Introduction

The Arctic Centre (AC) is a relatively new institution at a young university. The recent trend of studying peripheral areas, such as the Arctic, actually in the region is a welcome and interesting development in education (see Lange 1994 for a discussion of the benefits of such developments). The AC was set up to provide several roles: research into the impacts of change in the Arctic, an information and data service for the scientific community and for decision makers in the political and private sectors, and a science centre exhibition for the public; and to provide an education in the many facets of the Arctic for students from all over the world via The Arctic Studies Program (ASP). The ASP was first introduced in the spring of 1992, with the first full year program run in the academic year 1993-4. Because the ASP is designed as an international course, all tuition is in English.

The ASP is an undergraduate course that aims to instil an interdisciplinary approach to the problems of the Arctic. The course content covers a wide range of disciplines from the humanities, social sciences, and natural sciences. Also, the students come from a wide range of undergraduate and postgraduate degree courses (Figure 1), and from an increasingly wide range of countries (Figure 2). Rather than equipping conventionally trained specialists (whether scientists, lawyers, or economists) with a global (or Arctic) multidisciplinary outlook, the ASP seeks to change the traditional mind-set of the specialist student into a much freer and more rounded one. The students themselves certainly appreciate this approach to the course (Frame, in press: results of student evaluation of the ASP), and the chance to broaden their horizons. In many ways the wide ranging and interrelated issues that they tackle in the course provide a much more realistic training for future careers and lives after leaving university.

The ASP is therefore in some ways an alternative to a masters course, especially for students who may not wish to follow an academic career - those students

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who will play important roles as future law makers, industrialists, engineers, and decision makers. Thus in practical terms, courses like the ASP are of value in providing a broad multidisciplinary approach for students who will hopefully shape a more enlightened development of future society.

![Student Origin Fields](image1)

**Figure 1.** Breakdown of ASP students by field of their degrees in the first 3 ASP Introductory phases and the Spring 1994 Advanced Phase. The natural sciences include physics, biology, environmental science, and geography; social science includes anthropology, economics, sociology, humanities include law, history, international relations, and education.

![Student Origin Countries](image2)

**Figure 2.** Breakdown of ASP students by their country of origin in the first 3 ASP Introductory phases and the Spring 1994 Advanced Phase. Europe includes EU and Eastern European countries; others include Canada, U.S.A., and Venezuela.

Course Structure and Integration

The ASP consists of two phases: from September to Christmas (April 1) and from April to June. The Introductory phase is taught by lecturers in a wide range of fields, highlighting issues of global change, whether it be in the Arctic in the global system. The lectures are in small group, and topics (as in some courses) focus on the development in the Arctic. Since the participants are involved in hydrocarbon production, they are interested in the interrelatedness of the issues and the decisions to be made. The participants are often the jury of the earliest stage of the Kilpisjarvi Biological Research Center in Sami issues.

Students sample, often for the first time, the Arctic, receive lectures on Sami culture and language, take part in a course, based on student input, and write an initial orientation exercise in which they are expected to highlight the need for international cooperation on Arctic issues. Topics in the final course include the Arctic, lemmings, and future developments.

The Advanced Phase has a number of specialized, focused courses, usually lasting one week. Students choose 5 to make up their syllabus. These courses include "The Arctic and the Global System", "Arctic Sea Environment", "Winter Resources", "Military and Arctic Minorities", and "Art, Culture, and the Environment". The course is in the form of fieldwork, including visits to the Yamal Peninsula in Siberia, such as the Calotite Academy and the Julin Soviet Nickel (Russia).
Course Structure and Integration in the Arctic

The ASP consists of two semesters: the Introductory Phase running from September to Christmas (Appendix A), and the Advanced Phase from February to June. The Introductory Phase is structured as a set of courses provided by lecturers in a wide range of topics. Many of the topics address some aspects of global change, whether it be the more directly obvious, such as the role of the Arctic in the global system or the ice sheets and paleoclimate, or less obvious topics (as in some courses in the social sciences and humanities) on aspects of development in the Arctic, such as the environmental and cultural issues involved in hydrocarbon exploitation in the Russian Arctic. The interrelatedness of the issues in the real world is a constant theme and is illustrated at the earliest stage of the course during a week long field trip to the Kilpisjarvi Biological Research Station in the far north of Lapland. There the students sample, often for the first time, such Finnish cultural experiences as the sauna, walk the fells, and meet Sami people in their homes; in addition to receiving lectures on Sami culture and ecology. Back in Rovaniemi, the balance of the course is approximately equally divided between natural science, social science, and humanities, with typically 5 hours of lectures and seminars per day. Students are also expected to study a language (Finnish, Sami, or Russian) or to take a literature assignment. Assessment is based on overall performance in the course, based on student input to individual lecture courses, a field report of the initial orientation exercise in Kilpisjarvi, and a final paper on any subject that is expected to highlight the need and benefits of interdisciplinary approaches to Arctic issues. Topics in the past have included sustainable development in the Arctic, lemmings, and future economic development on the Kola Peninsula.

The Advanced Phase has a rather different structure with a range of short focused courses, usually lasting a week, being offered to students who typically choose 5 to make up their study plan. The courses on offer in 1994 were "The Arctic and the Global System", "Arctic Ecology and Management", "The Baltic Sea Environment", "Winter Ecology and Physiology", "Managing Biological Resources", "Military and Environment", "Legal Rights and Cultures of Minorities", and "Art, Culture and Design". Additionally an important part of the course is in the form of field trips such as to the Kola Science Centre and to the Yamal Peninsula in Siberia, and participation in international conference such as the Calotte Academy this May in Inari (Finland), Svanvik (Norway), and Nikel (Russia).
Global Environmental Change

For a number of reasons, within the study of global environmental change, the curriculum of a course dealing with changes in the Arctic and Subarctic must address the problems related to this region. In this course, we stress the interconnection of various regions and the linkages between them. This theme also lends itself to the discussion of global processes and the social impacts of global change issues in general. The role of the advanced integration into other global studies and the impact of industrial development can be expected, relies rather on the context. Advanced Phase course, students are expected to complete a 15 page report that, while challenging to undergraduates, is usually limited by time and other course commitments to fairly straightforward literature reviews and field work accounts. The future development of this research aspect of the ASP is aided by the AC proximity to, and good relations with, the Kola Science Centre (KSC) in the Murmansk Oblast of Russia. The KSC is the largest research institute in the Circumpolar Arctic and can provide numerous research opportunities through cooperation and student exchange. Several KSC employees have participated in the ASP as students and lecturers.)

Dealing first with the particular theme of this paper's authors in the region, the focus on the variability of the climate being involved in a larger context that accompanies real scientific knowledge of the course is the justification which accompanies such a project. GRIP being funded, which is not.

Another aspect is the overall coherency in the limits of current scientific knowledge of the region, consequently the limits of
Global Environmental Change Aspects of the ASP

For a number of reasons the polar regions attract ever increasing attention within the study of global change (see below). This fact should be reflected in the curriculum of a course dealing with the Arctic. We do this by presenting global changes in the Arctic as one of the overarching themes in the Introductory Phase, as well as in a focused short course of the Advanced Phase. In so doing, we stress the interconnectedness of the components of the Arctic system on one hand, and the linkages between the Arctic and the global system on the other. This theme also lends itself nicely to addressing the feedback between the natural processes and the social/human dimension issues in the Arctic. By addressing global change issues in the ASP, we also have the opportunity to deal with general issues of international research programs in the Arctic and their integration into other global change programs. Finally, we also cover questions relating to political decision making, as applied to policies that seek to avoid, or at least mitigate, global environmental changes in the Arctic. More specifically, we address the role of the Arctic in controlling the earth's climate, as a repository of climate information from the past that is available from ice cores, and the impact of industrial development in the region. The Introductory Phase, as may be expected, relies rather more on lectures and fairly direct teaching than does the Advanced Phase course, "The Role of the Arctic in the Global System", where students are expected to make much more active contributions during seminars and role playing exercises.

Dealing first with the paleoclimatic record, the personal experience of one of this paper's authors in the recent deep drilling program in central Greenland (GRIP) is used to present both the scientific findings regarding the pronounced variability of the climate in the past, and also the more personal impressions of being involved in a large scale international scientific collaboration. This combination is designed to try and instil the sense of excitement that can accompany real scientific research. One of the things that is not neglected in the course is the justification for the damage to the environment that necessarily accompanies such a project in the Arctic, and the political priorities that led to GRIP being funded, while other perhaps equally deserving science was not. Another aspect is the often lively debates that ensue during the course on the limits of current scientific knowledge and also on the limits of the imperfect scientific knowledge of the past and present, in modelling the future, and consequently the limits of science in political decision making.
The second role of the Arctic as a major player in the global climate system is covered with extensive reference to the current high profile of the greenhouse effect and the ozone hole. The IPCC reports on future climate change (Houghton et al., 1990, 1992) illustrate the very large changes in temperature that are expected to occur in the Arctic as a result of anthropogenic greenhouse gas emissions. The temperature rises predicted from GCM models are of the order of 3°C over the next 50 years. Such rapid changes exceed any changes in the historical record of climate, and almost certainly exceed any changes that have occurred since the end of the last ice age. The ice core records suggest that the last 8000 years of climate history have been remarkably stable compared with the previous 100,000 years at least. The reasons for such stability and the causes of its breakdown are under keen investigation at present, but it appears that changes in oceanic circulation play an important role. A majority of the sea ice in the Arctic Ocean spends the summer at temperatures within 2°C of the melting point, a rise in temperature would lead to a rapid decrease in sea ice cover in the Arctic Ocean as the positive feedback effect of lowering albedo by removing sea ice allows more heat to be absorbed causing more sea ice melting. Thus, it can be imagined that rather dramatic changes could take place within a very short period of time in one of the climate system's main parts.

The third aspect of the Arctic in environmental change concerns the human impact of industrial development in the Arctic. This is particularly obvious in the marine pollution of the Arctic Ocean with significant input of radiation around Murmansk and Novaya Zemlya, and large, very seasonal (due to freezing) inputs of PCBs and heavy metals from the main rivers of Russia into the Arctic Basin. The recent changes in the political situation in Russia have allowed investigation of the environmental damage around the large metal smelting plants in the Kola Peninsula to be internationally monitored. Damage to the ecosystems in such a fragile environment are likely to take generations to recover, if ever. Several research projects at the AC are studying the effect of air and water pollution on trees and sea ice organisms. It is, however, very striking that the attitudes towards environmental damage that are characteristic of most westerners are not shared by the Russian inhabitants of the Kola peninsula, most of whom are very happy to have well-paid employment in the mines, factories, and nuclear power plants, instead of doing the same job for half the pay in middle Russia (if they can get a job at all). While there is concern for the future state of the environment, the more everyday problems associated with providing themselves and their families with adequate food and other necessities mean that problems that may appear to be a climate problem may be a very important element of academic courses. The results of the dammed and flooded areas during a visit to the region. One further aspect that will affect the indigenous peoples of the Arctic (there is currently interest in this passage) to serve the Siberian peoples from Western Europe to the United States, if climate warming reduces the migration of sensitive to rises of a few degrees and pollution in the Arctic Ocean. And easier hunting activities through life.

Assessment of the individual lectures and is therefore the Arctic in the global system, given by each student on the course: "Climate Change", "Greenhouse, a Warmed World", "The Role of Cereal Agriculture in a Greenhouse," the course, students presented. The interdisciplinary nature of the course required the student to enter, illustrated by the following...
that problems that may appear in 20 or 30 years time have low priority. This
factor is a very important one to consider, and contrasts with the standard
element of academic courses in which students are usually only presented with
the results of the damaged environment. It is something that is best grasped
during a visit to the region. The fragile nature of the Arctic environment is also
a key element in studies of the impact of climate change in the region. Most of
the Arctic plant life is limited not by climate, but by nutrient availability. The
limitations of the often simplistic assumptions used by models of changes on
plant species limits and agricultural practices resulting from climate changes, do
not take into account other important factors such as the reduction in
biodiversity that will arise as less cold hardy plants out-compete the traditional
Arctic plant species.

One further aspect that we like to cover is the impact of change on the
indigenous peoples of the Arctic. This again can be illustrated in Russia where
there is currently interest in developing the Northern Sea Route (the North-East
passage) to serve the Siberian Arctic Ocean ports and function as a trade route
from Western Europe to the Far East. This could become much easier in future
if climate warming reduces the Arctic Sea ice cover (a factor which is very
sensitive to rises of a few degrees in temperature). Increased commercial traffic
and pollution in the Arctic would clearly have impact on the traditional fishing
and hunting activities of the indigenous people, and the possibility of much
easier communication with the region would also bring changes to their way of
life.

Assessment of the individual courses of the ASP depends on the requirements of
the lecturers and is therefore quite flexible. For the Advanced Phase course on
the Arctic in the global system, assessment was based on a 15 minute seminar
given by each student on the last day of the course. (Topics included "Natural
Climate Change", "Greenhouse Gases: Sources, Sinks and Trends", "Sea Level in
a Warmed World", "The Role of Sea Ice in the Climate System", "Changes in
Cereal Agriculture in a Greenhouse World"). Secondly, in the 2 weeks following
the course, students produced an essay of 3-5 pages in length that emphasised the
interdisciplinary nature of decision making in environmental issues and
required the student to express a personal but well-founded view. This is
illustrated by the following selection of essay topics:
"Explain the possible benefits of global warming in the polar regions and weigh them against the adverse effects of warming. What would be the balance between benefits and adverse effects in your view?"

"Suppose you were asked to make a choice between building a large nuclear power plant or to utilize an alternative form of energy production (hydropower, wind power) in the Arctic. What would be your choice, based on an assessment of relevant environmental factors, and how would you justify it?"

"Consider that you are a high-ranking politician. You have to make a decision of a) initiating a profitable development project (e.g., exploitation of oil and gas) in an area that is occupied by indigenous people, which would considerably raise the standard of living of these people through shared benefits; or b) of 'leaving them alone', knowing that it will take them a long time before they will ever 'catch-up' with the 'modern world'. What would your decision be and why?"

In summary then, the Arctic Studies program seeks to provide a rounded education for undergraduate students from across the range of the humanities and the natural and social sciences. Global changes and their relationships to the Arctic are a fundamental part of the course structure and provide one of the main thematic links between the individual courses that make up the ASP structure. Finally, by emphasising the links and feedback between the human and social worlds of the Arctic and the fragile, but still relatively undeveloped natural environment, we hope to leave a lasting influence on the students in whatever career they take up on leaving university.

References


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Arctic Studies Program
An Introduction

The Arctic Studies Program (ASP) is a six-week intensive research program (four study weeks), which provides an in-depth view of the authentic aspects of the Arctic. This introduction is written for students who will take part in the ASP, to demonstrate the complexity of the interrelationships between the people of the Arctic. It also strives to illustrate the concerns of the Arctic or the Circumpolar Arctic, including the indigenous peoples living there.

The Introduction to the Arctic Studies Program in the ASP is based on an excursion to Kilpisjarvi in Lapland, Finland. The course consists of several theoretical components. It begins in an international seminar, where students get a preliminary introduction to the ASP and the topics that will be covered in the ASP. Students have to prepare a 20 page study paper on the topics covered in the ASP.

Study Paper

1. Orientation
2. The Arctic in the Global Context
3. Indigenous Peoples of the Circumpolar Arctic
4. The Arctic as a Distinct Environment
5. Languages or Literature
6. Study Paper
Appendix A

Arctic Studies Program
A Program for the Introduction to the Arctic

The Arctic Studies Program (ASP) starts with the Introduction to the Arctic (15 study weeks), which provides a broad introduction to the Arctic and its manifold aspects. This introduction aims to broaden students in arctic and northern affairs, to demonstrate the complexity of processes in the region, and to highlight the interrelationship between these processes and others at work around the globe. It also strives to illustrate the interdisciplinary nature of issues relevant to the Arctic or the Circumpolar North and the particular role played by the indigenous peoples living there.

The Introduction to the Arctic includes orientation comprising both field (an excursion to Kilpisjarvi in Finnish Lapland) and classroom work. The basic course consists of several thematic units, seminars, and, if possible, participation in an international seminar or conference. In addition, language courses (through the University Language Centre), literature, and offerings from other departments are available. Course requirements include the research and preparation of a 20 page study paper.

Structure of the program

1. Orientation (2 study weeks)
2. The Arctic in the Global System (3 study weeks)
3. Indigenous People of the Circumpolar North (3 study weeks)
4. The Arctic as a Distinctive and Multiple-Use Region (3 study weeks)
5. Languages or Literature (2 study weeks)
6. Study Paper (2 study weeks)
Academic Fields:
All themes and subthemes of the program are under the following three academic fields:

A. Natural Sciences, "Ecology"
B. Humanities, "Peoples"
C. Social Sciences

The teaching of the program runs either under the three academic fields or be interdisciplinary teaching. Interdisciplinary teaching will mostly concentrate on a relationship between ecology and social affairs.

A Weekly Class Schedule:
Teaching from each of the academic fields during the ten-week study period will be done three days each week from Tuesday to Thursday. The teaching will include both lecturing and, once a week, an interdisciplinary seminar or discussion, which deals with a relationship between topics of two or three academic fields. On the "rest days" of the week (Monday and Friday), there will be languages, individual studying of the literature, and a study paper.

Study Paper:
All students will write a study paper on a chosen topic, which should deal with the themes discussed during the program, emphasizing the interdisciplinary nature of issues and problems of the Circumpolar North. The paper should be based on written material, lectures, and discussions, and not exceed 20 pages. The paper will be a university exercise, but it should be prepared like a scientific paper, e.g., with complete references. Student work will be supervised by one of the scientific staff members of the Arctic Centre or by one of the key lecturers of the ASP. The idea is that students prepare the paper during the course (by the beginning of December) and discuss it in a seminar in the middle of December.

Assessment System:
The studies of the ASP students will be assessed according to the elements of the course, e.g., a study paper, a report from the Kilpisjarvi excursion, languages, and each student's overall performance (participation in discussion, seminars, group work or other activities, and a seminar of study papers). Details of the assessment system are given to students in September at the beginning of the program.

Examples of some topics on which students are assessed are given in Appendix B.

ARCTIC STUDIES

GLOBAL A

The following exercise is designed to test whether you have been listening (or have!), but they are rather simple. Please give me your view on issues connected to climate change:

1. What are some of the consequences of global warming? Identify the factors that have been attributed to the reduction of ice in the Arctic.
2. Can you provide an example of the effects of climate change on the lives of people in the Arctic?
3. How would you define the concept of "carbon footprint" and list its components?
4. Suppose you were a policy maker. What actions would you recommend to minimize man-induced climate change?
5. Returning to our first exercise, what would be the benefits of reducing greenhouse gas emissions in the Arctic?

Please note that "climate change" has a scientific connotation and includes environmental, social, economic, and political aspects.

I am looking forward to hearing your thoughts.

Manfred.
GLOBAL CHANGES AND THE ARCTIC: A TAKE-HOME EXERCISE

The following exercise is not so much meant to "test" your knowledge and whether you have been listening carefully to the lectures (I am assuming you have!), but they are rather intended to provide all of you with an opportunity to give me your view on issues that we have addressed during the last few days.

Please, do not take more than about ten minutes and do not write more than half a page to answer each question. The whole exercise should really not require more than one hour of your time. However, I would appreciate if you would write clearly, thus helping me to find out what you are saying.

1. What are some of the major processes that link the polar regions with the global system? Identify whether global warming would be enhanced or reduced if changes in these processes would take place in Antarctica or the Arctic.

2. Can you provide (at least) one example each for
   - disturbances on the Arctic system caused by human activities and for
   - adverse effects of global changes on Arctic societies?

3. How would you define the three top research questions that need to be addressed in order to better understand the role of the polar regions in global change?

4. Suppose you were a (very powerful) politician. What would be your three top policy actions (e.g., environmental laws) that you would introduce in order to minimise man-induced disturbances on the Arctic system?

5. Returning to our first carbon dioxide exercise (GCI), please provide a cost-benefit analysis for each of the four options in the action/problem matrix. Please note that "costs" in this context goes far beyond the usual monetary connotation and includes things such as "changes in lifestyle", time and labour, losses in personal choice, career options etc.

Please hand your answers in (you can collect them and have them sent to me) no later than November 26.

I am looking forward to your answers. Thanks!

Manfred.


THE ROLE OF THE POLAR REGIONS IN GLOBAL ENVIRONMENTAL CHANGES

TOPICS FOR ESSAYS

Preface
You are asked to pick one of the topics given below for a three- to four-page essay. The essay should not so much reflect any "learned knowledge" but rather your personal view. However, it is expected that the latter and what you express in your essays is well founded. So, simple "personal arguments" or any "hand-waving" won't do!
Your essay should be typewritten on A4 paper and should be handed in no later than April 30 (12 o'clock a.m., sharp!!!). Please, contact either John or myself, if you have any questions.
We are looking forward to getting your essays!

Essay Topics
1. Suppose you were asked to make a choice between building a large nuclear power plant or to utilize an alternative form of energy production (hydropower, wind power) in the Arctic. What would be your choice, based on an assessment of relevant environmental factors and how would you justify it?
2. To what extent can/should research on global changes in the polar regions (i.e., Antarctica and the Arctic) be done with identical/similar methodologies and in what fields does it have to be done differently? Please explain and give concrete examples.
3. Explain possible benefits of global warming in the polar regions and weigh them against the adverse effects of warming. What would be the balance between benefits and adverse effects in your view?
4. Give a brief outline of a research project (including the rationale for choosing it) addressing the issue of global changes in the polar regions that you would consider to be of highest priority.
5. Consider to be a high-ranking politician. You have to make a decision of a) initiating a profitable development project (for instance a project dealing with the exploitation of oil and gas) in an area that is occupied by indigenous people, which would considerably raise the standard of living of these people through shared benefits; or b) of "leaving them alone", knowing that it will take a long time, before they will ever "catch-up" with the "modern world".
What would your decision be and why?

Education and Training in Europe

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The first Earth Summit held in 1992 and the growing economic development on the European Community have created a need for protection. The new Treaty of Maastricht objective the promotion of science (Act 2) (Commission of the European Communities).

The following characteristics:
- it maintains the overall balance of nature and its system;
- it maintains continuing protection;
- it avoids lasting environmental damage;

Today there is growing world concern about the state of the environment and of its systems. The ozone hole, the loss of biodiversity are some examples of the problems of the second Global Earth Summit and Agenda 21 for the protection of the environment.

Greece, a member of Europe, shares the problems and follows the situation. It is clear that the implementation of the Agreement in protecting the environment requires the trained activists and administrative background in environment.

In this paper, I will present some information related to environmental science in Greek universities.