase 2. This work will finally result in a “toolbox” that is ready for implementation by, e.g., governmental authorities.

However, developing a common, trans-disciplinary toolbox for landscape and impact evaluation, requires that human and natural sciences are conceptually merged in their approaches. This process will take time and will not be completed during the first phase of the programme. Methods to translate values and perception to quantitative data that can be visualises in a GIS, are not yet fully developed. Therefore, we need to invest relatively more into method development and data acquisition in project B) than in the ecologically focused project A).

The merging of human and natural perspectives will be prepared and attempted in the synthesis projects of phase 1. Most of this task, however, will be accomplished during phase 2.

For details about the individual projects, see chapter A6.

<u>Phase 1: 2006-2008</u>

International workshops:

- Spring 2006: Objectives, indicators and criteria for ecological and socio-cultural sustainability in landscapes and infrastructure.
- Autumn 2006: Critical limit values and functional thresholds in the impact of infrastructure on sustainability indicators for landscapes.
- Spring 2007: Tools, methods and approaches to include landscape sustainability in SEA and EIA of the transport sector.
- Autumn 2007: Barriers and bridges for sustainability concern in spatial and infrastructure planning.

A) Ecological impact

- Seiler et al. – Cumulative impact of infrastructure on habitat connectivity and suitability

B) Socio-cultural impact

- Wästfelt et al. – Cumulative landscape impact and heritage values in relation to users and development of transport infrastructure

C) Planning

- Isaksson et al. – Barriers and bridges in the planning process - natural and cultural landscape values in infrastructure planning and management

D) Communication & understanding

- Angelstam et al. – Integration of spatially explicit ecological and cultural dimensions into road planning – how to communicate landscape ecology?

Syntheses

- Helldin (coordinator) et al. – Syntheses of knowledge, tools and results developed in the course of the programme.

Associated project

- Degerman et al. – Cumulative impact of road crossings on watersheds (mainly financed by the Board of Fisheries)

  This project shall mainly be financed by the Board of Fisheries, but the approach and research activities are closely linked to the INCLUDE approach. Details in the funding and the cooperation with INCLUDE will be worked out during April and May 2005.

End-user conference and sum-up of phase 1

- Autumn 2008: CMB end-user conference (including stakeholders from those study areas and case studies that will be involved in phase 2 of INCLUDE).

Phase 2: 2009-2011

Tools and toolbox

- Folkeson et al (authors) – Application, test and development of INCLUDE impact assessment, evaluation, and planning tools in real-world case studies.
- Phase 2 will contain several work packages yet to be specified. The major focus will be on applying the methods and concepts developed in phase 1 to real-world cases, adapting tools and methods to the requirements of the different planning situations (EIA for roads or railroads, SEA, municipal spatial strategies, road maintenance plans, etc) and testing how employment of these methods would alter the conclusions or recommendations made so far. This shall prepare for a full implementation of the INCLUDE results by the authorities.

Implementation

- Logic continuation of the INCLUDE programme, however under full responsibility of the end-users. Not financed by INCLUDE.

Other related research

Many of the programme members are currently involved in other research projects that more or less directly link to INCLUDE, either through providing necessary empirical input for the spatial models, or through the study of ecological or socio-cultural impacts and planning processes that can broaden the narrow focus of INCLUDE. Examples of such projects are:

- **Mål och Mått** – ongoing research program of the Swedish Road Administration (VV) on objectives and criteria for monitoring of ecological and cultural values in the transport system (http://www.vv.se/templates/page3____476.aspx) (e.g., Nilsson & Sjölund 2003), 1998 - 2005. Link to INCLUDE: intimately thematically linked to INCLUDE, participation of several members in both projects, project leader is Anders Sjölund, VV.

- **MiSt** – Tools for environmental assessment in strategic decision-making (http://www.bth.se/tks/mist_eng.nsf), will be finished in 2008 and will provide input in assessment of cumulative impacts and the development of future scenarios. Link to INCLUDE: Tools and knowledge developed in MiSt will be integrated in INCLUDE, especially during the second phase of the programme. The sub-project on cumulative impacts is led by H-G Wallentinus, SLU.
- **Ecological evaluation of fragmentation effects of roads on wildlife**. – Research project financed by VV through 2005-2007. Will provide input data for parameterisation of barrier, mortality, and disturbance effects of infrastructure on wildlife. Link to INCLUDE: provides input data to INCLUDE and project leaders are A. Seiler, & P. Kjellander.
- **EKLIPS -** Ecological planning and design of roads (http://www20.vv.se/fudinfoexternwebb/pages/ProjektVisaNy.aspx?ProjektId=789) – Metria Miljöanalys, 1999 - 2005. Link to INCLUDE: first development of concepts and approaches that are also used in INCLUDE, project leader Kerstin Nordström and several project members are also members of INCLUDE.
- **Geoscientific values in infrastructure planning** (Geovetenskapliga värden i infrastrukturplaneringen). (http://www20.vv.se/fudinfoexternwebb/pages/ProjektVisaNy.aspx?ProjektId=1200) – VTI, 2004 – 2005. Link to INLCUDE: provides input data to INCLUDE regarding relations between geodiversity, land-use and infrastructure, e.g. potential threats and possibilities to develop and utilise the values. Research financed by VV 2004–05. Project leader is Mats Gustafsson, VTI.
- **Simulation of environmental stress caused by infrastructure constructions**. http://www.bom.hik.se/ess/index1.htm (financed by Univ. of Kalmar and the Graninge Foundation). May provide input to INCLUDE regarding modelling of landscape and habitat resource availability for birds and mammals and movement routes. Project leader is Görgen Göransson, HiK.
- **Multifunctional roadsides** (Multifunktionella diken – strategi för resursutveckling), ongoing research 2004–2007 in cooperation between VTI and SGI (Swedish Geotechnical Institute). May provide input to INCLUDE regarding management of roadsides by a holistic view on the various functions of the roadsides. Project leader is Göran Blomqvist, VTI.
- **Regional identity in the landscape** (Regional särart för landskapets natur- och kulturvärden). Research financed by VV 2005. May provide input to INCLUDE regarding landscape values and the EIA process. Project leader is Hans Antonson, VTI.
- **Identification, quantification of ecological values** in regional and local monitoring of objectives and criteria in the transport sector – SwedPower AB, 2003-2005. Link to INCLUDE: provides input data to INCLUDE and project leader Laine Boresjö-Brånge at SwedPower AB is among the collaboration partners of INLCUDE, project is commissioned by Anders Sjölund, VV.
- **Landscape memory** as means to deal with human impact on biotope resilience and potential biodiversity (financed by Formas 2002-2005). Link to INCLUDE

project B, will provide data, concepts and methodology. Project leader Helle Skånes.

- **Attitude investigation about water** (Interreg IIIB, SEAGULL). Lindström, M. A comparison study is performed between Sweden and Kaliningrad concerning water issues. Attitudes and behaviour among adult people are measured through questionnaires. The result will be analysed by the University of Kalmar. A comparison project measuring attitudes and behaviour among school children is planned.
- **Values of the Landscape.** A co-operation project between seven national boards in Sweden. Lindström, M., and Grahn, P. The project financed by the boards and is led by the National Board of Housing, Building and Planning
- **Citizens, Businesses and Public Heritage Management in Ystad** (Sub-project in Interreg III project: Sustainable Historic Towns). (Financed by National Heritage Board) Link to INCLUDE project B and C. Project leader Krister Olsson.
- **Sustainable Development and Economic Growth** – A socio-cultural perspective on regional programming processes. (Financed by MISTRA) Link to INCLUDE project C. Project leaders Tuija Hilding-Rydevik and Karolina Isaksson.

A5. Skills and networks

The INCLUDE consortium

The programme is based on collaboration between experts within three fields: ecology, socio-cultural sciences and infrastructure/spatial planning. In the programme there are a number of specialists who, in the same person, combine experience from two or all fields. The consortium includes applied scientists as well as practitioners. This will ensure the practicability of the results obtained. Most of the experts hold a Doctor’s degree and all have academic education. Technical skills within the group include GIS and remote sensing, which are the basic working tools in the programme.

During planning of the programme, we realized the traditional differences in our disciplinary approaches, but also important similarities that invite for complementary work and direct collaboration at project level. Generally, each of the research projects is open for expert input from different scientific domains, although the basic research in project A) and major parts of B) needs to be more intradisciplinary to begin with. Interdisciplinary approaches, which comprise the core of the entire programme, will be initiated in the synthesis projects during phase 1, and fully developed and implemented during phase 2.

For a complete list of INCLUDE members, see Appendix 1.

The involved universities and research institutes in Sweden are:

- Swedish Biodiversity Centre
- SLU, Dept. Conservation Biology
- SLU, Dept. Landscape Planning, Ultuna
- SLU, School for Forest Engineers
- VTI
- KTH, Dept. Infrastructure, Urban studies
- KTH, Dept. Land and Water Resources Engineering
- SU, Dept. Physical Geography and Quaternary Geology
- SU, Dept. Human Geography
- HiK, Univ. of Kalmar, Dept. Biol. & Environ. Sciences
- LiU, Univ. of Linköping, Dept. of Biology
- Miun, Mid-Sweden University, Dept. Engineering, Physics & Mathematics

We cooperate actively in our research projects, workshops and meetings with the following international experts:

- University of Sheffield, Dept. Town and Regional Planning, UK
- TØI, Institute of Transport Economics, Norway
- University of Turku, Dept. of Geography, Finland
- Kalingrad State Technical University, Russia

- Norwegian Space Centre, Oslo, Norway
- Department of Geography, Lviv University, Ukraine
- Institute of Zoology and Hydrobiology, Tartu University, Estonia
- International Institute of Sustainable Development, Winnipeg, Canada
- Department of Biological Sciences University of Alberta, Canada
- Fish and Wildlife Division, Alberta Sustainable Resource Development,Canada
- Department of Zoology, University College Cork, Ireland
- Mammal Research Institute, Bialowieza, Poland
- Chair of Nature and Landscape Protection, ETH, Switzerland
- ALTERRA, The Netherlands
- Department of Biology, University of Central Florida, USA
- Büro f. Raumforschung, Raumplanung u. Geoinformation, Oldenburg i. H., Germany

Non-academic members, authorities, consulting companies and other collaboration partners that will actively participate in INCLUDE research activities are partly also listed as users in chapter A3. See details under the respective project descriptions (A-E):

- Metria Miljöanalys, Lantmäteriet (Swedish National Land Survey, Kerstin Nordström)
- BoV, National Board of Housing, Building and Planning (Marianne Lindström)
- SRA, Swedish Road Administration (Anders Sjölund, Michael Frisk)
- SNRA, Swedish National Rail Administration (Jan Skoog, Ulrika Lundin)
- FV, Board of Fisheries (Torbjörn Järvi, Erik Degerman)
- Calluna AB (consulting company, contact: John Askling)
- Ramböll AB (consulting company, contact: Marie Jakobi, Tomas Grönlund)
- SWECO AB (consulting company, contact: Martin Ljungström)
- SwedPower AB (Department of Hydrology and GIS, contact: Laine Boresjö-Bronge)
- NILS programme (Host: RESGEOM, SLU, contact: Anders Glimskär, Sture Sundqvist, Anna Allard)
- Hagmarksmistra (Host: CBM)
- Naturvårdskedjan (Host: CBM)

Upon the decision of funding, we will extend our network to include transport and planning authorities and non-governmental associations at European and international level.

A6. Component projects

Component project A)
Cumulative impact of infrastructure on habitat connectivity and suitability

A. Seiler[1], G. Mikusinski[1,2], P. Angelstam[2], J. Davenport[3], W. Jedrzejewski[4], G. Göransson[5], J. Jäger[6], E. van der Grift[7], L. Kastdalen[8], I. Kruhlov[9], M. Kukurudza-Elbakidze[9], A. Lõhmus[10], U. Mörtberg[11], K. Nordström[12], R. Noss[13], K. Schmidt[4], C. Schürmann[14], J. Törnblom[2,15]

(1) Department of Conservation Biology, SLU, (2) School for Forest Engineers, SLU; (3) Department of Zoology, University College Cork, Ireland, (4) Mammal Research Institute, Bialowieza, Poland; (5) Dept. Biol. & Environ. Sciences, University of Kalmar; (6) Chair of Nature and Landscape Protection, ETH, Switzerland; (7) ALTERRA, The Netherlands, , (8) Norwegian Space Agency, (9)Department of Geography, Lviv University; (10) Institute of Zoology and Hydrobiology, Tartu University; (11) Royal Institute of Technology, Sweden; (12) Metria Miljöanalys, Lantmäteriet (Swedish National Land Survey); (13) Department of Biology, University of Central Florida, USA; (14) Büro f. Raumforschung, Raumplanung u. Geoinformation, Oldenburg i. H., Germany (15) Department of Aquaculture, SLU.

Significance

Knowledge on dose-response relationships in the ecological effects and the cumulative impact of infrastructure and transportation is a crucial prerequisite for the development f evaluation tools. In this component project A, we mainly focus on barrier and disturbance effects on large mammals. This is partly because these categories of effects are the most characteristic direct effects of infrastructure, partly because large mammals are among those species that are affected at a large, landscape scale, and utilize the landscape at a similar scale as humans. Results from this project are essential to INCLUDE as it 1) identifies and maps ecological values in the landscape that link to the indicators of sustainability which are affected by barrier and disturbance effects of infrastructure, 2) develops a methodology for illustrating and analyzing the cumulative impact at landscape or regional scale, and 3) provides a tool for running scenarios that help evaluating a) future changes in traffic and infrastructure, and b) the efficacy of alternative mitigation options. Methods and tools produced here will be used in component project D and combined with tools from project B in the synthesis project for the further development of the evaluation toolbox in programme phase 2.

Background

The INCLUDE programme aims at contributing to the development of an environmentally sustainable transport system. One of the basic requirements for ecological sustainability is the safeguarding of biodiversity in landscapes, and that includes protecting the diversity of species, of land cover types and structures that provide a functional habitat to these species, and of the processes and functions that link species to habitats (e.g., Noss 1990). The impact of traffic and transport infrastructure on these qualities is complex, usually summarized as “landscape fragmentation” (Forman et al. 2003, Jaeger 2002, Seiler 2003). The physical presence of roads and railways in the landscape disrupts natural processes and dissects habitats and migration corridors. Road maintenance and operational activities degrade the surrounding environment with a variety of pollutants and noise. In addition, infrastructure and traffic impose movement barriers to most non-flying terrestrial animals and cause the death of millions of vertebrates each year. Reduction of habitat quality and connectivity through disturbance and barrier effects characterise the environmental impact of the transport system. Compared with other land use forms, transport infrastructure occupies but a small fraction of the land, yet it affects the ecological functionality of the entire landscape.

Typically, infrastructure management focuses on individual road or railroad corridors rather than addressing the entire network of infrastructure facilities in a landscape. This is practise in the management of public roads, and certainly true for private roads for agriculture or forestry. As a consequence, the combined impact on habitat suitability and landscape connectivity, in particular, caused by the all infrastructure is often underestimated if not completely overlooked. This individual road (corridor) approach allows for a gradual deterioration of landscape quality as more and more infrastructure links are constructed and the network expands. The cumulative impact of particular infrastructure projects will ultimately lead to an irreversible loss of biodiversity at regional scale.

To overcome this deficiency, cumulative impacts should be assessed and evaluated not only in strategic and spatial planning, but also be part of environmental impact assessment (EIA) at project level (Eriksson & Skoog 1996). However, tools and concepts for integrating landscape ecology, sustainability, and biodiversity issues in EIA are rarely implemented and usually not appropriate to support this broad-scaled evaluation (e.g., Treweek et al. 1993, Seiler & Eriksson 1997, DeJong et al. 2004). Spatially explicit models on selected species’ habitat requirements and responses to landscape pattern can provide such tools (Scott et al. 2002, Gibson et al. 2004), especially if the direct effects of infrastructure and traffic on these species can be integrated in the model.

The challenge for new applied research is threefold: i) we need to develop appropriate indicators that help integrating landscape ecological principles in infrastructure management; ii) we need to understand functional thresholds in dose-response relationships, identify critical limit values for the impact on landscapes, and be able to predict consequences of changes in the impact; and iii) we need to develop efficient, communicable, and applicable tools that combine principles and knowledge with environmental policy and political goals to support decision making in the planning process. Essential for promoting long-term environmental sustainability is finally to support the dialogue between ecological interests, social and cultural dimensions and economical constraints by providing adequate and understandable information to the different stakeholders.

In addition, the level of ecological sustainability of the transport infrastructure network is linked to the surrounding landscape and to the characteristic of this network itself and. Since landscapes are dynamic systems (e.g. forest succession and ageing processes are constantly ongoing, land-use change continues due to economic and social developments) and sustainability implies a long time perspective, it is necessary to evaluate the impact of infrastructure not only in contemporary landscapes but also in respect to possible changes in landscapes. Working for a sustainable development of landscapes means protecting dynamics in landscapes to persist, not conserving a dynamics at a certain state!

Objectives

In this project we focus on quantifying, simulating, and evaluating the impact of transport infrastructure on the suitability of landscapes for selected indicator species, and through that develop spatial models that illustrate and communicate the impact and its potential consequences to the stakeholders. Modelling approaches will integrate disturbance and barrier effects at the scale of individual infrastructure links and the scale of infrastructure networks, respectively (i.e. landscape and regional scale). We will work primarily with real landscapes as provided by a number of commonly selected case studies, and create scenarios for an anticipated or assumed future to evaluate the cumulative impact of changes in infrastructure and the efficacy of counteractions. We will address questions such as the following: What indicators are appropriate under the given circumstances and at the given scale of the case studies? How do changes in infrastructure affect habitat suitability and connectivity for the selected indicator species? How do natural and human made dynamics in landscapes shift or create new, unforeseen, conflicts with infrastructure? How can disturbance and barrier effects, as well as the species' habitat requirements be parameterized if empirical data are scarce? How can suitability and connectivity models based on estimated parameters be validated? What level of precision and reliability in the models is adequate (sufficient) for implementation in planning processes?

Some of these questions relate to methodological and scientific constraints, while others will provide direct input into the INCLUDE component projects C and D as outlined in the programme proposal. Ultimately, we aim at contributing to a set of tools that enable decision makers (at individual as well as public level) to consider, understand, and evaluate landscape ecological impacts of infrastructure in the management of infrastructure.

Methods and work packages

Habitat Suitability Index (HSI) modelling (Scott et al. 2002) for focal species (*sensu* Lambeck 1997, 1999) is a useful tool that may help to incorporate the issue of biodiversity maintenance into spatial planning (e.g., Angelstam et al. 2004a; Gibson et al. 2004, Mörtberg et al. 2004, Gontier et al. 2005). By combining empirical or hypothetical data on species' or species groups' habitat requirements and their response to infrastructure with data on land cover and transport infrastructure, spatially explicit computer models can be used to produce HSI maps that can guide planner's decisions. At a broad scale, infrastructure density or other summary indices (Forman et al. 1997;

Jaeger 2002) could be used as predictor variables in HSI models with habitat suitability (in a broader sense species persistence) as the response variable. These models will be designed to INCLUDE both requirements at the level of individuals and populations. HSI models can be combined with rule-based movement models describing least-cost paths of individuals through a landscape. Habitat quality, connectivity and mortality risk can be translated into spatially explicit movement (or presence) cost for an individual (e.g., Adriaensen et al. 2003). Together, these spatial models will provide a means to i) evaluate the cumulative and long-term impact, ii) illustrate the outcome of alternative scenarios, and iii) communicate consequences of actions to decision makers.

We will develop HSI-based models adapted to evaluate and illustrate the effect of disturbance and barrier effects of infrastructure on selected focal species. Our work will contain five work packages:

1) Variables and parameter values for modelling disturbance and barrier effects

Based on the ecological (and socio-cultural) objectives and criteria for landscape sustainability that shall be developed in the first international workshop of the programme, we will start with establishing a set of indicators of the impact of transport infrastructure on biodiversity and sustainability criteria. Indicators will relate to the specific requirements that focal species or species groups (theoretical model species, ecotypes) impose on habitat quality and connectivity.

Such focal species will be selected according to their response to disturbance and barrier effects, to the spatial scale at which they utilise the landscape, and to their land cover preferences (forest, agricultural land, stream habitat; see Table 1).

Table 1. Examples of possible focal species as indicators for the study of disturbance and barrier effects at broad and local scales.

	Disturbance effects (noise, pollution, human activity, mortality, edge effects) = *affecting suitability of adjacent habitat*	**Barrier effects** (avoidance, physical barriers, traffic mortality) = *affecting habitat connectivity and movement pattern*
Regional- or continental scale	large mammals	large mammals
Landscape-scale	breeding birds	large and semi-aquatic mammals, fish (salmon)
Local scale	breeding birds, amphibians	amphibians, butterflies

However, modelling approaches require a parameterization of critical functional thresholds in the species' responses (Muradian 2001, Angelstam et al. 2004b, Seiler 2005). A key task is therefore to define parameter values for disturbance and barrier effects on these focal species at different spatial scales and for different types of landscapes (natural, rural, urban). This can be done either through field studies, through simulation studies that help identifying potential limit values in the response (e.g., Jaeger & Fahrig 2004), or, more applicable to our program, through relying on best available knowledge synthesised in an international expert workshop (see program plan).

With “knowledge” about the behaviour and ecology of the focal species or species groups, their requirements on habitat quality and habitat structure (size, dispersion, connectivity of habitat patches) and their response to traffic and infrastructure, rule-based, spatially explicit models can be developed using land cover and infrastructure data in a Geographical Information system (e.g., Scott et al. 2002; Schadt et al. 2002a; Adriaensen et al. 2003; Marulli & Mallarach 2005).

2) Models and case studies

In the second step in the project, we will develop and apply spatial modelling approaches that match the conditions of selected case studies and the respective planners’ and ecological scales at different stages of infrastructure management process (e.g., strategic level planning, project level planning, road maintenance). These models INCLUDE habitat suitability models with a focus on disturbance effects on species occurrence and population persistence (Scott et al. 2002, Angelstam et al. 2004, Mörtberg & Karlström 2004), cost-distance models with a focus on barrier effects on the movement and survival of individual animals (Singleton et al. 2002, Adriaensen et al. 2003), and other rule-based impact and fragmentation models (e.g., Reijnen et al. 1997; van Langevelde & Jaarsma 2004; Schadt et al. 2002b; Jaeger & Fahrig 2004; Seiler 2005). Modelling will be spatially explicit for a number of selected case studies that represent an increasing infrastructure pressure along a natural-rural-urban gradient in Sweden (landscape scale) and an East-West gradient in Europe (regional scale).

3) Scenario modelling

Third, we will use these models to forecast the impact of changes in infrastructure design (including mitigation measures), traffic volumes, and transportation pattern on landscape suitability in selected case study areas. Here, even the forecast of landscape change in the coming decennia will be incorporated. With these scenarios, we will evaluate if and how current trends deviate from a sustainable infrastructure development and prioritize locations and options for counteraction. Modelling will also help to establish potential thresholds in the response of the species (or the indicators) on the simulated changes. Although the quest for mathematical thresholds in dose-response relationships can be done more efficiently in theoretical models (e.g., Bender et al. 2003; Fahrig 1998; Jaeger & Fahrig 2004), real-case scenarios may have a greater applied value as they can be communicated to and understand by non-experts.

4) Evaluating mitigation efficacy

Working with scenarios also offers the opportunity to identify the need for and evaluate the effect of mitigation measures or alternative planning procedures. For instance, imagine a focal species living as a metapopulation (e.g., Hanski & Gilpin 1991) on a patchy set of habitats within a more ore less hostile landscape matrix. Through identifying potential (essential) movement corridors between source habitat patches, and evaluating their suitability with respect to the cumulative impact of infrastructure and other human and natural barriers in the landscape (open water, settlements), the need for remedying measures along with or within these corridors can be identified and ranked according to the effect on e.g., population persistence. Such ranking may help to produce an action plan for the conservation of the species that can be graphically illustrated to the different stakeholders in the landscape. Such models can be done at local, regional as well as at national scale (e.g., Ferreras 2001; Schadt et al. 2002a; 2002b).

5) Validation

Finally, we will attempt to validate model predictions and evaluate future scenarios depending on transport volume, road density and corridor design using analytical and correlative studies that rely on e.g., the distribution of animal-vehicle collisions in relation to predicted conflict points between transport and "ecological" infrastructure (e.g., Seiler 2005), or on known occurrences of the focal species at different spatial scales (European, national, regional scale; e.g., Mikusinski & Angelstam 1998, 2004).

Depending on the final budget of INCLUDE, validation efforts can be extended to encompass proposed associated studies on species occurrences (i.e. breeding birds in relation to infrastructure corridors; e.g., Helldin & Seiler 2003) or gene flow (i.e. genetic isolation in deer populations as a result of habitat fragmentation; e.g., Coulon et al. 2004).

Planned scientific deliverables

Naturally, our work will be published in scientific papers. At this moment, however, we can only give very approximate ideas, since neither project budget nor details of which study areas and hence which indicators we can work with are defined yet. Selection of study areas shall be done in cooperation with the partner programs in Sustainable Mobility and in dialogue with the authorities that will finance INCLUDE. Principally, we intend to produce the following scientific papers during the 3 year period. First authors and journals indicated below are only tentative.

- All project members: Indicators and focal species for evaluating disturbance, barrier and mortality effects of infrastructure – a review. *(Journal of Applied Ecology or Conservation Biology)*
    - *Selection of suitable indicators based on critical review of existing literature and results of the workshop 2; includes both species and landscape and traffic-infrastructure characteristics*
- Seiler, Jaeger, et al.: Simulation of barrier, disturbance and mortality effects of road traffic on animal movements. *Journal of Applied Ecology, Journal of Environmental Management, Ecological Modelling)*
    - *Spatially implicit models based on traffic flow theory, animal behaviour and population persistence*

- Mikusinski, Angelstam, Seiler et al.: Evaluation of broad-scaled landscape suitability for the management of large mammals in Europe *(Landscape Ecology)*
    - *Landscape connectivity models incorporating negative effects of transport infrastructure and landscape composition for a number of large mammals along the West-East gradient existing in Europe, validation against existing species presence data, link to ongoing and planned development of road infrastructure (main-trunk network level)*
- Seiler et al.: Localisation and prioritization of mitigation needs against fragmentation of wildlife habitat caused by transport infrastructure at regional, landscape and local scale (*Landscape and Urban Planning, Journal of Environmental Management, Ecological Modelling)*
    - *Using rule-based modeling, dispersal corridors or source areas can be identified where habitat connectivity or suitability is below critical limits and where counteraction would serve most efficient. This can be done either with three species groups at one scale, or with one species at different scales*
- Seiler et al: Predicting animal-vehicle collisions from least-cost movement models in changing landscapes *(Ecological Applications, Journal of Applied Ecology)*
    - *Contains two parts: A) Study of how least-cost modelling of animal movements through landscapes can help to identify accident sites*
    - *B) Analytical study: Based on the models from part a) and on knowledge about how the landscape factors that determine least-cost paths develop over time (e.g., forest succession), we predict future accident sites and put this prediction in relation to planned and existing mitigation measures*
- All project members: Dealing with landscape dynamics in transport infrastructure planning. *(Landscape Ecology, Landscape and Urban Planning)*
    - *The impact of transport infrastructure on ecological sustainability depends on landscape character, landscapes are dynamic however and conflicts between infrastructure and ecological corridors or biodiversity hotspots will change over time. This will also change human landscape perception and value. How can such long-term changes be considered and what is relevant to road management?*

Related studies

Examples of ongoing projects that will provide input to the project:

- Ecological evaluation of fragmentation effects of roads on wildlife. (Seiler, A. & Kjellander, P.; Project financed by the Swedish National Road Administration through 2005-2007).
- Effect and efficacy of road fencing – Significance of economic and ecological constraints on traffic safety. (Seiler, A.; Project financed by the Swedish National Road Administration through 2005.)
- HEUREKA – Biodiversity project (Edenius, L. and Mikusinski, G.)

- Habitat suitability modelling for Great Crested Newt – (Gustafson, D., Mikusinski, G.)
- Impacts of region-wide urban development on biodiversity in strategic environmental assessment. (Project financed by FORMAS 2005-2007. Balfors, B. and Mörtberg, U.)
- Prediction tools for biodiversity in environmental impact assessment. (Project financed by the Swedish Environmental Protection Agency through 2006. Mörtberg, U., Balfors, B. and Gontier, M.)

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Component project B)
Cumulative landscape impact and heritage values in relation to users and development of transport infrastructure

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Background

Despite the fact that Sweden has not yet ratified the Landscape Convention (European Council 2000), landscape today has become a rhetorical part in public infrastructure planning (Antonson and Blomqvist 2004, Antonson 2005). Due to multiple values attached to the landscape (e.g. ecological, economical, historical etc.) it functions as a common surface upon which to implement various planning and management actions. However, the Swedish infrastructure planning and management handle only small parts of the landscape or objects in the landscape, commonly defined as cultural or natural heritage in areas directly affected by the infrastructure. Hence, intangible aspects of the heritage and indirectly affected areas of the landscape are often neglected.

As society develops further into a post-industrial society, a traditional and homogenous concept of heritage and landscape qualities is challenged (Beckman 1998, Pettersson 2003). We are currently facing an inter-cultural world, with a vast range of possible social relations and supplies of knowledge and insights. How environmental qualities should be valued, is no longer only a question for heritage and planning experts, and decision makers, but also an important question for people as users of the common landscape (Olsson 2003). Different groups of citizens in society perceive and value the landscape in different ways, depending on how, when and where they experience the landscape and on e.g. their knowledge and profession (Meinig 1979, Lindström 2003, Lindström, et al. submitted). People often prioritise landscapes where they feel at home, a sort of familiarity, meaning that people rank areas they recognise and are familiar with very high (Kaplan and Kaplan 1989). Consequently, it is important to consider different value perceptions of the landscape in the planning and management of landscapes.

Both in the development of antiquarian policy (Saltzman 2001) and in social science in general, heritage values are no longer seen as something separated from praxis (Turnbridge and Ashworth 1996, Setten 2002). This means that, for example, a road and the use of the road communicate as well as create landscape and heritage values (Ingold 2000, Fast and Philipsson 2001). These kinds of immaterial values are however not easy to comprehend and to map in a traditional way (Malm and Wästfelt 2005). With the presented starting point it means that the use of landscape is intertwined with heritage values, which must be considered in the work towards sustainable land use and handling of heritage values.

Economists and other social scientists have, in the context of relative monetary value, sought to define the value of such environmental goals as clean air and clean water, leading to concepts of green values. Moreover, attempts have been made to employ economic analysis to decision-making concerning preservation of specific cultural and natural heritage assets (see Coccossis and Nijkamp 1995, Allison et al. 1996, Hutter and Rizzo 1997, Navrud and Ready 2002). However, the term value implies, in this research project, more than a simple financial valuation of cultural and natural objects and well-defined areas, also considering the relative importance of heritage and landscape values in the choices we as individuals and as society make.

A wide concept of heritage includes all aspects of the environments that people relate to. Thus, there is no clear-cut line between cultural and natural aspects of the environment, or between tangible and intangible environmental values (Wiklund 1995, Alzén and Hedrén 1998). Following this reasoning, also the infrastructure in itself is a part of the heritage. The starting point for assessing heritage and landscape values is not merely a question of restricting the preservation issue to tangible objects or conservation areas. Rather the task is to diversify the environment, considering tangible and intangible features, characteristics and qualities in the environment as a whole, including the values held by different groups of users of the landscape.

The physical environment is local in the sense that environmental values are spatially attached to the local community. For example, the local landscape is used for recreation and for recovering from stress (Kaplan and Kaplan 1989, Hartig 1993, Grahn and Stigsdotter 2003). In particular, cultural and natural tangible and intangible values in the environment are important for people as carriers of meaning and identity, and thus defining the landscape as a place of meaning rather than as a physical space (Tuan 1995, Casey 1998, Hubbard et al. 2004). The theoretical position here is that an understanding of landscape as a "place" is crucial for sustainable heritage and landscape management, and that cultural meanings are generated through a combination of people – place interactions in time and space.

However, the heritage management still rests on a spatially discrete and absolute notion of space, which holds a notion that landscape can be delineated into discrete parts managed by different interests (Wästfelt 2003). Research during the last decades show that landscape must be perceived as dynamic in both time and space, since it is continuously changing both physically, ecologically and mentally (Hägerstrand 1995, Russell 1997, Skånes 1997, Antonson 2003, Wästfelt 2004). This dynamic property obstructs our ability to predict and control the future development of a landscape (Bartel 2000). The awareness that the theoretical objectives and the practical response may not match should be taken into account when attempting to predict the effects of political and socio-economic decisions on the physical landscape (Hägerstrand 1994, Antrop 1998, Haines-Young 2000). The direct impact of human influence is often blurred by the fact that ecosystems and society tend to respond by successions in different directions and with varied time lags to changing environmental conditions (Skånes and Bunce 1997, Löfvenhaft et al. 2002, Wästfelt 2004). We mean that in order to handle the dynamic landscape development in relation to the infrastructure system, it is important to acknowledge that the heritage and landscape, as well as the infrastructure as such, represent multiple values to people as direct and indirect users.

Hence, valuation of the landscape and the infrastructure within it is clearly complex, taking into account the dynamics in time and space and the meaning of the landscape. For example, if limited to the economic valuation of the material landscape, each individual object has an external impact on surrounding objects and landscape. This external effect can be negative or positive, and will influence the value of adjacent qualities (DiPasquale and Wheaton 1996). In this way the surroundings or the landscape adds and compounds the real value of specific objects and defined areas.

One basis for the research is that the use of transport infrastructure has the potential to create heritage and landscape values for users of the infrastructure. A specific link in the infrastructure system is always a part of a network, and each specific transport communicates this network in a unique way. This means that a change in one part of the network can affect the network and the landscape, as well as the perception of the landscape, in other parts (Qviström 2003). Hence, values created by the use of infrastructure must be seen with a relational perspective and a wide spatial focus.

When people experience and value the landscape they can formulate what it represents, for instance in interviews when a road is to be built. Though there are situations when people don't make such a conscious reflection of landscape representation, despite the fact that it can be the same road that is experienced. There is, for example, reason to believe that the landscape affects drivers and that they are not aware of the cause of their driving behaviour. The driving behaviour is a question of traffic safety along the roads and in the long run how roads are designed and maintained. The driving behaviour can sometimes only be measured scientifically by instruments, sometimes through questionnaires (Solso 1998, Henrik Rundqvist Arkitektkontor AB and Temaplan AB 2004, Drottenborg 2002 and 2004, Brüde and Carlsson 2000, Varming 1970).

Thus, central to infrastructure planning in the future will be to contextualise and understand the ranking of heritage and landscape values in the hierarchy of societal values. Consequently, an interdisciplinary approach is essential for a further understanding of how transport infrastructure, direct and indirect, impacts our use, perception and valuation of the landscape and heritage along different types of transport infrastructure. A fundamental question raised in this project is what kind of values various heritages and landscape qualities represent to people as users of the infrastructure, directly and indirectly, hence the general landscape in a broad sense. Thus, this also includes how people are affected by the development of the infrastructure system, including roads and railways, in relation to their perception of the landscape.

Consequently an important research issue is to develop new methods to systematically evaluate the value of heritage and the landscape in the field of infrastructure. The idea behind the proposed research is that such evaluation must take its starting point in both existing value systems, employed by experts and decision-makers, and values that are defined in a user perspective.

Methods used in the project will include both qualitative and quantitative research methods, such as historical landscape analysis based on historical maps and fieldwork (Tollin 1991, Fast and Philipsson 2001) integrated with aerial photographs, satellite imagery and GIS analyses (Skånes 1997); participatory mapping combined with qualitative interviews and focus groups (Kohleer-Riessmann 1993, Kvale 1999, Johansson and Lindström 2003, Wästfelt 2004); simulation methods with landscapes virtually exposed to car drivers, and video supervision of cars.

Significance

The significance of this project is primarily to bring out new knowledge concerning how different users of the landscape and the infrastructure are affected by the concurrent development of transport system and landscape. Increased knowledge on how users perceive the landscape can facilitate the infrastructure planning and management. Furthermore, the research will contribute to analysis concerning how the social and cultural-heritage dimensions can be brought into infrastructure planning and management in a scientific and systematic way. Hence, the findings in the research will directly support analysis in component projects C) and D).

The project can also help filling the need for new valuation approaches of integrated (nature/culture) heritage values in landscapes where the management history, governing the structure and direction of change in the present-day landscape, must be accounted for. Our work on these aspects will be communicated to component project A (Cumulative impact of infrastructure on habitat connectivity and suitability) to harmonise socio-cultural and ecological approaches and improve our knowledge of anticipated dynamics also in ecological thresholds and limit values in dose-response relationships in the environmental impact. From our point of view, we presume that thresholds and limit values are not expected to be static and linear in the landscape but rather dynamic and complex as a result of landscape history and ongoing successions.

Objectives and project outline

From the significance point of view, the objective of this project is primarily to investigate how different natural/cultural values in the landscape intersect and interact as a consequence of the use and existence of transport infrastructure.
From this point of departure, the objectives for the research are to investigate the relation between landscape, infrastructure and people. The project aims to:

1. Critically investigate which historical, ecological and compound landscape values that are affected by transport infrastructure, using a dynamic conceptual landscape model.
2. To explore, describe and compare how people as users of the landscape create values and perceive heritage assets in relation to the development of local and regional transport infrastructure, and to compare how heritage values in the landscape designated by experts differ from values experienced by direct users and indirect users, i.e. those who are not using but are affected by the infrastructure.

3. To develop perspectives and methods that can be used in infrastructure planning and management to facilitate a systematic capture of values held by people as users of the landscape and the transport infrastructure.

The research will be developed in relation to differences in several dimensions:

- Infrastructure type: railroad, road (expressways, main roads, country roads)
- Landscape context gradient: rural - urban.
- Landscape character gradient: agricultural plains - woodlands.
- Landscape memory: land management history and successions
- User status: landowners, local residents, visitors.

To capture all these dimensions in this single project is not feasible. The dimensions that in the end will be included in the research depend on the common case study areas chosen for the whole programme. However, the research will include the following activities, as described below:

1. Mapping landscape character, landscape memory, and infrastructure
2. Expert valuation of the landscape
3. Valuation by users of the landscape
4. Valuation by road-users
5. Synthesis on the valuation of landscape and infrastructure

The research activities will take a starting point in the geographical case study areas along major landscape gradients (as described in component project A) common for the whole programme, making comparative analysis possible. Other case study areas might be sample quadrates from the NILS programme (National Inventory of Landscapes in Sweden).

1) Mapping landscape character, landscape memory, and infrastructure.

The point of departure here is that any successful infrastructure impact assessment and change scenario simulations should account for the integrated nature/culture values in landscapes and that landscape patterns should be viewed in a retrospective context. This includes mapping former functional relationships among present-day fragmented vegetation patches and successions (semi-natural and cultural). The objective of this theme is to develop operational combined landscape indicators to feed into dose-response relationship studies, and to assess a presumed plasticity in thresholds and indicators due to a dynamic landscape. Central to this approach is the concept of *landscape memory* - imprints of the historical development of a landscape (Skånes 1997, Wästfelt 2004) that can reveal anticipated or unexpected effects of new or modified infrastructure. We will further explore the use of *landscape change trajectory analysis*, based on GIS and available sources to landscape information (Käyhkö and Skånes accepted). The hypothesis is that monitoring of landscape memory and values in parts can be achieved using a combination of direct assessment and proxy data on landscape configuration using satellite imagery and digital aerial photographs in combination with thematic maps and field data.

2) Expert valuation of the landscape.

This activity aims to map existing expert valuation of landscape in relation to specific infrastructure projects in case study areas that are common for the programme (Storbjörk 2001, Olsson 2003). The work will be divided into two parts. The first part includes a description of general ideas that have guided the principle direction of planning and management of infrastructure historically. The second part includes an investigation of how the discourse has developed in the specific context during the last decade. Hence, it will include analysis of planning and management documents (e.g. heritage inventories, EIA, municipal comprehensive plans) from the planning and building of specific transport infrastructure in the case study areas. The specific aim of this activity is to establish a platform to which subsequent research activities in the project can be compared.

On a more detailed level the work will include analysis of how natural and cultural heritage assets in the landscape (i.e. objects, monuments, well-defined areas, as well as the landscape as such) have been valued and documented by experts in planning practise and in research. Hence, analysis of existing studies and research projects aiming to handle landscape values nationally and internationally will be an important input in this research activity.

3) Valuation by users of the landscape.

To include user valuations, interviews will be performed both stationary and while mowing along infrastructure (Ingold 2000, Fast and Philipsson 2001). The selections of interviews will be created in at least three dimensions. Firstly, based on a demographic aspect where both younger and older land users and road users are represented, secondly based on a geographical aspect where different kinds of typical landscape configuration are represented, and thirdly based on the type of road used in the specific case and fourth representatives of the local economy.

Focus groups interviews will also be used, meaning that a group of people (for example landowners) discuss the transport infrastructure of the landscape and also the values of the landscape. The researchers listen and note their discussion. Separate key issues will be discussed (such as consequences of a road project, nature and cultural values, values for recreation etc). The meeting is led by the researchers and the participants are encouraged to discuss the issues (Wibeck 2000, Steen Jacobsen 1999, Steen Jacobsen et al. 2002). This method was used in the project “Biological Diversity in the Public’s Mind” (Johansson and Lindström 2003) as a basis for developing a questionnaire for measuring different groups’ attitudes and values concerning biological diversity. Hence, a questionnaire based on the result of the focus group interviews can be developed and distributed to different user groups as the next step in future research activities within the programme.

4) Valuation by road users.

In the current infrastructure planning and management, major efforts are made to limit accidents on roads. However, the geographic location of the road and its visual qualities are not considered thoroughly from the perspective of drivers’ valuation of landscapes. A state-of-the-art study should be accomplished. Moreover, we will study how the valuation and behaviour of the driver and thereby the traffic safety are affected by scenic qualities of the landscape, with a special focus on the cultural heritage. This will be done using different methods based on advanced technical equipment at VTI, including the Driving Simulator III, and methods that will combine pulse gauge and/or the Eye Movement Recorder alongside GIS-studies.

In the end, drivers' experience of the landscape has effect on how to build roads, where to locate them and how to maintain them with regard to signs, parking areas, vegetation clearance and so on also from a traffic-safety point of view.

5) Synthesis of the valuation of landscape and infrastructure

The research results will be synthesised by combining the results from the different research activities. Hence, traditional heritage values and direct as well as indirect user values will be mapped together for an analysis of how different kinds of values in the landscape support and counteract each other. In sum, the idea is to put together and map the valuation of infrastructure and landscape from different users and indirect user perspectives.

Relevance for implementation

The knowledge gained in the project will contribute substantially to the development of heritage management in practice. Hence an important contribution will be a social and cultural sensitive way of designing infrastructure in the future, which handles indirect and immaterial values integrated with landscape memory and valuable physical remnants.

Thus, such research would bring out new perspectives and understanding of how the transport system as such directly and indirectly affects people. In this way the research will make a substantial contribution to the understanding of how transport system promote or counteract sustainable land use in a broad sense.

The empirical findings in this project have the specific purpose to contribute to the development of new concepts and theories. From this point of departure, the next step would be to develop criteria and measures that can indicate impact on the heritage and the landscape as defined and discussed in the project.

This project will also focus on penetrating the stated objectives in contemporary cases of road and railway planning. It is our intention to contribute to the development of methods for a practical planning that aims at identifying and systematizing the citizens' perceptions and valuation of direct, indirect, material and immaterial consequences for the natural and cultural environment. Knowledge on how people value the landscape could facilitate the planning towards a more sensitive planning process.

Increased influence of local values could strengthen the empowerment among landowners and local residents and increase the interest for participating in local projects concerning land use and infrastructure planning.

Planned scientific deliverables

Naturally, our work will be published in scientific papers. At this moment, however, we can only give very approximate ideas, since neither project budget nor details of which study areas and hence which indicators we can work with are defined yet. The suggested papers below are tentative.

- All project members: Cumulative landscape impact and heritage values in relation to users and development of transport infrastructure.
- Olsson and Wästfelt: Theoretical implications of landscape and heritage valuation.
- Lindström, Wästfelt and Olsson: User perspectives – landscape valuation by road-users, landowners, residents and visitors. (*Environment and Behaviour, Journal of Environmental Planning and Management, Transportation Research Record, Tourism Management (formerly International Journal of Tourism Management, Annals of Tourism Research or Landscape Journal)*
- Antonson et al: Traffic safety and landscape scenery. (*Transportation Research, Journal of Transportation or Transportation Planning and Technology*)
- Skånes, Käyhkö and Wästfelt,: LCT analysis as means to facilitate the infrastructure planning process. Linking ecology and landscape history (*Landscape and Urban Planning, Landscape Ecology, Environmental Impact Assessment Review*)

Furthermore, the results will be presented to practitioners in heritage and infrastructure planning and management, as well as in comprehensive municipal planning. In conjunction with the research, results will be presented at seminars and workshops, and in reports directed to planning practise.

Related projects

- **Landscape memory as means to deal with human impact on biotope resilience and potential biodiversity** (financed by Formas; Helle Skånes).
- **Citizens, Businesses and Public Heritage Management in Ystad** (Sub-project in Interreg III project: Sustainable Historic Towns), Olsson, K., Isaksson, K. and Cars, G. – Financed by National Heritage Board.Structural Change and the Impact on Cultural Heritage, Olsson, K. - Financed by National Heritage Board.
- **Landscape values – from competition about limited resources to a collective sense of responsibility**, Wästfelt, A. – Financed by National Heritage Board.
- **Landscape monitoring by remote sensing for landscape management of cultural heritage**, Jansson, J and Wästfelt, A - Financed by Swedish National Space Board
- **Attitude investigation about water** Marianne Lindström, Finaced by: EU Interreg IIIB, SEAGULL.

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Component project C)
Barriers and bridges in the planning process - natural and cultural landscape values in infrastructure planning and management

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Background

Planning issues that directly or indirectly affect the cultural and natural environment, e.g. in the field of transport infrastructure, are characterised by conflicts among different actors and stakeholders. Various groups of citizens and non-governmental organisations intervene in the planning- and decision-making processes. Often the processes are dominated by conflicts between different kinds of preservation interests or interests in favour of change (Linnros 1999, Isaksson 2001, Storbjörk 2001, Soneryd 2002, Olsson 2003). Since the mid-1990'ies, sustainable development is defined as an overall objective in Swedish planning and decision-making. Existing research and other experiences from this field however show that aiming at sustainable development has not led to easier planning- and decision-making procedures. Planning and decision-making today seem very complex and complicated, and it is evident that there is no straight and simple answer to how infrastructure projects can be planned and designed in an environmentally sustainable way. The sustainability objective can be interpreted in different ways, depending on what values and whose perspective that dominate the planning process. Conflicts might arise between, and within, different environmental values (e.g. cultural-historical values, recreational values, esthetical values, ecological values etc) and it is difficult to combine and balance ecological, economic and social sustainability-dimensions (Isaksson 2001, 2004, Storbjörk 2001, 2004, Boström and Sandstedt 2004, Macnaghten and Urry 1998, Owens and Cowell 2002).

The way the public planning- and decision-making procedures function in practice makes these difficulties even more complicated. Planning and provision of public goods, such as transport infrastructure and heritage values, is by tradition characterised by a strong public sector and by strict procedural links to the existing regulation system. However, in the few last decades it has been recognised that private and informal initiatives have an increasingly important role in the planning process, and hence for the provision of public goods. Interaction and negotiations among various stakeholders is today often a necessity to reach solutions on common planning problems (von Sydow 2004, Innes and Boocher 2003, Cars et al. 2002, Cars 2001, Healey 1997, Cars 1992). Consequently, formal planning activities according to the regulation system are often only a formality that confirms decisions that, in reality, have already been taken.

Moreover, the observation can be made that current planning practice to a substantial part is characterised by implementation of well-defined projects, and that these projects initiate comprehensive planning, rather than the other way around (Olsson 2004). These circumstances result in a situation where comprehensive considerations often are made in connection with the detailed project planning. These considerations are thus adjusted for project realization. In other words, infrastructure planning is not seldom organised and performed in such way that the consequence for the natural and cultural heritage are not discussed in a thoroughly and comprehensive way, at least not in the early stages of the planning and decision-making process. In general, only specific objects (monuments) and well-defined areas are considered in planning. Other natural and cultural values or functional linkages and processes in landscapes in particular, are often neglected or, at least, not handled systematically (e.g., Eriksson and Skog 1996, Seiler and Eriksson 1997). This is of course also a difficulty when it comes to the ambition to achieve an environmentally sustainable transport infrastructure in practice.

The observations above call for thorough research activities concerning the planning and decision-making process, and, eventually new approaches in land use planning and infrastructure management, with the purpose to contribute to sustainable transport systems in a broad sense. The overall question in this component project is how natural and cultural heritage is handled in contemporary transport infrastructure planning and management. Hence, the question is which values in the landscape and urban environment that are, and which are not, considered thoroughly when decisions are made in planning and management and the reasons behind this.

The conflicts that often appear in planning- and decision-making procedures concerning transport infrastructure are today expected to be handled by different means of control, i.e. legal regulation, economic incentives (e.g. loans and grants) and information, including planning tools such as EIA and SIA. However, in a situation when decision-making often is informal in practice, legal regulation and loans and grants as well as information appear as means to use in negotiations, rather than to have a self-adjusting effect. In the specific negotiation process information can play a substantial role for the outcome of the process. However, this might presuppose that the information exchanged between participating partners coincides with the different value systems held by various partners.

In order to comprehend current planning practice it is necessary to acknowledge that different interests (such as national and regional infrastructure planning, heritage management, municipal planning, businesses, non-governmental organisations, groups of citizens etc.) often employ or are guided by different value systems. Existing research shows that planning, as it is performed and organised today, is not at all the balanced and detached weighing-instance that it is so often presumed to be. The planning-process is in itself biased in a way that serves some perspectives and interests. In addition, some actors, representing certain values and perspectives, might not be able to act during the planning process in a way that suits their interest. Furthermore, some actors, values and perspectives may not be allowed, on formal or informal grounds, to take part in the planning process. It might not always be a case of explicit exclusion – patterns of prioritization can be manifested in more implicit but still very effective ways (Flyvbjerg 1998, Foucualt 1996, Isaksson 2001, Olsson 2003).

In conclusion, infrastructure planning is organised and performed in such way that consequences for cultural and natural heritage are not considered in a thoroughly and comprehensive way. This, in turn, is a main hindrance in the work for implementing the aim of sustainable development in practice. There are good causes to assume that a main part of the reason behind this problem lies in the existing widespread notion of infrastructure planning as an instrumental rational planning activity. For example, within such perspective, different sectorial interests, e.g. heritage agencies, are expected to deliver basic data for a rational adjustment by (political) decision makers. Furthermore, the planning and building legal framework states that the views of the citizens should be considered carefully in decision-making. However, it can be questioned whether decision makers and experts in reality can represent citizens and their values of the heritage and the landscape (Montin 1998, Johansson 2000, Olsson 2003). As noted above, there are reasons to question a notion of planning as an instrumental rational activity, also considering power relations between stakeholders and their incentives to take part in the planning process.

The theoretical framework for the research will be based on contemporary planning theory, (economic) value theory, decision-making and negotiation theory, focusing on the relation between instrumental rationality and communicative rationality (Sager 1994, Woltjer 2000), power relations (Forester 1987, Flyvbjerg 1998, 2002, Foucault 1996) and actor incentives and value systems (Olsson 2003).

Significance

In order to internalise natural and cultural heritage and landscape values in a broad sense in the decision-making process, it is important, but not sufficient, to bring out new knowledge about the impact on heritage, ecological and landscape values from investments in transport infrastructure. It is equally important to investigate the relation, interaction, and communication between actors with different values and perspectives that participate directly or indirectly in the planning process.

Thus, the significance of this project in relation to the program as a whole is that it will acknowledge the importance of relations, interaction and communication between various actors and stakeholders in infrastructure planning and management for a contribution to a sustainable transport infrastructure. In that sense, this project will contribute to an analysis of how, when and where knowledge gained in the program as a whole can be communicated and implemented in the practise of infrastructure planning and management.

Objectives

Hence, the communicative process in which various planning partners interact is of significant importance for understanding planning practice (Healey 1997, Tewdr-Jones and Allmendinger 1998, Throghmorton 1996, Storbjörk 2001, Dovlén 2005). It can be assumed that decisions made in infrastructure planning to a large degree are a result of power relations. In that sense, the possibility for various actors to influence decisions depends on the actors' power resources (Fog et al. 1992, Healey 1997, Flyvbjerg 1998, 2002, Isaksson 2001, Linnros 1999, Olsson 2003, Allmendinger 2002, Sandercock

1998, Richardson 2005). Consequently, the question and analysis of power and incentives to participate in planning is important for research aiming at a contribution to sustainable mobility and transport systems.

From this point of departure this specific project will include research activities directed to the, formal and in-formal, organisation and performance of the decision-making and planning process concerning transport infrastructure (roads and railroads), including the communication and interaction between various stakeholders in the process. Hence, important research questions are:

- How is the process organised?
- Who owns the initiative in the process?
- Who are allowed to take part in the process?
- Which values, perspectives, arguments, and motives dictate the process and guide the decision makers in rhetoric and in their priorities in practice?
- How are different attitudes, interests and values communicated or created during the decision-making process?

The emphasis in the research will be put on studies of planning processes for new infrastructure projects, including studies of sectorial infrastructure planning, as well as municipal comprehensive planning and other sectorial planning, e.g. heritage planning and management. The research will include the following main issues, as described below:

1. Synthesis of earlier research concerning infrastructure planning and management
2. Comprehensive analysis of actors and stakeholders in infrastructure planning and management
3. Studies of planning processes for new infrastructure projects
4. Analysis, discussions and proposals

1) Synthesis of earlier research concerning the infrastructure planning and management.

There exist a vast amount of literature and research from the last decades concerning planning processes, not least concerning transport infrastructure planning and management, see for example Isaksson 2001, Linnros 1999, Storbjörk 2001, Richardson 1999, Owens and Cowell 2002, Macnaghten and Urry 1998, Sjölander-Lindqvist 2004, Boholm 2000, Melin 2001. In broad terms, these studies are focused towards conflicts in infrastructure planning. However, none of them have specifically focused the issue of managing of heritage and landscape values in infrastructure planning. Still, however, these issues are included or at least touched upon in almost all of the studies. Thus, reviews of existing literature and research, for example the ones mentioned here, have a potential to bring out substantial knowledge concerning how heritage and landscape values are handled in infrastructure planning.

As a complement to the review of the international literature an international workshop will be organised within the project in order to further comprehend international experiences.

Hence, the first step in the research aims at establishing a basic knowledge, with the specific purpose to sharpen the research questions and to give a foundation for subsequent research activities.

2) Comprehensive analysis of actors and stakeholders in infrastructure planning and management

With at starting point in the review of earlier research and theoretical perspectives the second research activity will, from a general and theoretical point of view, aim at identification, description and analysis of groups of actors and stakeholders in infrastructure planning and management. The research in this part will especially draw experience from research activities within development field 1 (Criteria for sustainability) and 3 (Cumulative impact).

The purpose with this research activity is to give a theoretical foundation for understanding the actors and the stakeholders' values and perspectives concerning natural and cultural heritage, as well as their motives and incentives to act, or not act, during the planning process. Hence, the analysis in this part will support the analysis of the decision-making and planning process in subsequent research activities.

3) Studies of planning processes for new infrastructure projects

The main research activity in the project will include studies of decision-making and planning processes concerning recently completed and/or on-going infrastructure projects. The assumption is that detailed and thorough studies are necessary for a further understanding of the complexity that characterise the decision-making and planning process today.

In the research, we will put emphasis on the actors and stakeholders attitudes and conceptions concerning natural and cultural heritage assets in the landscape in relation to development of local and regional transport infrastructure systems. Hence, the analysis of the decision-making and planning processes will include the actors and the stakeholders motives, power resources, incentives, roles, status and responsibilities in the infrastructure planning and management. A preliminary list of actors and stakeholders include for example: infrastructure management authorities and heritage management authorities on local, regional and central level; concurrent views of citizens on heritage, landscape and infrastructure; municipal comprehensive development planning, from a politician and a planner perspective; businesses at local, regional and central level; non-governmental organisations at different levels.

The infrastructure projects that will be studied will be located in the geographical case study areas that are common for the whole programme, making comparative analysis with other research activities within the programme possible. We will study in total four infrastructure projects in rural as well as urban landscapes, including two road projects and two railroad projects.

In the research it will be important to observe that each infrastructure project is part of larger transport systems, and that it is planned and eventually carried out in a specific local and regional political, economic and social context. The assumption here is that the context is of significant importance for understanding the decision-making and planning process, and hence, which role local and regional heritage, ecological and landscape values have in the process.

Studies of each infrastructure project will include:

- Description of the local and regional political, economic and social context, including the transport system, using literature, available statistics and interviews with local and regional actors.
- Studies of the decision-making and planning process, using case study methodology (Yin 1994, Stake 1995, Merriam 1994) including studies of planning documents available as well as in depth interviews with different actors that participate in planning and/or is affected by the outcome of the process.

4) Analysis, discussions and proposals

The concluding part of the project will aim at synthesising the knowledge gained in the project. Considering the role of relations, interaction and communication between various actors and stakeholders, the ambition is to discuss and present proposals concerning how cultural and natural dimensions and values in the landscape can be maintained and developed in infrastructure planning and management.

The analysis of decision-making and planning processes will draw experience from studies of how different stakeholders and interest groups, including citizens, value the developing concurrent transport system and values in the landscape. Hence, the results from the research in the concurrent component projects in development field 1 (Criteria for sustainability) and 3 (Cumulative impact) will directly support analysis of the decision-making and planning processes in this component project.

The analysis will aim at analytical or theoretical generalisation rather than statistical generalisation, in order to further the understanding of the complexity of the decision-making and planning process. In that sense, the specific purpose is to develop concepts and a theoretical understanding concerning how, when and where to communicate knowledge about the impact from infrastructure on heritage, ecological and landscape values. Hence, the analysis will directly contribute to research activities in development field 4 (Tools for implementation).

Relevance for implementation

The research in the project will contribute to a further understanding of the complexity of decision-making in infrastructure planning and management, and the role of different values that can be associated with natural and cultural heritage in rural and urban landscapes. Through new knowledge concerning how, when and where various actors and stakeholders interact and communicate in the planning process, there is a potential for making the decision-making and planning process concerning transport infrastructure, more effective, i.e. less time-consuming, and more democratic, and hence contributing to a sustainable transport infrastructure system in a broad sense.

Deliverables

The project will result in scientific papers that will be presented at conferences and published in scientific journals and books.

Furthermore, the results will be presented to practitioners in heritage and infrastructure planning and management, as well as in comprehensive municipal planning. In conjunction with the research results will be presented at seminars and workshops, and in reports directed to planning practise.

Planned scientific papers for phase 1 (titles are preliminary):

- Olsson, K. et al. Conflicting perspectives on sustainability - actors and stakeholders in infrastructure management and planning and their values, incentives and motives.
    - *Paper on actors and stakeholders in infrastructure planning and management; their views and conflicting perspectives on natural and cultural values in the landscape and their incentives and motives to act, or not act, in the decision-making and planning process.*
- Isaksson, K. et al. The role of citizens for efficient and sustainable infrastructure planning.
    - *Paper about how to make infrastructure planning and management democratic and, at the same time, efficient as a method for sustainable planning in a broad sense.*
- Olsson, K. et al. Communicating heritage values in infrastructure management and planning - new approaches for public heritage management.
    - *Paper on how, when and where to communicate heritage values in the decision-making and planning process.*
- Isaksson, K. et al. Communication for sustainable infrastructure planning and management.
    - *Paper on the role of interaction and communication between actors and stakeholders for a sustainable infrastructure development.*

Related projects

- Sustainable Development and Economic Growth – A socio-cultural perspective on regional programming processes. Hilding-Rydevik, T., Isaksson, K. et al. - Financed by MISTRA.
- New Suburban Nodes for a Sustainable Future. Bergman, B., Höjer, M. et al. - Financed by FORMAS.
- Citizens, Businesses and Public Heritage Management in Ystad (Sub-project in Interreg III project: Sustainable Historic Towns), Olsson, K., Isaksson, K. and Cars, G. – Financed by National Heritage Board.
- Structural Change and the Impact on Cultural Heritage, Olsson, K. - Financed by National Heritage Board.

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Component project D) Integration of spatially explicit ecological and socio-cultural dimensions into infrastructure planning – how to communicate landscape ecology?

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Among different types of human-made infrastructures, roads and railroads affect a particularly large proportion of contemporary landscapes, especially in economically developed countries. Transport infrastructures as a physical construction with associated vehicular traffic entails various direct and indirect effects on the natural and cultural heritage, on biodiversity as well as on social life (e.g., Forman et al. 2003, Seiler 2003a). The present general quest of societies for sustainability of human activities demands that adverse effects of the transport system on the natural and cultural environment are evaluated and mitigated by proactive spatial planning at the scale of landscapes in regions and countries. This is particularly relevant in the context of developments in urban-rural and East-West gradients in Europe related to rapid economic change (European Commission 2004).

Landscape ecology, as an interdisciplinary domain of science dealing with multiple uses and interests in spatial pattern and structures, provides important guidelines for this endeavour (Naveh & Lieberman 1994, Forman 1995, Dramstad et al. 1996, Seiler 2003b). However, as the science of landscape ecology is a new and highly complex research discipline, it is crucial to communicate principles and applications in an understandable way to the end-users, i.e. the broader public, spatial planners, and stakeholders. Therefore, it is of paramount importance we understand the extent to which planners and professionals involved in spatial planning, Environmental Impact Assess ments (EIA) and Strategic Environmental Assessment (SEA) of the transport sector understand and implement landscape ecological knowledge in their work. We further need to understand what kind of information these people can make use of in the planning process and how we most efficiently communicate with them. One of the best tools for communicating landscape issues are visualisations based on Geographical Information Systems (Sandström et al. 2005, Manton et al. in press).

In this project we will evaluate, by interviewing actors and stakeholders in a suite of case studies, the extent to which GIS application techniques with their uncertainties and risks are understood (WP1), and landscape ecological principles are implemented (WP2) in the transport infrastructure planning process, or if not, the reason why they are not. We aim at identification of gaps in communicating and understanding landscape ecological principles and of landscape planning techniques among different types of actors in the research and the planning processes. We will cover different administrative levels by back-tracking the planning process bottom-up, and different spatial scales from the actual physical construction, to the level of landscapes in regions. This project will contribute to the communication, understanding and active mitigation of adverse effects of transport infrastructure on the functionality of landscapes.

Our focus is to begin with on the spatial pattern of habitat networks needed to maintain viable populations of animal species, as it is here where sufficient empirical spatial data is available and visualisation techniques have made most progress so far. Tools and approaches for visualisation of cultural heritage and landscape perception values are under development in INCLUDE component project B (see also http://www.raa.se/visavag/index.aspv) and shall be integrated later in the project.

(WP1) Uncertainty propagation and sensitivity analysis in scenario modelling

Spatially explicit modelling at multiple scales (time and space) is an efficient communication tool that can be used for evaluation of the functionality of habitat networks in the context of existing and planned transport infrastructure. We focus on habitat suitability and connectivity modelling (see component project A) as a tool for evaluating conflicts between existing ecological and transport infrastructures (e.g., Ferreras 2001, Schadt et al. 2002, Scott et al. 2002, Adriaensen et al. 2003), as well as a means of identifying options and needs of restoring habitat networks with poor functionality. In addition, we will test different ways of presenting the outcome of habitat and movement modelling for different stakeholder groups in different countries and regions. Model results presented as GIS-based maps that illustrate alternative development scenarios using e.g., photo realistic 3D-visualisations will be compared with more traditional, verbal, environmental impact assessment methods.

As any other type of models that aim at describing complex systems, the development of models is prone to errors and uncertainty concerning parameter estimates. Three important methods for assessing uncertainty propagation are sensitivity analysis, scenario modelling and uncertainty analysis. The latter refers to the propagation of uncertainties in source data sets and model parameters to the analysis results, whereas sensitivity analysis and scenario modelling refers to the relative importance that each source of uncertainty has on the analysis results (Crosetto and Tarantola 2001). The difference between sensitivity analysis and scenario modelling is that the first one is used for evaluation of existing plans and policies, and the last one for developing plans and policies (Olsson 2004, Wallace 2000, 2003). For example, HSI modelling is a spatially explicit assessment tool that involves the use of both verbal and mathematical models. As such, errors and uncertainties enter at various stages into the models and may have an influence on the final results. Connectivity and suitability models include a number of variables (patch quality and size, landscape configuration and habitat patch dynamics) as well as analytical techniques (Angelstam et al. 2004, Manton et al. in press, Rönnbäck and Angelstam ms.).

In this work-package we will perform sensitivity analysis, scenario modelling and uncertainty analysis from the point of view of actors' and stakeholders' ability to handle uncertainties and risks. First of all the various uncertainties (in the data as well as in the models) need to be estimated. In order to be useful in a realistic and practical way, uncertainties have to be handled already in the estimation process. Secondly, when comparing indicators with performance targets, and when aggregation into an index (such as an Habitat Suitability Index, see project 1), the meaningfulness of the results needs to be evaluated. These analyses will provide us with knowledge on weaknesses of modelling in a number of different geographic settings in selected case studies along a rural-urban and East-West gradient in infrastructure development (see project 1). An essential question is how methodological uncertainty and ecological fuzziness can be explained to the users and integrated in their decision making process. Planning for a sustainable future requires a better understanding and implementation of uncertainties and weaknesses in development prognoses.

(WP2) Obstacles for geographical presentation of ecological sustainability

While indicators and indices are often developed within pilot studies or research projects, their general implementation in practise is difficult. In order to identity and mitigate obstacles to effective communication it is thus important to study the communication between researchers representing different disciplines, and decision-makers at different levels of public administration and businesses (Riabacke, 2002).

The successful implementation of a certain spatially explicit assessment tool is dependent on a whole range of factors (Store and Jokimäki 2003, Manton et al. in press). In this work-package we will analyse three aspects of the application of GIS-technology for spatially explicit assessment and communication of the state of the environment: (A) the habitat suitability and connectivity modelling itself; (B) model validation; and (C) routine use and communication of the results.

(A). Habitat suitability as well as connectivity models basically contain three components: (1) Land cover data. With what range of spatial and thematic resolutions should different objects be possible to map? How can such themes become available as spatial data bases (in vector or raster format)? How can different data sources (remote sensing, digital elevation models, public spatial data bases) be used? Are these data bases available, to whom, and at what cost? (2) Focal species ecology and behaviour. Some specialised species indicating certain environmental conditions can be used as focal species (Roberge and Angelstam 2004) and are thus suitable for HSI modelling. Which species should be used as focal species for different terrestrial and aquatic ecosystems in a context of infrastructure planning? What are the habitat variables, and how can they be expressed spatially using the existing land cover data (Nordström et al. 2004)? What parameter values (thresholds) at the level of individuals and populations should be used? What is the regional variation regarding the three previous questions? Do different actors understand, are they able and willing to use these kinds of approaches (Uliczka et al. 2004)? (3) Modelling algorithms. To integrate land cover data and the qualitative and quantitative requirements of species, and the barrier and disturbance impacts of infrastructure and traffic in a spatially explicit manner, Geographical Information Systems (GIS) with a range of different algorithms will be used. This has, furthermore, to be integrated with some scenario modelling software for proper analysis of temporal and uncertainty aspects. How do models differ? How much can reality be simplified?

(B). Coming up with indicators, or doing models on the computer in the office is easy. To validate their functionality with independent field data, especially in applied work, is therefore crucial (Scott et al. 2002). Do indicators and indices really work? The actual validation process is dealt with in project 1. Here we focus on different actors understanding of the need to validate models.

(C). For practical implementation of assessment tools there remains an important step in terms of adapting indicators and indices to the end-users capacity and needs. Do the end users understand the models, and do they trust the results? How to improve their understanding and reliance?

We will evaluate, in collaboration with the rest of the INCLUDE projects, the extent to which existing uses of spatially explicit indicators and indices satisfy the range of requirements listed above. Particular emphasis will be put on geographic presentation of suitability and connectivity in the form of probability maps and landscape 3D-models draped with high resolution satellite imagery as being effective by means of communicating interactions between ecological and transport system networks.

Such visual pedagogy should be used frequently during the different phases of the whole research program. It will serve the research process and the users can formulate their needs and wishes in order to get the tools they need. It is important that these tools will mediate messages for the planners and the decision-makers. In part, this is a man – machine problem. There is need for an interface between the man (users) and the GIS tools (the machine) in order to use the proper information effectively.

A multiple case study design

In many spheres of science and society there is agreement that research on sustainable resource management requires holistic approaches that include several disciplines (Jakobsen et al. 2004). However, many projects fail to achieve collaboration because disciplinary boundaries are not truly broached (Olsson 2003). To avoid the dangers of becoming superficially multidisciplinary, but still be able to study the different dimensions of ecological sustainability and its implementation in management with disciplinary professionalism, the members of the present team are selected because they individually have developed skills in transdisciplinary empirical research. Thus, there exists experience and competence to use both qualitative and quantitative methods (Danermark et al. 2003) to study landscapes as integrated social-ecological systems (Angelstam and Törnblom 2004, Lazdinis and Angelstam 2004).

Much of the existing transdisciplinary research consists of in-depth case studies. Although these can reveal the complex links and feed-backs within and between local social and ecological systems, they are often limited in their ability to generalise and suggest strategies and 'tool-boxes' applicable in a wider context. To reach beyond this limitation we will use multiple case studies, with the overarching ambition to extract the general from the empirical and local. We believe that a comparative approach will show up a number of unexpected similarities between localities superficially quite different in terms of environmental, social and political features – and that these similarities can be used to formulate guidelines of more general value. We will examine two types of case studies.

The East-West gradient

Loss of habitat and reduced functional habitat connectivity is a major threat to forest biodiversity in Europe. However, the ongoing development associated with the economics of agriculture in general and the expansion of the European community in particular means that considerable areas are being passively or actively reforested. Hence, there is an opportunity to restore the functional connectivity of different kinds of habitat networks. On the other hand an increased development of transport infrastructure may aggravate the situation, especially for species with large area requirements (for details see project 1).

Since 1989 spatial development within the EU has developed into a new cross-sectoral policy field (the European Spatial Planning Perspective – ESDP), and since 1992 Sweden is a central partner in the co-operation programme about transnational planning between countries around the Baltic Seas called VASAB 2010 (Löwendahl 1997). According to the VASAB 2010 PLUS Report one of key themes in which VASAB proposes to concentrate is the development of trans-national green networks, including cultural landscapes. Similarly, according to the Agenda 21 for the Baltic Sea Region, (BALTIC 21 SECTOR AND SPATIAL PLANNING) a further development of sustainable forests in regional co-operation between the countries at various levels is emphasised. In European Conference of Ministers responsible for Regional Planning (CEMAT) guiding principles for sustainable spatial development of the European continent have been established. Appropriate measures in the field of landscape protection include: (1) strong cross-border, trans-national and interregional co-operation in fields of landscape development, exchange of experience and research projects involving in particular local and regional authorities; (2) strengthening of the awareness of people, private organisations and territorial authorities of the value of landscapes, their economic significance, their evolution and possibilities of conserving and improving them; and (3) stronger integration of landscape development into training programmes in various disciplines, and interdisciplinary training programmes. The European Strategic Environmental Impact Assessment (SEA) Directive (2001/42/EC) enforces the integration of ecological aspects in future planning and programming of infrastructure. Recently, a new ‘Code of Practice for the Incorporation of Landscape and Biodiversity in the Planning of Linear Transport Infrastructure’ has been developed by the European Council that includes recommendations for integration of the Pan-European Biological and Landscape Diversity Strategy in environmental impact assessment (Damard et al. 2003). However, the extent to which these objectives are implemented needs to be evaluated.

The potential positive impact of implementation of forecasting systems regarding the functionality of habitat networks based on landscape ecological principles in the development of transport infrastructure is therefore great in Eastern Europe. Sweden, with relatively low human population density and high forest cover resembles east European countries. Therefore, we will employ an international multiple case study approach with case studies on both East and West Europe. In all these countries the expertise concerning the impact of new and improved roads and increasing traffic is highly demanded, while there is a gradient in awareness and degree of implementation of measures from west to east. We also clearly see the opportunity for mutual learning since regional settings in these countries may serve as reference areas for Sweden.

Integration of natural and cultural visions for conservation

One of the Swedish environmental goals is described as “a varied agricultural landscape”. This means that species-rich wooded meadows and pastures being also an important part of our cultural heritage are preserved and managed so that their biological values are maintained. To reach this goal, i.e. to maintain a functional network of patches at the landscape scale, a wide range of actors need to collaborate (Angelstam et al. 2003). As a part of the European Common Agricultural Policy, agri-environment support is paid out for maintenance of meadows, pastures and other grasslands. However, stereotype advice and lack of landscape-scale incentives in CAP agri-environmental schemes (Larsson 2004) hamper the management of functional connectivity of habitat patches, and it is obvious that different interests and ideals collide in within the process. Agro-environment schemes applied with an overriding landscape scale strategy could, however, alleviate the situation. In this part of the project we will focus on the scale of farms in landscapes and use multiple case studies in Östergötlands län, Örebro län och Dalarnas län. Our research consortium INCLUDE has already established contact with landowners in all these regions (T. Ek, pers.comm., Angelstam and Törnblom 2005).

Deliverables

The project will result in a number of scientific papers. Their topic will largely follow the themes of the different work packages and geographical different case studies. The exact outline of the scientific deliverables will also be influenced by the models and results produced in component projects A) and B). Below, we outline tentative titles of potential scientific articles:

- Angelstam et al. Ecological dimensions in planning of transport infrastructure – do planners understand landscape ecology? *(Environment and Planning or Landscape and Urban Planning*)
- Mikusinski et al. Mapping and communicating ecological sustainability of transport infrastructure in the East-West gradient in Europe (*Environmental Management*)
- Rönnbäck et al. Scenario modelling in planning of ecologically sustainable transport infrastructure – a sensitivity analysis. (*Journal of Environmental Economics and Management*)

In addition, models and visualisations produced or used in this project will comprise user deliverables and shall be distributed as examples for educational purposes to the end users. This can be done through the INCLUDE website.

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Associated project
Cumulative ecological effects of road-crossings at the scale of watersheds

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In Sweden the total length of running waters is approximately 300 000 km. This "blue infrastructure" network has been surpassed in length by the network of roads and railroads. The length of the road network is 420 000 km and that of railroads 11 000 km. These artificial infrastructures have several negative effects on the aquatic habitat, processes and species (Gibson et al. 2005). Generally it has been shown that the abundance and diversity of fish (Thompson & Lee 2000, Sharma & Hilborn 2001, Paulsen & Fisher 2001, Schmetterling & Adams 2004), aquatic birds (Whited et al. 2000) and amphibians (Houlahan & Findlay 2003) decreases with increased road density (km roads/km^2) in the watershed area. No such detailed studies have been carried out in Sweden, but it has been shown that the number of road crossing in streams was negatively correlated to the ecological status of the fish community (Degerman et al. 2005a). However, other human activities were also correlated and the exact cause and the processes responsible were not identified. From the literature several negative effects of roads and railroads crossing streams have been observed; e.g.: (1) Fragmentation of the aquatic landscape (Warren & Pardew 1998); (2) Increased sediment load to surface water (Gunn & Sein 2000, Steadman et al. 2004); (3) Increased run-off, decreased low flows and increased peak flows due to increased drainage capacity and hard surfaces (Jones & Grant 1996); (4) Increased risk of hazardous spill of toxic compounds (c.f. Liljegren 2004); (5) Increased load of salts used on roads (Ramstack et al. 2004); (6) Loss of habitat, e.g. large woody debris (Degerman et al. 2004), as the riparian forest is impoverished or lost; (7) Increased public access to waters leading to increased fishing (Post & Johnson 2002, Gunn & Sein 2000) and stocking of fish and crayfish; (8) Disrupted movement of sediment and large woody debris (Jones et al. 2000).

Several of these negative effects may act cumulatively with small impacts in the headwaters leading to large effect downstream (Bergquist 1999). The effect on aquatic life mobility caused by inadequately designed road crossings is thus a common, serious and large-scale problem. In an inventory of road crossings in the county of Östergötland it was found that 34% potentially posed a migration obstacle to fish (Seiler & Rudin 1998). An inventory in the county of Västernorrland showed that especially culverts could impede migration possibilities as 42% of investigated culverts were considered migration obstacles for fish (Bergengren 1999). Culverts are commonly used for forestry roads or private roads that constitute 70% of the road network. This means that one third of forestry or private road crossing potentially impede fish movements. In a study of 55 coastal streams and rivers Degerman et al. (2005a) found that road crossings were situated on average 2.2 km apart in the streams, i.e. the aquatic landscape may be heavily fragmented.

Traditionally, the effect of single crossings is evaluated at the site scale, i.e. with assessment of probabilities for fish and other fauna to pass from downstream to upstream (e.g. Bergengren 1999). However, in Scandinavia the effects of road and railroad crossing have not been evaluated at the landscape/watershed scale. Knowledge about the cumulative effects of road crossings is of great importance for cost-efficient management and restoration of the ecological integrity of the aquatic ecosystems at the scale of watersheds.

This project proposal has been developed in collaboration with the National Board of Forestry, and the Regional Boards of Forestry in Västerbotten and Dalarna-Gävleborg.

Potential and observed effects of stream fragmentation at the landscape scale

Movements of fish can be impeded by natural barriers, such as waterfalls of only 0.5 m height or excessive water velocities at high flows. For example, long riffle areas with high water velocities may hinder cyprinids and other slow-swimming taxa. The major problem, however, is man-made barriers that act at other scales and may persist longer than natural short-lived barriers as log piles and beaver dams.

In a study of 88 reaches in four isolated streams it was found that density of adult cutthroat trout and habitat complexity increased as fragment size increased. In the smaller fragments, the density of adults was lower while that of juveniles was higher (Horan et al. 2000). In Oregon, USA, multivariate logistic regression was used to identify key factors linked to presence of Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). Stream basin isolation was the only factor significantly correlated and isolated basins lacked trout to a high degree (Dunham et al 1997). The isolation was often caused by human activities.

In a study of stream-dwelling char (*Salvelinus leucomaenis*) at 52 dammed-off sites it was found that populations were lost at 32% of sites. Lost populations were associated with long isolation period, small habitats and with low stream gradient (Morita & Yamamoto 2002, Morita & Yokota 2002). Further it was postulated that another 23% of the initial populations would be lost within 50 years. The authors suggest that extirpation of small, dammed-off populations are inevitable unless connectivity is restored (op. cit.). The exact cause of the extinction process was not identified. Several co-acting factors may lead to a dammed-off population decrease and extinction.

Objectives

This research proposal aims at evaluating the effects of road crossings at the riverine landscape scale (focusing on 2nd and 3rd stream order watersheds), i.e. addressing the cumulative effects on fish populations, using fish as focal species (Roberge and Angelstam 2004). This will be done by using as response variable the existing electrofishing database (Swedish Electrofishing RegiSter; SERS), which comprises 32

000 electrofishing occasions at 11 000 sites from all over Sweden. Using existing Swedish I.B.I. (Index of Biotic Integrity, Appelberg et al. 1999) sites classified as undisturbed and with low road density will be chosen for an estimation of road and land cover features important to fish community status at the local level. From this a model of undisturbed fish communities in areas with low road density can be established. After field validation, this model can be applied to watersheds with different densities of roads to evaluate the extent and direction of deviation of ecological status from predicted based on both road-related variables and land cover data.

Site-specific habitat characteristics such as substrate, depth, snout water velocity, riparian cover and abundance of competing or predatory species have important influence on species distribution and population characteristics. In practical watershed management such information is often lacking and is too expensive to gather. However, landscape-level factors such as geology, run-off and land use can determine the distribution of the site-specific variables and thereby the distribution and status of fish communities. Data on landscape features are often available more easily than site/reach-scale data. We will use Geographic Information Systems (GIS) to extract such data from existing spatial databases, such as the one the Dalälven watershed (Nordström & Olofsson 2003). For the land cover analyses we will collaborate with MISTRAs HEUREKA programme where PA is involved.

This will give the manager two important tools;

- a model to define biotic integrity using fish as focal species (PISCES, PrIStine Watershed Ecological Status)
- a model for assessing the effect of multiple road crossing on fish community status. (ROADFISH, Effects of ROADs on FISH community status)

Methods

A/ PISCES - a model to define biotic integrity using fish as focal species

Watersheds with sites of high or good ecological status according to Swedish I.B.I. will be included. The watersheds will be delineated and landscape factors important for the distribution and abundance of fish will be extracted using GIS. Previous studies have shown that slope, i.e. water velocity, is a major factor controlling fish distribution, abundance and size distribution as well as habitat factors (Markusson et al. 1997). Average flow can be determined by slope, watershed area and run-off and may be used instead of water velocity.

To make PISCES useful for all watersheds the prediction of the stream fish communities need also information on climate, productivity and re-colonisation history since the last ice age. GIS parameters representing these factors are average air temperature, chemical properties indicated by geological weathering tendency (Nordström & Olofsson 2003) and the highest sea level since the last ice age, as well as land cover as derived from HEUREKA.

Other factors that will be extracted using GIS are length of stream, stream order, hillside slope, network position, downstream connectivity, upstream connectivity, riparian vegetation, land use and water regime. The same factors will be extracted when developing ROADFISH.

B/ ROADFISH - assessing the effect of multiple road crossing on fish community status

For ROADFISH the input will come from PISCES and the GIS-variables indicating human disturbance. Watersheds with medium to high road density will be chosen. Using GIS watersheds without noticeable other human disturbance according to Degerman et al. 2005b will be selected. Watersheds will preferably also be such that have previous studies of migration obstacles, to assure that other obstacles than the road crossings do not impede fish movement. In each watershed every road crossing will be re-assessed in the field regarding possibilities for fish to pass. This will be done in a scale from 0 to 3 according to Bergengren (1999). Additional electric fishing might be required in some reaches where SERS does not have already fished sites.

The road density, the migration possibilities (0-3; with 0=no problem for migration) at each road crossing, the sum of migration possibilities, habitat size (minimum distance between nearest road crossings with impeded migration possibilities) etc will be evaluated against the prediction by PISCES. This will give the model ROADFISH, i.e. an estimate of the effect of single or multiple road crossings of different design on the ecological status of the fish community. ROADFISH could be used by the watershed manager to predict environmental effects on the aquatic landscape of establishing new road crossings or the effect of re-designing old crossings. As the model is simple it can be run using a simple spread-sheet program once the GIS data have been extracted.

C/ Joint validation of PISCES and ROADFISH

PISCES and ROADFISH will be developed from multivariate logistic regression. This will be used because it allows for independent variables that are both quantitative and qualitative. PISCES will predict species occurrence (give probabilities) and also give predictions of each species status (for each species status will be graded from 1 to 5 according to I.B.I.). The model will be validated on a subset of small watersheds not included in the primary data set used for the model.

To validate the models, road variables, stream and land cover data will be compared to evaluate the occurrence of cumulative effects on fish, and to evaluate the relative effects of road and land cover variables. In a field study in three river basins (river Dalälven, River Varjisån and River Emån) well spread over Sweden, independent watersheds will be sampled with electrofishing and migration obstacles will be assessed by local consultants to verify that the method is operable. In each river basin one watershed with low and one with medium-high road density will be chosen. GIS will be used to produce input to PISCES and ROADFISH.

To plan the work in detail we will organise in September 2005 a travelling workshop in Alberta with our colleagues.

Significance

The development of road networks is an inevitable outcome of any land-based development activity and has been shown to impact watershed health (e.g., Haskins and Mayhood 1997). Stream crossings can cause both immediate and longer-term effects on fish populations primarily by modifying water quality, substratum composition and fragmenting stream channels (Adams and Whyte 1990; Toepfer et al. 1998; Eaglin and Hubert 1993). Connectivity of fish habitats is considered to be critical in conserving the distribution and abundance of stream fish assemblages (Rieman and McIntyre 1993), while reductions in connectivity impede fish movements and alter fish community structure and likely threaten population viability (e.g., Morita and Yokota 2002). The practical use for PISCES and ROADFISH will help forestry managers and urban planners in planning for new, existing and old road crossings from a landscape perspective concerning cumulative effects and thresholds on the biota that are depending on functionally migratory networks within whole watersheds. Today there is a severe knowledge gap in the understanding of the spatially and temporal implications of the localisation of culverts, bridges, fords, and decommissioned crossings. This tool will help planners avoid further fragmentation of streams and riverine landscapes to establish more robust forestry infrastructures and suggest appropriate solutions to the technical implications concerning habitat restoration and establishment of new forestry roads, culverts and road crossings.

Deliverables

We will produce at least one scientific paper for each of the models described above. Main author and co-authorship have not yet been decided. A more detailed planning will be made when the decision about the position of this project within INCLUDE has been made.

Budget

The funding of this associated project is subject to discussion with the National Board of Fisheries and INCLUDE. A decision about how the Board of Fisheries will contribute to INCLUDE will be taken after the meeting with all involved authorities in early may.

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SYNTHESES

Syntheses of knowledge, tools and results developed in the course of the programme

Project coordinator: J-O Helldin and program management group

Project members: the entire consortium including our international experts and eventually additional scientists (to be decided later)

Background

An essential assignment in all Mistra programmes, or any complex and interdisciplinary programme, is synthesizing findings of the different research projects that arise during the life time of the programme. This applies for INCLUDE as well.

We will join several synthesis tasks in one project that runs parallel to the other component projects through the first phase of the programme. These synthesis tasks combine and transform available results from the four component projects and workshops, along with results from other (external) research on related issues (e.g., Mål & Mått, MiSt), into a preliminary set of assessment tools. In the second phase of the programme, these tools will be developed further into a "toolbox" that shall comprise a practical help to planners in their decision making at different levels of the planning process.

At present, we identify the synthesising tasks listed below, however, the total number and the final outline of these tasks may diverge from this proposal due to unforeseen factors that influence the progress of the component projects. Consequently, the responsibility for, and the work with, these tasks will not be with one single project leader, but with the researchers who will be assigned for the corresponding tasks. Their work will be coordinated by the program management group, in particular J-O Helldin, and the funding assigned for this project will be used to direct the individual involvement of the researchers in synthesis work.

Objectives

Initially, there is need to review current knowledge and approaches on e.g. Environmental Impact Assessment (EIA) and Strategic Impact Assessment (SEA) techniques, identify conflicts in quality objectives between natural and human sciences, summarise expert opinions on critical limits and functional thresholds. This will partly be achieved through international workshops with the involved foreign researchers and further invited experts (see A4 Programme structure); and partly through literature reviews and interviews with the experts involved in our network. These reviews will primarily be written as reports (which eventually may result in scientific publication).

In addition to these reviews, synthesis tasks will also involve the blending of ecological and human perspectives on landscape values, indicators and criteria established and used in the component projects A) and B). Accordingly, this will be done using spatial models and GIS.

Another synthesis task will consist in combining knowledge about the different constraints on assessment tools (models) imposed from planning processes (component project C) and from the knowledge and skills of the stake-holders and end-users of these tools (project D). This includes also the development of implementation strategies so that the knowledge and approaches can be used in the actual decision making process (e.g. as laws, monetary steering tools, policy, simple guidelines, etc.).

These syntheses will be summed up at the end of the first phase of the programme and presented as a preliminary "toolbox" in the CBM user conference in 2008. This toolbox will comprise the platform for all further work during the second phase of the programme.

In the following we give a brief description of the different tasks:

Task 1:

Review on concepts and definitions concerning sustainability of landscapes in relation to the impact of infrastructure.

Sustainability implies saving dynamics in landscapes, not conserving a certain state! Which are the essential dynamics and how can they be affected by infrastructure?

Timetable: first report available in early summer 2006, includes the first international workshop.

Task 2:

Review on critical limit values and functional thresholds in the environmental impact of infrastructure and traffic.

Where are limits and thresholds in the dose-response relationship in the impact of infrastructure on ecological and cultural values in landscapes. How much load can be tolerated, when are landscape dynamics significantly affected? This review combines knowledge from the second INCLUDE workshop with empirical and simulated knowledge on dose-response relationships obtained in other studies.

Timetable: autumn – winter 2006/07; resulting from the second international workshop and related projects.

Task 3:

Review on pro's and con's in current SEA and EIA approaches to assess cumulative impacts on ecological and socio-cultural landscape values.

What are the barriers and bridges in current tools and methods used in SEA and EIA or other planning processes to assess and evaluate impacts on ecological and socio-cultural values in landscapes. How do current methods consider landscape scale and sustainability? This review must be related to work in project C) and D).

Timetable: started during summer 2006 (after task 1), report in spring 2007.

Task 4:

Review on similarities and dissimilarities in human and ecological landscape values and goals.

How can socio-cultural and ecological values in landscapes be combined in assessment and evaluation? Which values and goals are harmonizing, which are conflicting with respect to sustainable development? To what degree can ecological concern be covered by securing socio-cultural landscape values? This review is based on a comparison of existing goals and values and discussions from the first workshop of INCLUDE.

Timetable: started during spring 2007, deliverable report in autumn 2007.

Task 5:

Sustainable mobility – analyzing barrier effects of transport infrastructure on animals and humans.

Landscape value and perception by humans and habitat suitability for animals are two sides of the same coin and could be studied and modeled with the same approach. Similarly, least-cost path models used to analyses animal movements through a landscape and axial-line distances calculated for human orientation and movement in urban habitats, are two methods that can be combined to study landscape connectivity from an interdisciplinary perspective. This project aims at applying and testing GIS modeling in suburban green areas with respect to a human perspective on landscapes. This "synthesis task" can be regarded as a pilot study for the tool development planned for the second phase of the programme. Cooperation with: Alexander Ståhle (KTH), Bette Malmroos (SL).

Timetable: start during autumn 2006 – finished before during summer 2008

PHASE II: Loading the toolbox

The second phase of the programme is a logic continuation of the research done during phase 1. Research activities in phase 2 will be characterized by trans-disciplinary, holistic approaches in dealing with ecological and socio-cultural impact assessments. The work will imply further development of the spatially explicit evaluation models developed in phase 1 and their complementation with other non-spatial approaches developed in parallel programmes such as Mål & Mått and MiSt into a common "toolbox" for assessment and evaluation of cumulative landscape impacts. This "toolbox" shall be a practical help to planners in their decision making at different levels of the planning process. It shall be established and tested through employment in real-world cases (SEA, EIA for new infrastructure plans, maintenance strategies, or spatial land use plans).

The close cooperation with the different stakeholders that are involved by space or topic in each case study is important. Therefore, a guiding-star in this phase is to produce something that is demanded by, among others, the road and rail agencies and by the practitioners. For this reason this phase of the programme should have a user-driven agenda. But at the same time it is essential to the researchers in the programme to make the stakeholders aware of new and important knowledge. Doing so, new paths can be explored, giving better planning tools as a result. It is probable that the direction of this phase can be changed by new political directives to the infrastructure agencies.

The final goal is to provide a set of tools that are robust and efficient in assessing and evaluating the impacts of infrastructure and traffic on ecological, social, cultural and recreational landscape values and sustainability criteria.

The aim of the second phase of the programme is to provide the infrastructure planner with methods and tools that take a holistic view and facilitate the planning process and the communication of comprehensible results with different actor and stakeholder groups.

Our basic concept is to discuss and test different tools to be included in a toolbox. The tools may have been constructed in INCLUDE or in other research efforts. However, a leading thought must be not to focus on production of new methods but in the first place to select existing methods and adapt them so as to become useful to practitioners, primarily road/railway planning teams. We intend to make a sketch of the contents of the toolbox and to test some of the tools in a real situation.

The project takes its departure from the present situation in infrastructure planning. What shortcomings do the planners face, and what are the opportunities? From that we can make a scheme of what tools are needed, which existing tools that can be further developed or adapted, and how should they be adapted. The resulting toolbox should be capable of handling all relevant aspects, such as sustainability questions, biodiversity, natural and cultural values, in a target-driven planning process.

Phase 2 will include a number of sub-projects. The sub-projects will be formed having the synthesis in phase 1 as starting point. We think that it is too early to lay down the exact format for them (see below). Instead some grounds for these sub-projects will be given.

- The approach should be interdisciplinary and the tools should, as much as possible, be the same in the different projects
- Development of tools for visualisation and analysis of different values in the landscape and the impact from infrastructure on these values
- The goals for ecological and cultural landscapes need to be harmonised. It has long been known among ecologists that ecology and culture go hand in hand, but because of the sectorisation in Swedish governmental organisation, the sectors have got goals that are not convergent, comparable or replaceable in all cases.
- We aim at increasing the stakeholders' participation and possibility to have influence on selection of sub-projects, etc.
- The tool should be applied and tested in real-case situations in Sweden and abroad. Infrastructure planning is a long process and therefore it is important to select a number of cases in cooperation with stakeholders, to be able to select projects being in the right stage for the testing. However, it is far too early to do it in this application.
- Quality control and review

Relevance for implementation

Road and railroad projects are always put in question by different groups of actors. In part this is a NIBMY ("not in my backyard") problem, but also to a certain extent the result of environmental questions not being investigated in enough detail, impacts not being foreseen or paid attention to, engineering and economic aspects being given too much weight, etc. A part of this is the integration of ecological and cultural environmental goals. Impacts affecting both these sectors might be shown to have cumulative impacts when seen together. Therefore, there is an urgent need for methods and tools that are easy to implement and for results that are easy to communicate to various stakeholder groups including the public.

Many attempts have been made to improve the communicative knowledge in infrastructure projects but as a rule they have not been successful. A reason may be that the methods are not adapted to a planning situation but often there is also a resistance among engineers, economists and planners to include environmental information. The reason for this is often a belief that such information could stop the project or at least make it more expensive. Therefore, in this project, there is a need for the involvement of competence in environmental communication.

As touched on above, what methods to be used and what specific results to be expected cannot be stated at this early planning stage—this has to be done in connection with the detailed planning of the sub-projects altogether and in cooperation with stakeholders.

A crucial issue is to be able to comprehend "everything" and at least not to exclude anything due to lack of data or knowledge. The core of the toolbox is the information logistics needed for the planner. The toolbox should be a decision aid, not an expert system. The toolbox should include methods for both EIA and SEA. At the same time, simplicity is a goal in itself. Much of the work should be carried out in a discussion with the receiver groups, i.e. road and rail agencies, other infrastructure agencies and boards, etc.

Examples of information to be used as input to the methods/tools:

- sources of available landscape information
- existing methods and models used by SEA/EIA practitioners
- available but not or sparingly used methods and models
- identified values (natural, socio-cultural, recreational) in the landscape
- identified threats to landscape values
- defined targets for landscape qualities and indicators of the development
- defined thresholds or limits to landscape load or pressure
- methods used for EIA follow-up
- criteria for the application of mitigation and compensatory measures
- the efficacy of mitigation and compensatory measures

Part B

Program deliverables, communication and budget

B7. Summary of planned programme deliverables

This section gives an overview of deliverables from the programmes phase 1. Deliverables from phase 2 can not be given at present. Detailed lists of component project deliverables are given in each project description. Programme deliverables include workshops and conferences at the programme level, publications, information, and contacts with organisations and authorities relevant to the subject of issue (however, the communication plan is presented in somewhat more detail in section B8). The programme management group is responsible for these deliverables, but all project leaders contribute.

Programme deliverables include:

1. Thematic workshops
2. Internal meetings
3. End-user conference
4. Scientific publications
5. Reports and other publications
6. Home page
7. Participation in external meetings, conferences etc.

International workshops

A major deliverable in phase 1 of the programme will be a series of workshops, relating to the 4 different development fields. Each workshop includes a preparatory phase, a 3-days meeting, and a subsequent reporting process.

1. In the preparatory phase, a tentative text with suggestions for conclusions and development is produced by the respective project leader. The preparatory phase may include correspondence or web-meetings among proposed co-authors.
2. In the meeting, the tentative text is discussed and re-written, aiming at finding a consensus among participants.
3. After the meeting, the text is submitted for scientific publication, or written as a report, 1^{st}-authored/edited by the same project leader.

To a workshop, all program staff, as well as other selected experts – Swedish and international – are invited (see component project descriptions). The selection is made to cover all fields of relevance to the particular question, and will naturally include both researchers and users. All participants are co-authors in the resulting report.

Main workshop themes:

Workshop 1

Objectives for ecological and cultural sustainability in landscapes – synergies and conflicts with transport infrastructure. - *International workshop on criteria and indicators for the impact of infrastructure on sustainability.*

Timetable: Planned for early spring 2006.

Workshop 2

Critical limit values and functional thresholds in impact of infrastructure on ecological and cultural landscape values. - *International workshop.*

Timetable: Planned for autumn 2006.

Workshop 3

Gaps and barriers in the planning process – *Workshop on the practice of planning, with a stronger national focus.*

Timetable: Planned for spring 2007.

Workshop 4

Communication and understanding of spatial models as tools for impact assessment and evaluation - *Workshop with a stronger national focus on the authorities and end-users that will be involved in the synthesis projects. Planned for autumn 2007.*

Timetable: Planned for autumn 2007.

Additional workshops

Additional workshops may be added, as associate projects, with themes relevant to the program. This option will be dependent on need and funding (outside the programme budget).

Internal meetings

Additional 3-4 meetings with the programme researcher forum will be held annually. Under the first phase of the program an excursion for all INCLUDE projects members will be arranged in Europe. It aims to meet up with partners in the field to improve the collaboration inside the research group. A special focus will be on the development of the infrastructure in Eastern Europe and its impact on the environment.

End-user conference

Late in phase 1, an end-user conference is planned, focusing on the new tools in practice, and describing their profits in infrastructure planning. Results and conclusions derived so far in the programme as well as the first results of the synthesis projects will be presented to and discussed with involved stakeholders and individuals from the respective study areas and case studies. A proceeding volume will be produced from this conference.

Timetable: We suggest that the biodiversity conference (“Mångfaldskonferensen”), arranged annually by CBM on different themes, in autumn 2008 will be used as this end-user conference for the INCLUDE program.

Scientific publications

Scientific writing for international, peer-reviewed journals is a natural and important part of the work within the component projects (see project details).

At programme level, scientific deliverables are primarily linked to reviews and proceedings accomplished in the synthesis projects (see syntheses details).

Résumés and non-scientific publications

Résumés , executive summaries of scientific proceedings and non-scientific publications in sector specific magazines are important components in the user communication of our programme. These deliverables will be prepared in cooperation with the informators at the involved organisations (agencies, companies). The internal magazines of the National Road Administration ("Våra Vägar") and the National Railroad Administration ("Rallaren") are possible targets for such writing.

1. Summaries of the reports produced in the synthesis projects.
    a. Pros and cons in EIA and SEA (task 1). Timetable: Autumn 2006.
    b. Critical limit values and functional thresholds (task 2). Timetable: Spring 2007.
    c. Human and ecological landscape values (task 3). Timetable: Autumn 2007.
2. Résumés of the international workshops. Timetable: See above.
3. Proceedings from the end-user conference. Timetable: Autumn 2008.

Additional popular reports may result from the component projects (see project descriptions).

When relevant for a broader audience, texts could also be made available on the programme web-site, for free publication. Details on the popular publications, such as titles and timetables, can not be given at present, but will be developed with the informators of the involved authorities.

Home page

A programme web-site, describing the contents of the programme and the projects, will be produced and administrated within the information/communication strategy. It is not yet decided whether we will utilize the existing internet resources of the Swedish Road Administration and the Swedish National Rail Administration. Alternatively, the home page can be hosted at the CBM (SLU) in direct connection to the virtual workspace that has already been established at the SLU web server.

Participation in external meetings, conferences etc.

The programme, as well as results from the different component projects, will be presented in relevant national and international conferences and meetings attended by the participants of the consortium. Such presentations can not be planned in detail at the time of writing.

B8. Programme communication

With its vision of an environmentally sustainable network of land transportation infrastructure, the most important end-users for this program are naturally the national road and railroad authorities. Also a wide variety of stakeholders of environment matters in the infrastructure planning process – such as governmental agencies for conservation of natural and cultural heritage, local and regional transportation practitioners, consultancy companies, and NGO´s for nature conservation and outdoor recreation – are important end-users, and will be included in the program on various organisation levels.

With these major end-users directly involved in the program, the most important task as to communication is to achieve an internal dialogue. Workshops and reports are the most important components in this communication. The workshops will also be an important forum for communication between researchers of different disciplines and from different countries.

With the limited funding for the program, no larger amounts can be set aside for information and communication. Therefore, the information effort must be limited, at least in respect to costs. To optimize the output – for program staff as well as for the governmental agencies involved – our strategy is to make use of the information facilities of these agencies. The road and railroad authorities both have a broad experience in information propagation, a well established contact net of practitioners (own staff, consultants, civil servants etc.), and professional magazines with important internal impact. If possible, information services at the Environmental Protection Agency and the Board for Housing, Building and Planning can be utilized likewise.

Close contacts with other related research programmes (such as MiSt, Mål-och-Mått, EKLIPS, Naturvårdskedjan) is guaranteed by programme members being involved also in these programmes (for further details, see section A4). Naturvårdskedjan is also administrated by CBM. In addition, CBM is currently planning a research and development programme on nature conservation in urban environments, with several links to the present programme, and potentials for synergies.

B9) Budget

In contrast to previous Mistra programmes, and to the other partner programmes in "Sustainable Mobility", INCLUDE will primarily be funded by governmental authorities.

According to MISTRA second call, MISTRA will provide 1 million SEK per year to the programme, provided that another 2 million SEK can be guaranteed from other sources, especially the Transport sector. The total of 3 million SEK comprised the absolute minimum budget for a program on the outlined topic.

During the planning period (Dec. 2004 – March 2005), the majority of Swedish authorities involved in spatial and infrastructure planning and natural and cultural heritage have expressed their interest in and financial support to INCLUDE. Details in the funding of the programme (the total amount and the relative contribution) will be worked out during a budget meeting in early May with all authorities involved.

In our present proposal, we present two alternative budget levels:

Alternative 1

represents a minimum budget of 4 million SEK. This budget will allow us to include four component projects at a salary of about 4-5 work months per project and year to be shared among several researchers per project. This budget requires significant external funding of the involved researchers, and bears the risk of other contracts may conflict with the researchers' participation in INCLUDE. In addition, at this budget, there will only very limited funding be made available to pay international experts for their cooperation in the programme.

A smaller budget than this will result in that the associated project as well as one or more component projects must be excluded completely.

Alternative 2

represents the annual budget level (5 million SEK) we perceive as most reliable for the achievement of the program target. Still, all project leaders and involved researchers must apply for their salary in other research projects, but the time they can allocate for INCLUDE will ensure productivity. In order accomplish high quality scientific research, develop new approaches that foster progress in science as well as in applications, sufficient time must be allocated to research activities, analyses, writing and cooperation. INCLUDE aims at the development of integrate planning tools that combine interdisciplinary approaches. Interdisciplinary work is necessarily more time consuming and thus expensive than disciplinary work. In our programme, practically all expenses will be used for the salary of senior scientists. A minor part will be expended for travels and GIS resources. This implies that the money invested in INCLUDE will translate into research activity rather than being used for technical equipment. A higher budget will enable us to involve international expertise to a greater extent and thereby increase the scientific productivity additionally.

During the following months (spring-autumn 2005), we will continue our quest for additional funding, either for the program as a whole or for the individual researchers (for example Formas).

Programme budget

Table 1. Allocation of the minimum budget of **4 million SEK** per year during the first phase of the programme.

Alt. 1 Programme budget in 1000 SEK	**2006**	**2007**	**2008**
Information	150	150	150
Management	400	400	400
Cooperation	200	200	200
not assigned yet	*300*	*300*	*300*
Component projects			
International workshops	200	400	200
Ecological impact A)	**550**	**400**	**500**
Socio-cultural impact B)	**698**	**600**	**548**
Planning C)	**453**	**400**	**400**
Communication D)	**408**	**398**	**445**
*Associated project**	150	150	150
Syntheses	500	600	700
TOTAL for phase 1	***4 008***	***3 998***	***3 993***

** The funding of the associated project is subject to discussion between the National Board of Fisheries and MISTRA. A decision about how the Board of Fisheries will contribute to INCLUDE will be taken after the budget meeting with all involved authorities scheduled for early May.*

Table 2. Allocation of the suggested budget of **5 million SEK** per year during the first phase of the programme.

Alt. 2 Programme budget in 1000 SEK	**2006**	**2007**	**2008**
Information	150	150	150
Management	500	500	500
Cooperation	200	200	200
not assigned yet	*400*	*400*	*400*
Component projects			
International workshops	200	400	200
Ecological impact A)	**625**	**575**	**575**
Socio-cultural impact B)	**810**	**725**	**660**
Planning C)	**650**	**575**	**575**
Communication D)	**520**	**520**	**595**
Associated project	**350**	**350**	**350**
Syntheses	600	600	800
TOTAL for phase 1	***5 005***	***4 995***	***5 005***

Explanation

Information

The costs that have to be allocated to information depend on to what degree information services at the involved authorities can be relied upon. A specific communication strategy with the Transport sector will be worked out during summer 2005.

Management

Costs relate to the work of the management group, to organization of meetings and related travel costs.

Cooperation

This post reserves a small budget to support the yet unspecified collaboration with the partner programs under “Sustainable Mobility”.

Not assigned yet

We reserved further money to maintain a flexibility in the program, in case unforeseen expenses increase costs or a need or wish for complementary research arises. This money shall also be made available to link relevant external projects to INCLUDE.

Workshops

We will look for additional (external) funding for organizing the workshops and meetings. The first workshop during 2006 has already received funding from the Swedish Road Administration (Contract with A. Seiler). During 2008, only one workshop = user conference is planned. Since this conference is paid for by the participants, the allocated budget above can eventually be made available for the research projects.

Syntheses

The funding assigned for syntheses will be used to manage and direct the individual involvement of the researchers in synthesis work. This is to ensure that syntheses are integrated and accomplished already from the beginning of the programme.

Component projects

For more details of budget of the individual project see below.

Project budgets

Table 3 and 4. Detailed budget of the component projects within INCLUDE at level 1 (total of 4 million SEK annually) and level 2 (5 million SEK annually). Work time for the respective studies and work-packages is given in months. Costs per work month are assessed to an average of 75,000 SEK (including social fees and administrative overhead of 35%). Travel costs and other expenses (as for GIS data, satellite imagery, etc) are given in 1000 SEK and include an administrative overhead of 35%.

Alt. 1 Project budgets

Component A	**2006**	**2007**	**2008**
Project lead (Andreas Seiler)	1	1	1
Work package 1 (Indicators)	1		
Work package 2 (Case studies and models)	2	1,5	1
Work package 3 (Scenarios)	2	1,5	2
Work package 4 (Mitigation)		1	1
Work package 5 (Validation)			1
Sum work time (in months)	*6*	*5*	*6*
Travels and expenses (in 1000 SEK)	*100*	*25*	*50*
Total cost for project A	**550**	**400**	**500**

Component B	**2006**	**2007**	**2008**
Project lead (Anders Westfält)	1	1	1
1. Mapping landscape character & memory	1,5	1	
2. Expert valuation of the landscape.	2	1	1
3. Valuation by users of the landscape.	2	2	1
4. Valuation by road-users.	2	1	1
5. Synthesis		1	2,5
Sum work time (in months)	*8,5*	*7*	*6,5*
Travels and expenses (in 1000 SEK)	*60*	*75*	*60*
Total cost for project B	**698**	**600**	**548**

Component C	**2006**	**2007**	**2008**
Project lead (Karolina Isaksson)	2	1	1
Analysis of actors and stakeholders	1,5	1	1
Case road project 1	1	0,5	
Case road project 2		0,5	1
Case rail road project 1	1	0,5	
Case rail road project 2		0,5	1
Analysis, discussions and proposals		1	1
Sum work time (in months)	*5,5*	*5*	*5*
Travels and expenses (in 1000 SEK)	*40*	*25*	*25*
Total cost for project C	**453**	**400**	**400**

Component D	**2006**	**2007**	**2008**
Project lead (Per Angelstam)	1	1	1
Uncertainty propagation, sensitivity analysis	1	1,5	1
Obstacles for geographical presentation of ecological sustainability	1,5	1	1,5
Improvement of experts-to-users communication in INCLUDE	1	1	1,5
Sum work time (in months)	*4,5*	*4,5*	*5*
Travels and expenses (in 1000 SEK)	*70*	*60*	*70*
Total cost for project D	**408**	**398**	**445**

Associated project *	**2006**	**2007**	**2008**
Project lead (Erik Degerman)	**1**	**1**	**1**
Developing PISCES	3		
Developing ROADFISH		3	
Validation of ROADFISH			3
Sum work time (in months)	*4*	*4*	*4*
Travels and expenses (in 1000 SEK)	*40*	*40*	*40*
*Total cost for associated project **	*340*	*340*	*340*
contributed from INCLUDE provided that the reamining costs are covered by the Board of Fisheries	**150**	**150**	**150**

Table 4.

Alt. 2 Project budgets

Component A	**2006**	**2007**	**2008**
Project lead (Andreas Seiler)	1	1	1
Work package 1 (Indicators)	1		
Work package 2 (Case studies and models)	3	2	1
Work package 3 (Scenarios)	2	3	2
Work package 4 (Mitigation)		1	2
Work package 5 (Validation)			1
Sum work time (in months)	*7*	*7*	*7*
Travels and expenses (in 1000 SEK)	*100*	*50*	*50*
Total cost for project A	**625**	**575**	**575**

Component B	**2006**	**2007**	**2008**
Project lead (Anders Westfält)	1	1	1
1. Mapping landscape character & memory	2	1	
2. Expert valuation of the landscape.	3	2	1
3. Valuation by users of the landscape.	2	3	1
4. Valuation by road-users.	2	1	2
5. Synthesis		1	3
Sum work time (in months)	*10*	*9*	*8*
Travels and expenses (in 1000 SEK)	*60*	*50*	*60*
Total cost for project B	**810**	**725**	**660**

Component C	**2006**	**2007**	**2008**
Project lead (Karolina Isaksson)	2	1	1
Analysis of actors and stakeholders	2	1	1
Case road project 1	2	1	
Case road project 2		1	2
Case rail road project 1	2	1	
Case rail road project 2		1	2
Analysis, discussions and proposals		1	1
Sum work time (in months)	*8*	*7*	*7*
Travels and expenses (in 1000 SEK)	*50*	*50*	*50*
Total cost for project C	**650**	**575**	**575**

Component D	**2006**	**2007**	**2008**
Project lead (Per Angelstam)	1	1	1
Uncertainty propagation, sensitivity analysis	2	2	2
Obstacles for geographical presentation of ecological sustainability	2	1	2
Improvement of experts-to-users communication in INCLUDE	1	2	2
Sum work time (in months)	*6*	*6*	*7*
Travels and expenses (in 1000 SEK)	*70*	*70*	*70*
Total cost for project D	**520**	**520**	**595**

Associated project	**2006**	**2007**	**2008**
Project lead (Erik Degerman)	**1**	**1**	**1**
Developing PISCES	3		
Developing ROADFISH		3	
Validation of ROADFISH			3
Sum work time (in months)	*4*	*4*	*4*
Travels and expenses (in 1000 SEK)	*50*	*50*	*50*
Total cost for associated project	**350**	**350**	**350**

Appendices:

- App. 1 Complete list of programme members
- App. 2 Full CVs for the intended programme directors and project leaders.

Appendix 1. Complete list of programme members

1) Program management

Name, title - role	Organisation	e-mail	Main field of expertise
Urban Emanuelsson, PhD - **DIRECTOR**	Swedish biodiversity centre	urban.emanuelsson@cbm.slu.se	Ecology, Heritage management
Andreas Seiler, PhD - **Ass. Dir.**	SLU, Dept. Conservation Biology	andreas.seiler@nvb.slu.se	Animal ecology, transportation
J-O Helldin, PhD - **Ass. Dir.**	Swedish biodiversity centre	j-o.helldin@nvb.slu.se	Animal ecology, transportation
Lennart Folkeson, Prof. - **Mgmt.group**	Road and Transport Research Institute, VTI	lennart.folkeson@vti.se	Ecology, Transportation
Marianne Lindström, PhD - **Mgmt.group**	Univ. Kalmar, Dept. Biol. & Environ. Sciences	marianne.lindstrom@hik.se	Environmental Psychology
Krister Olsson, PhD - **Mgmt.group**	KTH-Infrastructure, Urban studies	kristero@infra.kth.se	Hertiage management, planning
Anders Wästfelt, PhD - **Mgmt.group**	Univ. Stockholm, Dept. Human Geography	anders.wastfelt@humangeo.su.se	Human geography

2) Project leaders

Name, title - (project)	Organisation	e-mail	Main field of expertise
Andreas Seiler, PhD - **(A)**	SLU, Dept. Conservation Biology	andreas.seiler@nvb.slu.se	Animal ecology, transportation,
Anders Wästfelt, PhD - **(B)**	Univ. Stockholm, Dept. Human Geography	anders.wastfelt@humangeo.su.se	Human geography
Karolina Isaksson, PhD - **(C)**	KTH-Infrastructure, Urban studies	karolina@infra.kth.se	Environmental politics, planinng
Per Angelstam, assoc.Prof. - **(D)**	SLU, School for Forest Engineers	per.angelstam@smsk.slu.se	Landscape ecology and planning
Erik Degerman, MSc - **(E*)**	National Board of Fisheries, Örebro	erik.degerman@fiskeriverket.se	Aquatic Biology

3) Other participants

Name, title	Organisation	e-mail	Main field of expertise
Antoienette Oscarsson, MSc	SLU, Dept. Landscape Planning Ultuna	antoienette.oscarsson@lpul.slu.se	Cumulative EIA, biodiversity
Asko Lõhmus, PhD	Inst. Zoology and Hydro-biology, Tartu University	asko.lohmus@eoy.ee	Animal ecology,
B.M. Rönnbäck	Litoda AB, Sweden		GIS, modelling
Carsten Schürmann	Germany	cs@brrg.de	GIS
Edgar Van der Grift, PhD	ALTERRA, Dept. Landscpae Ecology, The Netherlands	edgarvandergrift@casema.nl	Landscape ecology, modelling
Grzegorz Mikusinski, assoc.Prof.	SLU, School for Forest Engineers	grzegorz.mikusinski@nvb.slu.se	Landscape ecology
Göran Blomqvist, PhD	Road and Transport Research Institute, VTI	goran.blomqvist@vti.se	engineering, transportation, pollution
Göran Cars, Prof	KTH-Infrastructure, Urban studies	cars@infra.kth.se	Planning
Görgen Göransson, assoc.Prof.	Univ. Kalmar, Dept. Biol. & Environ. Sciences	gorgen.goransson@hik.se	Animal ecology, GIS
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Josefin Kofoed Schröder, MSc	SLU, Dept. Landscape Planning Ultuna	josefin.kofoed@lpul.slu.se	Cultural heritage, EIA
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Leif Kastdalen, PhD	Norwegian Space Agency, Univ. in Hedmark, Norway	lkastdal@online.no	Animal ecology, Remote sensing
Leif Olsson, PhD	Dept. Engin., Physics,Mathematics, Mid Sweden University	leif.olsson@miun.se	Forest logistics
Lena Odeberg, BSc	National Heritage Board	lena.odeberg@raa.se	Cultural heritage
Magnus Ljung, PhD	SLU, Dept. Landscape Planning Ultuna	magnus.ljung@lpul.slu.se	Land use planning, communication
Marine Kukurudza-Elbakidze, PhD	Department of Geography, Lviv University		Physical Geograhy
Mats Gustafsson, PhD	Road and Transport Research Institute, VTI	mats.gustafsson@vti.se	Physical geography, pollution
Niina Käyhkö, PhD	National Heritage Board	niina.kayhko@utu.fi	GIS, landscape ecology
Petter Kjellander, PhD.	SLU, Dept. Conservation Biology	petter.kjellander@nvb.slu.se	Animal ecology,
Reed F. Noss, PhD.	Department of Biology, Univ. Central Florida, USA	rnoss@mail.ucf.edu	Landscape ecology,
Sergey Umansky, Prof.	Kaliningrad State Technical University, Russia	umansky@klgtu.ru	Ecology
Steen Jacobsen, Mag.Art.	Institute of Transport Economics (TØI), Norway	jsj@toi.no	Cultural heritage
Tim Richardson, PhD	Dept. Town and Regional Planning, Sheffield, UK	tim.richardson@sheffield.ac.uk	Land use planning
Ulla Mörtberg, PhD	KTH, Dept. Land & Water Resource Engineering	mortberg@kth.se	Land use planning, ecology
Włodzimierz Jędrzejewski, Prof.	Mammal Research Institute Bialowieza, Poland	wjedrzej@bison.zbs.bialowieza.pl	Animal ecology

Authorities

Name, title - role	Organisation	e-mail
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Kristina Feldhusen	Environmental Protection Agency	se
Sven Hunhammar	Environmental Protection Agency	se
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Ulf Troedson	National Board of Housing, Building and Planning	Ulf.Troedson@boverket.se
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Jan Skoog, MSc	National Rail Administration	Jan.Skoog@banverket.se
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Jerker Moström, MSc	National Heritage Board	jerker.mostrom@raa.se

Private sector

Name, title - role	Company	e-mail
Martin Ljungström	SWECO	Martin.Ljungstrom@sweco.se
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Kerstin Nordström, PhD	Metria Miljöanalys, Swedish National Land Survey	kerstin.nordstrom@lm.se

Appendix 2. CV’s of program director(s), management group and project leaders

In order of occurrence:

- Urban Emanuelsson
- Andreas Seiler
- J-O Helldin
- Lennart Folkeson
- Marianne Lindström
- Krister Olsson
- Anders Wästfelt
- Karolina Isaksson
- Per Angelstam