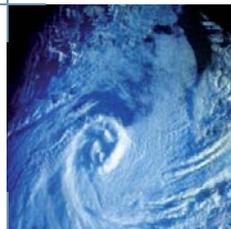




Revised programme plan 2008 - 2013

Large-scale programme
Climate change and impacts in Norway - NORKLIMA



Large-scale Programmes

The RCN initiative
to meet national
research priorities

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Summary

The ten-year NORKLIMA programme, one of the Research Council's Large-scale Programmes, focuses on improving our understanding of the causes and impacts of climate change in a *cohesive* perspective. The revised work programme is the fundamental document establishing the priorities and perspectives for the remaining segment of the NORKLIMA programme period, i.e. 2008-2013. The revision takes into account changes in the financial framework, experience from the first segment of the programme period, and the changing need for knowledge in society at large. During the first segment of the programme period, research projects under the NORKLIMA programme have played a part in strengthening and further developing Norwegian research on climate development and variability, and have contributed to the development of reliable global and regional climate models. While knowledge-related challenges still remain within this field, the final segment of the programme period will give higher priority to research on society's adaptation to climate change.

The programme's primary objective remains unchanged, and only minor changes have been introduced in the, scientific and strategic objectives. The scientific objectives as a whole encompass the entire range of research challenges related to climate development and to the impacts of and adaptation to climate change.

- 1) To improve understanding of the climate system and its variability, and to quantify uncertainty.
- 2) To improve knowledge of climate change and its impacts on buildings, infrastructure and other installations, both on land and offshore.
- 3) To improve knowledge of climate change and its impacts on natural and cultivated ecosystems and natural resource-based industries.
- 4) To improve knowledge of the impacts of climate change on society and how adaptive capacity can be strengthened.

The following scientific objective has been added:

5) To improve knowledge of the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

This objective has been included for two reasons. Firstly, research on international climate agreements, the factors that affect the design of and support for different types of agreements, and the possible impacts on climate development has been transferred from the RENERGI programme to the NORKLIMA programme. Secondly, research on emission scenarios and socio-economic scenarios is being given higher priority for the remaining segment of the NORKLIMA programme period.

The NORKLIMA programme's strategic objectives are to ensure satisfactory distribution of tasks at the national level, to foster research of top international calibre, to cultivate cross-disciplinarity, to maintain close contact between researchers and

society and achieve effective dissemination of research results, and to promote recruitment.

The NORKLIMA budget has decreased from roughly NOK 100 million in 2004 to NOK 88 million in 2005, NOK 87 million in 2006, NOK 70 million in 2007 and NOK 74 million in 2008. Should the programme's budget remain at the current level, it will not be possible to achieve the programme's primary objective or all of its scientific and strategic objectives. However, individual thematic areas and objectives will continue to be relatively well supported.

An analysis of research needs shows that the programme needs increased allocations of at least NOK 405 million for the period 2009-2013 (an additional NOK 77 million on average per year). A budget of this size would provide the latitude for action needed to achieve the objectives and goals set out in the work programme.

Based on a zero-growth budget, i.e. a continuation of the current budget framework, the programme will be able to allocate about NOK 70 million in new research funding distributed over the period 2009-2013. This is based on the assumption that the Ministry of Foreign Affairs will continue to allocate NOK 9 million per year to the programme, also after 2010, in connection with the collaboration with China on climate research. This would make an average of approximately NOK 14 million per year available to new projects throughout the period.

An intermediate budget alternative entailing an increase of NOK 225 million would result in reduced efforts related to all scientific objectives under the programme, and lead to stricter prioritising with regard to meeting the broader need for knowledge about climate issues for society as a whole and the sectors affected.

Introduction

The primary objective of the NORKLIMA programme is to generate vital new knowledge about the climate system, about climate trends in the past, present and future, and about the direct and indirect impacts of climate change on the natural environment and society, as a basis for adaptive responses by society.

The NORKLIMA programme has reached the halfway point in its programme period. At this juncture the programme board finds that a revision of the work programme is in order. The revision takes into account changes in the financial framework, experience from the first segment of the programme period, an analysis of the objectives achieved that was conducted at the end of 2007, input to the programme from research groups, and the changing need for knowledge in society at large. The Fourth IPCC Assessment Report and the cross-political agreement on climate policy achieved in the Storting contain important indications regarding the need for knowledge and research strategy.

The revised work programme is the fundamental document establishing the priorities and perspectives for the remaining segment of the NORKLIMA programme period, i.e. 2008-2013. The programme's priorities will be clarified and specified in annual action plans and calls for proposals.

Background

Defining features and added value of the programme

The ten-year NORKLIMA programme, one of the Research Council's Large-scale Programmes, focuses on improving our understanding of the causes and impacts of climate change in a *cohesive* perspective.

The NORKLIMA programme seeks to improve our understanding of fundamental questions related to the climate system and the causes of climate change, as well as of key social issues associated with climate change and how these challenges may be addressed. Climate change will have an impact on many segments of society, and all sectors will be affected in some way.

As one of the Large-scale Programmes, the NORKLIMA programme is a strategic research funding instrument that guides and directs research efforts at a general level. This entails the implementation of a conscious strategy for using the highest calibre research expertise and targeted recruitment efforts in order to develop the expertise needed for future research. The NORKLIMA programme will also attach special importance to the relevance of the research projects in addition to their scientific merit. In this context, relevance refers to how the research projects address the knowledge-related challenges that fall under the programme's scope of responsibility.

Establishment of the NORKLIMA programme

The NORKLIMA programme was established to address the major challenges that climate change on the scale predicted will pose for society. It is important to develop an understanding of how the climate system is likely to develop, and to be as well prepared as possible to deal with the impacts of climate change on the natural environment and on society.

The programme was launched in 2004 as the result of a consolidation of the Research programme on climate and climate change (KLIMAPROG), the Research programme on the impacts of and adaptations to climate change (KLIMAEFFEKTER), and the Polar Climate Research initiative. It was recognised that the research-related challenges of generating new, more relevant knowledge on climate change and its impacts were inherently cross-disciplinary, and that it was therefore not beneficial to divide the research activity among several programmes. One key goal when the NORKLIMA programme was established was therefore to forge links between research on the climate system and physical and biochemical changes, and research on impacts, vulnerability and adaptation. Research conducted under the programme must enhance society's ability to adapt to climate change. The process of linking such diverse research questions requires a high degree of cross-disciplinarity, and is demanding as well as time-consuming. Experience from the first segment of the programme period shows that such linkages have been highly productive and that a solid foundation has been built for future research activity.

The NORKLIMA programme and other programmes and initiatives

Due to its broad scope, the NORKLIMA programme shares an interface with a number of other programmes and initiatives at the Research Council. A key area in which a boundary has been drawn is technological R&D that generates solutions for reducing greenhouse gas emissions and develops instruments and incentives for ensuring that the technology is utilised. This area is not covered under the NORKLIMA programme, and falls instead under the Large-scale programme RENERGI on topics related to the energy sector and under other initiatives on topics relevant for other sectors. At present the NORKLIMA programme does not encompass social science research on emission reductions or climate policy instruments at the national level. The NORKLIMA programme does include research on international climate agreements.

Moreover, much of the independent basic research in relevant areas of the natural sciences addresses climate issues and makes a vital contribution to climate research. Such research falls in principle under the Research Council's Division for Science. The NORKLIMA programme will offer some support to strategic basic research that is directly associated with the programme's objectives. The Division for Science will be generally responsible for funding independent basic research in relevant disciplines through independent researcher-driven projects within the main disciplines.

Users of the programme's findings

The NORKLIMA programme was given status as a Large-Scale Programme primarily on the basis of its objective to raise the level of expertise to meet major challenges faced by society, in this case climate change. Consequently, the research findings

produced under the NORKLIMA programme are targeted toward a wide variety of stakeholders in society at large.

Public administration is a key target group. In order to designate policy at the national and international level, public administration is in need of knowledge about climate development as well as about climate change and its impacts, both nationally and internationally.

Trade and industry has use for the finding from NORKLIMA projects in their planning activities and daily operations. This is the case for sectors such as building and construction, transportation and primary industry. Future climatic conditions may also lead to changed social framework conditions for commercial activity, including those arising from amendments to rules and regulations.

Vis-à-vis the research community, the programme seeks to serve two main functions: 1) provide satisfactory framework conditions for institutions and research groups working at the forefront of international efforts, and 2) promote the further development of broad-based, general expertise in the scientific fields of significance for the climate problem.

The NORKLIMA programme will also generate knowledge for the general public to enhance insight into climate change – its causes and potential impacts. This is important in terms of shaping public opinion and encouraging participation in political decision-making processes and individual adaptation strategies.

Perspectives on climate research

Climate change is an issue of global importance, but will also have direct impacts at the national and local level. The NORKLIMA programme is intended to address both the national and the international perspective in climate research. In addition to sector-based research, the programme must include research on general and cross-cutting issues, such as treatment of uncertainty and risk, rights, accountability and costs. At the national level, Norway has certain advantages as regards climate research, and also has special research needs that will not be met by others:

- Several of the key processes in the global climate system operate in or close to Norway – in the oceans off its coasts, in the terrestrial environment, and in Norwegian territory in the Arctic. The Arctic plays a key role in the global climate system, and Norwegian climate research can contribute to knowledge about global climate processes at the international level.
- The boundaries of several climate zones and ecosystems are also to be found in or near Norway. Climate change will influence these boundaries, and Norway is well placed for studies of the effects of such shifts. This means that Norway can play an important role in international research programmes.
- The NORKLIMA programme is intended to address research needs related to the impacts of climate change and society's response to these impacts. This may for example include building up the capacity needed to cope with necessary adaptations, and how governance systems and the institutional framework can be adapted to make society more robust to climate change. There are links between the impacts of climate change and other challenges and

development trends that must be addressed, such as globalisation and market orientation. Climate change may pose challenges in the context of societal security. In addition, sectors of particular importance for Norway, such as fisheries, energy, agriculture and forestry, have special knowledge needs.

Climate change must be viewed in an international perspective. This is not only because climate processes operate on a global scale, but also because the direct and indirect impacts of climate change are very unevenly distributed through the world. Developing countries will be harder hit by climate change than Norway. In the field of climate research, Norway has the capacity and expertise to act as a global partner in building up knowledge that is needed by the global community. In this context, knowledge that can help developing countries to address the problems of climate change is particularly important. Given the growing international importance of climate change, the need for knowledge has increased since the NORKLIMA programme was launched. The impacts of climate change on Norway will also depend on the extent of climate change in other parts of the world.

Programme objectives

Primary objective

The programme board finds no reason to change the primary objective midway through the programme period.

The programme's primary objective is as follows:

The primary objective of the NORKLIMA programme is to generate vital new knowledge about the climate system, about climate trends in the past, present and future, and about the direct and indirect impacts of climate change on the natural environment and society, as a basis for adaptive responses by society.

Secondary objectives (scientific)

The NORKLIMA programme has five scientific objectives, which together cover the entire range of research questions related to climate development and the impacts of and adaptation to climate change.

- 1) To improve understanding of the climate system and its variability, and to quantify uncertainty.
- 2) To improve knowledge of climate change and its impacts on buildings, infrastructure and other installations, both on land and offshore.
- 3) To improve knowledge of climate change and its impacts on natural and cultivated ecosystems and natural resource-based industries.
- 4) To improve knowledge of the impacts of climate change on society and how adaptive capacity can be strengthened.
- 5) To improve knowledge of the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

Secondary objectives (strategic)

- National distribution of tasks: The NORKLIMA programme seeks to ensure satisfactory distribution of tasks at the national level in order to utilise top national expertise in the various research areas.
- High-calibre research: The NORKLIMA programme seeks to foster climate research of top international calibre.
- Cross-disciplinarity: The NORKLIMA programme seeks to ensure that Norwegian climate research utilises the potential inherent in cross-disciplinary cooperation.
- Communication: The NORKLIMA programme seeks to maintain close contact between researchers and society and achieve effective dissemination of research results.

- **Recruitment:** The NORKLIMA programme seeks to promote recruitment (at the doctoral and post-doctoral level) and to provide outstanding researchers above the post-doctoral level with the opportunity to conduct studies of climate impacts and climate change. In addition, measures will be implemented to recruit and develop new *research managers* in the area of climate research.

Analysis of the state-of-the art and knowledge-related challenges

Understanding of climate trends, variability and uncertainty

During the first segment of the programme period, research projects under the NORKLIMA programme have played a part in strengthening and further developing Norwegian research on climate development and variability, and have contributed to the development of reliable global and regional climate models. Within these fields, the objectives of the work programme have largely been achieved. Research to improve our understanding of the climate system (the ocean climate, atmospheric processes, natural variability, rapid change, and anthropogenic contributions to climate change) and on the development of regional climate scenarios has been adequately addressed. In addition, there has been some research on feedback mechanisms. The weakest area has been research linking climate trends to various socio-economic and emission scenarios. Such research is important for the development of mitigation options and for monitoring compliance with emission-reduction commitments. For the remainder of the programme period, natural climate variability and quantification of uncertainty are the areas where there is most need for new understanding. More research is also needed on feedback mechanisms in the climate system and their importance for future climate trends. Furthermore, research is needed to strengthen model development, particularly to develop better regional climate scenarios. Research in this field will also have considerable translational value and can provide a basis for better climate change adaptation strategies in other parts of the world.

Knowledge about the impacts of climate change

Until now, research projects under the NORKLIMA programme have only been able to cover a limited selection of research topics related to the impacts of climate change. One objective of the programme is to identify the most important challenges that climate change will involve for Norwegian society in the next few decades, on the basis of a quantified level of uncertainty.

The impacts of climate change depend on a system's vulnerability, adaptive capacity and resilience. The overall picture will vary a great deal. Some research topics will be cross-cutting and cross-sectoral, and projects should include research on the significance of climate change for different sectors.

Research on the impacts of climate change must therefore have a wide scope, and must include various economic sectors, distributional effects, interests and actors, and cover different regions and local communities. Climate research must also link together national and international perspectives. Research on the impacts of climate

change in other countries, particularly developing countries, should also be included. Developing countries will be more vulnerable to climate change than Norway, while impacts in developing countries may in turn affect Norway in various ways. The research in this field must among other things contribute to the development of a development cooperation policy that takes climate change into account. Key issues for developing countries will be the impacts of climate change on food production and water resources.

In the NORKLIMA programme, research on the impacts of climate change is split between three different scientific objectives. Until now, most research has been carried out on the impacts of climate change on ecosystems, with an emphasis on basic biological and ecological research related to the dominant ecosystems in Norway and individual species. Climate change may result in major changes in ecosystems, since the climate plays an important role in regulating distribution, growth and interactions between species. The objective is to identify how great an impact climate change will have on ecosystem distribution and functioning. To generate knowledge that is generally applicable, research should take an ecosystem perspective. It is particularly important to distinguish between the natural dynamics of ecosystems and populations, the effects of other environmental pressures, and the impacts of climate change.

In the context of natural resource-based industries, topics of special interest include the impacts of climate change on the long-term productivity of these industries and the implications for natural resource management in the future. Some research has been carried out on marine ecosystems and fisheries and on forestry, but the research effort should be intensified. There has been less research linking biological impacts and impacts on natural resources with economic impacts and social change.

Although climate change is very important in itself, it will also interact with other pressures on ecosystems and natural resources. Research looking at the importance of climate change in the context of other trends in society is urgently needed.

So far, the programme has only included a limited amount of research on the impacts of climate change on other sectors of society, such as transport, energy and planning, and there is a great need for more knowledge. Every year, weather conditions cause widespread damage to the built environment, including infrastructure, installations and the cultural heritage. The situation is likely to worsen with climate change, both with the gradual changes in average conditions and as a result of more frequent extreme weather events. A well-functioning and reliable infrastructure is an important basis for economic growth and social development. The lifetime of buildings and other infrastructure depends on the severity of local weather conditions. Temporal and spatial changes in snow cover and type, ice conditions, water flow regimes and sediment transport influence water supplies, energy production and transport. Flooding, landslides and a rising sea level have an impact on infrastructure and settlement patterns in municipalities that are affected by them. To generate sound, relevant knowledge it is important to strengthen interdisciplinary research on the impacts of climate change.

Knowledge about adaptation to climate change

Adaptation to climate change is a relatively new field of research covering all levels of society from local communities to national institutions. During the past few years, the NORKLIMA programme has launched several long-term studies of adaptation needs and strategies at the local level, and some sector-based research has also been conducted. Major gaps in knowledge remain in areas where research has been lacking, and there is a need to improve efforts to uncover and identify the needs for knowledge. In particular, research at the national level has been limited. Research has also been lacking on the legal and security policy challenges that may arise from climate change, the overall economic impact of climate change, or how a particular path of social development and the emission trends associated with it will influence the climate system.

Climate change may present a challenge in the context of societal security. Research must foster an understanding of the political processes that affect the basis for adaptation to climate change. There is a need for research that sheds light on the factors that strengthen society's ability to adapt and its capacity for restructuring in response to changed climatic conditions at and across various levels. Coordination across sectors of society and levels of public administration presents a special challenge. Research must be relevant for the formulation of policy and development of instruments in the climate field. In addition, research on adaptation to climate change should shed light on the conflicts of interest that may arise, on accountability and distributional effects, and on how power relations may affect these.

Prioritised research tasks

The research tasks listed under the various scientific and strategic objectives have been prioritised to support the programme's primary objective of generating the knowledge base needed for society's adaptation to climate change. A state-of-the-art review in the light of the original objectives has shown that stricter prioritisation is needed. In addition, the budget frameworks have been more limited than first anticipated. Ultimately, it is the funding that determines which research may be conducted.

Although the NORKLIMA programme has identified five scientific objectives, the research questions covered by these objectives are actually interconnected.

Two types of links are particularly important:

- Research on emission scenarios and the response of the climate system under different emission scenarios is relevant to scientific objectives 1 and 4.
- Research on impacts on cultivated ecosystems, which in practice means on natural resource-based industries such as forestry, agriculture, reindeer husbandry, fisheries and aquaculture, is relevant to scientific objectives 3 and 4.

Other thematic areas are also covered under other objectives. It is therefore crucial not to categorise the thematic areas too strictly according to objective, as there is a danger of vital research questions falling between the cracks. In the individual call for proposals, the thematic areas under each objective will be specifically prioritised

depending on factors such as available funding. The order in which thematic areas are presented is therefore not an indication of prioritisation between them.

Priorities for each of the scientific objectives

Scientific objective 1:

- To improve understanding of the climate system and its variability, and to quantify uncertainty

The NORKLIMA programme is intended to improve our understanding of climate change both globally and regionally, making it possible to construct more reliable scenarios for the future climate, particularly for Norway and adjacent areas.

General guidelines:

For the remaining segment of the NORKLIMA programme period, the following general guidelines will be followed for research under scientific objective 1:

- 1) There should be satisfactory progress in research on key themes from the International Polar Year (IPY), with a particular emphasis on polar climate processes and their importance in the climate system.
- 2) Research on processes in the climate system should improve the quality of climate models.

Priorities

The following thematic areas will be given priority in the remaining segment of the programme period:

- Reduction of uncertainties in climate scenarios, with a view to improving decadal time scale predictability:
 - ✓ The variability of the climate system and its sensitivity to different levels of radiative forcing
 - ✓ Teleconnections in the climate system
 - ✓ The existence of critical thresholds (tipping points) in the climate system
 - ✓ Cloud formation and ocean circulation
 - ✓ The biosphere and feedback mechanisms; should also be linked to adaptation measures in developing countries
- Earth system modelling:
 - ✓ Development of a global model including an interactive carbon cycle, in which the CO₂ content of the atmosphere is explicitly modelled as a response to climate change
 - ✓ Development of a regional climate model through Nordic cooperation
- Climate scenarios:

- ✓ Sector-based climate scenarios, including building up expertise for the further development of scenarios and downscaling products that target sectoral needs more directly
- ✓ Regional climate scenarios for use in research on adaptation to climate change in developing countries related to Norwegian development policy.

Scientific objective 2:

- To improve knowledge of climate change and its impacts on buildings, infrastructure and other installations, both on land and offshore

The NORKLIMA programme is intended to increase our knowledge of the impacts of climate change on the physical environment, including the built environment, water resources, flooding, snow and ice conditions, landslides and avalanches, erosion, glaciers, fjords, water temperature and sea level. Such physical factors are a key part of the framework for ecological systems, for production in the energy sector, agriculture, fisheries and so on, and for infrastructure of crucial importance to society, such as transport infrastructure. Research under this scientific objective should also generate knowledge that can be used to improve emergency response capacity, including clarifying responsibilities and dealing with uncertainty in this field.

General guidelines:

- 1) The NORKLIMA programme will encourage interactions between natural science, technological and social science research under this scientific objective.
- 2) Within this thematic area, the programme will reserve a certain amount of funding for Knowledge-building Projects with User Involvement.

Priorities

The following thematic areas will be given priority in the remaining segment of the programme period:

- Research that will help to build up adaptive capacity at the local, regional and national level with a view to reducing the vulnerability of buildings, infrastructure and installations to gradual climate change. Will include the effects of rising sea level, ice-melt, changes in the distribution of sea ice, changes in snow cover, changes in the permafrost, and damage to agricultural areas.
- Research on damage caused to infrastructure and installations by extreme weather events, and the impacts on various sectors, such as the construction industry. This includes research on extreme precipitation events and natural disasters (landslides, flooding, storm surges) resulting from climate change.

Scientific objective 3:

- To improve knowledge of climate change and its impacts on natural and cultivated ecosystems and natural resource-based industries.

The NORKLIMA programme is intended to identify and quantify the direct and indirect impact of climate change on marine, limnic and terrestrial ecosystems in terms of species distribution, interactions between species, relevant biogeochemical functions and productivity. Another important thematic area is how ecosystem functions and services will be affected by climate change. The biological and ecological processes that influence natural ecosystems will also affect industries based on biological production. The programme is intended to generate knowledge of how climate change will affect production and operating conditions in natural resource-based industries such as forestry, agriculture, aquaculture and fisheries.

Priorities

The following thematic areas will be given priority in the remaining segment of the programme period:

- Research to develop model-based analyses of the impacts of climate change at the ecosystem level, with a view to developing scenarios of changes in Norwegian ecosystems with climate change. This research should link basic scientific understanding with the knowledge needs of the public administration and relevant industries.
- Sector-based research on the social and economic implications of climate change for natural resource-based industries such as forestry, agriculture, reindeer husbandry, fisheries and aquaculture in Norway and developing countries. In the case of developing countries, the impacts of climate change on food production will be an important research question. Within this thematic area, the programme will reserve a certain amount of funding for Knowledge-building Projects with User Involvement.
- The interplay between climate change and other man-made pressures on ecosystems (including pollution and land use changes), if possible in cooperation with other research programmes.

Scientific objective 4:

- To improve knowledge of the impacts of climate change on society and how adaptive capacity can be strengthened.

Research under this objective should build up capacity for adaptation to climate change, and deal with how governance systems and the institutional framework can be developed to make society more robust. Research must be relevant to the development of policy and instruments in this field. Other relevant research questions will be which conflicts of interest may arise, accountability and distributional effects, and how power relations may influence the other factors.

Priorities

The following thematic areas will be given priority in the remaining segment of the programme period:

- Methodology and theory relating to social and economic vulnerability and adaptation to climate change at the local, regional and national level, both in Norway and in developing countries.
- The institutional and political framework in relation to adaptation strategies. This may be viewed in relation to power and accountability, planning, coordination, multi-level governance, etc.
- Legal issues viewed in terms of the impacts of and adaptation to climate change. Relevant issues in this context will include accountability and rights in the short and long term.
- The treatment of uncertainty and risk related to climate change in key areas of society, including an understanding of uncertainty in climate scenarios and economic uncertainty.

Scientific objective 5:

- To improve knowledge of the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

Research on international climate agreements, the factors that affect the design of and support for different types of agreements, and the possible impacts on climate development, has been transferred from the RENERGI programme to the NORKLIMA programme.

Research on international climate agreements should be linked to research on emission scenarios, the development of society, and compliance with climate agreements based on targets for the atmospheric concentration of CO₂. Cross-disciplinary research will be important under this objective.

Priorities

The following thematic areas will be given priority in the remaining segment of the programme period:

- Research linking climate scenarios and socio-economic scenarios, with a view to obtaining better knowledge of future emission trends and their importance for the development of society and climate development. This includes research to improve our understanding of the situation in developing countries under changed climatic conditions.
- The carbon cycle and monitoring of the atmospheric concentration of CO₂ in compliance with international commitments relating to target concentrations. This includes research that can improve quality assurance of investments made by the Government to halt deforestation at the global level (through Norway's International Climate and Forest Initiative).

- International climate agreements, the factors that affect the design of and support for different types of agreements, and the possible impacts on climate development.

Strategic objectives

- National distribution of tasks: The NORKLIMA programme seeks to ensure satisfactory distribution of tasks at the national level in order to utilise top national expertise in the various research areas.

The programme seeks to be an instrument for ensuring the optimal use of resources within climate research in the natural and social sciences. The NORKLIMA programme will encourage the highest quality research groups to apply for funding under the programme and will actively promote national cooperation. An important means of achieving this will be the use of coordinated cross-institutional projects at the national or regional level.

- High-calibre research: The NORKLIMA programme seeks to foster climate research of top international calibre.

Grant applications will be assessed by international experts to ensure the scientific merit of the research. Mid-term and final evaluations should be conducted of projects that are large-scale or long-term in nature.

The programme gives high priority to forging close links between Norwegian and international research activity in order to benefit from the international research that has been and is being conducted in the field. The objective is for Norway to make a significant contribution to international research activity.

- Cross-disciplinarity: The NORKLIMA programme seeks to ensure that Norwegian climate research utilises the potential inherent in cross-disciplinary cooperation.

The field of research addressed by the NORKLIMA programme is complex. Consequently, the scientific merit and relevance of research depends on sound cross-disciplinary projects and productive links between basic and applied research. The NORKLIMA programme will cultivate this by creating forums in which various research groups can meet, by giving high priority to cross-disciplinarity in its calls for proposals and by emphasising the translational value of the research.

- Communication: The NORKLIMA programme seeks to maintain close contact between researchers and society and achieve effective dissemination of research results.

The programme targets a broad user group, including sectoral authorities and public administration in general, relevant segments of the private sector (e.g. insurance, finance, building and construction, aquaculture) and the research community. Active, two-way dialogue between researchers and users will be crucial when identifying relevant research questions, especially those related to society's adaptation to climate

change. Certain projects should also maintain an ongoing dialogue with users to ensure that the research activity remains relevant.

Research findings must be disseminated in a dynamic, effective manner through a variety of channels, and have a form and substance that is adapted to the specific users.

- Recruitment: The NORKLIMA programme seeks to promote recruitment (at the doctoral and post-doctoral level) and to provide outstanding researchers above the post-doctoral level with the opportunity to conduct studies of climate impacts and climate change. In addition, measures will be implemented to recruit and develop new *research managers* in the area of climate research.

Recruiting researchers with a strong, broad-based scientific background is crucial for Norwegian research on the impacts of climate change. To facilitate such recruitment, the programme will award doctoral and post-doctoral fellowships to highly qualified candidates and provide support to young researchers above the post-doctoral level. Recruitment must be viewed in a longer term perspective to ensure that the number of research managers continues to grow in the next generation. It is essential to recruit research managers to avoid a weakening of the research field when the current research managers reach retirement age. This is a natural continuation of the researcher recruitment efforts carried out during the first half of the programme period.

Need for infrastructure

Up-to-date research infrastructure is essential if researchers are to meet the knowledge-related challenges within climate research. It is also a prerequisite for efficiency and quality in research. Research groups that have access to advanced research infrastructure – such as high-performance computing resources, key time series and databases, well-developed modelling tools, advanced measuring equipment, and a representative, advanced observation system – are more attractive as partners in international research collaboration, and in many cases is required for such collaboration.

Focus on research infrastructure is increasing dramatically in Europe, both at the national and pan-European level. The Research Council has drawn up strategies for new investment in infrastructure. These include the new strategy for eInfrastructure and the National Strategy for Research Infrastructure (2008-2017). In autumn 2006, the European Strategy Forum on Research Infrastructures (ESFRI) published Europe's first roadmap for research infrastructure, which identifies 35 large-scale, joint European infrastructures. This overview was updated with new projects in autumn 2008. Several large-scale research infrastructures, such as EMSO (deep sea-floor observatories), ICOS (monitoring of greenhouse gas fluxes) and Lifewatch (analysis of biodiversity), are relevant for climate research. Norwegian research groups have also put forth several research infrastructure platforms relevant for climate studies in connection with the national strategy. Continued focus on the use and further development of Svalbard as a pan-European platform for research, not least climate research, is important in this context.

Optimal use of funding also requires the effective organisation of infrastructure at the national level. The NORKLIMA programme will actively work to identify key national needs for infrastructure in the climate field. An important principle for national efforts is to ensure that allocations for national research infrastructure are consistent with the Research Council's overall priorities and other research funding.

Relevant forms of support

The NORKLIMA programme provides funding mainly to Researcher Projects and researcher recruitment (i.e. Doctoral and Post-doctoral Research Fellowships). This is considered essential for addressing the challenges facing climate research.

For some research questions, the programme will employ Knowledge-building Projects with User Involvement (KMB) as the funding instrument, as KMB projects are viewed as the most suitable instrument for involving trade and industry in climate research.

At this time, User-driven Innovation Projects (BIP) are regarded as unsuitable for use by the NORKLIMA programme because the climate field is not sufficiently developed for the commercial development and innovation required for BIP projects.

Budget

Budget development

The NORKLIMA budget was approximately NOK 100 million in 2004, NOK 88 million in 2005, NOK 87 million in 2006, NOK 70 million in 2007, and NOK 74 million in 2008. The budget has decreased despite proposals for budget increases put forward by the Research Council year after year. The programme has been financed primarily by the Ministry of the Environment and the Fund for Research and Innovation.

Table 1. The NORKLIMA programme budget 2004-2008, NOK 1000

Funding source	2004	2005	2006	2007	2008
Ministry of the Environment	38 100	38 100	39 600	39 600	41 150
Ministry of Education and Research	5 830	5 520	5 520	5 520	5 520
Ministry of Agriculture and Food	3 000	2 500	3 000	3 000	4 000
Ministry of Fisheries and Coastal Affairs	1 000	1 000	1 000	1 000	2 500
Ministry of Transport and Communications			1 000	800	800
Fund for Research and Innovation	48 300	41 000	36 000	20 000	20 000
Special allocations	4 500				
Total	100 730	88 120	86 620	70 720	73 970

Should the programme's budget remain at the current level, it will not be possible to achieve the programme's primary objective or all of its scientific and strategic objectives. However, individual thematic areas and objectives will continue to be relatively well supported.

Should the current budget framework remain unchanged, most of the funding will be pre-committed to meet obligations previously agreed to for the period 2009-2013. Given the call for proposals for NOK 50 million in research funding planned for 2008, and assuming that the current budget framework is continued, the programme will be able to allocate about NOK 70 million in new research funding distributed over the period 2009-2013. This is based on the assumption that the Ministry of Foreign Affairs will continue to allocate NOK 9 million per year to the programme, also after 2010, in connection with the collaboration with China on climate research. This would make an average of approximately NOK 14 million per year available to new projects throughout the period.

The NORKLIMA programme is in a difficult financial position. This revised work programme therefore puts special focus on clarifying the various priorities based on future budget parameters at different levels.

Ambition level and priorities at different budgetary levels

1. Zero-growth budget – and corresponding research priorities

In case of a zero-growth budget, most of the allocations will be pre-committed to meet obligations previously agreed to for the period 2009-2013. Given the call for proposals for NOK 50 million in research funding planned for 2008 and assuming that the current budget framework is continued, the programme will be able to allocate a total of about NOK 70 million in new research funding for the period 2009-2013, provided that funding is transferred from the RENERGI programme.

If the budget is not increased, the NORKLIMA programme will have to prioritise individually selected research questions that are viewed as important for generating knowledge about the climate system and the impacts of climate change on the natural environment and society as a basis for adaptive responses by society, but it will not be possible to meet the expectations for the programme's status as a Large-scale Programme.

Neither will there be a basis for adequate follow-up of climate research conducted under the International Polar Year (IPY), including the recruitment to climate research encouraged by the IPY.

Given the extremely difficult financial situation, priority will be given to conducting research of key importance and research that so far has received very limited funding under the programme. It will not be possible to maintain the research capacity that has been developed. However, under scientific objective 1, it will be possible to fund some research on the reduction of uncertainties in climate scenarios and thus provide a basis for sector-based climate scenarios. Under scientific objective 2, it will be possible to conduct some research on the vulnerability of buildings and infrastructure to gradual climate change. This has been a weak point in the implementation of the programme until now. Under scientific objective 3, it will be possible to include some research on the social and economic implications of climate change for natural resource-based industries, which so far has been poorly addressed under the programme.

2. Budget increase of NOK 405 million, shown in a needs analysis to be the necessary level of resources – and corresponding research priorities

An analysis of research needs shows that the programme needs increased allocations of at least NOK 405 million for the period 2009-2013 (an additional NOK 77 million on average per year). A budget of this size would provide the latitude for action needed to achieve the objectives and goals set out in the work programme. Such a budget increase will also enable the programme to give higher priority to international research questions, especially climate change in developing countries, than it has in the past. The volume of eligible grant proposals indicates that Norwegian research groups have the capacity for conducting high-calibre, relevant climate research within this budget framework. The section below discusses what the programme could accomplish if allocations were increased by NOK 405 for the period 2009-2013.

This would enable the programme to award research funding of about NOK 90 million on average per year (NOK 14 million + NOK 77 million) up to the programme's final phase (2009-2013). Most projects should be launched by 2011 to ensure completion within the programme period.

A budget increase at this level will also ensure satisfactory follow-up of key climate research questions addressed by the IPY.

Research that can be conducted with a budget increase corresponding to need (an additional NOK 405 million)

An allocation of NOK 90 million is proposed for scientific objective 1, which is to improve understanding of the climate system and its variability, and to quantify uncertainty. With a budget of this size, it will be possible to continue to build up research expertise on an understanding of the climate system. There will be a special emphasis on research to reduce uncertainty in climate scenarios, with a view to improving decadal time scale predictability. This will include improving understanding of the variability of the climate system and its sensitivity to different levels of radiative forcing, teleconnections in the climate system, the existence of tipping points in the climate system, cloud formation and ocean circulation, and research on the biosphere and feedback mechanisms. It will also be possible to continue research on key themes from the IPY. Moreover, the programme will be in a position to contribute to the development of an Earth system model and a regional climate model through Nordic cooperation. This will be contingent on funding at the Nordic level. A top-level Nordic research initiative, the Nordic Excellence in Research Programme, is currently being planned, and will probably make this possible. Furthermore, it will be possible for the programme to develop sector-based climate scenarios, including building up expertise for the further development of scenarios and downscaling products that target sectoral needs more directly. Finally, the programme will be able to continue building up expertise and cooperation on regional climate scenarios for use in research on adaptation to climate change in selected areas of importance for Norwegian development policy.

An allocation of NOK 95 million is proposed for scientific objective 2, which is to improve knowledge of climate change and its impacts on buildings, infrastructure and other installations. This will make it possible to increase research capacity and continue to build up expertise in research to develop adaptive capacity at the local, regional and national level with a view to reducing the vulnerability of buildings, infrastructure and installations to gradual climate change. This includes research on the effects of rising sea level, ice-melt, changes in the distribution of sea ice, changes in snow cover, changes in the permafrost, and damage to agricultural areas. The programme will also be able to increase research capacity and continue to build up expertise on damage caused to infrastructure and installations by extreme weather events, and the impacts on various sectors, such as the construction industry. This area includes research on extreme precipitation events and natural disasters (landslides, flooding, storm surges) resulting from climate change. Under this objective, the programme will fund a limited number of KMB projects by involving relevant industries and businesses (e.g. insurance companies).

An allocation of NOK 95 million is proposed for scientific objective 3, which is to improve knowledge of climate change and its impacts on natural and cultivated ecosystems and natural resource-based industries. This will enable the programme to increase research capacity and maintain expertise on the development of model-based

analyses of the impacts of climate change at the ecosystem level, with a view to developing scenarios of changes in Norwegian ecosystems with climate change. Progress in this area will make it possible to link basic scientific understanding with the knowledge needs of various sectors and relevant industries, including nature management, fisheries, aquaculture and forestry. It will also be possible for the programme to increase capacity and continue to build up expertise in sector-based research on the impacts of climate change on natural resource-based industries such as forestry, agriculture, reindeer husbandry, fisheries and aquaculture. In the case of developing countries, the impacts of climate change on food production will be an important research question. Under this objective, the programme will fund a limited number of KMB projects. In addition, the programme will be able to build up expertise and continue research on the interplay between climate change and other man-made pressures on ecosystems (including pollution and physical alteration of the landscape), in cooperation with other research programmes.

An allocation of NOK 65 million is proposed for scientific objective 4, which is to improve knowledge of the impacts of climate change on society and how adaptive capacity can be strengthened. This will enable the programme to increase research capacity and maintain expertise on methodology and theory relating to social and economic vulnerability and adaptation to climate change at the local, regional and national level, both in Norway and in developing countries. It will also be possible to increase research capacity and build up expertise on institutional aspects of the development of adaptation strategies. Furthermore, the programme will be able to play a part in increasing capacity and building up expertise on the treatment of uncertainty, including economic uncertainty, in climate scenarios in relation to risk assessment, and the application of such scenarios in a societal context.

An allocation of NOK 60 million is proposed for scientific objective 5, which is to improve knowledge of the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

This will enable the programme to increase research capacity and build up expertise on links between climate scenarios and socio-economic scenarios, with a view to obtaining better knowledge of future trends in emissions and the significance of this for climate change. This includes research to increase understanding of the situation in developing countries under changed climatic conditions. It will also be possible to increase capacity and build up expertise in research on the carbon cycle and monitoring of compliance with international commitments related to targets for the atmospheric concentration of CO₂. This includes research that can improve quality assurance of investments made by the Government to halt deforestation at the global level (through Norway's International Climate and Forest Initiative, investment level NOK 3 billion per year). It will also be possible to build up expertise on international climate agreements, the factors that affect the design of and support for different types of agreements, and the possible impacts on climate development.

3. Budget increase of NOK 220 million – in case of a smaller budget than suggested by the needs analysis – and corresponding research priorities

A budget increase at this level will enable the programme to follow-up on a moderate range of research areas and partially meet the need for follow-up of research conducted under the IPY.

Should the programme not be allocated the necessary resources for achieving the programme's objectives, cf. the needs analysis, priority will be given to the following areas:

Research that can be conducted with a budget increase of NOK 225 million

An allocation of NOK 35 million is proposed for scientific objective 1, which is to improve understanding of the climate system and its variability, and to quantify uncertainty. With a budget of this size, it will be possible to continue to build up research expertise on an understanding of the climate system. There will be a special emphasis on research to reduce uncertainty in climate scenarios, with a view to improving decadal time scale predictability. It will also be possible to develop sector-based climate scenarios.

An allocation of NOK 70 million is proposed for scientific objective 2, which is to improve knowledge of climate change and its impacts on buildings, infrastructure and other installations. This will make it possible to conduct some research to develop adaptive capacity at the local, regional and national level with a view to reducing the vulnerability of buildings, infrastructure and installations to gradual climate change. A certain level of capacity building will also be possible as regards research on the damage caused to infrastructure and installations by extreme weather events, and the impacts on various sectors, such as the construction industry. This area includes research on extreme precipitation events and natural disasters (landslides, flooding, storm surges) resulting from climate change.

An allocation of NOK 40 million is proposed for scientific objective 3, which is to improve knowledge of climate change and its impacts on natural and cultivated ecosystems and natural resource-based industries. This will enable the programme to maintain expertise on research to develop model-based analyses of the impacts of climate change at the ecosystem level, with a view to developing scenarios of changes in Norwegian ecosystems with climate change. The programme will also be able to increase capacity and maintain expertise in sector-based research on the impacts of climate change on natural resource-based industries, for a limited selection of sectors and industries.

An allocation of NOK 40 million is proposed for scientific objective 4, which is to improve knowledge of the impacts of climate change on society and how adaptive capacity can be strengthened. This will make it possible to maintain expertise on methodology and theory relating to social and economic vulnerability and adaptation to climate change at the local, regional and national level in Norway. It will also be possible to conduct some research on institutional aspects of the development of adaptation strategies.

An allocation of NOK 35 million is proposed for scientific objective 5, which is to improve knowledge of the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

Continuation of research on international climate agreements will be given priority. A budget of this size will make it possible to conduct research on the links between climate scenarios and socio-economic scenarios, with a view to obtaining better knowledge of future emission trends and their importance for climate development. In addition, it will be possible to conduct some research on the carbon cycle and monitoring of compliance with international commitments related to targets for the atmospheric concentration of CO₂. This includes research that can improve quality

assurance of investments made by the Government to halt deforestation at the global level (through Norway's International Climate and Forest Initiative).

Potential funding sources

Whether the objectives set out in the original work programme are achieved will depend on the funders that contribute to the programme and the priorities and guidelines that these endorse. The ministries and the Fund for Research and Innovation are considered to be the main potential sources of funding, but commercial enterprises may also contribute through their participation in KMB projects.

Any increase in the NORKLIMA budget must come primarily from ministries other than those that currently allocate the most to the programme. This will be followed up in the Research Council's budget proposal. Use of KMB projects could also increase funding for NORKLIMA research, and the programme will begin using this funding instrument as well.

International cooperation

The NORKLIMA programme seeks to strengthen international research collaboration by emphasising internationalisation in its calls for proposals and selection of research projects as well as through participation in international programmes and activities. Special focus will be placed on involving Norwegian projects and research groups directly in the implementation and management of major international programmes under the auspices of the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP). As far as possible, research projects should help to strengthen the efforts of the IPCC. The NORKLIMA programme will give priority to communicating relevant research findings to the IPCC by synthesising and presenting the results of Norwegian climate research.

Participation in international networks such as the ERA-NET scheme, European Science Foundation (ESF) initiatives and the like will be assessed in the light of whether such international participation will help to enhance research under the NORKLIMA programme and achieve the programme's scientific and strategic objectives.

Priority will be given to the following types of international cooperation:

- Projects that involve cooperation between researchers and institutions;
- Participation in the ERA-NET scheme. The NORKLIMA programme participates in the initiative on Climate Impact Research Coordination for a Larger Europe (CIRCLE) and in the European Polar Consortium: Strategic Coordination and Networking of European Polar RTD Programmes (EUROPOLAR) under the European Polar Board. The NORKLIMA programme issues joint calls for proposals in cooperation with these two initiatives.
- Participation by Norwegian researchers and the NORKLIMA administration in international scientific forums;
- Cooperation with the International Polar Year;

- Participation in the programme on the Challenges of Marine Coring Research (EuroMARC), an ESF initiative in the area of paleoclimate research;
- International research collaboration on climate change in developing countries.

Several important activities are underway which are crucial for NORKLIMA's future international efforts:

- Work has begun on the IPCC's next assessment report. In order to be taken into consideration, research results must be published by 2011. Through the NorClim project, among others, the NORKLIMA programme will also take part in running global climate models for the next assessment report. The programme expects that results from other NORKLIMA projects will also be used by the IPCC.
- A new research initiative has been launched on the significance of climate change for developing countries, especially China. The NORKLIMA programme will issue the first call for proposals in connection with this initiative in autumn 2008, and will follow it up on an ongoing basis within the programme's financial framework.
- A comprehensive, top-level research initiative in the areas of climate, energy and the environment is being launched in the Nordic region. The NORKLIMA programme will play a key role in establishing sound pan-Nordic climate research initiatives.
- During 2008-2009, a follow-up of the ERA-NET initiative CIRCLE in the area of climate research will likely be established. The NORKLIMA programme is participating in these planning efforts.

Communication – information and dissemination

NORKLIMA's communication plan from the first phase of the programme still applies. Communication plays a crucial part in addressing some of the programme's most important challenges, such as:

- Budget development, which has been negative and inadequate for meeting research needs. Good communication with decision-makers and clear dissemination of results will be one of several measures used in efforts to increase the budget.
- The programme's scientific range and the nature of the field. The NORKLIMA programme must be well-organised and represent the totality of Norwegian climate research. The strategy for achieving this has been two-fold: researcher meetings, which have produced concrete results for researcher cooperation and clear synergy effects for the programme, and strategically formulated calls for proposals, which have generated national cooperation and cross-disciplinary projects. This must continue.
- The users' need for results and knowledge along with the programme's need for profiling. Results from the projects have been disseminated in popularised form mainly through *Klima* magazine. Communication, especially the dissemination of results, has been enhanced starting in 2008. A new website has been established, and a number of articles presenting research findings have been published on various websites and in the mass media. The challenge is to take advantage of the enormous media interest in climate issues by

gaining more coverage for sound research results in general and for results produced under the NORKLIMA programme in particular.

Dissemination of research results has been based primarily on individual projects. Toward the end of the programme period it will become increasingly important to disseminate results from the programme as a whole.

A work plan for communication and dissemination is updated each year based on the following table:

Channel	Target group	Comments (annual objectives, deadlines)
<i>Klima</i> magazine	Researchers and users – public administration, trade and industry, and the general public	<ul style="list-style-type: none"> • 6 editions in 2007 á 8 -12 pages of NORKLIMA material; • Mostly articles from projects, written by researchers (reviewed by NORKLIMA's editorial board); • Other news from the programme.
Programme's webpages	Researchers, programme board, users	Includes new research articles, articles from <i>Klima</i> magazine, news from the programme (plans for calls for proposals, seminars, etc.), useful documents and the like.
Forskning.no, a research news website in Norwegian	General public	5-10 articles per year, based on new results (recycling of articles from the programme's webpages).
Research Council website		Recycling of articles and news from the programme's webpages that are of interest to large user groups.
Other websites	Varies	Recycling of articles from the programme's webpages.
Mass media	General public	Based on new research results, but opinion pieces are included as well.
Fact sheets	Users – public administration, trade and industry, and the general public	Recycling of articles on research results from the programme's webpages.
Annual report	Users, especially public administration (financing ministries)	Following the Research Council's template.
Researcher seminar	Researchers, the programme board and selected users	Approximately every other year.
User forum	Users, selected sectors	1-2 per year. Latest results + direct contact with researchers for the relevant sector.
Articles in professional journals	Trade and industry	Results and opinion pieces.

Targets (criteria for success), milestones and performance indicators

Targets (criteria for success)	Performance indicators
<p>High-level of scientific merit</p> <ul style="list-style-type: none"> • Produce climate research of high international calibre. • Develop research groups that are visible internationally and leaders in their respective fields. 	<ul style="list-style-type: none"> • Number of publications in scientific journals with peer review. • Number of publications in other scientific and/or scholarly journals. • Number of scientific books or monographs. • Number of publications at international conferences with peer review.
<p>Strengthened researcher recruitment</p> <ul style="list-style-type: none"> • Development of personnel with a high level of expertise in the programme's thematic areas. 	<ul style="list-style-type: none"> • Number of completed doctorates funded under the programme. • Number of doctoral research fellowships funded under the programme. • Number of post-doctoral researchers funded under the programme.
<p>Improved interaction across types of research, scientific fields and sectors</p> <ul style="list-style-type: none"> • Trigger the potential found in improved interaction between basic research, applied research and innovation. • Cultivate cross-disciplinarity. • National leadership and coordination of research in the programme's thematic areas. 	<ul style="list-style-type: none"> • Percentage of projects involving several natural science fields. • Percentage of projects involving basic research and applied research. • Percentage of projects that represent natural science and social science fields.
<p>New insight of relevance to society</p> <ul style="list-style-type: none"> • Develop research groups with expertise relevant for trade and industry and public administration. • Contribute to knowledge development for use in policy designation. • Play a role in solving social challenges/problems. 	<ul style="list-style-type: none"> • Examples that the programme has had a positive impact on public administration with regard to meeting social and environmental challenges. • Examples of references to the NORKLIMA programme or projects funded under the programme in key public documents.
<p>Strengthened international cooperation</p> <ul style="list-style-type: none"> • Be a bridgehead for increased interaction with leading international research groups in the field. • Prioritise participation in international research collaboration and the development of international networks. 	<ul style="list-style-type: none"> • Number of projects in cooperation with international research groups. • The research groups' project portfolio from EU programmes in the NORKLIMA programme's thematic areas. • Number of fellowship-holders/researchers on extended stays as visiting researchers in international research groups. • Number of international guest researchers associated with projects.

	<ul style="list-style-type: none"> • Other forms of international interaction, such as participation on international scientific committees and organised cooperation with leading international research groups.
<p>Good communication with the programme's target groups</p> <ul style="list-style-type: none"> • Active communication that also includes synthesising the programme's results and making recommendations for how these can be followed up. • Relevant, up-to-date information. • Effective dissemination of results. • Results that are utilised. • Visibility. • Publicity in the media and contributions to the public debate. 	<ul style="list-style-type: none"> • Information and dissemination measures for relevant target groups, including the financing ministries. • Satisfied users. • Profiling of the programme's webpages. • Implemented dissemination measures: <ul style="list-style-type: none"> open seminars and workshops presentations at scientific meetings meetings with funding sources and users books, reports, audio-visual products teaching material • Visible utilisation within trade and industry and public administration. • Measures targeted toward the general public (e.g. National Science Week in Norway and the research news website forskning.no) • News, interviews, feature articles, opinion pieces. • Number of weekly visit to programme's webpages. • Number of popular scientific publications.
<p>Increased budget/acquisition of new funding sources</p> <ul style="list-style-type: none"> • The budget for the NORKLIMA programme should be at least NOK 160 million per year, cf. <i>Nasjonal handlingsplan for klimaforskning</i> ("National action plan for climate research"). 	<ul style="list-style-type: none"> • Number of ministries as new funding sources. • Number of commercial fields as funding sources.

Organisation

The NORKLIMA programme board has nine members who are appointed by the research board of the Division for Strategic Priorities. The members of the programme board have been selected to ensure that the group as a whole represents a broad range of scientific expertise and user involvement and that there are no significant challenges in adhering to the Guidelines on Impartiality and Confidence in the Research Council of Norway when assessing grant proposals.

Based on the approved profile for representation of expertise on the programme board, the following NORKLIMA programme board was appointed in February for the period 15 February 2008 – 15 February 2011.

- Eli Aamot, Vice President of New Energy and New Ideas, Research and Development, Statoil (chair)
- Audun Rosland, Senior Adviser on Climate Change, Norwegian Pollution Control Authority (deputy chair)
- Eystein Jansen, Professor, University of Bergen, and Director, Bjerknes Centre for Climate Research
- Caroline Leck, Professor, Department of Meteorology, University of Stockholm
- Knut Alfsen, Head Research Director, CICERO Center for International Climate and Environmental Research - Oslo
- Eirik S. Amundsen, Professor, Department of Food and Resource Economics, University of Copenhagen
- Sune Linder, Professor, Southern Swedish Forest Research Centre
- Cecilie von Quillfeldt, Senior Adviser, Norwegian Polar Institute
- Elisabeth Nyeggen, Head of Innovation Department, Gjensidige Insurance Company

The programme board receives administrative support from the Research Council, Division for Strategic Priorities, as well as assistance from both the Division for Innovation and the Division for Science.

Appendix: External framework

Infrastructure

Scientific climate research consists of advanced field and laboratory studies, with high-quality measurements and long time series of climate observations. Such research is heavily dependent on well-functioning infrastructure for field observations, especially ocean-going and ice-class research vessels, permanent monitoring and experimental areas in terrestrial ecosystems, access to remote sensing equipment, and priority access to high performance computing resources. This underlying infrastructure, together with sufficient technical resources to run it, is perhaps the most important basis for continued improvement of the quality of Norwegian climate research and for achieving the targets of the NORKLIMA programme. However, the infrastructure described in this section cannot be funded over the programme budget. Funding for such infrastructure will therefore have to be given priority in the budgets of other administrative bodies and research institutions and other Research Council programmes.

Measurements/observations and the need for long time series

Norway has an international responsibility for ensuring the continuation of programmes to observe variability in the oceans, changes in sea ice cover, heat transport in the ocean-atmosphere system and the mass balance of glaciers. In particular, we must ensure that we meet our commitments towards the Global Climate Observing System (GCOS). It is also important that there are platforms for obtaining the necessary paleoclimate samples both on land and at sea. For atmospheric studies, systems for measuring greenhouse gases and aerosols are needed in addition to measurements of meteorological parameters. Marine activities are generally dependent on extensive use of research vessels, for example to maintain monitoring of variations in the flow of Atlantic water into Norwegian waters. To step up Norwegian climate research in the Arctic, an ice-class vessel is needed. This must be supplemented with access to infrastructure through international cooperation.

Long time series

The need for long time series of observations in environmental monitoring and research is indisputable. In many cases, it is not possible to obtain knowledge of climate change and its impacts without such time series, or to distinguish between natural variation and anthropogenic impacts. Long time series are also of crucial importance in making it possible to carry out analogous studies of the impacts of climate change, i.e. studies where analogies are drawn with earlier climate change and used to predict the consequences of changes in the future and identify how people and society best can adapt to such change. A central database of long time series is needed, and possibly standardisation and quality assurance. Initiatives have been taken to provide for these functions for data generated by modelling in Norway, and the International Council for the Exploration of the Sea (ICES) has a long tradition of maintaining data series for fish. Similar steps should be taken for other observation-based data that are relevant for documentation of other impacts of climate change.

The Research Council has published three reports on long time series of data for environmental monitoring and research, dealing with climate data series, terrestrial and limnic data series, and marine data series.

Automatic methods of field observation

One of the tasks of the NORKLIMA programme is to ensure closer ties between existing research groups working on the atmosphere and on terrestrial biochemistry relevant to the atmosphere, in order to establish a joint research platform that can be linked to ongoing international activities such as IGBP, FLUXNET, iLEAPS, GLOBEC and ASOF.

High-performance computing resources

Climate research is dependent on dedicated high-performance computing capacity, opportunities for flexible access to such resources and extensive database, data storage and data processing systems. Realistic climate simulations on the regional and global scale and implementation of most research targets are entirely dependent on access to national high-performance computing capacity. Climate research is and will continue to be one of the heaviest users of high-performance computers in Norway. Research on the impacts of climate change will over time require far more computing capacity than is currently available. In addition to the actual computing capacity, methods of storing large volumes of data and making them available are needed. To ensure that there is sufficient computing capacity for climate research, it is proposed that one member of the programme board should either also be a member of the national high-performance computing committee, or have close and regular contact with the committee.

Remote sensing

The advantages of satellite remote sensing over conventional observations of the atmosphere and oceans are that coverage is almost global and the frequency of observations is high. The use of multisensor techniques and calibration against long conventional series of observations will allow even fuller use of satellite data. It is important to make use of satellite measurements in studying climate processes and the atmospheric distribution and changes in atmospheric concentrations of greenhouse gases and gases that deplete the ozone layer. Satellite measurements and images also provide important support for land-based measurements of change in terrestrial ecosystems. Furthermore, satellite remote sensing is becoming increasingly important for meteorological and oceanographic measurements, particularly in sparsely populated areas. For marine purposes, floats (as used for example by the Argo programme) and autonomous vessels are important. Together with new technology on fixed installations, they provide valuable information on climate change and necessary input for models.

The number of satellites and satellite sensors operating will rise in the next 10 years, partly as a result of the European Space Agency's Living Planet Programme. Norwegian climate research groups must continue to make use of the information available from satellite measurements to optimise the outcomes of their research.

Technology and innovation

A research breakthrough often goes together with a technological breakthrough, in which new methodology generates new knowledge for use in research. It is a weakness of Norwegian research on climate and climate change that it involves too little technological innovation and experimental activity. This element must be strengthened in a long-term perspective to achieve the scientific objectives of the NORKLIMA programme. There are also good opportunities for industrial spin-off effects, since environmental monitoring is a growing international activity. This includes the development of complete model/data systems adapted to the management of ecosystems. There is a clear need for systems that can be used for detailed studies of processes in the atmosphere-ice-ocean system.



The publication can be ordered at
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