CROSSCUT - Drivers of change in circumpolar tundra ecosystems (TUNDRA)

1. Relevance of TUNDRA for Environment 2015 - Crosscut

ENVIRONMENT-2015: CROSSCUT	**TUNDRA:**
- System-oriented research	Crossdisciplinary analyses aimed to identify drivers of change in circumpolar tundra ecosystems
-Relationships between governance, nature systems, and the cultural environments	Understanding how governance and socio-economic conditions are drivers of ecosystems states and services
- Development of methods and models -	Devise spatial approaches to draw statistical inferences of the relationships between drivers, ecosystem changes and services on multiple spatial scales and in diverse contexts
- Cross-disciplinary	Crossdisciplinary design based on governance-based contrasts in anthropogenic drivers that link ecology and social sciences
- Northern Areas	Impacts of land use, pollution and resource exploitation on circumpolar tundra ecosystems
- International perspectives	Comparative analyses between Norway, Canada, USA and Russia

2. Scientific part

2.1. Circumpolar tundra ecosystems: drivers of change and effective management strategies

Ecosystem-based management requires insights about the drivers that influence ecosystem change and the services that people depend upon (MEA 05). Despite the introduction of multiple environmental policies on global, regional and local levels, ecosystem degradation continues at an accelerating rate. One reason may be that “Managerial approaches” fail to see the social causes behind ecosystem changes, which would have been better understood by an integrated analysis of anthropogenic and biophysical drivers (Turner 07, Young 06). Another reason may be the lack of basic knowledge about the effectiveness of management strategies under different socio-economic conditions and governance regimes. Whether ecosystems are managed by state regulations, free market mechanisms or subsistence communities, there are always examples of both successes and failures (Ostrom 07). Successful implementation of management strategies, such as environmental regulations, market-based incentives, green technology or changes in decision making processes - all depend on the existing environmental governance regimes (Lemos 06). These governance regimes vary considerably between different places according to the historical, political, cultural and economic contexts (Young 02).

The limited understanding about the effectiveness of management strategies could result from the typical procedure of first detecting ecosystem changes, followed by research on management strategies and societal consequences. An alternative approach is to use a comparative, spatial approach which starts with the contrasts in management strategies, and thereafter measure how well these strategies perform to mitigate anthropogenic pressures on ecosystems. Experiences from a study at a smaller scale in tundra ecosystems in Norway, where spatial contrasts in management approaches were used to understand social drivers of change in ecosystem properties, imply that using the same design to link drivers, ecosystem change and services to local people could be successful in terms of understanding the effectiveness of different management approaches (Bråthen 07, Ims 07, Hausner forthcoming).

Comparative analyses, which aim to identify anthropogenic drivers, are facilitated by relatively simple and comparable ecosystems, since the impact of biophysical drivers can be more easily controlled for. Stedman (07a) used this approach to understand the emergence of socio-culturally distinct lake regions that occupied similar latitudes worldwide. In circumpolar tundra ecosystems there is a strong spatial contrast in management strategies, whereas the basic ecosystem properties (e.g. the structure of the trophic web) are comparable. We will use these spatial contrasts in environmental governance and socio-economic conditions, to study how different management strategies influence ecosystems, and the services for local people.

Climate change and economic globalisation cause an unprecedented change in the socio-ecological systems worldwide (MEA 05). The circumpolar tundra contains both some of the most pristine ecoregions globally as well as some areas heavily disturbed by intense anthropogenic exploitation. These regions may be especially vulnerable to ecological change based on high levels of dependence on natural resources for economic development, native populations, and extra-local control. How endogenous drivers interact with climate change and economic globalisation is of vital importance for the resilience of this socio-ecological system (Chapin 06a,b). We propose a spatial approach to understand these relationships. The three major anthropogenic pressures which will underlie the spatial contrasts are land use, environmental degradation and harvesting.

2.2. Major research questions

1. How do environmental governance and socio-economic conditions influence ecosystems and the services they provide to local people?
2. What do these results imply with regard to the implementation of ecosystem-based management in circumpolar tundra ecosystems?
3. How effective is a spatial ecosystem analysis for understanding the linkages between management approaches, ecosystem change and the resource dependencies of local people?

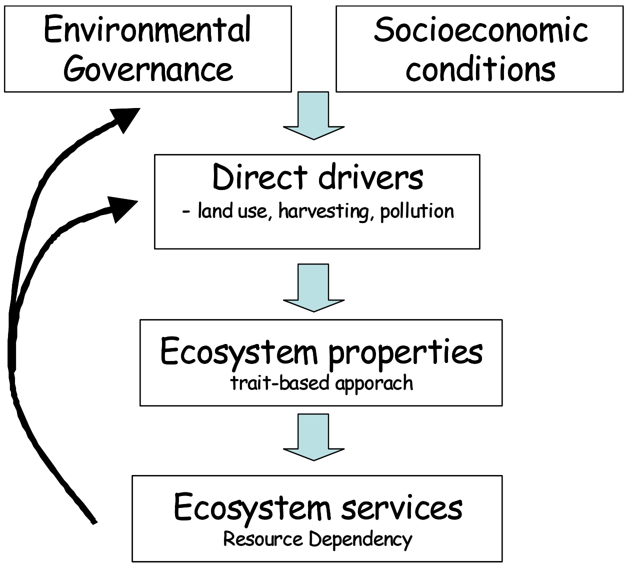
2.3. Cross-disciplinary design and analysis: spatial ecosystem analysis

These questions cannot be answered without a cross-disciplinary research design that integrates the ecological and social sciences. Cross-disciplinary ecosystem studies tend to suffer from the lack of comparability of case studies or enough replicates to draw robust statistical inferences (Young 06). Research on socio-ecological systems and adaptive management have advanced the field by exploring management concepts such as resilience, vulnerability, thresholds and adaptability, by the use of management experiments, long-term studies and simulations (Holling 02, Chapin 07, Folke 07). There has, however, been less focus on the use of current and historical socio-political differences in anthropogenic drivers to understand how society influences ecosystem properties, transitions and services. Spatial ecosystem analysis implies: i) use of spatial contrasts in anthropogenic drivers (indirect and direct) as *predictors*, ii) to investigate the *response* measured as ecosystems properties and services, iii) while controlling for the influence of contextual factors (e.g. political and biophysical environment). The analysis draws inspiration from comparative methods as *Qualitative Comparative Analysis (QCA)*, *Fuzzy set* and *Quasi-experimental design* (Grimm 06, Ragin 00, Shadish 02). The spatial ecosystem analysis deals with the major questions, but is supplied by auxiliary questions to guide the analyses in the different stages (see below).

Design and analyses

The project is divided into three stages**.** Since our focus is on human activities in tundra ecosystems, we restrict ourselves to administrative regions which have a high extent of low arctic or alpine tundra: Norway (Finnmark, Troms), Canada (Québec province, Nunavut, Northwest and Yukon territories), USA (Alaska) and Russia (Murmansk, Nenets, Yamal, Taymyr, Sakha, Chukotka).

THEORETICAL FRAMEWORK

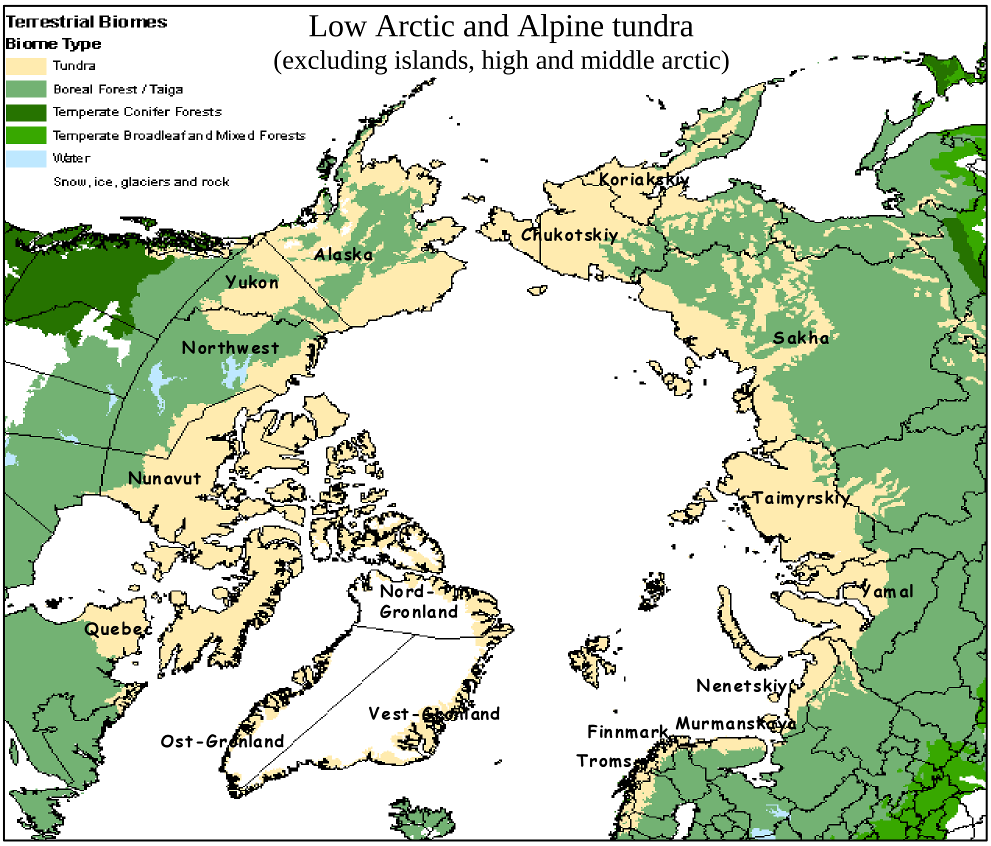


DESIGN/ANALYSIS

Stage 1. Indirect-direct drivers. Broad analyses of the relationship between environmental governance, socioeconomic condition and direct drivers (land use, environmental degradation and harvesting)

Stage 2. Drivers-ecosystems-services. More intensive methods are required for data acquisition in this stage. 3-6 municipalities in each region are selected for analysis of drivers – ecosystems – and provisional services. Cultural services and resource dependency will be analysed in a subset of 20 municipalities.

Stage 3. Major research questions and the fit between social-ecological systems



2.3.1 Stage 1. Indirect-direct drivers.

Environmental governance

Environmental governance refers to the changing roles of the state and government relative to other forces. Whereas governments traditionally have prescribed policies and environmental regulations, there is a movement towards communities and market solutions to reach environmental and economic policy goals (Fig. 2, Lemos 06). Command-control interventions (i.e., *sticks*), which imply that governments define both the goals and the means to reach the goals, are increasingly perceived as ineffective and New Environmental Policy Instruments (NEPI) are therefore promoted as alternatives. NEPIs seek to influence human behaviour by using incentives (i.e., *carrots*) or strategies more directed towards learning (i.e., *sermons*) (Jordan 03).

The effectiveness of environmental regulations and NEPIs to reduce anthropogenic pressures is dependent on existing governance regimes. Steering mechanisms which aim to influence human behaviour through both regulations and NEPIs are regarded as inadequate if there is a democratic deficiency and a general lack of legitimacy of environmental policies (Ostrom 02). Civil participation is therefore assumed as essential for reducing anthropogenic pressures on ecosystems. Furthermore, it is hypothesised that decentralised management strategies are more effective in terms of reaching environmental policy goals, due to increased efficiency and legitimacy, closeness to those affected by decisions, and inclusion of time and place specific knowledge (Lemos 06). Others hypothesise that privatisation of rights to resources are necessary to decrease anthropogenic pressures (Ostrom 02). The central point is that management strategies and policy instruments have to be analysed according to the existing governance regimes, including the hybrid relations between public and private agents.

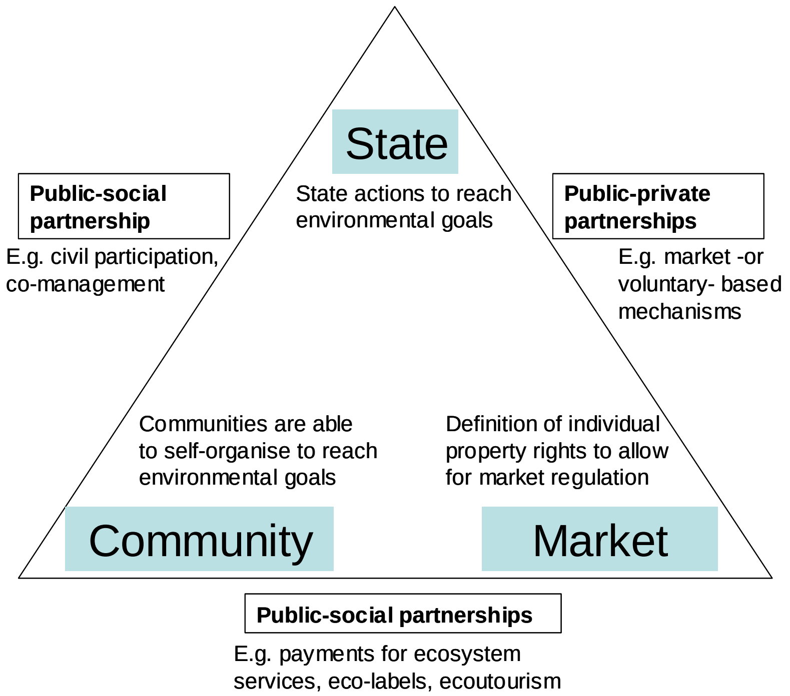


Figure 2. The circumpolar countries differ with regard to governance system, such as legal context, public participation and use of environmental regulations and NEPI's (Einarsson 04, MEA 05). NEPI's could be divided into market-based instruments (taxes, subsidies, and tradable permits), voluntary agreements (codes of conduct, negotiated agreements) and informational devices (ecolabels). Adapted from Lemos (06)

Auxiliary research questions: Environmental governance

Q1. How does environmental governance differ between nation states, and how does it influence management approaches in the different regions in circumpolar areas?

Q2. How do nation-states differ with regard to:

A. Use of command- and control-intervention, market-based instrument, voluntary agreements and informational devices?

B. Property rights to resources (including indigenous rights)?

C. Degree of civil participation (number of active environmental, indigenous and local NGOs, and incorporation in environmental legislation)?

D. Degree of devolution to regions and local communities?

Q3. How do regional differences in management approaches influence direct anthropogenic ecosystem drivers (land use, harvesting, and environmental degradation)?

Socioeconomic conditions

The "Environmental Kuznets Curve"(EKC), hypothesises that environmental impacts increase in the early stage of economic development, but as the economy matures, society will afford to invest in environmental quality and protection (Grossman 95). Empirical support for the EKC hypothesis is mostly inconclusive, and the theory has been suggested as too simplistic to understand the relationship between economy and ecosystem change (Perz 07). The EKC has been revised by introducing control variables linked to well-being such as income distribution, education and health (Costantini 08). Studies have shown that aspects such as health and education could be more strongly linked to ecosystem degradation than per capita income and suggest the use of human development indices as a better measure (Costantini 08). These indices reflect an alternative analysis of development and are based on life expectancy, the adult literacy rates, and enrolments for school. Both economic and human developments are dependent on governance (Perz 07). State policies could alter taxes or subsidies, which could lead to higher degree of land use, pollution and resource exploitation. Moreover, increased access to healthcare and education may encourage society's willingness to invest in the environment, which again could change anthropogenic pressures. The EKC is most likely conditional on demographic changes as some regions experience decline in populations; particularly the tundra regions in Russia. Finally, economic-and human development is usually measured on national scale, and therefore often ignores the effects of the global economy (Costantini 08). In the tundra regions ex-territorial industries and towns causes patterned anthropogenic pressures which need to be controlled for.

Auxiliary research questions: Socioeconomic conditions

Q1. What is the relationship between degree of economic development and direct anthropogenic ecosystem drivers (land use, harvesting, environmental degradation)?

A. Does this relationship depend on economic structure (primary, secondary, tertiary)?

B. Does this relationship depend on demography, education, health and income distribution?

Q2. What is the relationship between human development and direct anthropogenic ecosystem drivers?

Q3. How do these relationships depend on the influence of global economy in circumpolar areas (e.g. trade, manufacture, ex-territorial industries?

Q4. How is socioeconomic and environmental governance interlinked?

Data sources

Multilevel, comparative analysis of environmental governance will elucidate the governance structure in the four countries (see Fig. 2). **1. Environmental regulations**: implementation of international hard (legally binding) and soft law (guidelines, standards, criteria, codes- of practice, resolutions, principles and declarations) in national and regional environmental regulations of land use, pollution and harvesting will be analysed. **2**. **NEPIs:** Document analysis of the prevalence of marked-based instruments (taxes, subsidies, and tradable permits), voluntary agreements (codes –of conduct, negotiated agreements) and informational devices (ecolabels) will be analysed on regional scale. **3. Civil participation:** The legal analysis will be supplied by document analyses on a regional scale of civil participation, as well as measurement of number, size and activity level of environmental, indigenous and local NGOs.

Most data on *socioeconomic conditions* is publicly available on national and regional level (see ArcticStat.org). However, analyses of economic – and human development on municipal level will need both methodological advances as well as a period of data acquisition. However socioeconomic data has previously been compiled by use of agency data and expert assessment (Jernsletten 02). Local agency data and expert assessment will thus be used for filling gaps and for quality assurance.

Data on *Direct drivers* need to be acquired from different sources (see table 1 below). Land use activities, deriving from technical encroachments and vehicles could be detected by remote sensing and existing maps, whereas document analysis, public statistics, agency data and expert assessment are necessary to obtain data on resource exploitation and pollution. The analyses of drivers will therefore be conducted in two steps where we in the first two years cover as many municipalities as possible, but exclude municipalities in stage 2 where data have not been acquired. The municipalities in the next stage will also be selected by maximising contrasts and minimizing confounding among direct drivers, as well as minimising the variation in biophysical conditions.

2.3.2 Stage 2. Drivers-ecosystems-services

Drivers and ecosystems

Climate change is assumed to be the major driver behind a number of transitions of the tundra ecosystem (Table 1, ACIA 04, MEA 05). Trophic cascades and positive feedback will in many cases result in unexpected and abrupt changes of the ecosystem (Scheffer 01, Folke 04). For example, positive feedbacks between vegetation and soil insulation or albedo result in non-linear regime shifts in tundra vegetation under climate change (Chapin 05, Sturm 05). However, such transitions can be accelerated or reversed by changes in the grazing pressure (Ims 07). Indeed, positive feedback between grazers, vegetation and soil might be a key factor that determines the productivity of the tundra by switching the system between lichen, moss or grass dominance (vanderWal 06, Zimov 95). Oscillating population dynamics is a characteristic property of Arctic ecosystems (Ims 05). Collapses in population cycles of small herbivores change the disturbance regime (Ims 05) with consequences for the vegetation. Similarly, dominance of large herbivores (Côté 04) will lead to a different impact on the vegetation than the dominance of small herbivores. The composition and density of top predator communities determine how predators affect the ecosystem through trophic cascades. The presence of wolves might for example determine the grazing impact from large herbivores (Ripple 04).

Although climate is considered to be a key driver of change, the interactions with other anthropogenic drivers (Table 1) are poorly understood. Moreover, the links between transitions in different parts of the ecosystem have yet to be established. Harvesting, land use and pollution affect different parts of the system with unforeseen cascading effects. In marine ecosystems, such impacts have recently been mapped worldwide (Halpern 08) and the relationship to ecosystem properties and services has been quantified (Worm 06). Global warming imposes a directional change in a critical slow variable of the tundra ecosystem resulting in that no steady state relationship or stable reference point will apply (Chapin 06b). To overcome this problem, we suggest a multi-level large scale spatial study where the design is tailored to contrast the different anthropogenic drivers (Bråthen 07). We will select 3- 6 municipalities within the low Arctic tundra biomes in each region. The selection of municipalities will be stratified with respect to climate and anthropogenic drivers while controlling for topography and geological substrate. For each municipality we will gather data on ecosystem transition, anthropogenic drivers, and climate and ecosystem properties (Table 1).

Table 1 Ecosystem variables and direct drivers, indicators and data sources.

Variables	Data/indicator	Source
Ecosystem state (transition variables)		
Vegetation transitions		
Tundra - Shrub - Forest	Vegetation cover	R,G
Lichen - Mosses - Graminoids	Vegetation cover	R,G
Herbivore transitions		
Cyclic - non-cyclic population dynamics	Time series data on lemmings/voles	A,E
Large herbivores - small herbivores	Density of moose/caribou/reindeer vs. lemmings/voles	S,A,E
Predator transitions		
Specialist - generalist carnivores	Presence/absence or density	A,E
Large carnivores - scavengers	Presence/absence or density	A,E
Ecosystem properties		
Primary production	NDVI	R
Secondary production	Hunting yield, large herbivores	S,A,E
Trophic structure/ecotrophic efficiency (Krebs et al. 2003)	Trophic mass balance	R,S,A
Biodiversity	Species, functional groups	A,E
Drivers		
Climate	Temperature, precipitation	A,S
Harvesting		
large game	Hunting pressure	A,E
small game	Hunting pressure	A,E
predator control	Hunting pressure	A,E
Land use		
Grazing	Livestock density	M,S,A
Oil and gas installations	Presence	M,D,S
Orher technical encroachment	Wilderness	M,R,S
Pollution		
Fertilizers	Discharge levels	S,A,E
Heavy metals, PCB, DDT, ++	Concentrations	S,A,E

Data sources: A = **A**gency data , D =**D**ocuments, E = **E**xpert assesment, G = **G**round truthing, M = **M**aps, R = **R**emote sensing (satellite), S = Official **S**tatistics

Auxiliary research questions: Direct drivers – ecosystems

Q1. What is the relationship between direct anthropogenic drivers, climate and ecosystem state?

A. What are the relationship between transitions at different trophic levels?

B. How is the interaction between climate and anthropogenic drivers related to ecosystem transitions?

Q2. What is the relationship between direct anthropogenic drivers, climate and ecosystem properties?

A. What is the relationship between the different ecosystem transitions and ecosystem properties?

B. How is the interaction between climate and anthropogenic drivers related to ecosystem properties?

Ecosystems and services

The concept of ecosystem services has a dualistic meaning. Tundra people depend on ecosystems to fulfil a wide variety of needs, often including local economic development and cultural identity. At the same time, these activities often contribute to ecosystem changes. Resource dependency is at the core of this relationship as people who strongly depend on resources are more seriously compromised by their changes. Resource dependency theories suggest that the more vital resources are for local people, the more likely they are to engage in their protection, and the stronger role they should have in their management (Berkes 03). Institutional theories, on the other hand, assume that these relations are dependent on environmental governance, as free access may result in overexploitation despite strong dependencies on resources (Ostrom 02). Furthermore, the relationship between resource dependency, the well-being of human communities, and ecosystems is reliant on multiple factors, including the commodity being extracted, country and region (Stedman 04a), the indicators chosen to represent social well-being (Beckley 02), and the conceptualisation and measurement of dependency (Stedman 07b). These measures could be divided into economic, social and environmental dependency (Marshall 07). Economical measures include the financial status of resource users, and the size and type of businesses in a community. However, people are also socially dependent on resources through their i) attachment to the occupation, ii) employability in other sectors, iii) their mobility and attachment to place and iv) family situation. Level of environmental dependency could also be reflected by degree of specialisation and time spent harvesting the resource.

The MEA's conceptualisation of ecosystem services goes beyond the estimation of provisioning services to include regulatory and supporting services that capture the ecosystems long-term capacity to produce services (MEA 05). Since people depend on nature for more than economic development, but also for physical health, enjoyment, recreation, and spiritual needs, the MEA also adopted cultural services as an important aspect. Such categorisations of ecosystem services have been criticised for its ambiguity, double counting and for mixing processes (means) and final services (ends) (Boyd 07, Wallace 07). Measurement of ecosystem services needs first to identify the ecosystem properties valued by people and then measure the ecological processes maintaining these properties (Wallace 07).

Auxiliary research questions: Direct drivers – ecosystems

Q1. Which are the key ecosystems services that local people express themselves as dependent upon?

Q2. How well do the measured ecosystem properties reflect these services?

Q3. What is the relationship between resource dependency and direct drivers?

Q4. To what extent does this relationship differ according to environmental governance and socioeconomic conditions?

Data sources

In all the selected municipalities data on provisioning services (e.g. fish, game, reindeer, fuel) and simple measures of cultural services, such as access to recreational areas, protected areas, and culturally important species, will be acquired from public statistics, local agency data, maps and document analyses. Data could be obtained on income, degree of specialisation and alternative employment opportunities. However, other measures of social and environmental dependency cannot be based on existing data. Neither could the key ecosystem services that local people express themselves as dependent upon. To address these questions focus group interviews will be conducted, in the selected municipalities in two of the regions in Russia and Canada (7 regions in total). Identification of these regions will depend on contrast in socioeconomic conditions. School teachers, municipal authorities, environmental, indigenous and local NGO's will be selected as focus groups. The interviews will focus on contrasts in direct drivers (land use, pollution, and harvesting), and peoples expressions on how transitions may influence key ecosystem services. Photographs may be used as tool to identify cultural services (Stedman 04b). Interviews will be videotaped for further analyses.

2.3.3 Stage 3. Integrated analysis.

The ecosystem approach requires management of drivers that causes changes in ecosystem properties valuable to people. The major changes in tundra ecosystems may pertain to globalisation and climate, but these drivers are mostly **exogenous** to the decision makers in circumpolar areas. This project is focused on the **endogenous** drivers by using spatial contrasts to study their effect on ecosystems and services. This allows integrated analyses of the fit or mismatch between social-ecological systems and governance systems. Moreover, the spatial design of the project will allow us to investigate the interaction between exogenous and endogenous drivers. A major focus will be to identify transitions and thresholds, which may result from such interactions (Chapin 06a). Next we will analyse whether such transitions matters for people living in tundra ecosystems. The spatial ecosystem analyses will prepare for building of simulations or scenarios and institutional arrangement for monitoring and adaptations to changes (Young forthcoming)

Statistical analyses will rely on a portfolio approach (Young 06), as no single approach can provide satisfactory answers to the diverse set of questions – all have their advantages and problems. We will rely on a group of scientists with experience in dealing with e.g., multi-level/hierarchical analyses (Mysterud 08), meta-analyses (Geist 04), fuzzy sets allowing for qualitative coding of variable strength (Ragin 00) and qualitative comparative analyses (Grimm 06). This is clearly a challenging part of the project since this methodological integration is still in its infancy – it is, however, absolutely necessary and we see a circumpolar study of the tundra communities and ecosystems as a model system for developing this integration.

2.4. Project plan

The progress plan identifies who is responsible and involved in all activities.

Project plan

	Activity (responible)	2010	2011	2012	2013
Stage 1	Meeting & outreach, Stage 1, (**Steering Board**)				
	Design: socio-ecological systems (**OY**, **VH**, SC, OF)				
	Outlines: governance analyses/socioeconomy (**OF, VH**, OY, SC, SK)				
	Evaluation of databases (**PF/TT**, KK, SK, DE, RS, NY, PostDoc Ec)				
	Data and analysis, governance (**OY**, **VH,** SC, OF):				
	Data and analysis, socioeconomy (**Postdoc Ec**, SK, PhD (Rus):				
	Data on land use, pollution, harvesting (**PF/TT,** NY, DE, KK):				
	Statistic analyses: Indirect - direct drivers (**NY,** + all participants)				
	Interpretation and publication Part I				
Stage 2	Meeting & outreach, Stage 2, (**Steering board**)				
	Design based on direct drivers (**PF/TT, RI,** TC, SZ, VH, NY, PF, TT, DE)				
	Outline of ecosystem properties/services (**RI**, TC, SZ, PF, TT, NY)				
	Design ecosystem/resource dependency (**RS, KK,** JJ, VH, SC, SK)				
	Prep. Focus group Interview/tuition experts (**JJ, KK,** RS, VH)				
	Data: Ecosystem properties (**PF/TT, KK**, DE, SK, RI, NY, TC, SZ):				
	Data: Local ecosystem services (**JJ,** RS, VH, KK, SK, SC)				
	Focus group interviews (**JJ,** RS, VH, KK, SK, SC, PhD (Rus))				
	Stat analyses: direct drivers-ecosystems. (**NY**, + all participants)				
	Analyses_focus group interviews ((**JJ**, RS, VH, KK, SK, SC, PhD (Rus))				
	Stat analysis: resource dependency (**RS,** VH, JJ, KK, SK, SC, PhD (RUS)				
	Interpretation and publications part 2 and 3				
Stage 3	Meeting & Outreach, Stage 3 (**Steering board**)				
	Major research questions (**VH** + all participants)				
	Final meeting				
	Publications: socio-ecological systems				
	End report NFR				
	Outreach/summary report				

2.5. Budget: see application form

2.6. Project management

Steering board

Project leader
V. Hausner

Russia
K. Klokov

Norway
P. Fauchald

USA/Canada
O. Young
R. Stedman

Anthropology/sociology	**Environmental governance/law**	**Economy**
KK K. Klokov (Rus) **RS** R. Stedman (US/Can) **JJ** J.L. Jernsletten (Nor)	**OY** O. Young (US) **SC** S. Chernikova (Rus) **OF** O.K. Fauchald (Nor)	**SK** S. Khruschov (Rus) Post Doc (Nor)
Statistics and database management	**Ecology**	**Ecosystem management**
NG N.G. Yoccoz (Nor) **TT** T. Tveraa (Nor) **PF** P. Fauchald (Nor)	**TC** T. Chapin (US) **SZ** S. Zimov (Rus) **RI** R.A. Ims (Nor) **DE** D. Ehrich (Nor)	**VH** V. Hausner(Nor) 2 PhD (Rus)

The project will be managed by an international steering board lead by Vera Hausner. The other members in the board are responsible for research activities in each of the major regions (Russia, Norway and USA/Canada). The major function of the steering board will be to coordinate research activities, scientific publications and outreach. The steering board will meet to plan each of the stages in the project. Prior to each stages a research and publication plans will be prepared by the group responsible for the different subject areas (see boxes above). The major responsibilities of each participant are outlined in the project plan.

3. Perspectives and compliance with strategic documents

3.1. Compliance with strategic documents

The project focus on policies and natural resource management complies with the Research Council's strategy for the Northern Areas, and the strategy plans both at University of Tromsø and the Department of Biology. The research will strengthen the existing study program on Northern Natural Resource Management at UiTø. We will apply for additional funding to establish joint master and PhD studies on circumpolar ecosystem management with Saint Petersburg State University and University of Alaska, where we already have well- established study exchange agreements. The database could be used in our study programs.

3.2. Relevance to society

At present there is a lack of knowledge about how land use, pollution and resource exploitation affect the environment in tundra ecosystems and how these factors may interact with climate change. The strength of this project is the inclusion of social causes and the fit of current management strategies to environmental problems, which are questions which also apply internationally. Databases could also be made available for the public with additional funding.

3.2. Environmental perspectives

The project will contribute with knowledge for more effective management of the environment. We will try to reduce travelling by the use of video conferences.

3.4. Ethical Aspects

Several of the researchers have experience with research relevant to indigenous and local peoples. We will use the same procedures for application to the ethical committee for social science enquiries (NSD) as in the Ecosystem Finnmark project.

3.5. Gender equality and gender perspectives

The project leader and two other researchers are females. We will work to recruit a female PostDoc and encourage female students to link to the project.

4. Communication with users and utilisation of results: see application form

5. Literature cited (work published by research group is marked with *)

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*Beckley 02. Indicators of forest-community sustainability: The evolution of research. Forest Chron 78(5): 626-636.

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Ripple04. Wolves and the ecology of fear: Can predation risk structure ecosystems? Bioscience 54:755-766.
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