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SCIENCE, SULPHUR AND SUSTAINABILITY: ENVIRONMENTAL STRATEGIES OF MINING IN THE RUSSIAN KOLA PENINSULA

Doctoral Dissertation

Olli H. Salmi

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Abstract

This dissertation analyses the problem of co-aligning corporate strategy and public policy for effective environmental governance. A case study of the mining industry in the Russian Kola Peninsula shows how institutional arrangements (including public policies) affect the environmental performance of industrial organizations. The analysis emphasizes the motivations that drive people's decisions and how they are affected by culture and formal institutions both inside and outside the domain of public policy. It bridges management and governance studies with an added focus on engineering approaches to sustainability. In substantial terms, the dissertation has a strong focus on "complex utilization", which has been a common environmental and natural resource strategy in Russia since the 1930s. In an important respect, complex utilization both antedates and closely resembles industrial ecology that has been developed in the West. This suggests that a lack of technical knowledge was not the principal cause of the well-known environmental problems that existed in the Soviet Union. On the contrary, the potential benefits of complex utilization were not realized because Soviet political and economic institutions provided weak incentives for pollution control and efficient resource use. The central theoretical effort of this dissertation is to show how effective environmental governance is contingent upon emergent strategy and policy processes. Both corporate environmental strategy and public environmental policy depend on power relations and network building among a variety of actors in the society. The case study yields three different emergent processes: political embedding of scientific concepts, cultural contextualization of indicators, and legitimacy in stakeholder salience. The dissertation also delivers policy recommendations pertaining to the future development of the Barents Euro-Arctic region. This future depends both on the level of political centralization and on the future development of the oil and gas industry in the region. On one hand, it is possible that the mining industry will continue on the same path as it has done throughout the 2000s. It will continue to develop its environmental strategy primarily on the basis of signals from the international market and a few dominant stakeholder groups. On the other hand, it is possible that complex utilization will be strengthened as an environmental strategy in the region. The two future scenarios allow for case specific recommendations for indicators and environmental co-operation.

Keywords environmental strategy, environmental policy, emergence, environmental co-operation, mining, North-West Russia

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Tiivistelmä

Väitöskirja analysoi yritysstrategian ja toimintapolitiikan yhteensovittamista ympäristönhallinnan vaikuttavuuden parantamiseksi. Analyysi perustuu tapaustutkimukseen Kuolan niemimaan kaivosteollisuuden ympäristöstrategioista 1930-luvulta nykypäivään. Tapaustutkimus pyrkii osoittamaan kulttuurin ja instituutioiden vaikutuksia teollisuusorganisaatioiden ympäristökysymyksiä koskevaan päätöksentekoon. Väitöskirjan teoreettinen viitekehys koostuu laajalti johtamisen ja hallinnan teorioista sekä teknisestä ympäristönsuojelusta. Väitöskirjatutkimus kohdistuu keskeisiltä osiltaan ”kompleksikäytön” käsitteeseen, joka on ollut perustana Venäjän ympäristö- ja luonnonvarahallinnalle yli 80 vuoden ajan. Ympäristöstrategisena käsitteenä kompleksikäyttö muistuttaa läheisesti länsimaissa viime vuosina suosituksi tullutta teollista ekologiaa. Perustellusti voidaan olettaa, että teknisen osaamisen puute ei johtanut Venäjän mittaviin, neuvostoajoilta peräisin oleviin ympäristöongelmiin. Neuvostoliiton poliittisten ja taloudellisten instituutioiden sisältämät kannustimet sen sijaan ovat olleet riittämättömät teollisuuspäästöjen hillitsemiseen ja luonnonvarojen käytön tehostamiseen. Ympäristöpolitiikka ja ympäristöstrategiat rakentuvat yhteiskunnallisten toimijoiden välisistä vuorovaikutuksista, joissa oleellisina tekijöinä ovat toimijoiden väliset valtasuhteet ja verkostot. Keskeisenä teoreettisena tuloksena väitöskirja osoittaa ympäristönhallinnan riippuvuuden ympäristöstrategioiden ja ympäristöpolitiikan emergenteistä prosesseista. Kuolan niemimaan tapaustutkimus sisältää kolme erilaista emergenttiä prosessia: tieteellisten käsitteiden poliittisen juurtumisen, indikaattoreiden kulttuurisen kontekstualisoitumisen, ja sidosryhmien legitimoitumisen. Teoreettisten tulosten lisäksi väitöskirja sisältää toimenpidesuosituksia Barentsin Euro-arktisen alueen ympäristön ja luonnonvarojen hallintaan. Alueen kaivosteollisuuden tulevaisuus riippuu olennaisesti Venäjän hallinnon keskittämisestä ja jääämeren öljy- ja kaasuteollisuuden kehityksestä. Väitöskirja esittää kaksi mahdollista tulevaisuuskuvaa. Yhtäältä on mahdollista, että alueen kaivosteollisuus kehittää edelleen ympäristöstrategioita markkinasignaalien ja keskeisten sidosryhmien odotusten mukaan. Toisaalta alueen poliittiset ja taloudelliset toimijat ovat toistuvasti ehdottaneet paluuta kompleksikäytön strategiaan. Väitöstutkimuksen pohjalta esitetyt tulevaisuuskuvat antavat mahdollisuuden tapauskohtaisiin suosituksiin indikaattoreista ja kansainvälisestä ympäristöyhteistyöstä.

Asiasanat Strategia, ympäristönhallinta, emergenssi, ympäristöyhteistyö, kaivosteollisuus, Luoteis-Venäjä

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Preface

The General Secretary of the Kola Science Centre Anatoly Vinogradov looked puzzled. He was sitting in a comfortable chair in his spacious office of the Science Centre in Apatity, some 200 kilometres south of the city of Murmansk, looking at a sketch of a project I had just outlined on a piece of cross-ruled paper. The project I had proposed would estimate the by-product flows of the major industrial enterprises of the region, with an aim to add value to the region's products while at the same time reducing environmental emissions, which in the Kola Peninsula were known to be significant. The suggestion relied heavily on industrial ecology, a new approach to environmental management with which successful projects of the kind had been made in Europe. I had for the past three weeks been attending an interdisciplinary PhD course organized by the Circumpolar Arctic Environmental Studies Network in the Kola Peninsula and, having in a short time increased my knowledge about the region's industrial infrastructure and environmental problems tremendously, started to feel increasingly eager to learn more about them in an industrial ecology framework.

"This sounds interesting", said General Secretary Vinogradov in a few minutes. "You see, we have a long experience about doing things this way." Now it was my turn to look puzzled. Vinogradov casually dug out a rugged-edged book published by the Kola Science Centre nearly 20 years earlier. The book contained a detailed study of the integration of the entire heavy industry in the Kola Peninsula, with estimates of waste reduction potential and novel products. "We call it complex utilization and it is an idea of the academician Fersman from the 1930s." The plans contained a striking similarity to the models of industrial ecology and, as I was to learn later on, so did the underlying philosophy.

The discussion in the General Secretary's office in Apatity on the fair September day in 2001 started a six-year-long process that led to the compilation of the PhD dissertation at hand. How was it possible that industrial ecology, having gained a fairly widespread reputation in the West of being a new way of looking at human-environment interaction, had been common knowledge to the mining experts of the Kola Peninsula for decades? And, more importantly, how was it that no one in the West had given this knowledge any further thought? "I would give you this document", continued Chairman Vinogradov almost as if he had heard my silent questions, "but unfortunately the book has been declared confidential by the Government up until the year of 2002".

In May 2002 I was finally allowed to lay my hands on the document. An exciting journey into the peculiar industrial tradition of the Kola Peninsula began. A round of data collection started soon after the first visit to Apatity. By the spring of 2005, I had made 52 thematic interviews among the relevant stakeholder groups in the Kola Peninsula, reviewed more than 100 publications by different stakeholder groups, and collected detailed production and emission data from four of the region's largest mining companies covering a 25-year time span. The empirical research led to the publication of four

international peer reviewed journal articles, which form the corpus of this doctoral dissertation.

While the data gave a coherent picture of the environmental emissions of the mining industries in the Kola Peninsula, it became clear during the research process that no new ways of optimizing resource use in the Kola Peninsula would be achieved. The research would certainly provide a general-level description of resource use problems in the region—and careful suggestions of reformulating those problems as a way towards resolving them. But it stood clear that industrial ecology as a policy recommendation would not stand and defend itself in the case region. The reason was that the models of industrial ecology I had in mind when entering the field were the very models that had failed in the region 15 years earlier. These models that were crystallized in the plan presented to me by General Secretary Vinogradov, although great on paper, never took off in reality. To my surprise, however, it appeared that the plan, and the underlying arguments for its promotion, had remained nearly unaltered the past 75 years: the communist scientists of the 1930's, the scientists of détente of the 1980's, and the market oriented scientists of the 2000's all have seen the plan as a solution to a range of environmental and economic problems. The Kola Science Centre, a strongly mining-engineering oriented research hub, even established a unit to carry out the plan in 1988 with the emblematic name "Institute of Economic Problems".

Why, was my next question, would the production models of industrial ecology enjoy increasing popularity in the Nordic countries, such as Finland, Denmark and Norway, but not across the Finnish border in the Kola Peninsula? Obviously, there is some unexplored set of criteria in industrial ecology that makes the concept applicable in some contexts but not in others. What are these criteria? They will certainly change when perceptions of the environment change from one cultural context to the next. This means that environmental governance (defined as a set of mechanisms through which people interact in the context of the environment) plays a crucial role. To go further into governance, I chose to anchor the dissertation to corporate strategy and public policy. The underlying intellectual challenge was to uncover the process by which governance comes into being from the interaction between policy and strategy. The following pages draw together the contributions from a series of journal articles and illustrate ways in which strategy and policy interact. In addition, I will make recommendations to environmental strategy and policy in the Barents Euro-Arctic region.

Apart from Anatoly Vinogradov and his great insight, I would like to express my gratitude to many people in the Kola Science centre: Ludmila Ivanova, Vladimir Didyk, Vladimir Selin, Fedor Larichkin, Galina Charitonova, Larissa Ryabova, and many others who have helped me in collecting material and just plain surviving in the arctic. At Helsinki University of Technology, my colleagues and advisors at the Laboratory of Environmental Protection; Henrik Bruun, Katri Huutoniemi, Maria Höyssä, Nina Janasik, Richard Langlais, Mikko Rask, Martti Timonen and Aino Toppinen have had an immense impact on my work. I am particularly in debt to Aino Toppinen who has helped me to formulate some of the fundamental arguments in this dissertation. Joint writing with Nina Tynkkynen has given me an opportunity to critically review this dissertation at

its very final stages. My supervisor, Janne Hukkinen, has done a tremendous work in guiding me, first through a master's thesis and later through the PhD. Richard Howarth of Dartmouth College, a mentor and a dear friend, has put a lot of effort in reviewing and guiding my work. Thank you all ever so much. Finally, I would like to thank my family—Aino, Kaisa, Kari, Marie, Otso, Paavo, Raili and Toni—for supporting my long journey in the student world.

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List of publications

Salmi, Olli (2007): Eco-Efficiency and industrial symbiosis – a counterfactual analysis of a mining community. Journal of Cleaner Production 15(17): 1696–1705.

Salmi, Olli (2008): Drivers for adopting environmental management systems in the post-Soviet mining industry. International Environmental Agreements: Politics, Law and Economics 8(1): 51–77.

Salmi, Olli and Janne Hukkinen (2007): Cultural Contextualization of Indicators of Human-Environment Interaction: The Case of the Kola Mining Network. Environmental Sciences 4(4): 209–228.

Olli Salmi is responsible for the empirical sections of this article. The authors contributed equally to the theoretical sections of the article.

Salmi, Olli and Aino Toppinen (2007): Embedding Science in Politics: "Complex Utilization" and Industrial Ecology as Models of Natural Resource Use. Journal of Industrial Ecology 11(3): 93–111.

This article was written jointly by the two authors who contributed equally.

1. Introduction

On the face of it, things are beginning to look bright in the Kola Peninsula. The industry of the region is gradually reviving from the punch it took in the privatization process in 1993 and again during the economic downturn in 1998. The year 2006 saw the highest level of foreign investment—USD 101,9 million—in the region's history. The same goes for commodity exports, which exceeded USD 2,5 billion in 2006. In the social sector, the real average per capita income has increased above the average Russian level, and death rate showed a decrease for the first time in 8 years (Didyk and Riabova, 2007). The net level of industrial pollution, which up until now has caused significant environmental degradation in the Kola Peninsula, has decreased by 50% between 1991 and 2001 due to the simultaneous reduction in production volumes and the introduction of cleaner technology (Murmansk-Oblkomstat, 2001).

The decreasing level of industrial pollution in the Kola Peninsula and other industrial regions has had a far-reaching impact on the environmental policy of Russia. As the reduction of emission volumes was a typical phenomenon at the time of the Soviet Union downfall, the federal government has since then been able to take a range of actions that rest on claims of an improved environmental profile of the country. The government's ratification of the 1997 Kyoto Protocol on climate change, for instance, has been seen as a political chip by which Russia attempts to re-achieve its status as a great power, and as a tactical move to secure considerable income from international carbon dioxide trade in the future (Tynkkynen, 2005). Yet the federal government has shown little interest in resolving a number of long-term environmental problems related to emissions from industry. These emissions continue to raise concern in the localities where they are created and, as will become clear in the following pages, across national borders as well.

The Russian government's environmental policy is weak not because of low pollution levels. Although lower than before, they still exceed the typical values in the West by orders of magnitude. In the Kola Peninsula, sulphur was emitted in 2003 from the region's cupro-nickel smelters in amounts exceeding the net national sulphur emission of Finland (Article 1, Statistics Finland, 2006). Unlike carbon dioxide, sulphur dioxide does not travel very far from the source and does not in a strict sense contribute to global environmental change[1]. Its local ecosystem effects, however, are significant. These effects are highlighted in regions with high level point sources such as the Kola Peninsula, in particular as they are accompanied by emissions of heavy metals (AMAP, 1998). Pollutants continuing to pose more subtle threats to the region's ecosystems include airborne phosphorus from the apatite industry. Both of the aforementioned pollution issues raise concern among the citizens of the Kola Peninsula as well as across the border in Finland, Sweden and Norway. Surely, anyone travelling through the cities of Monchegorsk and Nikel in the Kola Peninsula during the summertime is able to see the

[1] Anthropogenic sulfate aerosols are, however, a leading explanation for the global cooling that occurred in the 1950s and 1960s. In this way, sulfur dioxide emissions do have global impacts that partly offset the effects caused by rising greenhouse gas concentrations.

total devastation of ecosystems caused by the long term sulphur dioxide and heavy metals emissions from the copper-nickel smelters there.

The Nordic countries have been particularly active in attempting to control the mining-related pollution in the Kola Peninsula through co-operation. To an important degree, this co-operation has been based on a number of multilateral and bilateral treaties and policy statements, such as the agreement on the reduction of Long Range Transboundary Air Pollution (LRTAP) signed by the Soviet Union in 1979, the Finnish-Soviet joint venture on restructuring the Pechenganikel works in the Kola Peninsula in 1989, and the Russo-Nordic ministerial declaration on the Barents region environment in 1992. The longest enduring and perhaps the most influential of these treaties is the restructuring project of Pechenganikel, which has been repeatedly renegotiated for the past 18 years. Despite the treaties and policy statements, however, foreign counterparts involved in environmental co-operation continue to wonder whether they negotiate with the correct government level or whether the government is the correct partner to negotiate with in the first place. A key cause of this dilemma is the volatility of Russian environmental governance. For the foreign counterparts, the dilemma becomes visible in prolonged periods of project implementation due to constant changes or even loss of project partners (Darst, 2001). The interplay of Russian environmental governance and international co-operation should be better understood for more effective co-operation.

On the technical side, attempts to solve the pollution problems in the Kola Peninsula have been numerous. Some of these attempts date back to the late 1970s, some even to the early 1930s. The more recent attempts, during the 1990s and 2000s, have on many occasions been tied to the aforementioned international co-operation. Up until the early 1990s, technical solutions to environmental problems in the Kola Peninsula were based on two interlinked strategies. First, pollutants would be captured at the end of the enrichment process, with the so-called end-of-pipe technology, and stored in waste deposits in the Kola Peninsula. In the second strategy, pollutants that previously were emitted into the environment would be re-used within a complex structure combining mining and metallurgy, chemical industry, and construction industry. This second strategy is commonly known as “complex utilization” in the Kola Peninsula.

Complex utilization is in many ways analogous to the concept of industrial ecology, which has gained notable academic and industrial interest since the early 1990s. A central aspect of industrial ecology is that it is a metaphor: it suggests that natural ecosystems can be used as models for industrial systems to achieve sustainability. Similarly, the metaphor of complex utilization links properties of nonliving nature into industrial practices. It conveys the idea that a complex mineral ore should be utilized in its complexity; in other words, extracting all the components of an ore and converting them to products. It does so by deriving design imperatives from one of the most important minerals in the Kola Peninsula, apatite–nepheline of the Khibiny Mountains. Apatite–nepheline is found in complex formations, which means that the mineral’s constitutive compounds form strong physical bonds that require a number of processing stages if any single compound is to be extracted. Thus, the word complex refers not only to the Khibiny ore, but also to the entire industrial process that the ore is a part of (Article 4).

The second analogy between industrial ecology and complex utilization is related to their practical implications. Both concepts are directed toward the industrial processing of natural resources and have similar prescriptions for industrial systems. According to industrial ecology, industrial ecosystems are supposed to optimize the use of energy and material through internal circulation. In the case of complex utilization, the complex constitution of the natural resource dictates that, in order for it to be fully utilized, the resource needs to be processed in a complex production system.

Third, the two concepts are analogous in that they have been created and cultivated by scientific communities, which have also become the principal constructors and communicators of the societal meanings and justifications of the scientific metaphors. Through this political dimension of their activities, the scientific communities—including scientists and possibly other intimately connected proponents who are initiated into the science based concepts—have become involved in natural resource policy (Article 4). This last point bears significance as it delineates some important aspects of the policy networks in which complex utilization has been promoted (details to follow).

Since the early 1990s, the solutions to environmental problems have increasingly been based on the increase of eco-efficiency through plant-specific modernization programs, but rigorous end-of-pipe technology is still a widely used method to curb emissions. The target emission levels that are expected to result from the application of these environmental technologies are based on both Russian environmental regulation and international negotiations. In the latter case, sustainability indicators retrieved from international sustainability declarations have been proposed repeatedly, but their effectiveness in the case study region is far from clear. In addition, production models for sustainability, such as industrial ecology, while well received in Europe and in the US, have failed to deliver the expected environmental benefits in the Russian context. Importantly, the mining companies have during the 2000s adopted standardized environmental management systems (EMS) largely due to consumer demand.

An exploration into the discrepancy between the effectiveness of sustainability indicators and production models in different cultural contexts—North-West Europe and North-West Russia—is important in two respects. First, it reveals previously hidden patterns of political embedding of scientific models for human-environment interaction. Second, it allows for a better understanding of the mechanisms with which indicators of human-environment interaction are culturally contextualized. Both of these aspects are necessary for the application of scientific concepts in resolving local environmental problems in the global economy.

Put simply, corporate environmental strategy and public environmental policy in the Kola Peninsula do not currently have much common ground. Yet strategy and policy are key governance mechanisms. To achieve better environmental governance requires understanding how strategy and policy interact. This introductory chapter links strategy and policy in a coherent manner by using concepts from management and governance theories. In particular, my empirical research pinpoints several dependencies between

"strategic fit" and policy networks. In addition to these two concepts, the following pages will make frequent reference to a number of theoretical concepts. As these concepts often lack rigorous common definitions, I have developed a terminology specific for this dissertation in Table 1.

Table 1. Theoretical concepts and their cross dependences as used in this dissertation

Concept	Definition	Cross dependence with other concepts
Environmental management	Form of organizational management in which environmental issues are brought into decision making	Varies according to the strategies with which the organization engages its stakeholders
Environmental strategy	A framework guiding the organization's practices in the context of the natural environment	Part of environmental management, influenced by public policies
Strategic fit	A measure of how well strategy is in line with its context	Constructed in policy networks
Environmental governance	Any set of mechanisms through which groups of people work together and/or interact in the context of the environment	Governance mechanisms include strategy and policy
Institutions	"Humanly devised constraints that shape human interaction" (North, 1990: 3)	Institutional arrangements (including public policies and corporate strategies) affect the performance of industrial organizations
Environmental policy	Concerns the structure and content of state institutions (environmental laws, regulations, administrative practices and court rulings)	Formed partly as a response to corporate environmental strategy
Policy networks	Inter-organizational modes of interaction through which distinct organizational entities come into contact.	Mediate between corporate strategy and public policy
Human-environment indicators	Repeated measurements of the state, functionality and performance of socio-ecological systems	Contribute to policy network building and community processes
Environmental co-operation	Agreed upon, planned or implemented environmental work by organizations from different cultural contexts	Work in which institutions from different cultures are contested

Although I extend the scope of this dissertation back to the Soviet time, where no private corporations existed, the main viewpoint I apply is that of the industrial corporation. A key rationale for this choice is that industrial companies have become important actors in the environmental governance structure of Russia (details to follow). This means that corporate environmental management has emerged as a central institution of environmental governance in Russia. Having this in mind, I take up three distinct but interrelated elements of corporate environmental management in this dissertation:

environmental strategy, indicators of human-environment interaction and *environmental co-operation* (Figure 1). The schematic in Figure 1 introduces two key processes in Russian environmental governance: privatization and re-centralization. Three "snapshots" are highlighted: 1990, 2000 and 2015. While the findings in the first two snapshots lay the empirical grounds for this study, I use the third one to illustrate possible futures for environmental strategy in the Kola Peninsula. The dominant *environmental strategy* in the Kola Peninsula has shifted from complex utilization to adaptation to international environmental standards. The two possible future outcomes are either the re-establishment of complex utilization or the further "greening" of the mining business through standards. Similarly, the key *human-environment indicators* within the mining industry have undergone a transition from eco-efficiency towards profitability. Analogous development paths are possible for indicators as for strategy: the first alternative is conditioned on the market and co-operation, the other on complex utilization. Finally, *co-operation* has changed from government-driven and centralized into more fragmented and local. The potential futures in co-operation depend partly on the dominant environmental strategy and can be increasingly based on multilateral local environmental programs. Alternatively, increased federal involvement can be expected should complex utilization be re-established.

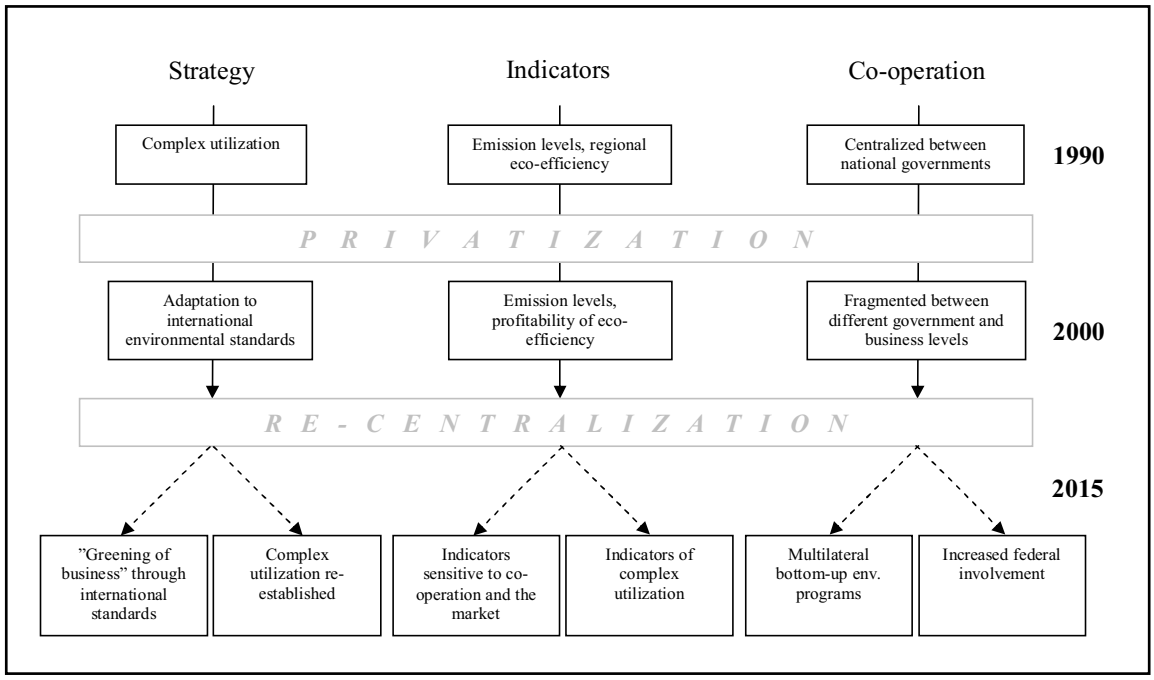

Figure 1: Past, present and expected changes in environmental management in the Kola Peninsula

The fundamental research question behind the dissertation emerges from the empirical schematic in Figure 1: How do policy networks mediate between strategy and policy to respond to, and to reconstitute, environmental governance? From the corporate perspective, the solutions are embedded in corporate environmental strategy, in which environmental indicators and co-operation with domestic and foreign partners play a key role. But the corporation does not act alone with regard to the natural environment. Its environmental strategy is guided and constrained by public environmental policy, which, to make things more complicated, is formed partly as a response to the environmental strategy of the corporation. Thus, the task of this dissertation is to analyze the interdependence between corporate strategy and environmental policy.

By responding to the research question, the dissertation reveals some of the environmental strategies with which the mining industry of the Kola Peninsula has participated in the formation of environmental governance during the past 27 years. By linking the environmental strategies to specific technical solutions—most of which are being promoted in Europe and the US—the dissertation assesses conditions for success and failure of these technical solutions. This approach brings forth a range of complex issues. To start with, the strategies presented in Figure 1 are not entirely fixed to the time periods. Parts of them continue to be promoted by various influential actors in the case region, which signals strong heterogeneity and path dependence in the strategies. Path dependence and heterogeneity, in turn, make visible the needs and demands in different cultural contexts and governance structures, and the need for them to be incorporated into corporate environmental management. The central message of this dissertation, therefore, is to instruct how to do the incorporation successfully. In international environmental co-operation, cultural contextualization of environmental management is crucial. Ample evidence of the failure to do so is found in Russia and in cases of international aid (Roe, 1994; Darst, 2001).

This introductory chapter is based on the outline in Figure 1. I begin by giving an outlook of the relevant parts of governance and management literature as they apply to the research question. I then proceed to describe recent changes in environmental governance in Russia, together with an account of environmental strategy before and after these changes (Figure 1). The four journal articles following the introductory chapter reveal a broader picture of the case study, and will in part open the analysis towards directions that transcend the main research question of the dissertation.

2. Environmental Strategy and Policy

This dissertation is first and foremost about the boundary between corporate environmental strategy and public environmental policy. The outline in Figure 1 is composed of generalizations for phenomena that I have observed in the empirical study of the mining industry in the Kola Peninsula. But while the outline emerges from the empirical material, its contents resonate well with the literature on environmental management and governance. The fragmentation of power over environmental protection, which has taken place in the case region, is familiar from governance studies in the

European context (Rhodes, 1996). New challenges have also arisen in the legitimation of the mining activities in the Kola Peninsula: the mining companies now need to pay more attention to international non-governmental organizations (NGO) and actors on the global market. Similar issues in the legitimacy of environmental management have been observed in the mining industry in general (Warhurst and Mitchell, 2000; Humphreys, 2001; Peck and Sinding, 2003).

In addition to the methodology and theories used in the articles for this dissertation, there is a more general phenomenon that I feel compelled to describe: the *emergent* properties of environmental governance. In short, the processes behind environmental governance are tied to a specific context and community. This means that it appears impossible for scholars and policymakers alike to develop any general criteria for the governance process (Meadowcroft, 2002; Haila and Dyke, 2006). Yet, the real-life actors negotiating environmental governance do arrive at closure over the conditions for environmental strategy and policy. It is likely, therefore, that the governance process exhibits a number of emergent properties. While the search for specific criteria for environmental governance appears fruitless, the dynamics of these emergent properties bear promise for a better understanding of governance (Meadowcroft, 2002; Haila and Dyke, 2006).

Two theoretical concepts find support from the empirical work done in this dissertation: strategic fit and policy networks. Both of these concepts have been used in a broad variety of research orientations. In strategic fit, the spectrum spans from business policy to organization theory (Venkatraman and Camillus, 1984). Policy networks, in turn, have generally been viewed either as typologies of interest intermediation or as a form of governance alternative to hierarchies and the market (Börzel, 1998). The most relevant orientations within these theories are those with a process view of strategy and policy, which, thus, allow for the study of the emergent properties of environmental governance. Before proceeding to the empirical findings of the case study, I will briefly introduce the two theoretical concepts.

2.1. Business Organizations and their Strategic Fit

The relationship between the business organization and its operational environment (as a distinction from the natural environment) has been in the focus of extensive research for decades. Depending on how the operational environment is defined, a distinction is made between rationalistic, evolutionary, and constructivist approaches (Scott, 1981; Hatch, 1997). In the rationalistic approach, an organization is perceived to interact with its environment through the acquisition of resources. At the same time, the available resources (labour, capital, raw materials, technology) constrain the activities of the organization. The evolutionary approach, in turn, emphasizes the ways in which the organization shapes and is shaped by its environment. The organization may be seen through the population ecology metaphor, in that survival in competition against other organizations and the environment becomes a defining factor. Finally, the constructivist approach emphasizes the ways in which the members of the organization make sense of and give meaning to the relationship between the organization and its environment.

Regardless of the approach, however, it is understood that an organization passes information and material to and from its environment. Sometimes the actors within organizations are unaware of this exchange but, typically, they attempt to intentionally steer it. In this steering activity, organizational strategy is a pivotal tool.

Institutional theory argues, that, while economic resources are critical to the operation of industrial companies, they should not forget the importance of maintaining social legitimacy: if an organization violates the expectations of its social environment, the environment may invalidate the organization (North, 1990; DiMaggio and Powell, 1991; Hatch, 1997; Scott, 2001). Therefore, it should be of interest to corporate managers and strategists to pay attention to how their organization performs in relation to its operational environment.

Corporate environmental strategies are frameworks that guide the organization's practices in the context of the natural environment. Depending on the strategy, the practices may or may not include a dialogue with the society's requirements for a "good environment". Environmental management literature typically defines strategy in terms of the type of engagement that a corporation has with the natural environment and stakeholders. The level of engagement, in turn, is influenced both by the risk of environmental harm from the actions of the company, and by its environmental business opportunities (Welford, 1998). Business opportunities, however, are typically not fixed or readily observable. It is surely up to an individual company to create them, to see an opportunity where its competitors do not. It is thus contingent upon a company's entrepreneurial stance and psychological state, not its industrial activity per se, whether it perceives and exploits business opportunities.

What is more, understanding business opportunities as fixed and readily observable ignores the actual formation of the governance processes that both shape and are shaped by corporate strategy. An organization theory view on strategic fit gives a more nuanced picture. In this view, strategy has been seen as a way for the organization to steer its internal structure and processes, to influence the structures and processes of the operational environment, or both (Venkatraman and Camillus, 1984). Drawing from a population ecology metaphor, the concept of *fit* has been used to describe a number of ways by which the members of an organization formulate and implement strategy (Chandler, 1962; Miller, 1988). In simple terms, by achieving a fit between strategy and its context—be it internal or external—an organization is expected to perform better (Venkatraman and Prescott, 1990). Additionally, strategic fit has been found to be inherently dynamic. That is, companies that are able to maintain a sufficient level of change between organizational resources and environmental forces are successful while those changing too slowly or too fast experience negative performance consequences (Zajac and Kraatz, 2000). Another distinction is found between the content and process of fit (Venkatraman and Camillus, 1984). The content of fit is emphasized by the design school of strategy and involves aligning strategy with the organization's internal and external elements. This view of strategy has faced criticism due to its deterministic undertone, which aims at the separation of strategy formulation from strategy implementation (Mintzberg, 1990). The network school, emphasizing the processes of

arriving at fit—the *gestalt* of fit—requires analysis on networks of organizations with interdependent strategies (Venkatraman and Camillus, 1984). It therefore touches closely upon the emergent properties of governance and (as will become clear below) coincides with the process view of policy networks.

The case study in sections 4 and 5 deals with the patterns of interaction in a network of organizations and sometimes actors, rather than with the content of fit as such. What is still lacking from this picture is the formation of environmental policy that sets the boundaries for corporate activities, and the ways in which corporations take part in policymaking. The concept of the policy network helps us to further conceptualize strategic fit.

2.2. Governance and Policy Networks

Governance has been typically understood as how the society is "steered" (Rhodes, 1996; Stoker, 1998). The steering is conducted by various actor groups and networks in society, including the central government. More precisely, governance is about the distribution of decision-making power between the state and other actor groups in the society, such as supranational governments, local governments, private businesses and non-governmental organizations. Historically, governance has been defined as a process with two stages: first, in the post Second World War Europe, nation states gained foothold as dominant political decision-makers. Second, by the 1990s, many European nation states had to a significant degree lost or given up their decision-making power. In processes of Europeanization and globalization, governance appeared in the form of privatized public services and the strengthening of supranational structures such as the EU and the EMU (Pierre and Peters, 2000). Typical governance processes are the expansion of constituencies (EU, NGO), decentralization of policymaking (local governments, NGO), or privatization of goods and services production (Pierre and Peters, 2000). In environmental governance, environmental policy instruments (indicators, incentives, scenarios, standards) are defined by voluntary agreements and market-based mechanisms as well as government command and control (Jordan, Wurzel et al., 2005).

Against this historical background, governance presents itself as a continuum in which at one end there is strong state government (e.g. Europe in the 1940s - 1970s) and at the other end there is strong distributed governance (e.g. Europe in 2008 or sometime in the future). At the state government end, then, one would find environmental policy instruments based on command and control, while at the distributed governance end, the dominant instruments are those based on voluntary agreements between different groupings in society. Although compelling, this view does not give much support to the task laid out earlier for this dissertation: to shed light on the emergent rather than predetermined governance processes.

In Russia, state governance structures are being partly replaced by non-state governance structures. Research on Russian corporate governance has been conducted (Kosonen, 2002) but here, too, governance converges to a traditional resource-dependence view of

the organization. A good example of governance research in a transition-economic setting is a recent number of *Environmental Politics*, which assesses environmental governance in China mainly from the perspective of ecological modernization (Mol and Carter, 2006).

One general argument for studying environmental governance in Russia is that the state has an important role to play in governing, but to be able to retain its power it needs to be able to adapt to the emerging alternative decision-making configurations, and it needs to be able to allocate its decision-making power to those configurations (Pierre and Peters, 2000). It follows that the state needs to maintain several scenarios and future configurations consisting of economic, political, social, technical and environmental factors, while it at the same time needs to maintain the credibility of its actions. The case study conducted in this dissertation reinforces in a rare context the argument that there is a discrepancy between changes in legal and constitutional frameworks and actual political and institutional behaviour. This discrepancy, so the argument goes, cannot be sustained for a long period of time (North, 1990; Pierre and Peters, 2000, pp. 17). Legal and constitutional frameworks should "catch up" with actual behaviour but since the changes in the latter have been spontaneous and organic, it is difficult to harness the change in the formal frameworks.

To analyze the interplay between strategy and policy, I use the concept of *policy network*. The new governance literature considers the policy network as a new mode of public management in sectors where the government alone cannot act effectively (Dowding 1995; Börzel 1998; Evans and Davies 1999; Marsh and Smith 2000). Policy networks usually display a predominance of informal, decentralized and horizontal relations (Kenis and Schneider, 1991: 32). In addition, policy networks can be considered as inter-organizational modes of interaction through which distinct organizational entities—groups with their own structures, functions and goals—come into contact. Network interactions are characterized by trust and cooperation (see Rhodes, 1996), but also hierarchy and conflict (Meadowcroft, 1997: 440). Patterns of network interaction are shaped by governments, and by legal and institutional frameworks.

Most policy network models tend to be better at explaining stability, i.e., demonstrating similarities across nations or sectors where different formal institutional processes exist, than at explaining policy change or fundamental political processes (Dowding, 1995). Taking the process dimension seriously means that "policy networks should be viewed as part of the broader social world and are always in a state of becoming. They are not fixed and determinate entities. Their major features—power dependency, goals, dominant coalitions and appreciative systems, processes of exchange, rules of the game, and so on—are the outcroppings of the process of social construction" (Evans, 2001). The following analysis does not support policy networks as rational forms of organization, but, rather, gives reasons to see them as products of an ongoing process of social and political construction which is intertwined with broader systems of governance in complex ways (Kingdon, 1984; Marsh and Olsen, 1984, cited in Evans 2001: 546). Accordingly, in the following analysis, I will identify a number of policy networks and investigate the processes through which these policy networks are produced and

reproduced. In this dissertation, policy networks are found in the context of some specific environmental problem or technological model. The interests and ideas of people and their power to produce and maintain a network formation are central as they form the mechanisms that maintain and reproduce the established network form and define the capacity to control the direction of policy (Evans, 2001: 545-547).

As the regulation and planning of human-environment interaction is primarily based on scientific knowledge of the environment, indicators, models and standards continue to play an important role in environmental governance and, consequently, in policy networks (Hezri and Dovers, 2006). Moreover, as will become clearer in the following pages, the changes in the structures of environmental governance induce changes in corporate environmental strategy as well.

3. Material and methods

The case study area of this dissertation, the Russian Kola Peninsula, is located south of the Arctic Ocean, north of the Arctic Circle, and east of Finland and Norway (Figure 2). It is an area of immense natural resources, of which mainly minerals have been extracted since the 1930s. As a result of this extraction, several sites in the Western parts of the peninsula were brought to an ecological disaster by the 1960s. Consequently, the Russian government imposed pollution restrictions on the mining industries in the 1970s. Along with the Soviet politics of détente at the end of the 1980s the considerable environmental degradation of the Kola Peninsula was revealed to the rest of the world. In the early 1990s, then, the Russian government significantly increased its focus on environmental issues and tightened its environmental policy on several government levels (Darst, 2001; Oldfield, 2005). On the Kola Peninsula, this coincided with increased Western attention on the environmental impact of the mining industries and the Arctic nuclear fleet. Since the late 1990s, however, the Russian government and the president have consistently reduced their interventions in environmental issues and industrial pollution. At the same time, mining companies in Russia have adopted standardized international EMS, mostly due to pressure from the international market on which these companies operate today.

The ecological consequences of emissions of heavy metals, sulphur dioxide and phosphates in the Kola Peninsula have been in the focus of a numerous Russian and international scientific studies for the past 15 years (for good overviews, see e.g. Kozlov and Barcan, 2000; Hønneland and Jørgensen, 2003). Yet, research on possibilities for ecological restructuring of the predominant polluter of the region—the mining industry—has been sparse. Even though the industrial infrastructure of the region continues to have a significant impact on the economic and ecological development of the entire European North, there is little knowledge on the history and present situation of environmental and natural resource management practices in the Kola Peninsula. Ambitious scenario work on the Barents region as a whole has been conducted recently (Brunstad, Eivind et al., 2004), but these studies tend to be on too general a level to address the specific solutions on human-environmental interaction that have been implemented in the region's mining industries during the past two decades.

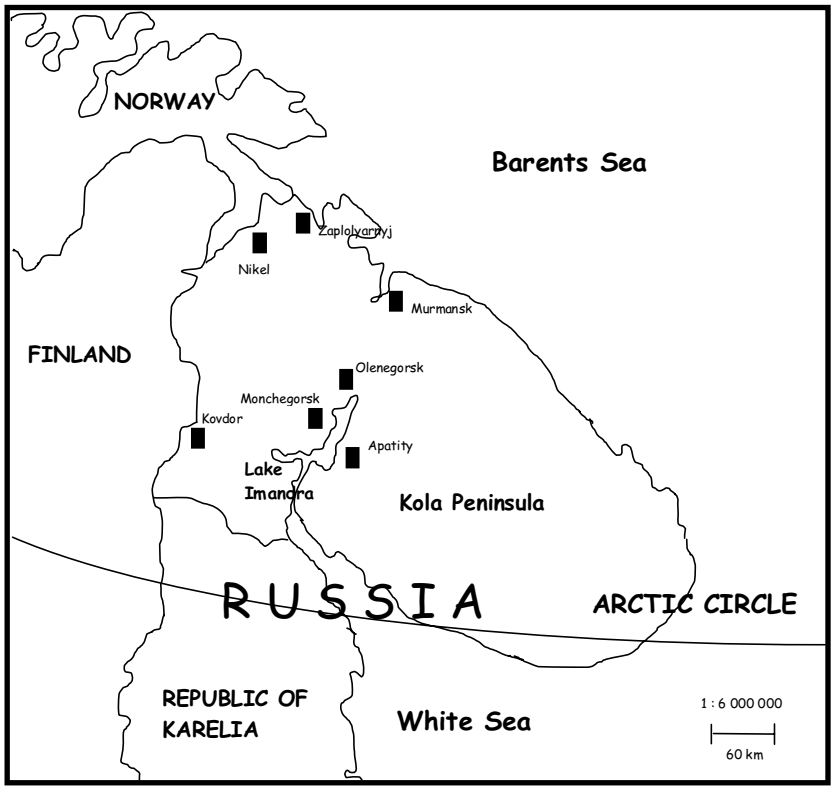

Figure 2. The case region with its six mining locations and the region's capital Murmansk.

The analysis in this thesis is based on both qualitative and quantitative data. The qualitative material consists of 52 thematic interviews with relevant stakeholders in the Kola Peninsula including mining experts from the Kola Science Centre (KSC), managers from the four major mining companies of the region—Kola Mining and Metallurgical Company (KMMC), JSC Apatit, Kovdor GOK and Olenegorsk GOK—directors from regional and local administration, and key individuals in local environmental Non-Governmental Organizations (NGO) (Table 2). Three rounds of interviews were held, in 2002, 2003, and 2004, and conducted either in English or with the help of an English–Russian translator. The interviewees were chosen with the snowball sampling methodology in which each interviewee was asked to give the names of additional people to be interviewed on the environmental situation in the Kola Peninsula. In addition, the qualitative material consists of over 100 documents written by the relevant stakeholders. These documents include publications in Russian and international scientific journals and proceedings, reports from the KSC, monographs by mining experts and annual reports of the mining companies. The quantitative material consists of production and pollution data collected from the four major mining companies in the Kola Peninsula, and from the regional authorities.

Table 2. Qualitative data sources used in this dissertation. The 1st hand oral accounts (number of interviews in parentheses) are recollections of the interviewees' personal experiences or their opinions. The 2nd hand oral accounts are the interviewees' opinions about issues they have not personally experienced.

Oral	Written
KSC (25), industry (18), regional government (2), NGOs (4), local government (3) (1st and 2nd hand oral accounts)	Scientific and newspaper articles by KSC, regional government, mining industry, General Secretary/President Gorbachev, Russian Academy of Sciences

The research data provided grounds for four different historical and interpretive narratives, as presented in the four journal articles following this introduction. These narratives explain how human actions have affected the environment and how this has been conditioned by institutions in the case study region. This introductory chapter, too, provides a "meta narrative" that builds on those constructed in the articles. In constructing the narratives, my co-authors and I have used counterfactual modelling, legitimacy analysis, cultural analysis and frame analysis. I will briefly introduce each method of analysis.

The first method of analysis is quantitative and differs therefore from the three qualitative ones described below. Counterfactual analysis estimates the present effects of hypothetical changes in a system's history. It is a method typically used in cognitive and social psychology (see Roese and Olson, 1995), but also in scenario work (Baas, 1998; Begg, Jackson et al., 2001). In the Kola Peninsula case study, I modelled the expected environmental and economic consequences of operationalising complex utilization (one of the key long term environmental strategies in the region). I then compared it with the actual production and emission data from the mining industry. Used this way, the counterfactual method does not allow direct comparison between the modelled and actual developments. Rather, in relation to each other, the modelled and the actual outcomes behave like scenarios in the sense that they are two possible development paths out of many more (Bruun, Hukkinen et al., 2002). In this way, the counterfactual analysis provides a "quantitative" narrative for this dissertation.

The second methodology I have used in this dissertation assesses the legitimacy and institutional isomorphism in the mining industry. In short, legitimacy is a ''generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions'' (Suchman, 1995: 574). For the purposes of the dissertation, legitimacy offers a useful way of expressing the drivers behind environmental strategy in corporations. In their attempt to achieve legitimacy and comprehensibility, organizations may resort to mimetic isomorphism (DiMaggio and Powell, 1991; Suchman, 1995). Along with the two other types of institutional isomorphism—coercive and normative isomorphism—mimetic isomorphism may guide the decision of an organization to apply a system of environmental and social responsibility standards. In particular, mimetic isomorphism is understood as the tendency of business organizations to mimic the behaviour of other

similar actors in the field in order to reduce uncertainty. Coercive isomorphism, in turn, is understood as the tendency of business organizations to behave homogenously in order to avoid sanctions, for example by regularly complying with environmental emission norms. Finally, normative isomorphism is related to the change in values and norms of an organization, in this context of following an environmental standard or agreement (DiMaggio and Powell, 1991).

Third, the cultural analysis utilizes the cultural theory framework (Douglas, 1982), storylines (Hajer, 1995), and indicator theory. The cultural theory framework expresses five different cultural biases relative to two dimensions: *group* and *grid*. Group delineates how sharply the members of a community are separated from those who do not belong to it. In terms of environmental and natural resource management this boils down to use rights: Who has the right to exploit a given natural resource or pollute the environment? Grid measures the strength of "visible rules about space and time related to social roles'' (Douglas, 1982). In other words, grid is a measure of how tightly society controls its members' ways of exploiting natural resources and polluting the environment. Different combinations of weak and strong grid/group yield five cultural biases: egalitarian, hierarchic, individualistic, fatalistic and hermit (Douglas, 1982). Each of these biases is given specific characteristics that allow for each social structure to be present in at least one of the five biases at all times. Storylines, in turn, are narratives with a beginning, middle and end. They describe the social reality by combining elements from many different domains. They provide actors on a policy issue with symbolic references that suggest a common understanding. As such, they are essential political devices that allow actors to overcome fragmentation and achieve discursive closure (Hajer, 1995).

Notably, cultural theory has been criticized for its inability to explain differences in inter-individual perception of risk (Sjöberg, 1998). Whether the same applies for the perception of nature, further research is warranted. This dissertation, however, aims not at explaining inter-individual difference. Rather, it analyses how specific actor groups choose human-environment indicators under some general perception of the environment. The analysis draws from the extensive research by Mary Douglas in cultural anthropology. As Douglas is careful to note, however, all cultural biases are likely to appear in any given culture at any given time. Even the individual can exhibit a number of different cultural types and switch smoothly from one type to another. Douglas' overall point, which is furthered by the research of Thompson (1990) and Schwarz and Thompson (1990), is that in communities some cultural types dominate others. Thus, at any given time, a society is composed of a number of different communities that are guided by a dominant way of life (although other views may exist within the community).

The importance of storylines to this dissertation, in turn, lies in that they not only enrich the cultural theory framework, but also help us understand the context-specificity and path dependence of human-environment indicators. Indicators are repeated observations and measurements of the economy, human well-being, and impacts of human activities on the natural world. In sustainability policy, their purpose is to "sound alarms, define challenges, and measure progress" (National Research Council, 1999: 233-4). Storylines act as interpretive frameworks for indicators in two ways. First, they justify the existence

of individual indicators and thus guide the choice of relevant indicators with which to measure a particular phenomenon. Indicators relevant to sustainability storyline A, for example, may differ from those relevant to sustainability storyline B. Second, storylines provide benchmarks for assessing the significance of specific indicator values and thus guide the setting of a permissible range within which the value of a particular indicator may vary. In the earlier example, even if sustainability storylines A and B share an indicator, the permissible range of variation in the value of the indicator differs from A to B (van Eeten and Roe, 2002; Hukkinen, 2003). What is more, the dimensions of the cultural theory framework, group and grid, correspond conceptually with indicator systems. The choice of relevant indicators is an important part of the self-definition process by which a community separates those who belong to it from those who do not (the group dimension); and the determination of permissible value ranges for indicators is a key aspect of rule-setting by the community (the grid dimension).

Finally, the fourth method, frame analysis, addresses the construction of reality and meaning in sense-making and communication processes (Fisher, 1997; Benford and Snow, 2000). Frames can be understood as interpretative schemes that people use in order to make sense of the world (Fisher, 1997). Framing an event or issue in a certain way highlights selected aspects, thus constructing meaning and suggesting guidelines for action. In other words, frames define problems, diagnose causes, make moral judgments, and suggest remedies (Entman, 1993). The potential communicative success of a given frame depends on how well it resonates with the audience or recipient that is to be mobilized behind the framed idea. Better resonance, in turn, can be sought through frame alignment, which implies strategically designing frames to invigorate existing values or narratives, to encompass concerns of potential adherents, or to change the prevailing understanding of a particular issue (Snow, Rochford et al., 1986; Benford and Snow, 2000). In our frame analysis, the interview transcriptions and documents were screened for arguments as to why a specific environmental strategy in the Kola Peninsula is of importance (Article 4).

The qualitative methods help me describe how policy networks are maintained and reproduced for strategic fit. The quantitative methodology, in turn, helps me describe (partly) the environmental impacts of a given strategy, i.e. to find out if an environmental strategy in fact delivers the expected outcomes during implementation.

4. Environmental Strategy and Governance in the Kola Peninsula

In this section, I open up and explain the schematic presented in Figure 1. I illustrate how, during the past 20 years, environmental strategies, indicators and the style of co-operation have co-evolved with environmental governance in the Kola Peninsula. Two shifts in environmental governance can be identified: privatization and re-centralization (Figure 1). The first one, treated in the following subsections, is a well-known shift in the very social order of Russia. The second one looks into the near future and illustrates environmental strategy under two alternative governance outcomes: one in which state governance structures once again replace the non-state governance structures, and the

other in which state governance structures continue to be replaced by the non-state ones. I take a closer look at these future trends in section 6.

In subsection 4.1, I begin the story by introducing the first governance shift in Figure 1: privatization. Before and after the governance shifts, those deciding over and implementing the mineral resource use and environmental protection in the Kola Peninsula have needed to rethink their strategies and policies. In the dissertation, this network of actors has been defined in two closely related ways. The Kola mining network (Article 3) refers to an *ecological epistemic community*: its members hold similar beliefs about the need to preserve environmental quality and similar views on the origins of pollution, the policies necessary to control pollution, and the research needed to determine the physical linkages between sources of pollution and ecosystem health (Haas, 1989; Hajer, 1995; Dryzek, 1997; Jamison, 2001). Accordingly, the members of the Kola mining network emphasize the need to preserve environmental quality through a technological system that will achieve both environmental and economic benefits; they share an expert view of the sources of pollution from the mining industry; they emphasize the government's role in establishing the desired technological system; and many of them are practicing research on the effects of industrial pollution on ecosystems.

The CU's proponents (Article 4), in turn, are political, scientific and industrial actors who have simply taken part in the promotion of complex utilization throughout the industrial history of the Kola Peninsula. The distinction between these two is minor but relevant: while the CU's proponents were defined strictly in relation to complex utilization, the Kola mining network contains individuals that have promoted alternative ways of resource use as well. Given that this introductory essay addresses environmental strategies beyond complex utilization, I will in the following use the broader term, the Kola mining network.

4.1. Environmental Policy in Russia: The Path into the 2000s

Although the significant negative environmental impacts of the Soviet industry throughout the 1900s would seem to suggest otherwise, environmental protection was never absent from the Soviet politics. Strict nature reserves (zapovedniki) established in the early 1900s were considered a proper means of protecting nature from the dominant threat – resource extraction (Article 3; Weiner, 1999). In retrospect, of course, it is easy to see how this way of protecting the environment in small separate entities was a strategy doomed to fail. Stronger environmental policies were to follow. In the 1971 – 1975 five year plan, the Soviet economic growth was to be based on maximized utilization of mineral resources and the general growth of the heavy industry (Strishkov, 1971). Accordingly, the 1972 Supreme Soviet decree "Concerning Measures for the Further Improvement of Nature Protection and the Rational Utilization of Natural Resources" outlined a holistic environmental policy. Previously, environmental policy was implemented by a number of ministries and state committees (Oldfield, 2005). The increasing importance of environmental policy was visible in the fourth Soviet constitution of 1977, which explicitly conditioned economic growth with environmental

well-being. In addition, following the 1972 decree, environmental legislation was developed and initiated in four sections covering water, minerals, forests, and air quality. To an important degree, this division of environmental policy domains is replicated in the current Ministry of Natural Resources.

The 1980s saw a heightened level of enthusiasm in the environmental East-West co-operation. A lot of the credit for this enthusiasm goes to Mikhail Gorbachev's reforms from the mid-1980s on but already in the 1970s Leonid Brezhnev's regime had used international environmental policy as a key element of détente. In fact, Brezhnev's contribution to the agreement on the LRTAP in 1979 has been assessed as crucial for the treaty (Darst, 2001). This point may be significant in understanding the Soviet involvement in international environmental policy. The LRTAP, however, had little actual effect on the emissions of the industries like the cupro-nickel smelters of the Kola Peninsula—not until the 2000s, that is. Nevertheless, the "greening" of the Soviet foreign policy continued during the Gorbachev era. This meant that environment was used as a pretext to get Western funding for economic restructuring. As will become clear in subsection 4.2, the significance of the "greening" lies in the ways in which it shaped the environmental strategies of Russian industries.

In the early 1990s the profile of environmental policy was further enhanced as the Russian government in 1991 upgraded the previous State Committee of Environmental Protection and Natural Resources to become the Ministry of the Environment, and issued the law "Concerning the Protection of the Natural Environment" (Kotov and Nikitina, 1993; Oldfield, 2005). Two important elements were introduced in these changes. First, the law imposed strict restrictions on pollution, which were enforced with a command-and-control based pollution charge system. That is, industrial companies became liable for paying a certain per-ton base rate for emissions of pollutants listed in the law up to given emission limits and a five-fold rate for emissions exceeding the limits. Second, in conjunction with the upgrading of the environmental committee into a ministry, a number of environmental funds were established on regional and federal levels. As decentralized units of environmental regulation, these funds had the task of allocating money to environmental projects. The funds were financed by the revenue from the pollution charges, from which 90% was directed to the fund and 10% to the federal budget (OECD, 2004).

During the remaining part of the 1990s, however, the Russian presidents continually reduced the position of environmental agencies in the Russian political hierarchy. In 1993, the newly established ministry lost its jurisdiction over a number of key industries, such as the atomic industry and minerals export. In 1996, the ministry was reassigned the status of a State Committee, with many of its previous tasks now coordinated by the Ministry of Natural Resources.

In 2000, President Putin eliminated the State Environmental Committee and the regional environmental funds, and redistributed the tasks of environmental protection to the Ministry of Natural Resources. The rationale for this change was officially stated as an interest in better allocation of implementation responsibilities between federal, regional

and local administrative bodies. What little economic decision-making power was previously given to the regional environmental funds was now returned back to the central government. As a result of the reorganisation, 90 percent of the federal staff and equipment were transferred to regional administration and most of the responsibility was devolved to the regional governments. However, these changes did not result in budget increases to the regional administration and remained institutionally rather ambiguous, creating confusion with regard to responsibility for compliance and enforcement. There is thus some doubt that these changes were motivated by a desire to downscale environmental policymaking as a whole in the country, rather than by a systematic administrative reform program. According to a study conducted by the World Bank in 2004, more progressive and economically viable regions and cities scrambled to make up some of the shortfalls, while most regions did not make it (World Bank, 2004).

It is fairly difficult to distil a clear pattern of power shifts between the federal and the regional authorities in Russian environmental governance from the early 1990s on. Although the Ministry of the Environment was retained in the administrative structure of the Russian Federation, the late 1980s—early 1990s centralization of environmental management did not have long lasting effects. Apparently some power was leveraged to the regions, but this too may have had adversary impacts on the environment. This is evident in the Kola Peninsula where regional actors were allowed to deal with the environment at will, while at the same time they were competing for control over the region's natural resources. In the absence of well-functioning property rights and a corresponding judicial system, privatization led rapidly to a situation where the managers of extractive industries in particular were able to exploit the environment and natural resources regardless of what the society may have considered desirable. At the same time, decentralization of government allocated significant power to regional political leaders. Combined with the Soviet tradition of industrial managers and political leaders forming strong regional elites, decentralization allowed the regions to act free of the control of federal government (Kotov and Nikitina, 1996). Rather than investing into the future of the regions, however, the elites typically exploited the regional revenue for their own benefit.

The Soviet system of environmental governance included key targets that are analogous to the aims of sustainable development as defined in the Rio Declaration on Environment and Development of 1992 (Oldfield, 2005). Yet, the reorganization of the entire Russian political-economic system required the system of environmental governance to be reorganized as well. The result was not a system of coherent environmental policies but, rather, fragmented governance that takes many forms. It is therefore reasonable to look at individual cases of environmental strategy and policy. In the following section, I will take a closer look at the strategies, indicators and modes of co-operation of the Kola Peninsula mining industry during the privatization period.

4.2. Environmental Strategy: From Complex Utilization to Environmental Management Systems

A key environmental strategy in the Kola Peninsula mining industry in the late 1980s was complex utilization, which focused on the systemic increase of production volume and the reduction of environmental impacts. This was to be implemented with large scale production models for regional inter-industrial waste re-use. Complex utilization had been under development in the Kola Peninsula since the late 1920s, and it reached maturity and partial implementation in the late 1980s. The production model was to solve the environmental problems caused by gaseous sulphur dioxide emissions and deposited nepheline tailings by feeding these wastes back into the production system (Luzin, Peshev et al., 1988). The priority of complex utilization over other environmental strategies was highlighted in the Presidential decree from Mikhail Gorbachev:

> "In a number of districts ecological situation is unfavourable. The ministries of ferrous metallurgy, nonferrous metallurgy, fertilizers, building materials did not follow the governmental decisions on deepening processing of the extracted materials, wider application of modern resource saving and ecologically clean technologies.'' (Gorbachev and Ryzhkov, 1988, pp. 1)

With "deepening" of extraction, Gorbachev and Ryzhkov referred to the utilization of waste materials and the creation of new products. All mining and construction companies in the Kola Peninsula would take part in this enormous top-down steered recycling system. The waste feedback would require new processes that would add value to the region's products and broaden the product mix. The main mass flows of the existing mining companies in the Kola Peninsula are given in Table 3. In addition, Table 3 presents a range of novel products that were planned to be obtained with complex utilization.

Overall, the plan for complex utilization was well in line with the general Soviet environmental and natural resources policy of the 1980s. First, it provided a practical way of reducing the negative environmental impacts of mining in the Kola Peninsula while increasing the amount of valuable mineral products. Second, it enhanced the freedom of economic activity in Russia by allowing the industry to export its production surplus. The latter was a central aspect of Gorbachev's economic restructuring. Suffice it to say complex utilization—had it been implemented in full scale—would certainly have increased the region's industrial output and reduced the per-product level of pollution. It is likely, however, that the absolute pollution levels in the Kola Peninsula would on some occasions have increased (Article 1). In addition, the environmental and technological risks related to the introduction of new process elements became pressing in the late 1980s when the incentive for complex utilization was at its highest (Article 3).

It appears that both environmental concerns and economic opportunities were behind the implementation of complex utilization. Environmental issues surfaced in the Soviet Union in the 1970s and 1980s in the wake of the Chernobyl accident and the Aral Sea eco-catastrophe (Graham, 1998).

Table 3. Main mass flows of the five case companies, and the hypothetical Kola Chemical Plant, obtained from Article 1. Bauxite is the main market substitute for nepheline concentrate. Organic fertilizers are the main substitutes for apatite concentrate, super phosphate and fused potassium magnesium fertilizers (FPMF).

		Complex utilization		**Actual development**	
		Supplier / consumer within the Kola Peninsula	**Supplier / consumer outside the Kola Peninsula**	**Supplier / consumer within the Kola Peninsula**	**Supplier / consumer outside the Kola Peninsula**
Severonikel	Supplies:	Iron pellets, sodium salts, sulphuric acid	Copper, nickel, cobalt, sulphuric acid	Sulphuric acid	Copper, nickel, cobalt, sulphuric acid
	Consumes:	Virgin ore, Cu-Ni matte, iron filtrate, calcinated soda, Portland cement	Cu-Ni matte	Cu-Ni matte	Cu-Ni matte
Pechenganikel	Supplies:	Cu-Ni matte, sulphuric acid, commodity slag		Cu-Ni matte, sulphuric acid	Cu-Ni matte, sulphuric acid
	Consumes:	Cu-Ni ore, silicates, Portland cement	Cu-Ni ore	Cu-Ni ore	Cu-Ni ore
Apatit	Supplies:	Nepheline concentrate, iron filtrate	Apatite concentrate, nepheline concentrate, sphene, titanomagnetite, Al-coagulants, Na-K-Ca-saltpetre, Amorphous silicates, P-K fertilizers	Sphene, titanomagnetite, Al-coagulants	Apatite concentrate, nepheline concentrate, aegirine
	Consumes:	Virgin ore, sulphuric acid, Portland cement	Flotation reagents	Virgin ore, sulphuric acid	Flotation reagents
Kovdor (with super phosphate and FPMF plants)	Supplies:	Calcium carbonate, iron filtrate	Iron ore concentrate, apatite concentrate, baddeleyite concentrate, super phosphate, FPMF		Iron ore concentrate, apatite concentrate, baddeleyite concentrate
	Consumes:	Virgin ore, tailings, calcinated soda, silicates, sulphuric acid, Portland cement		Virgin ore, tailings	
Olenegorsk	Supplies:	Silicates, iron filtrate, gravel, sand	Iron ore concentrate, iron ore super concentrate, gravel, sand	Gravel	Iron ore concentrate, gravel
	Consumes:	Virgin ore, Portland cement		Virgin ore	
Kola Chemical Plant	Supplies:	Alumina, Portland cement, calcinated soda, potassium silicate	P-K fertilizers, potash, saltpetre		
	Consumes:	Nepheline, calcium carbonate, commodity slag,			

To finance the clean-up of industries and many polluted areas, the Soviet government sought money from foreign governments through various co-operation treaties. Some of these treaties, it has been claimed, were set up entirely for financial opportunities and little was done for actual environmental protection (Darst, 2001). Complex Utilization shows both sides of the story. On one hand, the Degree issued by President Gorbachev for the implementation of complex utilization highlights the unacceptably poor state of the ecosystems in the Kola Peninsula and gives detailed procedures for remedy. On the other hand, complex utilization meant a significant increase in the output of industrial products from the region. The Pechenganikel co-operation project, for instance, was marketed to the West as an environmental project but domestically, the project was justified by the potential for increasing production capacity (Article 3).

The implementation of complex utilization came to a full stop at the downfall of the Soviet Union in 1991. In spite of this, the concept has remained as a potential future strategy among those promoted by the Kola Mining community. The concept is strikingly similar to the principles and technologies of sustainable development, which perhaps explains its persistence.

Although complex utilization remains a viable option in parts of the Kola Mining network, its implementation continues to face considerable obstacles. After privatization, and throughout the 1990s and early 2000s, the mining industry has decreasingly been steered by the state. A holistic production and environmental strategy is therefore not perceived as feasible by the industrial actors. As the state has given up its steering of environmental management as well, a new trend among the mining companies has emerged: they have been active in adopting international EMS. The mining companies, in short, strive for good environmental profile in the international commodities market. The main driver for these systems has been "market pressure", i.e. the demand from the global commodities market for environmentally friendly raw materials (Article 2).

It is obvious that the environment has become such an important legitimacy issue to the mining companies that they need to do more than just comply with pollution permits and other (ineffective) government regulation. In doing so, the companies not only view other market actors as sources of legitimacy. Legitimacy is also involved in drivers such as stakeholder and regulatory pressure, organizational culture and learning, and the influence of individuals (Article 2). As environmental management by the state is deemed insufficient by a number of actors granting legitimacy to the mining operations, much of the future environmental state of the peninsula depends on the voluntary EMS. Due to the recent past of the industries in the Kola Peninsula as "town-forming enterprises", however, much of their social role still remains. Community responsibility is frequently present in the articulations of corporate executives on environmental issues.

The development and adoption of both complex utilization and the EMS are constrained and accompanied by a number of factors. In the following two subsections, I will further describe two such factors (see Figure 1): environmental indicators and models of co-operation.

4.3. Environmental Indicators: From Eco-efficiency to Profitability

The Kola mining network has relied on a number of indicators measuring human-environment interaction during the past 75 years. In the 1930s, when large-scale utilization of the mineral resources in the region began, the prevailing strategy was to separate nature from the industry in nature reserves (Article 3). From the mining community's point of view it was fully acceptable to exploit the ecosystems in and around the mining sites to a point of collapse. This strategy required the use of production indicators for maximizing the exploitation of natural resources on one hand and indicators for the protection of key ecosystem functions in secluded nature reserves on the other. At the same time, however, the community faced the tremendous task of overcoming the harsh natural conditions of the arctic in setting up and later expanding the mining activities.

The Soviet system aimed at complete control through inherent orderliness, which was to be reached with the control figures of the five-year plans. In the terminology of cultural theory, this way of measuring human-environment interaction reflected a hierarchic storyline. Strong group cohesion allowed for a clear-cut choice of indicators that further separated those who had the right to exploit natural resources from those who did not. The distinction between "intact nature" and "resource pool", for instance, completely isolated the ethnic Sámi population from the resource use scheme (Sarv, 1996). Strong grid, in turn, allotted an undisputed authority to those high in the hierarchy to define the permissible range of variation in the key indicators. In the "resource pool", extraction activities were taken to the extreme (with well-known environmental consequences). The nature reserves, representing the "intact nature", were protected from any use including the traditional semi-domesticated reindeer herding by the Sámi.

In the 1980s, the strategy of complex utilization contradicted the previously held idea of separating nature from industry, but rather, it emphasized a simultaneous reduction of the negative environmental impacts and a boost in the economic performance of all the industrial sectors of the Kola Peninsula. The key indicator in this strategy measured the mass and value of new products, such as Portland cement, that were produced from wastes that were previously emitted into the ground or the atmosphere. These indicators, therefore, were an indirect measure of the human impact on the environment.

The production system based on complex utilization had one aspect that raised concern among the decision makers in the Kola Peninsula: although the system would reduce the amount of conventional pollutants, it was possible that the complex system would begin to emit novel pollutants into the environment. Precaution with novel pollutants was therefore recommended as a key element in environmental and natural resources management. In addition, the amount of technogenic earthquakes had increased significantly during the 1980s – a trend that continued in the 1990s. These earthquakes were the direct result of mining activities and posed a risk to both workers and equipment, and the mining companies employed a seismic indicator system to improve the safety in the mines. Thus, the late 1980s saw a change in the human-environment indicators in the Kola Peninsula. The new indicators were based on the salience of

environmental and technological risk. They challenged the previous hierarchic cultural storyline by questioning the capability of those high in the hierarchy to determine the permissible range of variation. As the grid in this way was reduced, the Kola Mining network moved toward an egalitarian cultural storyline (Article 3)

From the mid 1990s on, as the significance of complex utilization diminished, the Kola mining network has adopted a more market-oriented view of the environment and natural resources. Several factors led to this change. At the downfall of the Soviet Union, much of the domestic market for the mineral products disappeared. Typically, the quality of these products, while acceptable on the Russian domestic market, did not meet the demands of the international market. Moreover, as the regional industrial actors had little experience in international trade, they were ill prepared to market their products to international customers. As a consequence, production levels of mineral products in the Kola Peninsula dropped as much as by 69% between 1990 and 1994 (Article 1). The industrial operators were forced to focus on product quality rather than a large-scale complex utilization. What is more, the plummeting production levels meant that the net pollution levels from the industry took a downwards turn as well (Figure 3).

In the minds of the decision makers, this solved, at least partly, the environmental problems of the Kola Peninsula. The old end-of-pipe environmental protection systems were perceived to be more than sufficient to manage the remaining pollution from the industry. But the customers on the international market were not convinced. The Kola Peninsula has, after all, a reputation of being one of the most severely polluted spots on earth. To improve its image in the international market, the industry relies increasingly on international standards for environmental and social responsibility. The level of emissions remained a key indicator for the environmental performance of the mining industry but it is increasingly being defined by actors and standards outside the Kola Peninsula and even Russia.

Uncertainty related to the market also plays an important role in what is left of the complex utilization strategy. While in the current situation the mining industry does not view the utilization of old production wastes as profitable, it is believed that market fluctuations may quickly change the picture in a way that complex utilization, once again, becomes a key environmental and natural resource strategy.

The key environmental indicators for complex utilization were the absolute emission levels but, also, the degree of pollution feedback into production. Naturally, this feedback also had a cost in the Soviet economic system, which was read in terms of eco-efficiency. Environmental indicators, many of them still measuring emission levels, have been increasingly utilized in the new market-based environmental strategy. This means that the known solutions to environmental problems in the region, such as complex utilization, are given priority only when they have a sufficient profit margin. The choice of indicators itself is subject to market fluctuation and, consequently, has become more uncertain than ever before. In the cultural theory perspective, this plays out as a reduction in group cohesion and a shift towards an individualistic cultural storyline.

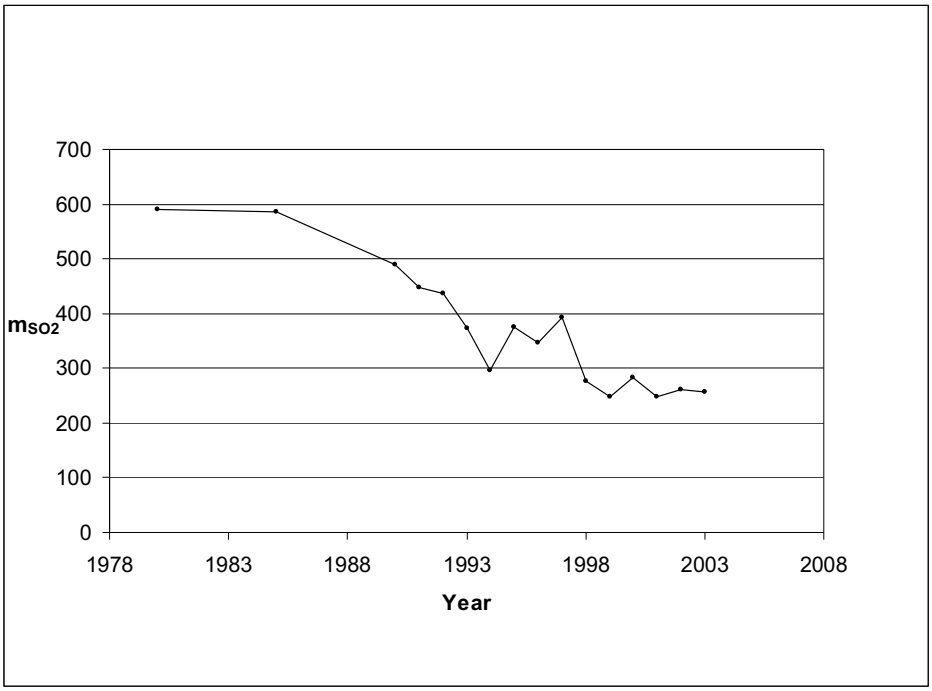

Figure 3. Sulphur dioxide emissions (in 1000t) from the cupro-nickel industries of the Kola Peninsula. Data collected from the Severonikel and Pechenganikel mining companies.

Although the Kola mining network has played a central role in the way environmental strategy and governance have been formed in the Kola Peninsula, actors outside the network have been influential as well. Environmental co-operation (Figure 1) with the Nordic countries is a fairly recent phenomenon in the Kola Peninsula, but it does date back to the end of the Soviet period. In the following subsection I take a look at how environmental co-operation has influenced environmental strategy and governance in the Kola Peninsula through the Pechenganikel restructuring process. In this context, I use policy networks to illustrate the competing alternatives for environmental strategy during changing governance.

4.4. Co-operation: From Centralized to Fragmented Negotiations

In 1985, sulphur dioxide emissions from the Pechenganikel cupro-nickel smelters in the North-West corner of the Kola Peninsula amounted to 343 000 t, exceeding 50% of the region's total sulphur emissions (Article 1). The emission volumes had grown consistently from the 1960s on and—contrary to what the reader may expect—the Soviet government and the mining industry in the Kola Peninsula did consider the emissions a serious problem to the well-being of the region. Consequently, a central aim of the complex utilization plan in 1988 was to increase the profitability of the collaborating

industries and, as a side benefit, convert over 80 per cent of the region's sulphur dioxide emissions into sulphuric acid (Luzin, Peshev et al., 1988).

At the same time, ecosystem destruction in the Russian Kola Peninsula received great media attention in the neighbouring Norway and Finland. The Norwegians feared that their north-eastern coastline ecosystems would meet the same fate as those on the Russian side (Hønneland, 2003). The Finnish debate, in turn, focused on forest defoliation in the Finnish Lapland, which was assumed to be induced by sulphur dioxide and heavy metal emissions from the Kola Peninsula (Väliverronen, 1996).

In 1989, Soviet Union and Finland launched a joint project to reduce the emissions at Pechenganikel. The actual environmental impacts of mining in the Kola Peninsula were not widely known in the West at that time, and the co-operation was driven rather by economic and political incentives than by environmental concern. The Finnish government considered the joint project a sign of good relations between Finland and the Soviet Union. The Soviet leaders, in turn, used it as a showcase and an experiment of the political and economic restructuring—and a key element of complex utilization (Darst, 2001). The reduction of the Pechenganikel emissions through international co-operation during the late 1980s, thus, needs to be understood as a minor part of large-scale industrial restructuring. What is more, it was the only part of the complex utilization plan that was made public. A dominant covert driver on the Soviet side was to increase the production capacity of the mining industry in the Kola Peninsula as a whole.

In spite of its political, economic and environmental importance, the Finnish-Soviet joint venture proved extremely difficult to implement. The Finnish mining company Outokumpu proposed to reduce the Pechenganikel sulphur dioxide and heavy metal emissions at the cost of USD 640 million (Interfax, 1993b). In 1992, the Russian government rejected this as too expensive. In the spring of 1993, Norilsk Nikel released a tender for the reconstruction of its subsidiary Pechenganikel (Interfax, 1993a). The winner of the tender was a Scandinavian consortium consisting of Norwegian, Finnish and Swedish governments, private companies and intergovernmental agencies. Their reduced budget of reconstruction was USD 300 million. For this budget, the Norwegian government would chip in with USD 42 million. On July 1, 1995, the Russian government, referring to the LRTAP, and to the severity of environmental problems on the Kola Peninsula, announced that it had allocated USD 42 million to the project of reconstructing Pechenganikel[2]. The remaining part of the entire USD 300 million excepting the Norwegian support was left for Norilsk Nikel to pay.

Meanwhile, however, research results in Finland showed that the forest damage in Finnish Lapland was not caused by the Russian emissions but by a combination of several factors. First, during the winter of 1986-1987, the root systems of the forests in Lapland were damaged, which resulted in nutrient deficiency and defoliation during the following summer. Second, sprout loss was caused by an outburst of a fungal disease. Third, reindeer grazing on protective lichen cover caused a decline in the microbiological activity of the forest soil. Finally, climatic changes were shown to cause occasional

[2] Resolution N 667 of the Government of the Russian Federation

decline in the forest foliage of North-Eastern Lapland (Tikkanen and Niemelä, 1995). Consequently, the Finnish debate on the Kola Peninsula emissions was soon subdued (Väliverronen, 1996). In Norway, however, the debate on smelter impacts persisted. In 1997, after five years with no visible progress in the co-operation for emission reductions in Pechenganikel, Nordic environmental organizations asked the Nordic Investment Bank (NIB) to initiate negotiations with Norilsk Nikel. While Norilsk Nikel had severe economic problems at the time, it had not—unlike most Russian heavy industries—experienced much reduction in production volumes after the collapse of the Soviet Union. As a result, the company was in 1997 producing large quantities of commodities with inefficient production facilities topped with emission levels far above its global competitors.

At this point, two very different strategies to solve the Pechenganikel issue had been at play. First, the Soviet and later Russian governments were in favour of the complex utilization plan but would not allow the Western counterparts into the details of these plans. It is therefore hardly surprising that complex utilization has been completely absent from the international negotiations for Pechenganikel restructuring. The policy network behind complex utilization, therefore, was reduced to Soviet/Russian government, private and public Russian research organizations, and the management of the mining companies.

The second strategy, end-of-pipe pollution reduction, had initially been the primary aim of the Nordic countries in the co-operation with Pechenganikel. Norwegian politicians insisted on an unconditional reduction of the pollution volumes but paid little regard to the effects this would have had on the economy of the Murmansk region. In this strategy, the key actors were Western government officials and engineers, and the solution to the emission problem was to be found with Western technology (Darst, 2001). The Russians would act as spectators and potential financers. At the end of the privatization process, however, those responsible for the Pechenganikel project at the NIB were working directly with the different departments of Norilsk Nikel. Neither the Russian federal government nor the Murmansk regional government were involved in the negotiations.

Interestingly, the two negotiating parties—NIB and Norilsk Nikel—both needed to change their understanding of the desired outcome of the restructuring project. Although pollution reduction was a key aim of the Nordic countries, the NIB was to find out that pollution reduction through end-of-pipe methods alone was not a viable alternative for a business organization. Increasing economic returns were needed in restructuring projects. The mining company, in turn, was to learn that a positive environmental image can help bring in the desired returns on investment.

In other words, the co-operation partners had arrived at a shared understanding of eco-efficiency, with specific engineering solutions for Pechenganikel. This appears crucial to project implementation. In the mid-1990s, the two parties had goals that involved strategies representing two very different approaches towards eco-efficiency: one conditioned with pollution reduction and the other conditioned with the development of production capacity. Suffice it to say these two approaches may have very different environmental impacts and consequently stood in the way of effective project

implementation. What is more, those claiming to be involved in the Pechenganikel case tended not to share the same view of the composition of the policy network. While the NIB emphasized the role of direct negotiations with Norilsk Nikel, the Murmansk regional government felt strongly that it should be involved as well.

In sum, the long-term Nordic co-operation to reduce pollution from Pechenganikel reflects a number of changes both in the power relations of the policy network and the desired technical fix. Analogous to the ways in which complex utilization was promoted in the 1980s, Norilsk Nikel saw an opportunity in the Nordic concern over the environmental situation in the Murmansk region and tried to finance its production development with capital from the Nordic countries and the Russian government. This contradicted the expectations of the Nordic partners and the restructuring project was stopped. With the rising global nickel prices in the early 2000s—and certainly with the help of export tax exemptions from the Russian government—Norilsk Nikel suddenly gained enough capital to be able to conduct the capacity development project itself, with corresponding reductions in sulphur dioxide emissions. It can be concluded, that the significance of the Nordic-Russian co-operation lies more on the persistent Nordic action in the Pechenganikel restructuring project rather than on the Nordic financial input. In fact, it is only with the introduction of the ISO 14001 EMS that Norilsk Nikel has tied the Pechenganikel restructuring project to its environmental performance: in its annual reports between 1999 and 2004, the company has highlighted the Pechenganikel reconstruction as an example of successful environmental management and emphasized the co-operation with the Nordic countries on one hand and the LRTAP on the other. The fact that the NIB and Norilsk Nikel were able to arrive at a shared understanding of the specific meaning of eco-efficiency in the case appears to be a key issue in successful implementation. It is also likely that government absence from the recent negotiations between the NIB and Norilsk Nikel has had a similar impact.

Western government agencies now often negotiate directly with the executives of individual Russian companies. In part, this is due to the decision-making power of individual industrial companies having increased significantly during privatization. The success of co-operation may, however, depend critically on the organization, business, and the economic performance of the company.

The different policy networks behind the environmental strategies in the Kola Peninsula help in understanding the formation of environmental governance in the region. Yet, merely describing the policy networks does not say anything about what goes on in the organizations implementing environmental strategy. To shed light on this side of the story, I will in the following section look—once again—at complex utilization and the EMS. This time, however, I will look at them through the conceptual apparatus of strategic fit.

5. Fit in the Environmental Strategies of Mining: Lessons from the Case Study

Strategic fit measures how well strategy is in line with its context. In this dissertation, environmental strategies are in focus. The context is therefore conditioned by the natural environment and, in particular, the risk of negative impacts on the natural environment. I have approached the environmental strategies of industrial organizations with two theoretical concepts: framing and institutional isomorphism. In the case context, I use framing to analyze complex utilization and institutional isomorphism to analyze standardized EMS. As noted previously, these two environmental strategies have been developed in the case study region during different time periods but both are likely to remain as parts of the environmental policy of the Kola Peninsula. I will in the following first explain strategic fit through the framing of complex utilization and thereafter discuss it through institutional isomorphism of EMS.

Throughout the past 75 years, individuals in the Kola mining network have influenced natural resource use and environmental protection in the Kola Peninsula. A pattern of maintaining and re-introducing the concept of complex utilization is pervasive in how these individuals have claimed to solve the environmental and economic problems in the region. What is more, these arguments, while changing in style and nuance, have remained fairly unaltered the past 75 years. Sorting these arguments based on their similarity yields five simple frames (Table 4): *nature, economy, science, efficiency, and self-sufficiency* (Article 4).

First, the way in which nature should be understood in relation to industrial activities has been a key driving force behind complex utilization. The arguments specifying this relation have changed from the "exploitation of nature" in the 1930s through "nature protection" in the 1980s to the "adaptation of industry to nature" in the 1990s. We have formed these categories on the basis of the most frequent expressions of industry-environment relationship that the interviewees and literature sources used. Second, as the Russian economy relies strongly on the extraction and utilization of the nation's natural resources, the decision makers in the Kola Peninsula, too, have made arguments for strengthening the economy with complex utilization. The role of complex utilization in these arguments, however, has changed from "constitutive of the national economy" in the 1930s to "saving the economy from further losses" in the 1980s further to "strengthening the regional economy" in the 1990s. Third, the role of science in the Kola Peninsula has been important to the thriving mining industry there and, therefore, the relationship between science and complex utilization has been frequently highlighted. The arguments for science follow a pattern of change from complex utilization as "pure natural science" of the 1930s, as "applied natural science" of the 1980s and, finally, as "science of military-strategic significance" of the 1990s. Fourth, complex utilization has been understood as a way of obtaining a maximum value with minimum input of labour and mineral resources in the 1930s; as a specialization strategy against diminishing ore quality in the 1980s; and as a way of producing competitive products with low

environmental impact in the 1990s. Fifth, and finally, decision makers in the Kola Peninsula have linked complex utilization with issues of self-sufficiency. During the Soviet time, this was self-evident, and complex utilization was seen as a way of eliminating the need for imported raw materials. In the Post-soviet times, complex utilization has been seen as a way of securing the production of military-strategic materials—an argument also found in the science frame.

The Kola mining network has made significant efforts to achieve strategic fit of complex utilization with the repeated redefinition of the aforementioned frames. Some of the frames, such as efficiency, nature and economy, are so general that they could, on the face of it, provide a rationale for environmental strategy in virtually any cultural context. In the Kola Peninsula, the expected efficiency gains from achieving fit of complex utilization during the late 1980s were substantial (Article 1). Yet, the underlying arguments of the efficiency frame had changed significantly during the Soviet years and continue to do so today. Other frames, such as self-sufficiency, are bound to the specific context of the complex utilization strategy.

Framing of environmental strategies is a general activity that is not limited to the Kola Peninsula. In fact, there are striking similarities between the framing of complex utilization and that of industrial ecology in entirely different contexts. Perhaps the most famous case of industrial ecology is an industrial park in Kalundborg, Denmark. During the past 30 years, the industries in Kalundborg have developed a complex waste-reuse network that significantly reduces the use of virgin raw material (Grann, 1997). Kalundborg has therefore frequently been presented as the ultimate embodiment of industrial ecology: to design industrial systems to resemble natural ecosystems (Frosch and Gallopoulos, 1989; Ehrenfeld and Gertler, 1997; Cohen-Rosenthal, 2000). Critics of industrial ecology have pointed out that Kalundborg may not be a good example of an application of industrial ecology: the mainstay of the system is the coal-fired power plant (Asnaes) on which nearly all waste and by-product flows depend. If this installation were to be shut down, the whole system would collapse (O'Rourke, Connelly et al, 1996). The Kalundborg industrial ecosystem participants have, however, been able to demonstrate significant reductions in emissions and in the use of virgin raw material. They have recently reported an overall reduction of 25 per cent reduction in water consumption (equalling 2,9 million cubic meters per annum); 20 000 tons in oil consumption per annum; 80 000 tons fly ash waste per annum; 200 000 tons gypsum waste per annum; 130 000 tons carbon dioxide emissions per annum[3]. In addition, the industrial ecosystem partners have reported a number of smaller reductions in the use of chemicals (Grann, 1997).

It has been claimed that the difficulties of implementing industrial ecology on the grassroots level result largely from a lack of social legitimacy and poor political embedding (Lifset 2005; Cohen and Howard 2006). The numerous studies puzzling over the difficulty of replicating the Kalundborg industrial ecosystem illustrate the challenges of overcoming contextual differences in implementation. The dilemma is that, on one hand, Kalundborg is seen as a benchmark for industrial ecology, but on the other hand, its

[3] The Kalundborg Centre for Industrial Symbiosis (www.symbiosis.dk). Accessed 15 June 2008.

success is frequently attributed to its unique characteristics (Brings Jacobsen 2006; Heeres, Vermeulen et al, 2004; Ehrenfeld and Chertow, 2001; Andrews 1999; Cosgriff Dunn and Steinemann 1998).

Kalundborg and the Kola Peninsula are in many ways of a different scale. The former is a municipality of 604 km^2 and 50000 inhabitants, while the latter is a province of 144900 km^2 and nearly 900000 inhabitants. Kalundborg houses a number of medium size industrial companies, while in the Kola Peninsula vast amounts of mineral resources are extracted in numerous locations far apart. In spite of the differences in scale of these two regions, similar frames (such as nature, efficiency and economy) have been used by the promoters of both complex utilization and industrial ecology (Table 4). The arguments behind the frames, however, were different between the two regions. Moreover, these arguments had changed substantially within the complex utilization case as the industrial system of the Kola Peninsula evolved. While ostensibly unaltered, the frames were aligned to resonate with the audience or recipient that was to be mobilized behind the framed idea (Article 4). This implies that the frames of natural resource use, such as those of complex utilization, can be viewed as strategic design efforts to invigorate existing values or narratives, to encompass concerns of potential adherents, and to change the prevailing understanding of a particular issue (Snow, Rochford et al., 1986; Benford and Snow, 2000).

Table 4. The frames of complex utilization and industrial ecology in Kalundborg. Adapted from Article 4. The shared frames between the two cases are placed in adjacent cells in the table. The case-specific frames are placed on individual rows.

	COMPLEX UTILIZATION	INDUSTRIAL ECOLOGY IN KALUNDBORG
FRAME	Economy	Economy
	Efficiency	Efficiency
	Nature	Environment
		Sustainability
	Self-sufficiency	
	Science	
		Mental proximity
		Awareness

In addition to the different types of frames found in the case studies of the Kola Peninsula and Kalundborg, the process of framing itself is of interest. Successful political embedding of scientific concepts depends on effective framing, which, in turn, depends on three interrelated factors (Article 4). First, generalized frames, such as nature or economy, need to be made meaningful to a variety of actors in the policy network and aligned with their perceptions of the issue at hand. Second, the relative significance of different frames used in the promotion of a scientific-technical model varies in time and between cultural contexts. This variation needs to be taken into account by those applying science-based sustainability standards across cultural contexts. Third, not only the generalized frames but also the more subtle ones particular to each case need to be elicited and accounted for. In every new implementation of industrial ecology in a new

cultural context, there are specific concerns, topics and particularities, which, if left unattended, will reduce the value of the Kalundborg industrial ecology as a science-based sustainability standard. The comparison of Kalundborg and the Kola Peninsula shows the interpretative flexibility of industrial ecology, i.e., that it can be applied to cases that are very different in their technical details.

The second key environmental strategy of the Kola Peninsula mining industry is that based on international EMS. The use of EMS has proliferated in the industry during the late 1990s and early 2000s and, today, all mining companies in the region hold some form of an EMS. The industry has used the EMS in order to gain legitimacy from various stakeholder groups. This type of legitimacy seeking typically reflects some form of institutional isomorphism: mimetic, normative or coercive. Institutional isomorphism and strategic fit may be seen as closely linked but contradictory processes. Strategic fit is defined as a process by which an organization functions more efficiently (Venkatraman and Prescott, 1990). Isomorphism, in turn, makes organizations more similar but does not necessarily make them more efficient (DiMaggio and Powell). In attempting to achieve strategic fit, companies may replicate the practices of their successful competitors (mimetic isomorphism) or match their goals with the perceived values of the employees and shareholders (normative isomorphism). In the Kola Peninsula case study, the EMS driven environmental strategy is likely to make the mining companies more aligned with the requirements of the international market. Yet, there is no evidence that the mining corporations would have become more effective after adopting EMS. Three specific drivers of EMS adoption can be linked to institutional isomorphism in the case study: market pressure, organizational culture, and the influence of individuals. I will discuss each driver in the context of institutional forces in brief.

First, a predominant driver of adopting EMS in the Kola Peninsula has been that of market pressure. Generally, market pressure is understood as stemming from either the consumers' requirement for audited environmental performance or peer pressure from other companies, or general reputation in the market (Esty and Porter, 1998; Warhurst and Mitchell, 2000; Hilson, 2003). A change in the behaviour of a company as a response to peer pressure and consumer demand signals the presence of coercive isomorphism. "Coercion" is not necessarily exercised by a governmental authority but, as DiMaggio and Powell (1991) note, "direct imposition of standard operating procedures and legitimated rules and structures also occurs outside the governmental area" (DiMaggio and Powell, 1991: 68). In the Kola Peninsula case, market pressure was expressed as either direct signals from customers or as indirect intuition among the executives of something that the ''international market requires'' (Article 2).

Second, the change in organizational culture in the mining companies has been noteworthy during the privatization period. This change has been particularly strong in environmental thinking and boils down to the companies now having to conduct environmental management independently without state control. Institutional theorists have argued that incorporating an externally legitimated formal structure (which an EMS without a doubt is) increases the commitment of the organization's members and its external constituents (Meyer and Rowan, 1977). Legitimacy from the employees and

shareholders of the companies in the Kola Peninsula has become increasingly important as organizational culture changes (Article 2). Restructuring the organization for environmental management brings the organization's actions more closely with the perceived values of the employees and shareholders. In this way, the change in organizational culture indicates the presence of normative isomorphism, in which organizations adopt the general norms of the industry as part of their regular operations.

Third, the influence of individuals is among the key drivers for EMS in the Kola Peninsula mining industry (Article 2). Environmentally oriented individuals—if granted proper legitimacy—can introduce elements of environmental thinking into the organization's practices from outside the organization itself. Take the environmental managers in the Kola Peninsula as an example. They are active members of the local community and express sustainability concerns regarding the operations of their companies. As these individuals clearly have a personal stake in how well their company is performing with respect to the environment, they are seen by the corporation as guaranteeing pragmatic legitimacy. During the recent decade, environmental initiatives driven by environmental managers in the Kola Peninsula have enabled companies to maintain and recreate their environmental reputation among each other, the regional authorities, international organizations, and the corporate level management (Article 2). This is normative isomorphism in the making: it signals a "growth and elaboration of professional networks that span organizations and across which new models diffuse rapidly" (DiMaggio and Powell, 1991: 71). In addition, by introducing environmental thinking into the regular practices of the corporate organization the individuals strengthen normative isomorphism.

So far I have mentioned two specific groups that can grant legitimacy to an organization: employees and shareholders. In theory, however, legitimacy can be granted by any stakeholder of the organization. Yet from the organization's point of view not all stakeholders are equally significant in granting legitimacy. Moreover, different stakeholder groups exert different types of pressures on the organization (Mitchell, Agle et al., 1997). In the case study of this dissertation, the federal government was perceived to be a *dominant* stakeholder alongside employees and shareholders (Article 2). But while the shareholders resort to market pressure as a key rationale for good environmental conduct, the federal government exercises regulatory power on the companies. In yet another way, the employees affect legitimacy through the aforementioned influence of individuals, and changes in organizational culture and learning. These three stakeholder groups are the most significant ones granting legitimacy and receive prominent attention from the management of the mining companies. *Expectant* stakeholder groups—including the regional scientific community, international NGOs, foreign governmental organizations, customers and competitors—are viewed as potentially significant grantors of legitimacy. Finally, local and regional NGOs are considered as *latent* stakeholder groups by the mining industry, and are not currently viewed as significant grantors of legitimacy. These different stakeholder groups are categorized according to stakeholder salience and the different drivers in Table 5.

Table 5: Stakeholder salience within the drivers of adopting EMS in the Kola Peninsula mining industries. Adapted from Article 2.

		Driver				
Stakeholder salience		**Market pressure**	**Stakeholder pressure**	**Regulatory pressure**	**Organizational culture and learning**	**Influence of individuals**
	Latent		Local and regional NGO			
	Expectant	Customers, rivals	KSC, EU, international NGO, foreign governments, regional government	Regional government		Regional colleagues / rivals
	Dominant	Shareholders		Federal government	Employees, shareholders	

Suffice it to say, the Kola Peninsula mining industry needs legitimacy to secure its resource access. But according to the managers the industry really only needs legitimacy granted by the elite fraction of the society—the Ministry of Natural Resources, the Murmansk region governor, the President of Russia, or the customers. A lack of social legitimacy granted by marginalized groups in the Kola Peninsula, like the Sámi, will likely not prevent the mining activities from continuing. Therefore, the managers have not perceived them as salient stakeholders. On the positive side, however, the industry does feel the pressure from the market to clean up its act. This opens a possibility for NGOs (even local ones in cooperation with foreign organizations) to question the legitimacy of those doing business with the Kola Peninsula industry and – consequently – the legitimacy of the industry itself.

Summing up, by approaching strategic fit with the theoretical concepts of framing and isomorphism, the dissertation delivers two observations. First, strategic fit has in the case study been achieved by the maintenance and reproduction of frames that operate on different levels of generality. It should be noted, however, that this case-based interpretation of strategic fit deviates somewhat from the definition of fit for a company strategy. The case study focuses on a network rather than on an organization. Strategy researchers typically focus on the business organization when analyzing fit. The approach in this dissertation, therefore, runs the risk of obscuring the organization and its boundaries when discussing strategic fit. The network school, however, has called for analysis of networks of organizations with interdependent strategies (Venkatraman and Camillus, 1984). In this respect, the frame study of the Kola Mining network and its efforts to promote interdependent environmental strategies is of value. The network has actively worked to politically embed and shape complex utilization in a given institutional environment at a given time.

Second, strategic fit is influenced by the institutional forces within and outside the organization but also by the salience of the stakeholders granting legitimacy to the organization. The conceptual difference between “fit” for a company’s strategy and the

"fit" of the development of EMS in the Kola Peninsula with the socio-political context is, however, noteworthy. "Fit" in the latter case is less of an objective than an outcome. That is, it has been the result of the interplay of different institutional forces in the case. It is important to clarify at this point that isomorphic forces emerge from real-life practices of individuals in organizations. The new generation of environmental managers in the Kola Peninsula, for instance, actively create a new type of professionalism that includes rules about professional and organizational behaviour (DiMaggio and Powell, 1991). Whether institutional isomorphism of environmental management in the case region has increased organizational efficiency is a question for future research.

On a related notion, indicators I discussed previously in this section contribute both to the strategy formation process and to the formation of policy networks. Indicators of human-environment interaction are more than (ostensibly) objective measurements of the socio-ecological system, conducted outside of the system itself. An auxiliary value of indicators lies in their ability to open up a dialogue for network building, trust creation and considerations of power relations in a community. Contributing to network building and considerations of power relations, indicators are an important part of the formation of policy networks. In an important sense, therefore, indicators act more as communicative devices than as externally imposed objective criteria. In the Kola Peninsula case, the choice of indicators has been an important part of the self-definition process by which a community separates those who belong to it from those who do not. The determination of permissible value ranges for indicators, in turn, has been a key aspect of rule-setting by the community.

Finally, environmental policy and management in North-West Russia is in constant focus of international politics and the operational part of these politics rests heavily on co-operation. This highlights the relevance of studying corporate environmental strategy for those involved in international environmental co-operation. International environmental co-operation is a complicated field and it needs to resonate with different governance styles and decision-making cultures. In this context, the concept of complex utilization is pivotal. It both antedates and closely resembles industrial ecology that was developed in the West. This suggests that a lack of technical knowledge was not the principal cause of the well-known environmental problems that existed in the Soviet Union. On the contrary, the potential benefits of complex utilization were not realized because Soviet political and economic institutions provided weak incentives for pollution control and efficient resource use. This is a familiar story. Complex utilization, however, has not been forgotten among the mining specialists, business executives and politicians of the Kola Peninsula and it continues to play a part in the industrial future of the region. Depending on the way in which complex utilization is framed and the boundary conditions it is given, the Western aid partners will have a key role in the environmental development of the Kola Peninsula. It is this future of the Kola Peninsula environment that I will turn to next.

6. Future Trends in Environmental Strategy in the Kola Peninsula

The preceding sections have given an outline of how mining-related environmental strategies have been developed in the Kola Peninsula in policy networks with the objective to achieve strategic fit. In this section I look into the future and juxtapose two alternative future paths for mining-related environmental strategy (see also Figure 1). On one hand, it is possible that the mining industry will continue on the same path as it has done throughout the 2000s. It will continue to develop its environmental strategy primarily on the basis of signals from the international market and a few dominant stakeholder groups. Straightforward pollution permits issued by the federal government continue to play a minor role. On the other hand, it is possible that complex utilization will be strengthened as an environmental strategy in the region. This re-establishment of complex utilization would require substantial government subsidies, although business interest in complex utilization has been increasing recently as well (details in a moment). How the combination of these two strategies will play out in the end is contingent upon two major issues: the development of the Russian federal government's environmental policy and the development of the energy sector in the Barents Euro-Arctic Region.

6.1. Environmental Policy in Russia post-2000

In 2002, a new Framework Law on Environmental Protection replaced the former environmental protection law from 1991. The new Federal Law is indicative of the federal government's attempts to reinstate its power over the regions during the 2000s. This re-centralization stands in clear contradiction to the decentralization of power to the regions in the 1990s. As the regions were powerful relative to the federal government in the early 1990s, decentralization of power was perceived as crucial to keep the Russian federation from falling apart. The economic crisis of 1998, however, hit the regions with a force that brought them to tighten their relationship with the federal administration. In addition, one of the central aims of President Putin's recentralization of power has been to reduce ambiguity and corruption in the regional administration. During the 2000s, this has brought a need to clarify the division of responsibilities between the federal and regional administration, and has led to a series of reforms in regional governance (Solanko and Tekoniemi, 2005; Ollus, Simola et al., 2007).

Along with the legislative reform, the Murmansk Region committee of natural resources was abolished in September 2004. As the natural resources of the region were controlled by both the federal and the regional administration, the committee as well fell under the control of the Ministry of natural resources and the Governor of the Murmansk Region. After the 2004 reform, the ministry of natural resources lost its economic and controlling functions and was left with functions to prepare regulatory laws only. The connection between the governor and the Ministry of natural resources was thus lost as the functions were re-allocated. All environmental issues related to mining in the Murmansk region are now controlled by the state inspection and their resource use is controlled by the agencies. The power of the regional administration over mining companies is restricted to

territorial development and construction work. The 2004 reform can be seen as an attempt to re-establish a centralized control over environmental issues in the Russian regions. It holds at least some promise for improving both the independence and effectiveness of compliance and monitoring functions.

The effects of these recent reforms on the environmental strategies of mining in the Kola Peninsula are yet to be seen. The Kola mining network's attempts to re-establish complex utilization have rested heavily on the federal involvement in mining-industrial strategy. If the government in fact is willing and able to design effective policies that guide corporate environmental strategy, complex utilization may well be developed further as a parallel strategy to the EMS.

In terms of indicators, they would again measure either the market value or the military strategic significance of waste raw materials (Vinogradov, Kalinnikov et al., 2003). In addition, novel indicators would be needed due to the uncertainty in the complex utilization system. That is, the system would produce new kinds of wastes for which there are currently no practises of treatment in the mining industry. On the whole, these novel indicators should have a multi-industrial focus as opposed to the plant-specific indicator systems that are already in place. They would also need to enable decision makers to make a priori judgements of negative environmental impacts of new production configurations. Lessons from industrial ecology may prove useful in the possible re-development of complex utilization and its holistic indicators. As has been shown, however, applying concepts from industrial ecology in non-Western contexts may result in outcomes that are far from being environmentally sound (Article 1). Recommendations of developing industrial ecology in the Kola Peninsula should therefore be taken with caution.

How about co-operation in this scheme? Due to the issues of military security associated with complex utilization, international co-operation would likely be limited in that particular strategy. Yet the 30-year-old history of direct co-operation between Finnish companies and the Kola Peninsula mining industry should not be forgotten. Many of the enrichment processes have been designed and built by Finnish companies. Environmental co-operation, as illustrated in subsection 4.4, has proved more difficult. In this respect, complex utilization, being a technology-oriented environmental strategy, may yield increased possibilities for direct business to business co-operation. Such co-operation should be facilitated jointly by the Nordic and the Russian governments.

The other possible outcome is that the federal government remains uninterested in the environmental management of the Kola Peninsula in spite of the general trend of re-centralization. Consequently, the regional government would be left even more unarmed than before to promote its own environmental objectives. This means that the mining companies could continue to pursue their own environmental strategies, primarily guided by the drivers behind the EMS. An important emerging trend is "green marketing" for the worst polluters in the region. The indicators related to this trend should be sensitive for strong advocate groups such as foreign partners and other market actors, but the expectant and latent stakeholder groups should not be forgotten (Table 5). These groups

may gain power and legitimacy in the future and increase their salience. The development of the energy sector (see subsection 6.2), for instance, may directly compromise the rights of the indigenous Sámi people. This would increase the salience of the regional and international NGOs.

In terms of co-operation, the multilateral environmental programs initiated by the EU and the Nordic Countries in the Kola Peninsula will continue (Article 2). In the best case, the lack of government coordination can lead to "windows of opportunity" in which the mining industry is able to improve its environmental performance through co-operation with foreign partners. The case of Pechenganikel restructuring is an example of such co-operation. Similar examples can be found elsewhere in Russia as well (Tynkkynen 2008).

Although important, the federal government's environmental policy is only one of the factors affecting the future of mining-related environmental strategy in the Kola Peninsula. The Russian North-West houses significant hydrocarbon reserves with several as of yet unexploited gas and oil fields. How these reserves are exploited and how the hydrocarbons are transported will have a great impact on the economy of the Kola Peninsula. At the same time, the hydrocarbon issue will affect the development of complex utilization in an important respect.

6.2. Complex Utilization and the Development of the Energy Sector

The oil and gas reserves in the Barents Sea area of the Arctic shelf have been known for decades. With the current record high oil price the reserves are becoming increasingly lucrative. One of the largest deposits in the area, the Shtockmanovskoye gas field was discovered in 1988 with proven reserves of substantial 2200 billion cubic metres. The field is located 650 km North of Murmansk in the Arctic Sea under harsh weather conditions. A number of smaller oil and gas fields have been identified in the Arctic shelf closer to shore but none of these have as of yet been exploited. The development of the Shtockmanovskoye field has been difficult not only due to the harsh weather. Both political and corporate strategic interests have stalled the field from being exploited during the past (Brunstad, Eivind et al., 2004; Kovalev, 2007). For the Kola Peninsula economy, the utilization of Shtockmanovskoye field would certainly give a boost.

The Kola Peninsula construction industry, having experienced a radical downfall in the early 1990s, would benefit from new onshore infrastructure projects for the gas industry. It is hardly surprising that the construction industry of the Kola Peninsula is closely connected to the mining industry through complex utilization. Aluminium production from nepheline tailings (one of the key processes in complex utilization) creates substantial amounts of Portland cement (2,5 tons cement per 1 ton nepheline). This side product could be used for onshore infrastructure development in the Kola Peninsula. Currently, around 10% of the nepheline tailings (1 million tons annually) is enriched into nepheline concentrate and transported to the Leningrad region for alumina extraction (Article 1). There are no equivalent installations for nepheline treatment in the Kola Peninsula but the situation may change in the near future. In 2006, the fertilizer producer

Akron won a tender auction over two apatite-nepheline deposits in the Khibiny Mountains of the Kola Peninsula. The company aims to produce 3 million tons apatite concentrate and 2 million tons nepheline concentrate annually from the deposit. The Russian aluminium giant SuAl has expressed its interest in further treatment of the nepheline concentrate (Interfax, 2006a). Whether it would start operating a new plant in the Kola Peninsula or export the nepheline elsewhere is an open question. The first alternative would effectively re-establish complex utilization as an environmental strategy in the Kola Peninsula.

As regards the main mineral products of the Kola Peninsula mining companies, no significant growth in extraction will be expected. However, with the recent dramatic increases in commodities prices, the industry has been able to maintain its production. The price of nickel skyrocketed from a mere USD 4000 per ton in 1998 up to almost USD 55000 in 2007. Copper prices have experience a similar though more modest trend from below USD 2000 in 1998 to above USD 8000 in 2005[4]. Although nickel prices descended below USD 25000 in 2008, the industry is still in a much better position than 10 years ago. At the same time, Kola Mining and Metallurgical Company has maintained its metals production around 200 000 ton during the 2000s[5].

With the new global increases in food prices the jump in the price of mineral fertilizers is also expected to continue. The average European spot price of diammonium phosphate (produced e.g. by Apatit mother company Phosagro in Russia) rose from USD 450 per ton in July 2007 to USD 1200 per ton in May 2008. Apatit has been able to stabilize its annual production of apatite concentrate (a raw material of mineral fertilizers such as diammonium phosphate) to around 9 million tons during the past ten years and expects to maintain the production level in the future[6]

A stable production level of apatite also means a stable production of nepheline (in roughly equal amounts). The feasibility of alumina production from nepheline depends on the market price of alternative sources, mainly bauxite. The United States average bauxite price for 2006 was USD 28 per ton, with the corresponding alumina raw material price USD 47 per ton (assuming 60% Al_2O_3) (U.S. Geological Survey, 2008). The Kola Peninsula nepheline, in turn, was in 2006 sold at the price of USD 19 per ton, with the corresponding alumina raw material price USD 63 per ton (assuming 30% Al_2O_3) (Chibinskyi Vestnic, 2003). With today's surging Chinese aluminium demand, bauxite export prices up to USD 80 have been reported[7]. Consequently, alternative processes for aluminium production, such as the nepheline process, may become economically lucrative in the near future.

In the energy sector, the exploitation of the Shtockmanovskoye field may increase the share of gas-based energy in the Kola Peninsula. The mining industry depends critically on the energy produced in the Kola Peninsula. Currently, with the generation level around

[4] London Metal Exchange (www.lme.com). Accessed 13.6.2008.
[5] Norilsk Nikel Annual Report 2006 (www.nornik.ru). Accessed 13.6.2008.
[6] Interview with a business manager of Joint Stock Company Apatit, 2004.
[7] Reuters India (in.reuters.com). Accessed 15 June 2008.

16 TWh annually, the region has an energy surplus of 25%. This surplus is exported to the neighbouring Karelia, Finland, and Norway. Roughly one-half of the power produced in the region is supplied by the four reactors of the Kola nuclear power plant (Kinnunen and Korppoo, 2007). The two oldest reactors are planned for decommissioning between 2010 and 2020. One of the alternatives after decommission is to increase gas- and oil powered energy conversion. This would change radically the energy structure of the Kola Peninsula and would require large investments and political will from the Russian government (Kinnunen and Korppoo, 2007).

Although the Murmansk regional government has little power over energy infrastructure issues, it seems to be in favour of developing the thermal power base. In recent negotiations with the Murmansk government, the Norwegian Hydro has expressed its interest in aluminium production. The company would refine bauxite from the Komi Republic at a new aluminium plant in the Kola Peninsula. The Murmansk Region Governor Yuri Yevdokimov announced that the aluminium plant would be powered by a new thermal power plant to be constructed in the Kola Peninsula. The thermal plant would use gas from the Shtockmanovskoye gas field. Yevdokimov added—again echoing the strategy of complex utilization—that Norsk Hydro should use the voluminous Kola nepheline tailings as a source of aluminium rather than the Komi bauxite (Interfax, 2006b).

A second area of interest is the oil produced onshore in the Timan-Pechora basin east of the Kola Peninsula. The oil exports from the basin are estimated to amount to 15 million tons before 2010 (Brunstad, Eivind et al., 2004). The oil is currently exported via rail and small tankers but plans to build a pipeline under the White sea and across the Kola Peninsula are being considered (Tsukerman, 2002). The oil would further be exported through the ice-free Murmansk deep harbour. This transport strategy would increase the oil exports from Timan-Pechora up to 120 million tons (Brunstad, Eivind et al., 2004) but the construction has also been stalled for a range of political and corporate strategic interest conflicts. The Russian government has approved the pipeline already in 2003 on the condition that it would be financed with private investments from the oil companies. After the construction, however, the management of the pipeline would have to be handed over to the Russian government (Brunstad, Eivind et al., 2004).

The effect of the pipeline to the Kola Peninsula economy would be similar to that of the offshore gas extraction. The construction of the oil-industry infrastructure would benefit the region's construction industry and possibly provide a window of opportunity for complex utilization. The increased oil flow through the region would also allow for the change in the energy infrastructure of the Kola Peninsula. In addition, the construction of the pipeline would facilitate access to the yet unexploited mineral reserves of the Eastern Kola Peninsula, providing significant future prospects for the mining industry (Tsukerman, 2002).

The flipside of both of these plans is that they would increase the risk of negative environmental and social impacts in the Kola Peninsula. The development of the Shtockmanovskoye gas field would pose risks to the marine ecosystems of the Barents

Sea, particularly to the benthic species communities (Brunstad, Eivind et al., 2004). This may have further negative effects on the fish populations depending on the benthic ecosystems and, consequently, threaten the thriving Murmansk fishing industry. Similar risks are associated with the oil pipeline construction. In addition, the oil pipeline construction would interfere with the traditional reindeer husbandry of the indigenous Sámi population in the central parts of the Kola Peninsula. The reindeer migratory paths would likely to be compromised by the pipeline, which could in the extreme case lead to the termination of reindeer husbandry in the Kola Peninsula (Robinson and Kassam, 1998; Brunstad, Eivind et al., 2004). This progression, however, could be circumvented by drawing the pipeline along the South bank of the White Sea rather than through the central Kola Peninsula.

7. Conclusion

The Russian political and economic reforms of the 1990s were expected to result in political and economic institutions (and substantive outcomes) that would resemble those of Europe's industrial democracies. In fact, however, the Soviet system was replaced by an anarchic economic order in which the legal mechanisms necessary to support well-functioning markets were simply not in place. This is quite well-known. Less well known, however, is how international efforts to "clean up" the environmental legacy of the Soviet Union failed—fundamentally. They failed because proponents in Europe focused on the technology-side while implicitly assuming that European institutional structures could be taken for granted. This is a cautionary tale with important lessons for all international environmental efforts that focus on nations where Western political-economic institutions are not entrenched.

Consequently, this dissertation has focused less on the technological aspects of industrial production (managing mass and energy flows to conserve resources and reduce pollution) than on the difficult challenges that arise in bridging the gap between technical potential and real-world implementation. Accounting for human factors, management practices, and the boundary conditions imposed by public policy must play a key role in the development of fields like industrial ecology. This is a cutting-edge, interdisciplinary activity that links engineering and management with the general field of science and technology studies. A key issue is how to translate scientific knowledge into positive social outcomes.

The mining industry continues to play a significant role both in the economy and the ecology of the European North. In this future, the environmental strategies chosen in the Kola Peninsula are pivotal. From a broad perspective, the formation of environmental strategy is a process of communication and network building among a variety of actors in the society. Although environmental strategy typically is formulated by corporate executives or government officials, its implementation is contingent upon the power relations and structure of the policy networks. The Kola mining network is one such policy network. It has attempted to achieve a strategic fit between complex utilization and the socio-economic context in which the mining industry finds itself. Again, very

different policy networks are found behind the adoption of the EMS or behind the clean-up of the Pechenganikel plant. In the latter case, the environmental threat that Pechenganikel posed to Norway was a nexus that connected engineers and politicians across the Nordic countries to take action. These different environmental strategies have not been any easier to fit into the local context, not the least due to the conflicting goals between the members of the policy networks. In this concluding section, I will return to the heuristic concept of emergence and place it in the context of the empirical material of the dissertation.

7.1. Emergent Properties in the Kola Peninsula Case Study

The complexities involved in the implementation of environmental strategies in the Kola Peninsula have been central to this introductory text. These complexities support the issue of emergence in governance processes (e.g. in strategy and policymaking). The key point in emergence is that it makes universalistic design models for strategy and policy of little value. Understanding the emergent properties of governance processes in specific cases, however, can guide decision making at least through analogies. In this dissertation, I have presented one such analogy between complex utilization and industrial ecology. Emergence becomes visible in the type of frames that the proponents have used in marketing their strategies (complex utilization vis-à-vis industrial ecology) to wider political audiences. Even frames that are ostensibly identical (efficiency, economy) reveal context-specific meanings when examined in detail. What is more, entirely case specific frames are needed for the successful political embedding of concepts such as industrial ecology. These frames are very difficult to model or standardize a priori because they emerge from context specific concerns, topics and particularities.

Another example of emergence in governance is found in indicators. New environmental strategies may require production solutions that bring along unanticipated environmental consequences. Indicator systems that help decision makers to anticipate future environmental threats and make sense of complex interdependencies in the socio-ecological system are needed. Our framework towards the cultural contextualization of indicators is an attempt to incorporate this kind of "robustness" into governance processes. Cultural contextualization of indicators is central to environmental strategy and policy. A prime example is the Pechenganikel restructuring project: partners on both sides of the border held eco-efficiency as a suitable indicator for project success. Their underlying cultural storylines and the associated environmental impacts, however, were different. In the end, the project partners had to redefine their understanding of the acceptable level of production and pollution in order to carry out the project. A similar dilemma is likely to occur in the future if the oil and gas industry will invest in the transport and extraction in the Kola Peninsula. Monitoring the remote regions of the peninsula will become topical as the unexploited (reindeer herding) regions will be developed. This will also require consideration of the conflicting interests between reindeer herders and oil companies.

The point on interest conflict leads to my last example of emergent governance. Strategic fit requires acknowledging those stakeholder groups who are most salient for legitimacy. The trouble is, salience is not a fixed entity but varies over time and place. Stakeholder urgency and power are variables that may require the Kola Peninsula mining industries to redefine their environmental strategies. Stakeholder groups that are found irrelevant (the Sámi people), latent (local NGOs) or expectant (the EU) today may become dominant in the future. All this feeds back to the discussion on indicators above. Using stakeholder salience (with its context specific variables) as a socio-ecological indicator may provide valuable insight into emergent governance in future research. In the next subsection, I will consider some limitations that this dissertation has not been able to cover and introduce possible new avenues for post doctoral research.

7.2. Limitations and Future Research

Overall, the analysis of the storylines and frames of natural resource management in the Kola Peninsula suggests a trend from holistic systems approaches towards fragmented market-driven EMS. This trend has both positive and negative effects on environment and equity. The rapid dismantling of Russian environmental governance has reduced the incentive for the Russian companies to improve their environmental performance. Therefore, at least large companies that operate on the international market are pushed towards better environmental performance by consumers. The positive environmental effect of the "invisible hand" may be substantial because the large companies have traditionally been the worst polluters in Russia. The downside is that the environmental performance of the smaller companies operating within Russia is regulated by neither the government nor the market. Previously, in the system oriented models, the environmental performance of the smaller companies was considered in concert with that of the larger companies. This feature is lost with the dominating EMS approach to environmental management. What is more, with decision making power being increasingly centred in the headquarters of large industrial companies in Moscow and, in many cases, abroad, the local communities that bear most of the negative impacts of environmental pollution are left with little means to manage their own environment. Future research on the environmental strategies of small and medium sized companies in Russia will benefit from and contribute to this dissertation work.

In an important respect, the Kola Peninsula case study does not reveal how the pollution induced environmental problems would de facto have changed with complex utilization (Article 1). Environmental impacts of pollution typically depend on absolute levels of pollutants. Eco-efficiency, being a relative measure, may lack explanatory power in such large-scale systems as the Kola Peninsula Mining Complex. The analysis I have conducted assesses possible reductions in given pollutants, which could have been achieved with complex utilization (Article 1). It does not attempt to model specific ecosystem effects related to those pollutants. The analysis suggests instead that industrial ecological systems may require substantial waste material flows to be produced and then again re-used. This is necessary for the industrial systems to work properly and to maintain vital ecological functions of the biological ecosystems they are connected with.

Consequently, the argument boils down to the roots of industrial ecology: there is ample evidence that biological ecosystems circulate excessive amounts of residual material (i.e. they are inefficient on the level of a single organism), which is carefully assimilated within the system (or by a system with completely different boundaries up to the level of the entire biosphere). The key question is how this observation would work in industrial systems. For complex utilization, there is a need to understand the magnitude to which waste material flows can be increased to maintain the vital functions of a particular region's ecosystems. It is clear that these functions have not been maintained in the past, i.e. in the absence of complex utilization. The dissertation does not answer the question for the simple reason that complex utilization was never implemented in full scale. It does, however, raise a relevant alternative to setting absolute pollution limits to single industrial processes.

To avoid overburdening the reader in this introductory text, I have left out some of the theoretical concepts that I used in the articles. The myth of nature (Article 3) is one such concept. As opposed to cultural theory, myths of nature do not emerge from cultural anthropology but, rather, from systems ecology (Holling, 1979, 1986). The strength of these myths is that while they are clearly cultural products, they are at the same time intimately connected to ecosystem dynamics. A single ecosystem, for instance, can be extremely resilient towards disturbance at the early stages of its succession. At a later stage the ecosystem resilience declines and the system is likely to be driven into chaos by a small disturbance (Holling and Sanderson, 1996). What is more, ecosystem dynamics does not converge towards a single global optimum but, rather, ecosystems experience a number of local domains of stability during the course of their development. This means that after a chaotic period, resilience is again restored (at some level) at a different domain of stability (Ludwig, Walker et al, 1997).

Being both cultural products and rooted in observed ecosystem behaviour, myths of nature yield a powerful alternative to devising human-environment indicators. More broadly, Douglas' cultural types have been used previously as heuristic boundary conditions for integrated assessment modelling and future studies (van Asselt and Rotmans, 2002). In that research, the construction of multiple perspective model routes was guided by cultural types to give the modellers a limited variety of perspectives as regards uncertainty (van Asselt and Rotmans, 2002). Clearly, further research is needed in how to fit together the two domains. Alternative approaches to cultural bias worth examining are political attitudes (Dake, 1991) and elite groups (Rothman and Lichter, 1987).

I would like to emphasize that I am relying on a "meta text" analysis, i.e. I have not directly asked the interviewees to position themselves in the cultural theory framework. Rather, I have analyzed the interview material and the publications by the Kola Mining Network for both the indicators they wish to use at a given time and the rationale behind those indicators. This method was found successful in "teasing out" the cultural storylines. But the method also influences the results. The Kola Mining Network, for example, being a main promoter of the complex utilization strategy, would be hard

pushed to let out a fatalistic message to its stakeholders. After all, the members of the network were (and still are) active scientists, politicians and industrialists strongly devoted in the development of the Kola region. What is more, interviewees would be likely in a face-to-face interview to overstate their active role, and thus understate any fatalistic behaviour, for reasons of personal pride.

Finally, there is a strong emphasis on upstream processes in complex utilization. The important note, however, is in the substitutes for virgin raw materials that complex utilization would yield. Addressing the entire value chain of a product is an important part of industrial ecology. I have limited the analysis of this thesis to the first stages of the value chain, but the latter stages warrant further research.

8. About the Publications in this Dissertation

The first article of the series, *Eco-Efficiency and Industrial Symbiosis - a Counterfactual Analysis of a Mining Community*, assesses eco-efficiency against industrial symbiosis in a 20-year time series model. It starts out by introducing how complex utilization, a production model analogous to those described by industrial ecology, was planned at the Russian KSC in mid-1980. The model, a key environmental strategy for the entire mining industry of the region at the time, integrates the waste streams of the industry in such a way that waste from one industrial operator becomes raw material for another. Using a counterfactual method, the article determines the eco-efficiency of the model between the years 1985 and 2005. A parallel study of the eco-efficiency of the actual system, i.e. in the absence of complex utilization, is performed for the same time period.

The study shows that complex utilization would indeed have yielded increased eco-efficiency, even though not all environmentally harmful emissions would have decreased. As a result of market collapse and the use of upstream pollution prevention together with traditional end-of-pipe technologies, however, the actual system shows net emission reductions similar to those modelled in complex utilization. The article suggests that in systems like the mining industry of the Kola Peninsula, with high production volumes and poorly developed environmental technologies, upstream pollution prevention together with traditional end-of-pipe technologies may prove more attractive than industrial symbiosis, despite the substantial increases in eco-efficiency of the latter. Industrial ecology may not deliver the expected gains in economic and ecological well-being in non-Western contexts. Conversely, the article claims, even the most carefully chosen environmental indicators will fail if they are set on rigid premises of what constitutes a "good environment".

It was my intention to continue the theme of Article 1 and assess the different aspects (business potential, environmental issues, management issues) for complex utilization in today's world. After my second round of interviews, it stood clear that the mining companies thought little of complex utilization in the form of a regionally integrated system. This lack of interest has to do with the current general reluctance of the Kola mining companies to collaborate with each other. The Soviet-time idea of the integrated

complex utilization system requires a high degree of openness among the industries with regard to process solutions. Such openness was found foreign in the current management of the mining companies. At the same time, none of the interviewees denied the importance of complex utilization in the extraction of the Kola Peninsula mineral resources. They were just unable to express exactly how complex utilization should be implemented.

Two things happened after the second round of interviews. First, it appeared that there were multiple perceptions of and drivers for complex utilization among the mining specialists, politicians and managers in the Kola Peninsula. Second, the environmental management of the mining companies had rapidly converged toward adopting EMS. Consequently, I analyzed the EMS in light of legitimacy and institutional forces in Article 2. The EMS provided one clear sign of how environmental management in the Kola Peninsula is changing. I wanted, however, to get at the wealth of different ideas and changes in the environmental field. Articles 3 and 4 therefore focus exclusively on the different scientific and political dimensions of complex utilization, and how these have changed during the past decades. Obviously, I am only able to scratch the surface of the ideas and changes in the two articles: "Europeanization" of environmental policy and management has occurred to an extent but at the same time ideas from complex utilization add to the ways in which environmental problems are framed and solved. Frame analysis and cultural theory worked well for the purposes of finding out about the specific kinds of environmental management and policy being practiced in the Kola Peninsula.

The second article of the series, *Drivers for Adopting Environmental Management Systems in the Post-Soviet Mining Industry*, describes the effects that the privatization of the Russian industry together with organizational changes in the federal government have had on environmental policy and management in the Kola Peninsula. The article starts out by claiming that the past decade has witnessed a coherent dismantling of public environmental policy in Russia. At the same time, Russian companies involved in natural resources extraction have adopted standardized EMS. In this way, much of the responsibility of environmental policy in Russia has been transferred to private industries and their management systems. These systems do not, as such, guarantee increased environmental responsibility. The article addresses the privatization of the Russian environmental policy in light of legitimacy and uncertainty involved in standardized EMS.

The Kola Peninsula mining industry's attempts to gain legitimacy from various stakeholders were reflected in the reasons that corporate executives gave for adopting EMS. In the empirical work, 16 mining executives (of the 52 interviewees in Table 2) were asked to describe the style and structure of environmental management in their companies. The interviewees were further asked for specific reasons for adoption of EMS in their company. Statements describing why the companies adopt and maintain EMS were extracted from the transcribed interview data. Similar statements were categorized according to common environmental drivers in the mining industry found in previous

research. In addition, the salience of stakeholder groups granting legitimacy was assessed in terms of three variables: power, stakeholder group's own legitimacy, and urgency.

The case study is used in two ways in Article 2. First, environmental policy conflicts between public bodies and mining companies in Russia are illustrated with two case examples. Second, key drivers for adopting EMS in the Kola Peninsula mining companies are extracted from thematic interviews. The identified drivers are market pressure, stakeholder pressure, regulatory pressure, organizational culture and learning, and the influence of individuals. These drivers are analyzed for their impact on unit and corporate level decision making. In addition, the drivers are categorized according to the type of legitimacy and stakeholder salience that they reflect. It is shown that unit and corporate level applications of environmental management have different societal and environmental implications. Furthermore, while market pressure appears to be the most significant driver both in terms of legitimacy and stakeholder salience, the remaining four drivers bear significance in the local-level processes for sustainability. On the basis of the case study it is suggested that the support of latent and expectant stakeholder groups may increase the moral legitimacy of the corporation's operations and therefore allow a better alignment of corporate goals with societal goals of sustainability.

The third article of the series, *Cultural contextualization of indicators of human-environment interaction: The case of the Kola mining network*, which I have written together with Janne Hukkinen, returns to the problematic of human-environment indicators laid out in Article 1. In the third article we developed and tested a framework for addressing the socio-cultural dimension of environmental indicators, such as eco-efficiency in the previous article. The third article combines cultural theory with indicator theory and assesses the case study of the Kola Peninsula mining industry in a 70-year time span. We identified indicators with which the Kola mining network has measured the performance of mining operations since the 1920s in three consecutive time periods: 1920s to 1930s, the late 1970s to the early 1990s, and the early 1990s onwards.

It should be noted that the time period between the 1930s and the 1970s is missing because, to our knowledge, the development of complex utilization was halted after the Second World War and re-initiated only in the mid-to-late 1970s[8]. We analyzed the cultural contextualization of human-environment indicators related to complex utilization. In spite of significant attempts, we have obtained no empirical material related to complex utilization between late 1930s and late 1970s. Because of the fact that the analysis focused on complex utilization, it does not yield knowledge of the cultural types related to other production strategies that have appeared in the region, particularly between the Second World War and the late 1970s. It is possible that a prolonged hierarchic storyline prevailed throughout the 1950s and 1960s but, due to the lack of empirical evidence, we were unable to make that claim.

Overall, the third article shows further that it is possible, partly, to escape the contingencies in indicator design in a way that is better linked to the cultural history of the specific region. It is expected that the framework for cultural contextualization of

[8] Interview with a senior scientist at the Kola Science Center, 2004

indicators allows planners involved in international co-operation to better align specific indicators with the local diversity of values.

In detail, the article employs cultural theory, indicator theory and research on ecological modernization to create a framework for assessing indicators of human-environment interaction in different cultural contexts. In the framework, indicators are articulated in terms of two cultural indexes: myth of nature and scope of knowledge. This articulation is conducted with a case study of the *Kola mining network*, which is defined as a group of individuals who are connected to each other through the physical mining activity of the Kola Peninsula, and who have been key decision makers of environmental and natural resources management in the region.

The article delivers a result general for the practical application of sustainability indicators: no indicator or indicator value can be regarded as an objective measure of the sustainability of a social-ecological system, but ought instead to be interpreted with explicit reference to the particular cultural storyline in which the system operates. This result emerges from the empirical account of how the set of indicators on one hand and indicator bandwidths on the other shape and are shaped by culture. In addition, the article contributes to the development of international environmental co-operation in the North. The analysis contradicts the widely-held notion that Russia has moved from a hierarchic directly into an individualistic cultural domain. We illustrate how, between these two domains, an egalitarian cultural storyline has played an important role in the shaping of human-environment indicators in the Kola Peninsula. We conclude with policy recommendations relevant for the co-operation that the international community is currently promoting in North-West Russia.

Finally, the fourth article of the series, *Embedding Science in Politics—"Complex Utilization" and Industrial Ecology as Models of Natural Resource Use*, which I have written together with Aino Toppinen, continues to explore the cultural contextualization of science-based sustainability standards. In detail, the article analyzes the ways in which scientific concepts such as complex utilization and industrial ecology are framed in different socio-cultural contexts. A key contribution of the article is that it reveals previously hidden patterns of political embedding of scientific models for human-environment interaction. We claim that industrial ecology has devoted limited attention to the ways in which the technical models of industrial ecology both shape and are shaped by social processes. Yet, the practitioners of industrial ecology frequently encounter challenges pertaining to contextualization when embedding the general model in different local contexts. In addition, we claim that the models of industrial ecological systems become politically meaningful only when they are carefully contextualized and linked to local needs.

In order to get an understanding of the political embedding of industrial ecology, we conduct a frame analysis of complex utilization – defined as a scientific policy instrument analogous to industrial ecology. We identify five frames (nature, efficiency, economy, science and self-sufficiency) with which complex utilization has been promoted between 1935 and 2005 within the Kola Peninsula mining community. These frames are then

compared to six frames (environment, efficiency, economy, sustainability, mental proximity, awareness) identified in the industrial symbiosis in Kalundborg, Denmark. We find that effective political embedding relies on frames that function both on a general level and in the local context. General frames, such as efficiency, economy and the environment, need to be aligned with local perceptions of the particular issues. What is more, sensitivity to purely context-specific frames, such as self-sufficiency and awareness, is necessary for effective political embedding. Finally, we illustrate how the political processes of framing also shape the scientific-technical models that are being promoted.

References

AMAP, 1998. AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

Andrews, C. J., 1999. Putting industrial ecology into place: Evolving roles for planners. Journal of the American Planning Association **65**(4), 364–375.

Baas, L., 1998. Cleaner production and industrial ecosystems, a Dutch experience. Journal of Cleaner Production **6**(3-4), 189-197.

Begg, K.G., Jackson, T. and Parkinson, S., 2001. Beyond joint implementation - designing flexibility into global climate policy. Energy Policy **29**, 17-27.

Benford, R.D. and Snow, D.A., 2000. Framing processes and social movements: An overview and assessment. Annual Review of Sociology **26**, 611-639.
Brings Jacobsen, N., 2006. Industrial Symbiosis in Kalundborg, Denmark: a quantitative assessment of economic and environmental aspects. Journal of Industrial Ecology **10**(1-2), 239-255.

Brunstad, B., Eivind, M., Swanson, P., Hønneland, G., Øverland, I., 2004. Big Oil Playground, Russian Bear Preserve or European Periphery? The Russian Barents Sea Region Towards 2015. Eburon Academic Publishers, Delft.

Bruun, H., Hukkinen, J., Eklund, E., 2002. Scenarios for coping with contingency: The case of aquaculture in the Finnish Archipelago Sea. Technological Forecasting and Social Change **69**(2), 107-127.

Börzel, T.A., 1998. Organizing Babylon - on the Different Conceptions of Policy Networks. Public Administration **76**(2), 253-273.

Chandler, A.D., 1962. Strategy and Structure. The MIT Press, Cambridge, MA.

Chibinskyi Vestnic, 2003. JSC Apatit annual report for the year 2002. Chibinskyi Vestnic, July 4, 2003. Apatity, Russia.

Cohen, M. J. and Howard, J., 2006. Success and its price: The institutionalization and political relevance of industrial ecology. Journal of Industrial Ecology **10**(1–2), 79–88.

Cohen-Rosenthal, E., 2000. A walk on the human side of industrial ecology. The American Behavioral Scientist **44**(2), 245-264.

Cosgriff Dunn, B. and Steinemann, A., 1998. Industrial ecology for sustainable communities. Journal of Environmental Planning and Management **41**(6), 661–672.

Dake K., 1991. Orienting Dispositions in the Perception of Risk: An Analysis of Contemporary Worldviews and Cultural Biases. Journal of Cross-Cultural Psychology **22**(1), 61-82.

Darst, R.G., 2001. Smokestack Diplomacy. Cooperation and Conflict in East-West Environmental Politics. The MIT Press, Cambridge, MA.

Didyk, V. and Riabova, L., 2007. Murmansk Province in 2006. Biannual monitoring review. Kola Science Centre, Institute of Economic Studies. Online: http://www.economicmonitoring.com/data/reports/Murmansk%202006%20ENG1.pdf. Accessed 7 September 2007.

DiMaggio, P.J. and Powell, W.W., 1991. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. In: Powell, W.W. and DiMaggio, P.J. (Eds.), The New Institutionalism in Organizational Analysis, The University of Chicago Press, Chicago, pp. 63-82.

Douglas, M., 1982. In the active voice. Routledge & Kegan Paul Ltd, London, UK.

Dowding, K., 1995. Model or Metaphor? A Critical Review of the Policy Network Approach. Political Studies **43**, 136-158.

Dryzek, J.S., 1997. The Politics of the Earth: Environmental Discourses. Oxford University Press, Oxford, UK.

Ehrenfeld, J. R. and Chertow, M. R., 2001. Industrial symbiosis: The legacy of Kalundborg. In: Ayres, R.U. and Ayres, L.W. (Eds.), A handbook of industrial ecology. Edward Elgar Publishing, Cheltenham, UK, pp. 334-348.

Ehrenfeld, J. and Gertler, N., 1997. Industrial ecology in practice: The evolution of interdependence at Kalundborg. Journal of Industrial Ecology **1**(1), 67-79.

Entman, R.M., 1993. Framing: toward clarification of a fractured paradigm. Journal of Communication **43**(4), 51-58.

Esty, D.C. and Porter, M.E., 1998. Industrial Ecology and Competitiveness: Strategic Implications for the Firm. Journal of Industrial Ecology **2**(1), 35-43.

Evans, M., 2001. Understanding Dialectics in Policy Network Analysis. Political Studies **49**, 542-550.

Evans, M. and Davies J., 1999. Understanding Policy Transfer: A Multi-Level, Multi-Disciplinary Perspective. Public Administration **77**, 361-385.

Finnish Ministry of the Environment, 2004. Study on the Institutional and Legislative Framework of Environmental Management in the Russian Federation and in the City of St. Petersburg. Finnish Ministry of the Environment, Helsinki.

Fisher, K., 1997. Locating frames in the discursive universe. Sociological Research Online **2**(3).

Frosch, R.A. and Gallopoulos, N.E., 1989. Strategies for manufacturing. Scientific American **261**, 144-152.

Gorbachev, M. and Ryzhkov, N., 1988. Decree on measures for acceleration of economic and social development of the Murmansk region in 1988 – 1990 and for the period up to 2005. Moscow, The Central Committee of the CPSU.

Grann, H., 1997. The Industrial Symbiosis at Kalundborg, Denmark. In: Richards, D.J. (Ed.), The Industrial Green Game. Implications for Environmental Design and Management. National Academy Press, Washington, D.C., pp. 117-123.

Graham L.R., 1998. What have we learned about science and technology from the Russian experience? Stanford, California, Stanford University Press.

Haas, P.M., 1989. Do regimes matter? Epistemic communities and Mediterranean pollution control. International Organization **43**(3), 377-403.

Haila, Y. and Dyke, C., 2006. Introduction: What to Say about Nature's "Speech"? In: Haila, Y. and Dyke, C. (Eds.), How Nature Speaks: The Dynamics of the Human Ecological Condition. Duke University Press, Durham, NC, pp. 1-48.

Hajer, M.A., 1995. The Politics of Environmental Discourse: Ecological Modernization and the Policy Process. Oxford University Press, Oxford, UK.

Hatch, M.J., 1997. Organization Theory. Modern, Symbolic and Postmodern Perspectives. Oxford University Press, Oxford.

Heeres, R. R., Vermeulen W. J. V. and de Walle, F. B., 2004. Eco-industrial park initiatives in the USA and the Netherlands: First lessons. Journal of Cleaner Production **12**(8–10): 985–995.

Hezri, A.A. and Dovers, S.R., 2006. Sustainability indicators, policy and governance: Issues for ecological economics. Ecological Economics **60**, 86-99.

Hilson, G., 2003. Defining "cleaner production" and "pollution prevention" in the mining context. Minerals Engineering **16**, 305-321.

Holling, C.S., 1979. Myths of ecological stability. In: Smart, G. and Stansbury, W. (Eds.), Studies in Crisis Management. Butterworth, Toronto, pp. 97-109.

Holling, C.S., 1986. The resilience of terrestrial ecosystems. In: Clark, W.C. and Munn, R.E. (Eds.), Sustainable Development of the Biosphere. Cambridge University Press, Cambridge, pp. 292–317.

Holling, C.S. and Sanderson, S., 1996. Dynamics of (dis)harmony in ecological and social systems. In: Hanna, S.S., Mäler, K-G. and Folke, C. (Eds.), Rights to Nature. Island Press, Washington DC, pp. 57-85.

Hukkinen, J., 2003. Sustainability indicators for anticipating the fickleness of human-environmental interaction. Clean Technologies and Environmental Policy **5**(3-4), 200-208.

Humphreys, D., 2001. Sustainable development: can the mining industry afford it? Resources Policy **27**, 1–7.

Hønneland, G., 2003. Industrial Pollution Discourse in the European Arctic. Acta Borealia **1-2003**, 49-73.

Hønneland, G. and Jørgensen, A.-K., 2003. Implementing International Environmental Agreements in Russia: Lessons from Fisheries Management, Nuclear Safety and Air Pollution Control. Global Environmental Politics **3**(1), 72-98.

Interfax 1993a. Tender for reconstruction of Pechenganikel to take place in mid-1993. Russia & CIS Metals & Mining.

Interfax 1993b. Western companies ready to reconstruct Pechenganikel plant. Russia & CIS Metals & Mining.

Interfax 2006a. Deadline looms in Khibin alkaline massif tender. Russia & CIS Metals & Mining.

Interfax 2006b. Murmansk region, Hydro discuss aluminium plant project. Russia & CIS Business and Financial Newswire.

Jamison, A., 2001. The Making of Green Knowledge: Environmental Politics and Cultural Transformation. Cambridge University Press, Cambridge, UK.

Jordan, A., Wurzel, R.K.W., Zito, A., 2005. The Rise of 'New' Policy Instruments in Comparative Perspective: Has Governance Eclipsed Government? Political Studies **53**, 477-496.

Kenis, P. and Schneider, V., 1991. Policy Networks and Policy Analysis: Scrutinizing a New Analytical Toolbox. In: Marin, B. and Mayntz, R. (Eds.), Policy Networks. Campus Verlag, Frankfurt am Main, pp. 25-59.

Kingdon, J., 1984. Agendas, Alternatives and Public Policies. Little Brown, Boston, MA.

Kinnunen, M. and Korppoo, A., 2007. Nuclear power in Northern Russia: A case study on future energy security in the Murmansk region. Energy Policy **35**, 2826-2838.

Kosonen, R. 2002. Governance, the Local Regulation Process and Enterprise Adaptation in Post-Socialism. The Case of Vyborg. Economic Geography. Helsinki, Finland, Helsinki School of Economics**:** 277.

Kotov, V. and Nikitina, E., 1993. Russia in Transition. Obstacles to Environmental Protection. Environment **35**(10), 10-20.

Kotov, V. and Nikitina, E., 1996. Norilsk Nikel. Russia Wrestles with an Old Polluter. Environmet **38**(9), 6-37.

Kovalev, S., 2007. The oil and gas pole. Oil of Russia 1/2007. Online: http://www.oilru.com/or/30/559/. Accessed 18 January 2008

Kozlov, M.V. and Barcan, V., 2000. Environmental Contamination in the Central Part of the Kola Peninsula: History, Documentation, and Perception. Ambio **29**(8), 512-517.

Lifset, R., 2005. Industrial ecology and public policy. Journal of Industrial Ecology **9**(3), 1–3.

Ludwig D., Walker B. and Holling C.S., 1997. Sustainability, Stability, and Resilience. Conservation Ecology **1**(1), 7-30.

Luzin, G.P., Peshev, N.G., Milner, B.Z., Abahov, J.M., Belolipetskij, A.M., Volosnikov, N.M. and Psarjov, G.M., 1988. Osnovnye polozheniya kontseptsii sovershenstvovaniya upravleniya predpriyatiyami Kolskogo gornopromyschlennogo kompleksa (nauchno-metodicheskie rekomendatsii) [Basic Conditions for the Consensus of Improving the Management of the Kola Mining Complex Enterprises (Scientific-Methodological Recommendations)]. Soviet Union Academy of Sciences, Apatity, Soviet Union.

Marsh, D. and Smith, M., 2000. Understanding Policy Networks: Towards a Dialectical Approach. Political Studies **48**, 4-21.

Meadowcroft, J., 1997. Planning for Sustainable Development: Insights from the Literature of Political Science. European Journal of Political Research **31**, 427-454.

Meadowcroft, J., 2002. Politics and scale: some implications for environmental governance. Landscape and Urban Planning **61**(2-4), 169-179.

Meyer, J.W. and Rowan, B., 1977. Insitutionalized Organizations: Formal Structure as Myth and Ceremony. The American Journal of Sociology **83**(2), 340-363.

Miller, D., 1988. Relating Porter's Business Strategies to Environment and Structure: Analysis and Performance Implications. Academy of Management Journal **31**(2), 280-308.

Mintzberg, H., 1990. The Design School: Reconsidering the Basic Premises of Strategic Management. Strategic Management Journal **11**(3), 171-195.

Mitchell, R. K., Agle, B. R. and Wood, D. J., 1997. Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of Management Review **22**, 853-886.

Mol, A.P.J. and Carter, N.T., 2006. China's Environmental Governance in Transition. Environmental Politics **15**(2), 149-170.

Murmansk-Oblkomstat, 2001. Environmental Protection in the Murmansk Region. Goskomstat (Russian Federal State Statistics Service), Murmansk, Russia.

National Research Council, 1999. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington DC.

North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge.

OECD, 2004. Reform of Pollution Charges in the Russian Federation: Assessment of Progress and Opportunities and Constraints for Further Improvement. ENV/EPOC/EAP/POL(2004)1. Organisation for Economic Co-operation and Development. Online: https://www.oecd.org/dataoecd/20/36/34500191.pdf. Accessed July 14 2006.

Oldfield, J.D., 2005. Russian Nature: Exploring the Environmental Consequences of Societal Change. Ashgate, Aldershot Burlington, VT.

Ollus, S.-E., Simola, H. and Tekoniemi, M., 2007. Venäjän aluepolitiikka 2000-luvulla - mitä uusi alueluokitus merkitsee? [Russian regional politics in the 2000s - what is the significance of the new regional classification?]. Bank of Finland Institute of Economies in Transition (BOFIT). Online: http://www.bof.fi/NR/rdonlyres/2EC0F20E-9A7C-4627-A3FD-F34F8E1F1A64/0/bon0907.pdf. Accessed 19 September 2007.

O'Rourke, D., Connelly, L. and Koshland, C., 1996. Industrial Ecology: A Critical Review. International Journal of Environment and Pollution, **6**(2-3), 89-112.

Peck, P. and Sinding, K., 2003. Environmental and Social Disclosure and Data Richness in the Mining Industry. Business Strategy and the Environment **12**(3), 131-146.

Pierre, J. and Peters, B.G., 2000. Governance, Politics and the State. MacMillan Press, Hampshire, UK.

Rhodes, R.A.W., 1996. The New Governance: Governing without Government. Political Studies **44**(652-667).

Robinson, M.P. and Kassam, K.A.S., 1998. Sami Potatoes. Bayeux Arts Inc., Calgary, Alberta.

Roe, E., 1994. Narrative Policy Analysis. Duke University Press, London.

Roese, N.J. and Olson, J.M. (Eds.), 1995. What Might Have Been: The Social Psychology of Counterfactual Thinking. Lawrence Erlbaum Associates.

Rothman S. and Lichter S.R., 1987. Elite Ideology and Risk Perception in Nuclear Energy Policy. The American Political Science Review **81**(2), 383-404.

Sarv, M., 1996. Changes in the Social Life of the Kola Saami. In: Seurujärvi-Kari, I. and Kulonen, U.-M. (Eds.), Essays on Indigenous Identity and Rights. Helsinki University Press, Helsinki, Finland, pp. 131-139.

Schwarz, M. and Thompson, M., 1990. Divided We Stand. Redefining Politics, Technology and Social Choice. Harvester Wheatsheaf, Hertfordshire, UK.

Scott, R.W., 1981. Organizations: Rational, Natural and Open Systems. Englewood Cliffs.

Scott, W.R., 2001. Institutions and Organizations. Sage Publications, Thousand Oaks.

Sjöberg, L., 1998. World Views, Political Attitudes and Risk Perception. Risk: Health, Safety & Environment **9**(137), 137-152.

Snow, D.A., Rochford, E.B.J., Worden, S.K. and Benford, R.D., 1986. Frame alignment processes, micromobilization, and movement participation. American Sociological Review **51**(4), 464-481.

Solanko, L. and Tekoniemi, M., 2005. To recentralise or decentralise - some recent trends in Russian fiscal federalism. Bank of Finland Institute of Economies in Transition (BOFIT). Online: http://www.bof.fi/NR/rdonlyres/2EC0F20E-9A7C-4627-A3FD-F34F8E1F1A64/0/bon0505.pdf. Accessed 19 September 2007.

Statistics_Finland, 2006. Luonnonvarat ja ympäristö (Natural Resources and the Environment). Report. Statistics Finland and the Ministry of Environment.

Stoker, G., 1998. Governance as Theory. International Social Science Journal **155**, 17-28.

Strishkov, V.V., 1971. The Mineral Industry of the U.S.S.R. U.S. Bureau of Mines, Washington D.C., USA.

Suchman, M.C., 1995. Managing legitimacy: strategic and institutional approaches. Academy of Management Review **20**(3), 571-610.

Thompson, M., Ellis, R. and Wildavsky, A., 1990. Cultural Theory. Westview Press, Boulder, USA.

Tikkanen, E. and Niemelä, I. (Eds.), 1995. Kola Peninsula pollutants and forest ecosystems in Lapland. Final Report of the Lapland Forest Damage Project. Gummerus, Jyväskylä.

Tsukerman, V.A., 2002. Growth Prospects Through Innovation Systems for Utilising Mineral Wastes in Production. Green Processing 2002. International Conference on the Sustainable Processing of Minerals, Australian Institute of Mining and Metallurgy, Cairns, Queensland.

Tynkkynen, N., 2005. Russia, a Great Ecological Power? On Russian Attitudes to Environmental Politics at Home and Abroad. In: Rosenholm, A. and Autio-Sarasmo, S. (Eds.), Understanding Russian Nature: Representations, Values and Concepts. Aleksanteri Papers 4/2005. Aleksanteri Institute, Saarijärvi, Finland, pp. 277-296.

Tynkkynen, N., 2008. Constructing the Environmental Regime between Russia and Europe. Doctoral Dissertation, University of Tampere, Department of Regional Studies, Juvenes Print, Tampere, Finland.

U.S. Geological Survey, 2008. Mineral commodity summaries 2008. U.S. Geological Survey.

van Asselt M.B.A. and Rotmans J., 2002. Uncertainty in Integrated Assessment Modelling. From Positivism to Pluralism. Climatic Change **54**(1-2), 75-105.

van Eeten, M.J.G. and Roe, E., 2002. Ecology, engineering and management: Reconciling ecosystem rehabilitation and service reliability. Oxford University Press, Oxford, UK.

Venkatraman, N. and Camillus, J.C., 1984. Exploring the Concept of "Fit" in Strategic Management. Academy of Management Review **9**(3), 513-525.

Venkatraman, N. and Prescott, J.E., 1990. Environment-Strategy Coalignment: An Empirical Test of Its Performance Implications. Strategic Management Journal **11**(1), 1-23.

Vinogradov, A.N., Kalinnikov, Petrov, V.P., Selin, V.S. and Tsukerman, V.A., 2003. Kolskaya gorno-promyshlennaya korporatsiya kak klyuchevoe zveno gosudarstvennoga rezerva strategicheskih materialov [Kola Mining Corporation as the Key Component of the Government Reserve of Strategic Materials]. In: Kalinnikov, V.T., Alimov, A.N. and

Vinogradov, A.N. (Eds.), Sever - 2003: Problemy i resheniya [The North - 2003: Problems and Solutions]. Kola Science Centre, Russian Academy of Sciences, Apatity.

Väliverronen, E., 1996. Ympäristöuhkan anatomia [The Anatomy of an Environmental Threat]. Vastapaino, Jyväskylä, Finland.

Warhurst, A. and Mitchell, P., 2000. Corporate social responsibility and the case of Summitville mine. Resources Policy **26**, 91-102.

Weiner, D.R., 1999. A Little Corner of Freedom. Russian Nature Protection from Stalin to Gorbachev. University of California Press, Berkeley, USA.

Welford, R., 1998. Corporate Strategy, Competitiveness and the Environment. In: Welford, R. (Ed.), Corporate Environmental Management. Earthscan Publications Ltd, London, pp. 13-34.

World Bank, 2004. Environmental Management in Russia: Status, Direction and Policy Needs. The World Bank, Washington D.C.

Zajac, E.J. and Kraatz, M.S., 2000. Modeling the Dynamics of Strategic Fit: A Normative Approach to Strategic Change. Strategic Management Journal **21**(4), 429-453.

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