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# Keeping an environmental research institute successful

## Organisational issues

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## **Preface**

This study was presented, and accepted, as the thesis for the degree of Master of Technology Management (MTM) in September 2002. The degree was awarded by the Norwegian University of Science and Technology (NTNU) and the Norwegian School of Economics and Business Administration (NHH) in November 2002.



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## **Abstract**

The research sector in Norway has recently been the object of quite considerable attention from the political and administrative authorities regarding allocation of resources and scientific quality. An overview of these issues is given on a general level with respect to the Norwegian research community as a whole. The situation within the environmental research sector is discussed more specifically, focusing on the role of the independent environmental research institutes.

The current position of the Norwegian Institute for Air Research (NILU) is described in terms of stakeholders and the institute's strengths, weaknesses, opportunities and threats. Organisational issues are discussed as part of the analysis. The emphasis is placed on these topics, which are internal to the organisation, and is aimed at making NILU's operations more focused and efficient in the future.



# Keeping an environmental research institute successful

## Organisational issues

### 1 Introduction

The curiosity and practical needs of human beings have always led them to explore their surroundings and invent new ways of using available resources to their ever-increasing advantage. We owe much of our modern societies' wealth and comfort to the drive for new knowledge. Today we have to a large degree formalised this kind of activity in what we call Research and Development (R&D). Although it is more difficult to see the immediate rewards of research efforts today, it is still this creativity that will shape and influence what our near future will look like. This is underlined by the fact that R&D today is also about mitigating the effects of previous activity. The degree to which a nation regards R&D as an important investment depends on a number of factors of which culture, the educational system, circumstances and financial situation are some. Regardless of this, it is in the best interest of every country to make the most of its efforts with respect to the use of resources and the quality of outcome.

This thesis is about resources and quality in the more traditional research environments in Norway, with a clear focus on the situation within the environmental institute sector.

#### 1.1 Problem

The Norwegian research sector is currently under a lot of political, administrative and scientific pressure to reorient itself. The general impression is that the debate can be summarised into two main issues; *resource allocations* and *scientific quality*. On the one hand, the overall resources allocated to Norwegian research are seen as inadequate compared to what is needed for the research sector to address the issues that are currently on the agenda and those that are considered to be of major importance in the future. On the other hand, the overall quality of the research that is currently being performed is viewed as unsatisfactory compared to international research as well as to the general expectations and the needs of our society at large.

A large portion of the resources made available to the research community is public funds allocated by government. The political signals issued by Cabinet and Parliament, as well as other governmental institutions and funding bodies, are therefore of great interest in order to understand what kind of allocations one can expect in the near future, and which scientific issues will be given priority.

The task of increasing the quality of the research efforts has to be addressed primarily by those actually conducting the research, namely the institutions and the scientists working there. The question is how one can achieve greater effectiveness and quality as well as higher efficiency and productivity in research than what is currently the case. In other words, in what way can one organise the

research in order to meet the expectations within the resources that at any time are put at one's disposal.

In order to discuss the relationship between resources and quality in broader terms, it is important to take into account the political, organisational, economic and professional realities of the Norwegian research community. It is also important that the shortcomings of the current practices are acknowledged and addressed, especially considering the expectations that the quality of our research should be at the same levels as that of the international research communities. In order to achieve this, the need for change will have to be acknowledged and certain changes implemented. The Norwegian research sector is non-homogeneous in that there are a number of different types of institutions that perform research, and these are all faced with different challenges with respect to internal structure and external governance.

The analytical part of this thesis focuses on the characteristics and specific problems of the Norwegian Institute for Air Research (NILU), which is one of the environmental research institutes. For this type of institution the combination of public governance, private business operation with respect to marketing and competition, and the continual demands on quality in order to secure public funding and support, represents a unique type of organisation. As such, the research institutes are a kind of hybrid organisation, which is not to any significant degree dealt with in the organisational literature. Many of the specific issues of interest to the institute are, however, addressed in numerous scientific publications. The issues that appear to be of the greatest relevance and interest to the institute are addressed in this thesis.

## **1.2 Method**

This thesis gives an overview of the above-mentioned issues on a general level with respect to the Norwegian research community as a whole. The situation within the environmental research sector is discussed more specifically, focusing on the role of the independent environmental research institutes. The goal is firstly to give an overview of the current situation within the Norwegian research community in terms of resources, current and future, as well as the demands and expectations regarding outcome and quality. Secondly, the aim is to summarise the situation within the environmental research sector regarding current and future priorities within climate research and, finally, to analyse the situation for the environmental institutes, exemplified by the Norwegian Institute for Air Research (NILU), and give some recommendations on future operations.

The aim of this analytical part is first and foremost to address issues and areas where it is desirable or necessary to initiate organisational or administrative change in order to make NILU's operations more focused and efficient in the future. The scientific content of the recommended activities is not touched upon. The analysis is structured around a SWOT (strengths, weaknesses, opportunities and threats) analysis. The emphasis is placed on these topics, which are internal to the organisation, and the various elements of the analysis are therefore not treated in equal depth. Where appropriate, support has been sought in the literature and the theoretical aspects of some of the issues are dealt with as a part of the analysis.

### **1.3 Structure of the thesis**

The second chapter of this thesis addresses the question of what goals and priorities society, represented by the political and administrative bodies that have the responsibility for managing research, has for Norwegian research activities and what kind of resources it is willing and able to provide. An overview of the current situation based on available information is given. Chapter three is concerned with the environmental sector and gives a description of the political priorities for Norwegian climate research, current sources of funding and the basis for future operations in this sector. In the fourth chapter, an analysis of NILU's position specifically in terms of stakeholders, strengths, weaknesses, opportunities and threats is given. In addition, organisational issues are discussed and the need for and implementation of strategic planning in terms of process oriented organisational development are described.

## **2 The Norwegian research sector**

The first section of this chapter gives an overview of the opinions and priorities that have been voiced concerning the funding and quality of the Norwegian research sector on behalf of politicians, government and administrative bodies. Many of the views have been expressed in speeches and parliamentary white papers, but in addition a large number of reports have been written by officially appointed committees.

The Research Council of Norway has an important role when it comes to shaping the future of Norwegian research and several opinions on their role have been expressed, especially following the international evaluation of the Research Council. An account of the Research Council's current strategies and priorities are given in the second section.

The general increase in resources made available, regarding money and personnel, the demands on quality that go with it and what this entails for the research sector, is discussed in the last section.

### **2.1 Political priorities, expectations and demands**

As of 1999, there has been an increased focus on Norwegian research policy regarding resources, quality and priorities. Norway is currently heavily dependent on income from the oil and gas industry and the rest of the economy is also to a large extent based on the utilisation of natural resources. The country needs to use its current economic freedom of action to build other and more knowledge-based types of industry for the future. Investing in research and development is crucial, both to building these new types of industries and to strengthening the ones that already exist. In the future we therefore need to invest enough resources in the promising areas that demonstrate sufficient quality and have the potential for growth.

It has been clearly expressed on several occasions by the authoritative levels of government that if Norway is to assert itself as a nation of knowledge and know-how, it has to direct its efforts towards building a stronger base in Research and Development (R&D) than what is currently the case (Kirke-, utdannings- og

forskningsdepartementet, 1999; Utdannings- og forskningsdepartementet, 2002). In order to achieve this, an adequate amount of funding must be made available for research activities.

It has also been pointed out that the resources allocated to R&D in Norway are lower than the corresponding numbers in other OECD (Organisation for Economic Co-operation and Development) countries. In 1999, the total Norwegian expenditure on R&D amounted to 20.3 billion NOK (Norges forskningsråd, 2001a). This relates to spending in both the public and private sector and represented 1.7% of the Gross National Product (GNP). The equivalent average spending on research in OECD countries was 2.2%. One of the goals is, therefore, to escalate the funding of R&D activities to the average OECD level by 2005. The government's estimate for the requirements to meet this goal has, however, increased from 5 billion NOK in 1999 to 10 billion NOK in 2001 (Norges forskningsråd, 2001a). The government therefore intends to increase the public expenditure by 1 billion NOK yearly until 2005 and encourage the private sector to increase its R&D activities (Utdannings- og forskningsdepartementet, 2002) in order to bring it up to the level of the other OECD countries.

In parallel with the debate about resources, the subject of quality in Norwegian research has been discussed. Even though Norwegian researchers are at a high international level in certain areas, evaluations have shown that there is a need for general improvement. It has been pointed out that Norwegian researchers in general publish less and are quoted less frequently in the scientific literature than their counterparts in the other Nordic countries (Utdannings- og forskningsdepartementet, 2002; Norges forskningsråd, 2001a). One therefore recognises that the need for improved quality is a major priority.

On this subject, Kristin Clemet, minister for research, expressed the following tasks as being the most important for the Norwegian research sector in the future (Clemet, 2002a):

- The quality of Norwegian research must be improved. This is the single most important task.
- We must obtain a higher degree of internationalisation than today. This is another important goal. If we are to excel in our research, we must cooperate with top international expertise and improve the recruitment to research.
- It is necessary to have a strong scientific leadership in research. The leadership function within the scientific communities must be strengthened.
- In order to exploit our scientific results and achievements better, the mobility of researchers must be improved. Our innovative capabilities will be improved if we can secure a better exchange of knowledge between research communities and commercial enterprises.

Regardless of the amount of resources, one is concerned with utilising the available resources in the most effective way possible (Utdannings- og forskningsdepartementet, 2002). Norway is a small country in terms of population and resources, and one cannot expect to carry out high-level research in more than

a few designated areas. Certain areas will therefore have to be given priority. One major priority for the public sector is to invest in long term and basic research, as one sees these research environments as fundamental for future success. A great deal of the growth in the research sector will, therefore, be aimed at developing the basic research groups at the higher educational institutions. Further, the government wishes to give priority to the four thematic areas of marine research, information and communication technology, medical and health-related research and research at the interface between energy and environment (Kirke-, utdannings- og forskningsdepartementet, 1999).

## **2.2 The role of the Research Council of Norway**

The Research Council of Norway will, to a large degree, be faced with the task of implementing and carrying out the government's directions. Their interpretation of the political guidelines is therefore of great interest and will decide the fate of many research institutions and form the basis for their future activity, at least in the short term.

The Research Council was subject to an international evaluation in 2001 (Arnold et al., 2001). When established in 1993, the Research Council was charged with the tasks of funding both basic and strategic research, promoting technological development, as well as a number of strategic tasks such as defining research tasks and new fields of research and analysing policy needs (Arnold et al., 2001). The Research Council is also expected to integrate a policy advisory role with operational work as well as having responsibility for the research institutes. In addition, the sponsoring ministries direct the Research Council's activities in a fairly detailed way. In combining all these roles, the Norwegian system stands out internationally.

The evaluation committee concluded that the Research Council has achieved a lot over the years it has been in existence, but has fallen short of realising the ambition of an integrated independent council with which it began. This is, however, more the result of inconsistency between the aim and mission it was given and the means put at its disposal, rather than poor performance. The committee's recommendations for the future include a better adaptation of the Research Council's structure to its mission and weakening the links to various sectors. Changes in framework conditions are also a requirement for the successful continuation of its work.

When the organisational issues of research are discussed, the future role and structure of the Research Council is of prime importance. The question is what kind of role the Council should have in terms of its strategic influence and resource allocations. Kristin Clemet, minister for research, signalled that there was a need for a "new" Research Council, building on the strengths of the current organisation. She summarised the Cabinet's views in terms of the future organisation of the Research Council as follows (Clemet, 2002b):

- Fundamental research must be taken care of in a better way.
- The innovative functions must be coordinated and strengthened.

- Organisation, steering/management and work practices internally must be improved.

It is also emphasised that the Research Council should no longer be the sole deliverer of strategies and priorities related to policies of research and that other bodies must be systematically called upon.

In a letter to the Ministry of Research, the Research Council has made the following recommendations regarding the future structural reorganisation of the Council (Norges forskningsråd, 2002d):

- The board of directors will concern themselves much more in designing the strategies of the Council.
- One will maintain the current structure of three levels of decision-making.
- The Council should be organised in four main departments that will take care of basic research, the institute sector and applied research covering:
  - Culture and Society,
  - Medicine and Health,
  - Bio production, Environment and Development, Natural sciences and Technology,
  - Industry and Energy, including all user-oriented research.

Based on its previous position as strategic advisor to the government in research matters, the Research Council has prepared and compiled a number of reports and evaluations over the last couple of years on the state of Norwegian research, as well as recommendations for future activity. Their Report on Science and Technology, Indicators for Norway (Norges forskningsråd, 2001a) describes the joint national resources for research including both financial and human resources, cooperative relations both nationally and internationally, and evaluates the results that have been obtained. The main focus is on quantitative measures of resource investments. In addition, a qualitative assessment is given of research in terms of bibliographic parameters, number of resulting patents and a general evaluation of innovative qualities. The general conclusions are that the resources placed at the disposal of research, as a percentage of GNP, are limited compared with other western countries, especially the other Nordic countries. Furthermore, it is noted that the quality of Norwegian research falls short of what is to be desired in an absolute sense and when taking into account the resources made available.

In a speech held in April 1998 following the first report on Indicators for Norway (Norges forskningsråd, 1997a), the director of the Research Council noted that, based on these observations, Norway was not visible enough as a research nation, that one had not yet utilized one's potential in terms of human resources and economic freedom of action, and that we were directing our competencies more towards distributing our resources rather than developing new ones (Hambro, 1998).

The Research Council has also concluded that in terms of international activity, the Norwegian research community has been less successful than our neighbouring countries (Norges forskningsråd, 2000a). The institute sector was in

general mostly dependant on national assignments and was not to any significant degree based on internationally funded projects. The Research Council therefore vowed to increase its focus on international cooperation and involvement through its programmes. The aim was to increase the number of positions made available to foreign researches, make sure that doctoral students would spend some of their time abroad, and finally, use the degree of internationalisation as a means of allocating the base grants to the research institutes.

### **2.3 Resources and quality**

Norway has, like the other OECD countries, experienced a considerable growth in resources for Research and Development (R&D) activities during the last decades. However, the growth has been slower in Norway than in most other countries during the 1990s (Norges forskningsråd, 2001a). In 1999, the R&D expenditures in the industry sector represented 47% of total R&D expenditures. The institute sector and higher education sector accounted for 25 and 29 %, respectively. The main sources of funding for R&D activities in 1999 were industry, with 49 %, and government, chiefly the state, contributing 42%. In addition, 7% came from abroad, while other national sources financed roughly 2%.

The allocation of public resources and funds towards research activities is characterised by a top-down process based the extent to which the Norwegian society wishes to support this kind of activity. As mentioned previously, the fraction of GNP used for research in Norway is substantially lower than in the other OECD countries. As noted in the Research Council's annual report for 2001, it will be necessary to increase funding by 1,5 billion NOK annually over the next three years in order to fulfil the ambition of bringing Norway level with its OECD counterparts by 2005 (Norges forskningsråd, 2002b). Previous estimates have been somewhat lower. The Research Council is reportedly working on different ways to support this escalation plan and make the need for increased funding more visible. Regarding the allocation of resources between different areas, there seems to be agreement that certain areas will be given priority, based on national needs and available resources.

There are many research institutions in Norway that have advocated the need for governmental funding. The public funds are intended to support the development and maintenance of a strong knowledge base as well as further research within important areas. If the available resources are spread too thinly, the effectiveness will suffer. Lack of priority will therefore lead to poorer quality and less relevance of the research activities. One way of dealing with this situation is to subject the allocation of research funds to competition based on quality. The Research Council has, to a large degree, used this method when meting out funding for research proposals. It is important that the criteria for this kind of evaluation are clearly defined and communicated to the applicants. Another way is to try to avoid scientific and thematic overlap between different research institutions and encourage cooperation between the institutions instead, in order to secure synergy effects. The institutions may have difficulties establishing this kind of cooperation themselves, in which case incentives should be integrated into the criteria for funding.

Resources do not, however, only comprise money. As is generally the case in Norway, the supply of human resources is a critical factor. In science the competence and experience is as important as the general access to enough people. The director of the Research Council spoke on this issue at the annual meeting in April 2001 (Hambro, 2001). He stated that the plan for increasing the research funding meant an increase of 30% in the fraction of GNP invested in research. An increase in GNP over the years to come would result in a 47% increase in funding. In terms of man-labour years, this represents an increase of 13 000 compared to the current stock of 25 000. In general, the influx of academically qualified personnel is expected to be adequate in the years to come. The critical point is the number of doctorates. Disregarding the distribution over the different disciplines, there will, however, be enough people. This view is supported in White Paper 35 (Utdannings- og forskningsdepartementet, 2002). It is then assumed that the universities will hire technical support personnel, to the level normally held in other countries. In addition, investments will have to be made in technical equipment. The director concluded that the greatest challenges would not lie in recruiting personnel, but in strengthening the quality of the research, both in terms of scientific yield and usefulness to society. The escalation plan should, therefore, be used offensively to strengthen the quality and efficiency of Norwegian research.

In contrast to resource allocation, the task of ensuring better quality is a bottom-up process and calls for a completely different approach. The actual research activities are carried out by scientists individually or in research groups, preferably in institutions that offer adequate support functions in the form of efficient administration and, in many cases, a technological infrastructure. The fundamental prerequisite for good quality is, however, that the scientists either possess or are capable of acquiring the necessary competence and experience to achieve top level results. In the White Paper, the Quality Reform (Utdannings- og forskningsdepartementet, 2002) the prerequisites for high scientific quality were summarised as follows:

- The quality of the researchers in terms of talent, education and motivation
- The quality of recruits e.g. doctoral students
- A stimulating scientific environment led by competent and capable managers
- Adequate resources
- Adequate technical and administrative support
- Adequate and modern equipment
- International cooperation
- Working conditions and welfare arrangements that encourage concentration on the research work at hand

In order to improve quality, certain things will have to change. Evaluations of Norwegian research institutions draw attention to weak scientific leadership (e.g. Norges forskningsråd, 1999) in terms of lack of follow-up, insufficient prioritising of tasks and general lack of planning. This can lead to fragmentation of research groups in the long term and research becomes more vulnerable because of increased dependency on the individual scientist's competence and ability to secure funding.

Compared to many countries, Norway is in a good position to succeed in its research efforts. The country has a well-developed national structure for research in terms of public infrastructure, and many regionally placed institutions. The population has a high level of education and more than half the people now going through school will in the course of their life complete a higher educational degree. Even compared to the Nordic countries, this is a high fraction. The challenge lies therefore in how to make the most of this knowledge base.

### *Summary*

Based on the signals from political and governmental authorities it seems reasonable to assume that the research sector will experience a substantial increase in funding in the years to come. At the same time, the distribution of these funds will depend heavily on a demonstrated ability to produce results of high quality. Since the call for increased quality is almost unanimous and is gathering substantial support, it is no longer a question of whether research institutions should dedicate themselves to improving the quality of research, but how they should go about doing it. Research management at all levels will have to take this challenge seriously, both in the short and long term.

Bringing more money into this sector will in many respects alter the conditions for Norwegian research in fundamental ways. Increased resources will, on the one hand, enable a higher level of activity within both established and newer areas of research. On the other hand, a shift in priorities and expectations will raise new issues of organisational, administrative and scientific nature. The changes in conditions may even force organisational change at several levels between and within research institutions. This may in time also alter the way resources are allocated, decision-making processes and the execution of research work itself.

## **3 The current situation within environmental climate research**

Environmental issues have always been placed relatively high on the political agenda in Norway. This is natural since Norway has a fragile and vulnerable nature, which is susceptible to natural, and anthropogenic influences. Problems such as acid rain lead to considerable scientific effort on Norway's part as well as motivating participation in international negotiations and agreements on the issue.

The climate issue is currently one of the major environmental problems facing not only Norway, but the whole global community. The following overview and interpretation of the Norwegian environmental research sector is therefore limited to climate issues.

The first section is devoted to overall considerations and priorities. An overview of current sources of funding is given in the second section. The third section gives a description of the environmental institute sector and addresses the institute sector's future possibilities based on the guidelines and expectations given by the authorities which were reviewed in Ch. 2.

### 3.1 Political, scientific and qualitative considerations and priorities

The following is a summary of the government's views on the priorities of Norwegian climate research, laid before the Parliament. The Ministry of Environment is responsible for defining and formulating the priorities that will shape Norway's future policies in climate issues.

In White Paper 29 (1997-1998) (Miljøverndepartementet, 1998), the contribution from scientific research towards the understanding of the climate issue is divided into three categories:

- Problems that include an understanding of the fundamental relationship between natural and anthropogenic climate variations, climate models and the consequences of climate change.
- Analysis of societal conditions and instruments of influence.
- Development of technology to reduce carbon dioxide and other climate gas emissions, including development of renewable and alternative energy sources as well as more environmentally friendly and efficient use of energy.

The white paper also prepares the stage for increased activity within climate research in Norway maintaining that this will:

- Contribute to Norway's input in areas where we have able scientific groups and high competence, thereby adding to the international community's knowledge on climate issues.
- Be a condition for making use of the international development in the understanding of these issues.
- Be in accordance with our responsibility towards acquiring new knowledge about the consequences for our region and development of technological know-how that will enable Norway to fulfil its obligations according to the Kyoto protocol.

White Papers 39 (1998-1999) (Kirke-, utdannings- og forskningsdepartementet, 1999) and 8 (1999-2000) (Miljøverndepartementet, 1999) pointed to the need to step up the activity within climate research and also highlighted the areas of social sciences, natural sciences and technology. Within the natural sciences, attention is drawn to the following topics:

- More knowledge on the development of climate in Norway and surrounding areas using regional climate models.
- Further development of numerical models describing the carbon cycle in relationship to the atmosphere and the oceans.
- Increased monitoring of the ocean and research on how changes in the North Atlantic currents can affect our regional climate, and vice versa.
- More knowledge of the effects of climate change on biological diversity and how this diversity affects the climate issue e.g. forests, wetland and agricultural areas.

In White Paper 54 (2000-2001) (Miljøverndepartementet, 2001) on Norwegian climate politics it is noted that one wishes to strengthen climate sciences focusing on regional climate modelling and research in the Arctic region, as well as research on the effects of climate change and development on national strategies for adaptation to climate change. The Cabinet thereby wishes to narrow the efforts to a limited number of areas of special importance to Norway. Research groups of high scientific standing that through quality and choice of research topics can produce results that will contribute to the understanding of the problem and the shaping of policies, both nationally and internationally, will be prioritised. White Paper 15 (2001-2002) (Miljøverndepartementet, 2002) upholds the need to understand the relationship between natural and anthropogenic climate variations, the use of climate models and the consequences of climate change.

White Paper 39 (1998-1999) (Kirke-, utdannings- og forskningsdepartementet, 1999) emphasises the need for increased quality. Stimulation of scientific achievement on an international level should be rewarded. The aim is that Norwegian scientists should be able to utilise and contribute to top-level research in the area. Additional funding will, to a large extent, be used to promote quality. Based on good experiences in other countries, it was suggested that one should establish so-called Centres of Excellence. The Research Council of Norway was set with the task of preparing a report on how this could be done (Norges forskningsråd, 2000b). Further, it was proposed to establish a foundation for the endowment of research (Forskningsfondet). The funds were procured through sales of state-owned shares and the foundation was established in July 1999 with a capital of 3 billion NOK. This is part of the effort to secure public financing of research and the earnings are managed by the Research Council. Some of this money was used to fund two advanced research groups within climate research. As of 2002, the capital has been increased to 13 billion NOK (Norges forskningsråd, 2002a).

In the same parliamentary report it is suggested that within the university and college and institute sector one should:

- Make more frequent use of evaluations as a base for decisions.
- Place more emphasis on quality when apportioning base grants.
- Strengthen and develop the scientific management and leadership functions.
- Strengthen and develop scientific strategies in order to support specialisation and concentration.
- Make more use of quality assessments when allocating funds internally.

The area of climate research is complex in nature, as it is dependent on contributions from diverse scientific communities. The report on Climate Research in Norway (Norges forskningsråd, 2000c) points to the important strategic role of the Research Council in coordinating and setting the agenda within this area and highlights actions that should be taken by the Research Council. The following criteria should be used in prioritising research:

- Areas where Norway has specific strengths and competence internationally and can contribute in cooperative terms

- Areas which contribute to the knowledge base for negotiations and the fulfilment of obligations and commitments under international agreements and treaties
- Areas which address the country's resources, geographic position and structure of trade and industry

The committee further emphasises the need to promote quality in order to meet the scientific challenges through more stringent priorities and by channelling a larger portion of the available funds to a smaller number of internationally competitive research groups. These groups, in the form of advanced research groups or centres of excellence, should receive funding for longer periods in order to facilitate research towards long-term goals. A competitive selection process is recommended and the groups should be subject to international evaluation midway.

Securing Norwegian participation in international programmes and networks is considered important. Norwegian climate research should give priority to subjects where one can make the most substantial contribution internationally.

## **3.2 Current sources of funding**

### ***3.2.1 The Research Council of Norway***

In the following, an overview of the research programmes funded by the Research Council is given, concerning their scope, priorities and economic limits.

#### ***3.2.1.1 KlimaProg***

The Research Programme on Climate and Climate Change (KlimaProg) covers natural science research that has the goal of increasing our understanding of the climate system and natural as well as human-induced climate variability. The programme runs from 2002 through 2011 and the yearly budget is approximately 26 million NOK.

The overall objective of KlimaProg is to facilitate Norwegian climate research in natural sciences at the highest international level. The programme shall enable the researchers to conduct research leading to substantial research breakthroughs on at least three of the prioritised research challenges in the Programme Plan (Norges forskningsråd, 2001b). These are:

- Detection of on-going climate changes, understanding of their causes and how they can be related to natural and anthropogenic forcings.
- How will the climate develop in our region, and to what degree are climate changes in our region influenced by effects from remote regions?
- How large is the probability of abrupt changes in the climate system, particularly those associated with the ocean circulation? Which processes cause abrupt changes and how large are the forcings needed to set off such changes?
- Why do large-scale climate changes of regional or global character arise on time scales from 10 to 1000 years? How do such changes affect the present-day climate developments? What is the climate system's

sensitivity to various natural and anthropogenic forcings that operate on longer and shorter time scales?

- What is the origin of inter-annual to decadal variability in the North Atlantic/Arctic system, and is it possible to predict this?
- Improved understanding of key processes, particularly those associated with feedback processes and non-linear phenomena, in the climate system.
- Improved understanding of exchanges of greenhouse gasses (particularly carbon, methane and nitrous oxide) between terrestrial systems, the atmosphere and the ocean, and how the exchanges and greenhouse gas forcings are changed under global warming.
- How will greenhouse gasses and aerosols be affected by physical and chemical processes in the atmosphere?
- What role does ozone have as a greenhouse gas today, and what role will it have in the future?

The Programme Committee intends to continue to allocate significant funding; tentatively 14-18 million NOK per year, to four coordinated projects in the coming four-year period. Basically, these coordinated projects will cover the research areas of the ongoing coordinated projects. However, based on the evaluation of the current coordinated projects, certain modifications and restructuring are recommended for the next phase.

The Programme Committee has identified some priority areas for independent projects. These are to a large extent based on recommendations for future work stated in the IPCC Third Assessment Report (TAR). The prioritised areas for independent projects are i) ultraviolet radiation, ii) clouds, iii) biogeochemical cycles, iv) paleoclimate modelling and v) troposphere/stratosphere coupling and exchange. The total amount available for the initiation of new independent projects based on the call for proposals for 2002 is expected to be in the range 3-5 million NOK per year.

### ***3.2.1.2 Effects of climate change***

The Research Council has established a ten year research programme (2003-2012) on effects and adaptation to climate change (KlimaEffekter). Research activity on effects of climate change previously organised under other programmes will now be gathered under the new programme. The annual amount available for projects is approximately 10 million NOK.

This programme will initially focus on the important effects of climate change and strategies for how society can adapt to these changes. The studies are limited to Norway and the surrounding oceans as well as the Arctic region. Fundamental problems related to natural sciences and social sciences will be addressed as well as problems pertinent to certain industry sectors, primarily the basic industries like fisheries and fish farming, agriculture and forestry. A great deal of stress will be put on integrated studies which study several aspects of the effects and adaptive strategies related to climate change and in context with other societal change processes. The aim is here to contribute to an overall understanding of the consequences of climate change for Norway as a whole and for some specific regions.

### **3.2.1.3 Polar Climate research**

Polar Climate Research (Polar klimaforskning) is a new five year programme (2002-2006) which is financed by the foundation for the endowment of research (Forskningsfondet) (see Ch. 3.1). The total amount of money allocated to this programme is 110 million NOK.

The scientific focus of the programme is:

- Marine climate in the northern parts of the Norwegian Sea including the Greenland Sea, the Fram Strait and the Barents Sea.
- The ecological consequences of climate change in the above-mentioned areas and on Svalbard.
- Technology and methods for Earth observations and oceanographic measurements in the deeper oceans seen in relation to the above-mentioned problems.

### **3.2.1.4 Related research programmes**

In addition to the above-mentioned climate research programmes there are some programmes that address issues that have relevance to the climate issue or in some way have an interface with them. These are:

#### *Computational mathematics in applications (BeMatA) (2000-2006)*

The aim of the programme is to develop and analyse mathematical models, numerical techniques and application software in order to solve computational problems in technology and the natural sciences.

#### *Surveillance of marine and terrestrial systems (2000-2004)*

The aim of the research programme is to develop knowledge and techniques of importance for future surveillance of environment and natural resources. This includes renewable marine and terrestrial resources.

#### *Pollution: Sources, dispersal, effects and measures (ProFo) (2000-2005)*

The aim of the programme is to enhance knowledge and competence regarding sources of pollution, dispersal, exposure and the effects of pollution on the environment.

## **3.2.2 The European Commission**

Norway participates in a number of international research programmes of which European programmes make the larger part. Many of these are organised by the European Commission. In addition, there is considerable exchange with the larger research laboratories and research installations. The Commission is becoming an increasingly important factor in European research and advancement of knowledge both economically and through setting the research agenda in terms of focus and work practices. Norway has access to the European framework programme for research and technological development (RTD) through the European Economic Area (EEA) and the Norwegian budget for R&D activity within the framework of the EU has almost tripled between 1994 and 2000 (Norges forskningsråd, 2001a).

Under the Fifth Framework Programme (1998-2002), the programme Energy, Environmental and Sustainable Development (EESD) has addressed environmental issues directly. Norwegian researchers from universities and research institutes have been particularly successful within this programme.

The Sixth Framework Programme will go into effect from 2002 and last till 2006. The first call for proposals will be published in November 2002. Seven thematic priority areas have been selected under this programme:

- Genomics and biotechnology for health;
- Information Society technologies;
- Nanotechnologies, intelligent materials, and new production processes;
- Aeronautics and space;
- Food safety and health risks;
- Sustainable development;
- Citizens and governance in an open European knowledge-based society.

### **3.2.3 Other sources of funding**

The following overview of funding for environmental research is limited to the environmental research institutes. The figures are taken from or derived from information provided by Norges forskningsråd (2002c).

The environmental research institutes receive a basic grant from the government to support their activity in the capacity of national competence centres. The grant represents 10 to 20% of the institutes' income, and is managed by the Research Council of Norway. Part of the grant is given to support research areas of special scientific interest through the so-called Strategic Institute Programmes (SIP). On average the environmental research institutes received 190 000 NOK per head of scientific personnel in 2001.

In addition, the institutes receive funding from the Research Council in the form of support for scientific research projects. These funds are to a large degree distributed through thematic research programmes, some of which were described in Ch. 3.2.1. The allocations of this funding are based on assessments of the quality and relevance of the proposal and are won in open competition. On average 15% of the research institutes' income is provided through this source.

Public funding sources, other than the Research Council, contributed almost 50% of the environmental institutes' total income in 2001. Trade and industry accounted for 17% of the total income while foreign sources contributed 9%.

## **3.3 The environmental research institutes**

### **3.3.1 Background**

Of the total R&D activities performed in Norway, approximately one fourth is performed in the so-called institute sector (Norges forskningsråd, 2001a), see Ch. 2.3. The institute sector is a term, which includes non-profit research institutions not belonging to the higher education sector. It is a distinctive feature of the Norwegian research system and includes research institutions primarily

servicing industry or government, public institutions performing R&D to varying degrees, and non-profit R&D performing institutions of idealistic character. Approximately 60 institutes have R&D as their main activity and are subject to the government guidelines for public funding of research institutes.

There are six institutes devoted to research on various environmental issues. The institutes focus on environmental problems related to different media, such as e.g. soil, water, air etc. The Norwegian Institute for Air Research (NILU) is one of these institutes, and works with problems related to various aspects of air pollution.

The environmental institutes play an important role in research and in the building of knowledge and competence within the environmental sector in Norway. The institutes are national centres covering different aspects of environmental problems and as such, their main task is to serve the country's many needs in these areas. In addition, they take on contracted research projects on a competitive basis in their areas of expertise.

The independent environmental research institutes therefore differ from ordinary advisory enterprises and businesses. They were established in order to solve the environmental problems that were not addressed by universities, colleges and private organisations, but which the government and trade and industry saw the need for. National funding is provided to enable the institutes to fulfil this role, and is a prerequisite for building up and maintaining a high level of competence. This financial support is provided by the government through base funding supplied by the Research Council of Norway. It is divided into so-called Strategic Institute Programs (SIP) and unspecified basic grants (see Ch. 3.2.3). The institutes are required not only to maintain a high level of expertise, but also to pass on this knowledge to governmental users. In addition, they serve private and public customers in providing research based products and services.

The environmental institutes are organised as private non-profit foundations and function as independent research institutes. They bear the characteristics of both public entities and private enterprises, and are also closely connected to the university sector.

Governmental control is based on the articles, which state the foundation's mission operation guidelines, and is handled by the Ministry of Environment and the Research Council of Norway. The institutes are governed by a board of directors of which the majority are officially appointed.

In economic terms the institutes operate like a for-profit limited company in the private sector. The articles instruct the institutes to maintain a self-supporting economy with adequate financial reserves. The institutes are economically dependent on the governmental basic grant and on securing a part of the public funding which is allocated to the environmental sector annually in the form of project support. A substantial part of the institutes' revenues is expected to come from nationally and internationally contracted projects and the institutes are free to act in a competitive market. Periodically the institutes are subject to public

evaluation in terms of scientific orientation and focus, quality of work and economic matters (e.g. Norges forskningsråd, 1999).

Institute researchers can experience conflict between market demand and the desire for scholarly recognition and competence development (Mathisen, 1989). The increasing economic pressure causes tension between the short-term economic needs and the building of competence in the long run (Fløisand, 2001). It has been found that research institutes to an increasing degree are managed in ways similar to private firms, although their culture, mission and organisational status remain rooted in the primacy of their scientific expertise (Turpin and Deville, 1995).

### ***3.3.2 Premises for future operations***

Given the political and administrative signals (see Ch. 2) it is clear that the research institutes will have to pay attention to the priorities that have been stated and reorient their activities accordingly:

- Focus on the prioritised topics
- Maximise the efficiency to lower the resource intensity
- Meet the demands on quality
- Increase the international relations

As mentioned earlier, we are now past the stage of groping round for answers to the most basic questions regarding the climate system and how climate change occurs. Continued research on fundamental characteristics of the climate system will still be of prime importance, but the secondary effects of climate change are receiving increasingly more attention. This is because effects of climate change on our ecosystems, and regional climate conditions could have great consequences for our society in terms of the primary trade and industry sectors, which are mostly based in the more vulnerable and exposed areas of our country. In turn this could change the settlement patterns of Norway. Some of the effects may be irreversible and change the biodiversity and cultural landscapes forever.

Research on issues related purely to natural science issues is, therefore, no longer enough, because the questions that are now being asked are of an interdisciplinary nature. The problems that are currently being stated by society cannot be addressed by means of natural sciences alone but require the cooperation of research groups with competence and experience in social sciences.

There is reason to believe that the government wishes to see a major part of the basic research taken care of by the universities, thereby leaving the applied research to the research institutes (Clemet, 2002b; Norges forskningsråd, 2002d; Utdannings- og forskningsdepartementet, 2002). It is therefore the institutes that will be faced with answering the complex questions posed by government concerning the future state of ecosystems and the effects on our society. For all practical purposes, this could mean a reorientation of the research institutes more in the direction of the think-tank concept. The purpose is then to provide information and results that can provide the underlying facts, influence and support the government in its decisions. The aim would then be to develop

decision support systems that can be used to investigate different scenarios and possible strategies to meet the forthcoming challenges. The problems and questions are highly complex in nature and one will probably have the need to supplement one's area of expertise with adjoining competence. This can be done through hiring additional personnel or by building alliances with other institutions.

## **4 Assessment of NILU's organisational position**

A summary of the political and administrative views and decisions with respect to the research sector in general and the environmental sector specifically, have been given in Ch. 2 and 3. One of the conclusions was that there is reason to believe that added resources will be made available in the near future and that greater demands will be placed on the quality of research.

This chapter is about the future operation of the Norwegian Institute for Air Research (NILU) specifically, but may have relevance also for similar institutions. An introduction to the institute is given in the first section. This includes a brief description of the areas of activity and the institute's goals, methods and structure. The second section is an analysis of the institute's stakeholders. The third section is an analysis of NILU's strengths and weaknesses, opportunities and threats, using the SWOT analysis approach. This analysis is used as the basis for recommendations regarding the organisational issues the institute should focus on in the future.

### **4.1 The institute**

The Norwegian Institute for Air Research (NILU) was established in 1969 under the administration of the Royal Norwegian Council for Scientific and Industrial Research (NTNF). In 1986 NILU was made into a private foundation and is now an independent research institute.

The institute conducts environmental research with an emphasis on the sources of airborne pollution, atmospheric transport, transformation and deposition and is also involved in the assessment of the effects of pollution on ecosystems, human health and materials. NILU aims at providing scientific facts on the quantitative relationships between these factors and at the same time making the results available to the public.

Based on the preamble, NILU has formulated its vision (e.g. Hov, 1999):

- NILU is a competitive, internationally recognised centre for research and specialist expertise.
- NILU provides the technical premises for sustainable management of the atmosphere.
- NILU makes society aware of airborne pollutants and their consequences.
- NILU is a future-oriented builder of alliances.
- NILU is an attractive place to work and contributes to the development and well-being of its staff.

NILU handles approximately 250 projects each year for governments, industries and national and international organisations. The institute has 140 employees, half of them with a scientific background. The laboratories for chemical analyses and monitoring instruments are accredited according to international standards. NILU's annual turnover is approximately 100 million NOK. About 11% of the budget is in the form of a base grant from the Norwegian Ministry of the Environment and the Research Council of Norway to support NILU as a national research institution for air pollution. Approximately two thirds of NILU's earnings come from national sources, and the remaining third from international organisations and clients. The time span of the projects and assignments differs from a matter of weeks to several years. The project budgets can vary from fractions to many percent of the total turnover. NILU's head office is at Kjeller outside Oslo. A specialised office for Arctic-related matters is an integrated part of the Polar Environmental Centre, situated in Tromsø.

NILU offers a range of services and products to customers in Norway and abroad. The institute undertakes tasks ranging from basic research to specific scientific problems, long-term research programmes for the European Commission and individual analysis for smaller businesses. NILU aims at meeting the customers' need for applicable results, whether to evaluate consequences and effects or for use in political analysis. Active utilisation of electronic media and modern database methods and solutions are central to the daily functioning of the institute.

NILU has scientific expertise in the following areas:

- Industrial pollution
- Urban air and traffic pollution
- Indoor environment
- Eutrophication and acid rain
- Surface ozone
- Toxic compounds
- Radioactivity
- Ozone layer and ultraviolet radiation
- Climate change

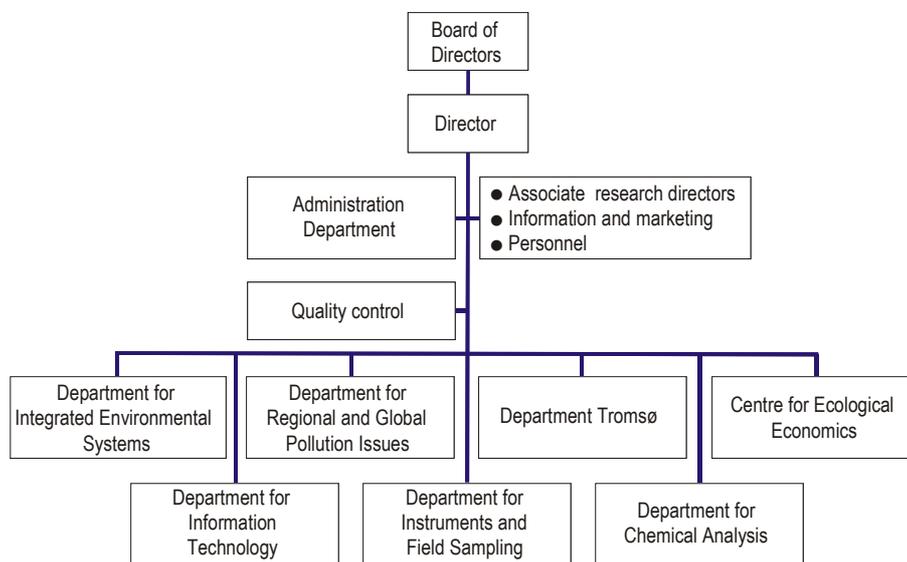
In these areas NILU does both basic, process-oriented research and investigations of the conditions in society that give rise to pollutant emissions which change the state of the atmosphere with effects that require political or technological response. Effects on human health and ecosystems are studied in relation to urban air and traffic pollution and indoor environment and toxic compounds. NILU has recently established a new centre for ecological economics to develop further the research on the socio-economic effects of pollution. The effects of atmospheric pollution on various materials, important for the degradation of cultural heritage, are also studied at NILU.

To work on these issues, NILU develops and uses methodologies such as:

- Emission estimation and modelling
- Field measurements, monitoring and instrument development

- Chemical analysis and the development of analytical methods
- The development and application of numerical dispersion models
- Air pollution forecasting and early warning systems
- Exposure estimate, dose/response: health, materials and ecosystems
- Consequence analysis and action plans
- Cost-benefit and socio-economic analyses
- The development of integrated environmental systems
- National and international co-ordination (including data centre)

NILU has formulated a strategic plan for the period 2000-2004 (Hov, 1999) based on the institute's vision, which describes the strategic goals for the various research topics, that NILU addresses. The means for achieving these goals are described in annual activity plans (e.g. Hov, 2001).



*Figure 1: NILU's organisational structure.*

The institute has a board of directors and a managing director. NILU's organisational structure is shown in Figure 1. The structure partly reflects the methods in use (chemical analysis, instrumentation, integrated surveillance systems), partly services (information technology, administration), partly environmental topics (regional and global issues) and finally geographical placement (the department in Tromsø). Despite the hierarchical nature of the structure, NILU is, for most practical purposes, organised as a matrix. In order to execute a project, resources from several departments may be needed. In this way the project organisation becomes visible with continuously ongoing projects headed by project managers.

Figure 2 depicts NILU from a slightly different angle as it illustrates the different aspects of its operations, which must be addressed in order for the institute to be successful. The main purpose of the figure is to illustrate the functioning and challenges of the institute, seen from various viewpoints. NILU has, first of all, to behave in a business-oriented way in relation to a market to which it offers certain

research based products and services. At the same time, the institute is obliged to contribute to the fulfilling of regional, national and global goals concerning the general environmental developments.

The first requirement is that NILU, as a business, functions properly. The elements here are a sound economy, an expedient and effective organisation and innovative and productive management of human resources.

The second question that needs to be asked is where the funding is going to come from, or rather what will be the future markets for products and services that the institute can offer. These can roughly be divided into governmental grants and funding from national and international sources, either as support for scientific research or as payment for commissioned projects. The trend towards market orientation implies that NILU needs to have customers and financial contributors in focus and make choices based on both long-term consideration and short-term opportunities.



*Figure 2: The different aspects of NILU as an organisation.*

The third aspect is what kind of tangible or intangible products NILU actually offers. These range from instrumentation, measurements and analysis through implementation of surveillance and monitoring systems, to basic and applied research communicated through reports and articles on specific subjects.

The fourth area of concern is what NILU can contribute to society. The issues here are an understanding of the more serious global and domestic problems resulting from air pollution and problems that influence limited areas of society.

## 4.2 Stakeholders

Stakeholder analysis is an important tool in strategic planning efforts because stakeholder satisfaction is critical also for the success of non-profit organisations (Bryson, 1995). This is the single most important criterion by which to judge performance. In addition, the stakeholders will often be in conflict over the control of the organisation's focus, resources and output. A stakeholder analysis can help to provide a clearer picture of these competing interests and set the stage for a discussion of the organisation's mission.

The first step in a stakeholder analysis is to identify who the organisation's stakeholders are, what their criteria for judging performance are, and how well the organisation is performing according to those criteria from the stakeholders' point of view (Bryson, 1995). Further, one can attempt to understand how the various stakeholders influence the organisation, identify what the organisation needs from the various stakeholders and rank their relative importance.

In the following, the first steps in a stakeholder analysis of NILU are presented. It is based on an analysis given in Fløisand (2001). A distinction is made between internal and external stakeholders.

### 4.2.1 *Internal stakeholders*

NILU's internal stakeholders include the board of directors, the managers, the institute's employees as well as the labour unions.

The board of directors is responsible for the institute's strategic decisions and priorities as well as ensuring that the economic goals are achieved. It consists of seven members, of whom the Ministry of the Environment appoints three, the Research Council of Norway appoints two and the employees elect two representatives among themselves. As such it is made up of representatives of both external and internal stakeholders. NILU is a non-profit organisation and the board members are appointed as individuals. It is in the interest of the board that the institute fulfils its national obligations, that it continues evolving under the influence of a changing environment, that the employees sustain a high standard of work and keep up a high level of productivity and, finally, that the economy is sound. The board is also responsible for appointing the institute's director.

NILU has a fairly flat organisational structure, and apart from the institute's top management there is, for all practical purposes, only one level of middle management. Despite being organised in departments, the structure is very project-oriented. However, certain administrative processes, such as overseeing the economy and organising strategic processes and so forth, are handled through the departmental structure. The professional or technical work undertaken by the department is sometimes far removed from the managers' own area of expertise. They might, therefore, be faced with the task of supervising and taking responsibility for projects for which they lack the insight necessary for constructive criticism and for taking corrective action. The middle managers are therefore dependent on relevant information from their staff concerning the department's activity and needs in order to allocate resources and make priorities.

They might sometimes find themselves torn between the demands of the top management and considerations towards, and expectations from, their staff.

The institute's employees are essential to the successes of an institute like NILU. To a certain degree, competency is held collectively within the organisation itself, and a steady strengthening of this competence should be an independent goal in order to minimise the vulnerability of the institute. However, in order to sustain and develop the organisation, employee satisfaction is extremely important. The employees expect to earn salaries that match their skills and competence and which, to a certain degree, are equivalent to what they could earn elsewhere. The desire to work in an environment that gives them the possibility to develop their skills and knowledge is probably even more important. At the same time it is important for each individual to be able to contribute to the general scientific standing and reputation of the institute, both nationally and internationally. The general strategy of the institute should, therefore, be to match the specialities of the individual employee, and, at the same time, have an accepted strategy for systematic development of competence and experience in areas that are expected to be of the greatest importance in the future.

The unions, of which there are three represented at the institute, negotiate salaries and are represented in many of the committees and panels at the institute. They have especially the welfare of the employees in mind.

#### **4.2.2 External stakeholders**

NILU has several external stakeholders. These can roughly be divided into the customers in a broad sense, the government, the general public and the institute's collaborators.

The institute has both domestic and international customers. They include international organisations, governmental agencies, scientific funding agencies, local and sectorial authorities, and private companies. The latter two categories are mainly interested in reports on specific problems, whereas the funding agencies are primarily interested in supporting innovative and original scientific research.

Those who look to NILU to perform contracted work are mainly concerned with the quality and the price of the product or service they are receiving. The research that has been performed over the years and the knowledge that in this way has been built up, is the basis for the quality of the work being offered. Some customers also value the institute's independent position and unbiased opinion. To a certain degree one has, however, experienced that competitors with cheaper, but maybe less extensive solutions, have been preferred. It is therefore obvious that price and performance are of major concern to this group of customers.

The funding agencies, both national and international, are more concerned with the quality of the work performed. The competition for funding is severe, and competing applications are grouped together in broader topics, so it is vital to demonstrate that the problem one proposes to address is of superior interest and that the suggested methodology is feasible. Proposals are often reviewed

scientifically by international experts in the field, and therefore need to be at the cutting edge of science.

Governmental agencies, such as the National Pollution Control Authority (SFT), and international bodies, such as the United Nations (UN), are looking for organisations that can take on a designated piece of work within certain economic limits. They need competent institutions with the necessary experience and infrastructure to carry the assignment through.

The government is an important stakeholder. The institute represents the Ministry of the Environment's scientific expertise on air pollution problems. This is important from a general point of view as well as in the interest of managing the country's resources. In addition, the need for domestic know-how is important when Norway partakes in international negotiations on emissions of airborne pollutants. If the authorities are contemplating investments in measures to reduce the effect of air pollution or introduce preventive measures, their decision should be founded on reliable research and careful analysis.

As a national environmental institute, NILU is expected to keep the public informed about the current status and development of environmental issues relating to air pollution. The public awareness, and also the insight into these problems, has grown over the years. It is a challenge to make information available to the people who are interested, but it is equally important to supply the media with factual information and thereby help to prevent articles containing, at best, misleading information and, at worst, factual mistakes. This can only lead to confusion and frustration. The general trend in today's society is an increasing demand for current and up-to-date information.

At the time when many of the environmental institutes were established, one viewed environmental research in terms of media. The perspective has since then changed and the environmental sciences have, by nature, become more interdisciplinary. This calls for extensive collaboration between institutes dealing with different aspects of the problem. The need for solutions and reports that address the environmental system as a whole makes the institutes mutually dependent. NILU's collaborators are therefore important stakeholders.

### **4.3 SWOT analysis**

In a forever changing world the need to understand one's working environment, both internal and external, and thereby develop effective strategies to meet the emerging challenges, is becoming increasingly important. Such an assessment can take the form of a SWOT analysis (strengths, weaknesses, opportunities and threats) (e.g. Ansoff, 1965) and the purpose is to provide information about the organisation's strengths and weaknesses in relation to the opportunities and threats it faces. Strengths and weaknesses are usually internal and refer to the present state of the organisation, while opportunities and threats are typically external and future-oriented (Bryson, 1995). A SWOT analysis can help set the stage for the identification of strategic issues and it is the actual discussions in connection with the analysis which are the most important and will generate the most important outcome.

A tentative analysis of NILU has been performed (see Table 1) and is used as a framework for the composition for this section. It should be noted that the sequence in which the topics are presented does not represent any kind of ranking. The various topics are treated with varying thoroughness. Wherever pertinent, a theoretical background is given.

*Table 1: SWOT analysis of NILU.*

SWOT	
Strengths	Economic and financial situation Infrastructure Internationalisation Competence and competence management
Weaknesses	Human Resource Management (HRM) Strategic planning Quality control
Opportunities	Increased funding New opportunities and needs
Threats	Competition Lack of internal communication and collaboration

### **4.3.1 Strengths**

#### **4.3.1.1 Economic and financial situation**

The institute's revenue for 2001 was just over 100 million NOK, resulting in a profit of almost 2 million NOK. The income has been steadily increasing over the years, both in absolute terms and measured per man year. Apart from 1997, the institute has made a profit over the last five years in the order of one or two million NOK. These results compare favourably with those of the other environmental research institutes.

The various sources of income for the last five years are shown in Table 2. It is worth noting that the basic grant from the Research Council represents only 11% of the total income and constitutes a steadily decreasing part of the institute's total earnings. In the annual report for 2001 (NILU, 2002) the income earned from international sources is reported to be 37% of the total income.

The institute has a well developed support system for monitoring and reporting on economic matters. All employees have ready access to most of these data and updated reports are distributed regularly.

NILU is a non-profit institute, and it is required to have a self-sustaining economy. According to the institute's articles one is obliged to set aside adequate reserves in the case of future loss of income. Apart from that, any revenues are supposed to be reinvested in the operation of the institute. The institute is financially in a very fortunate situation, with a sound economy and reserves, which in 2001 amounted to 48 million NOK. This gives the institute a certain freedom to pursue new scientific directions, build competence and invest in

Table 2: NILU's sources of income for the period from 1997 to 2001.

	2001	2000	1999	1998	1997
Basic grant	11,5	11,2	11,2	11,2	11,2
Foreign aid projects **)	4,8	3,7	6,4	8,4	
EU commission **)	8,2	9,3	6,5	8,2	
United Nations (UN)	7,9	7,4	8,2	4,7	5,2
Projects Research Council	9,4	11,8	10,7	6,0	6,0
The Norwegian Pollution Control Authority/The Norwegian Radiation Protection Authority	19,8	19,3	20,7	17,8	19,8
Industry and trade	21,5	10,8	10,4	11,9	6,7
National authorities *)	18,0	20,8	13,0	17,1	29,1
<b>SUM</b>	<b>101,1</b>	<b>94,3</b>	<b>87,1</b>	<b>85,3</b>	<b>78,0</b>

\*) Including the Tromsø grant and national functions for the Ministry of Environment.

\*\*\*) Included as of 1998. Numbers for earlier years are incorporated in Industry and trade

scientific equipment. Financial reserves cannot protect the institute from fundamental irreversible changes in the market or otherwise, but will serve as a buffer in order to reduce the financial strains of necessary reorientation.

The Research Council's economic recommendation for the research institutes is an operating profit of 4% of the gross revenue. NILU's own target is 5% of the net revenue, which is roughly equivalent. The institute has chosen to target its profit goal according to net revenue because the direct project expenses, which can be quite substantial, are not considered relevant in this context. The net profit has been of the order of 1-3% over the last couple of years. The board has requested an evaluation of the institute's economy in terms of profitability and the institute's management is currently in the process of analysing the situation and reviewing possible appropriate actions.

Whether the economic reserves currently set aside are adequate or not, might be judged in different ways. While setting funds aside will contribute to financial robustness, investing them might increase the ability to compete in the future. The course of action that is most beneficial for NILU's survival in critical situations to come, will always be a matter of judgement. It is, however, important to realise that a non-profit organisation in some respects must act like a for-profit one in terms of running a profitable business.

NILU's future challenges, therefore, lie in using its strong economic situation to build competence and invest in areas of strategic importance and societal interest and relevance. It is also important to take measures to sustain the institute's economic advantage, mainly by increasing its ability to compete. This requires an ever present vigilance and consciousness among all the employees concerning economic practices, the institute's financial situation, as well as short-term and long-term plans. As a major source of inspiration and interest, the criteria for economic assessment must be commonly known and accepted among all the employees in order to secure compliance on all levels and in all parts of the organisation.

On the basis of clearly communicated economic criteria, the organisation as a whole could focus more on reporting deviations rather than scheduled formatted report on the general state of affairs.

#### **4.3.1.2 Infrastructure**

The institute has a good physical working environment and a well-developed infrastructure. The administrative routines and practices function well and there is adequate technical and administrative support staff. In addition, the institute has advanced computer facilities, state of the art laboratory equipment and analytical instruments, as well as highly developed information communication and technology systems (ICT). These include databases, economic support systems, extensive presence on the Internet, etc.

With a highly developed infrastructure comes the challenge of utilising it to the full. It is in the interest of all levels of the organisation to make an effort to do so because of the great impact this could have on the efficiency of the institute's work as a whole. This might be obvious from a managerial point of view, but it is also in the best interest of the employees to be involved in developing and fine tuning the administrative and technological system, in order to avoid tedious inefficient and non-productive practices. One very important aspect of this is that sharing information, knowledge and competence across internal borders, might have important implications for the institute's total management of human resources (see Ch. 4.3.2.1) and competence management (Ch. 4.3.1.4).

Experience shows that researchers are not always sufficiently aware of tools that have been developed by others and which might help them solve their current problems or research challenges. Similarly, colleagues might have theoretical knowledge or experience that would be useful, but is not available for others because the relevant knowledge and competence to a large degree is tacit.

A highly developed infrastructure is a prerequisite for an extensive flow of information, knowledge and competence within the institute, a feature of ever increasing importance. For many practical purposes, however, the departmental structure limits the flow of information within the institute. The different departments address specific aspects of air pollution and related issues, and researchers tend to focus on the projects which are the most relevant for themselves, without being fully informed, or informing others, of related efforts in other parts of the institute. As pointed out by Armbrecht et al. (2001), being affiliated with a particular group means each member is more likely to interact with another person in this group. To overcome this, more emphasis should be placed on matrix teams with members from different departments, e.g. project groups. In other words, one needs to strengthen the project structure and the way it is actually functioning. In addition each department is evaluated independently in terms of economy and the use of resources. This does not encourage either the department head or the researchers to engage in cross-departmental activities. The fact that the work pressure is quite high does nothing to help matters.

As an example, the use of personal intranet (or internet) websites is a means for stimulating and facilitating knowledge sharing and access across real or imagined borders. There are two major lines of thought around the use of ICT to provide

access to the tacit knowledge of an organization (Armbrecht, 2001). One is to capture as much of the individual's knowledge as possible and archive it in searchable databases. A second approach utilizes databases or intranet web pages to allow each person in the organization to make known, and even advertise, their knowledge and expertise. The searchable content in these pages could be based on résumés, publication lists, internal documents, report titles, areas of interest, etc. The thought behind this technique is that a person seeking new ideas may know which general area to query, but not know what specific questions to ask. A colleague who is familiar with the general area can usually be a much richer source of knowledge than written documents.

A hybrid approach, using a search engine in an archived database of technical reports, articles, and the like, to find individuals who have participated in general areas of work, and linking it to a personal web-page, might prove to be a good solution. The payoff lies in identifying people with relevant experience who can share their knowledge. Surveys suggest that these systems will be used about twice as often as traditional information databases (Teltech, 1997), and appear to have a considerable potential for research institutes like NILU.

#### **4.3.1.3 Internationalisation**

NILU is a highly international institute with respect to research orientation, sources of funding as well, as networks and cooperation.

As mentioned before, a substantial part of NILU's revenues come from international sources. These include the European Commission, the United Nations, the Nordic Council of Ministers, international aid projects and private companies. In total this represents 37% of the institute's income. The average for the environmental institutes is 9% (Norges forskningsråd, 2002c).

NILU currently employs 18 scientists of non-Norwegian background, coming from 10 different countries. The institute also hosts doctoral and post doctoral students as well as visiting scientists from foreign institutions. These visits typically have a duration spanning from a couple of weeks to more than a year. In addition, the institute receives trainees in connection with international projects. Likewise, scientists from NILU have spent time at foreign institutions.

Research is becoming more and more international in its nature. International cooperation has always been important and an increasing amount of funding is being channelled through international bodies such as the EU. NILU has been extremely successful in securing funding under the EU's fourth and fifth framework programmes. In 2001 the institute received 15 million NOK on project contracts from the EU, which was half the amount secured by all the six environmental institutes in total (Norges forskningsråd, 2002c).

Under the fifth framework programme the funding has been awarded from the following programmes:

- Energy, Environmental and Sustainable Development (EESD)
- Quality of life and management of living resources (QOL)

- User-friendly information society and technology (IST)
- Competitive and sustainable growth (GROWTH)

NILU has also been highly successful in becoming a scientific centre with a large international interface (Norges forskningsråd, 1997b). This international network originates from the institute's early days and has been systematically developed and maintained over the years. The network consists of both an institutional component and an individual component. NILU's scientists in general have a highly developed personal network, which has proved to be of great importance when it comes to gaining access to internationally funded projects.

As described in Ch. 2 and 3, the government wishes to strengthen the internationalisation of Norwegian research and will use this as a criterion for allocating and increasing the financial support. Despite its historical and current strong international focus, NILU therefore needs to maintain and further develop the international orientation, in accordance with the government's wishes. Internationalisation will also be a criterion for the allocation of basic grants to the research institutes in the future (Norges forskningsråd, 2000a).

One area in which the institute could strengthen its international collaborative effort and relationships is through the exchange of scientists. This includes making more short-term positions available for visiting scientist as well as encouraging NILU's scientists to spend more time at research institutions abroad. This should be seen in relationship to the institute's efforts in competence development (see Ch. 4.3.1.4) and it also constitutes a part of maintaining and building international networks.

#### ***4.3.1.4 Competence and competence management***

For a research institute like NILU, the most valuable assets are knowledge, experience and competence within its field of operation, some of which has been earned over many years of effort. The institute works on many different topics related to air pollution (see Ch. 4.1) Some of these form the basis of the institute's activity while others are more peripheral. It is within the areas where the institute has exceptional competence the future products and services will emerge. The institute needs to make a conscious effort to identify those areas, their potential for development and the markets, which they will serve.

This section describes the concept of core competence and capabilities, based on Wille (1996). Furthermore, an analysis of NILU's competence and capabilities is given and the future implications in terms of competence management are discussed.

The success of an enterprise is in most cases first and foremost based on its competence. It is the ability to utilise one's competencies in making products and offering services that are in demand that will justify one's existence and decide the degree of success. Competencies are divided into core competencies and capabilities.

Core competences form the base of the organisation's qualifications and know-how. There are four criteria that must be satisfied in order for a competence to qualify as a core competence. The criteria are:

- Difficult to imitate or copy
- Built over time
- Unique
- Add value

Capabilities are defined as critical processes taking place in the organisation, which lead to excellence in performance.

Competence is, in general, defined in terms of the three components; knowledge, skills and organisation. In addition, integrity, or the ability to reflect critically on the state of affairs, is a dynamic and inherent part of competence. In an ever-changing world it is vital to be able to analyse the situation critically in order to position oneself favourably in relation to future challenges. The concept of competence is illustrated in Figure 3.

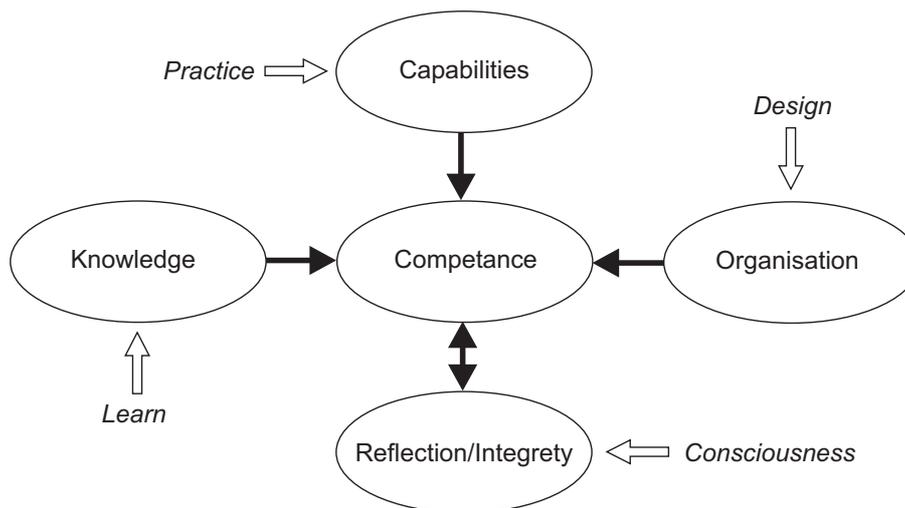


Figure 3: Definition of competence (adapted from Wille (1996)).

Knowledge can be divided into explicit and tacit knowledge. The explicit knowledge is articulated and formalised. It is fairly easy to document and thereby transfer to others. Tacit knowledge, on the other hand, is tied to experience and can be difficult to articulate. It is also biased in terms of attitude, understanding and perspective. The sharing of tacit knowledge within an organisation can therefore be a problem. The reasons have to do with e.g. culture, organizational structure, strategy and organizational goals.

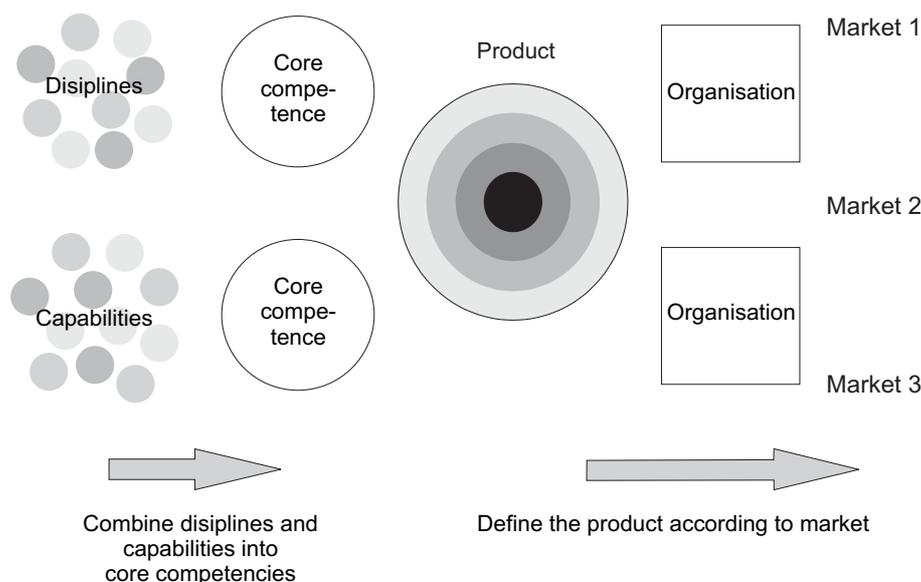
Capabilities and skills are tied to the ability to carry out activities and processes. This involves the utilisation of knowledge in order to reach a goal and is dependent on time and place.

The organisation is the means to which to reach an end and, as such, has no value in itself. It is a set of relations between different participants who work together in order to meet specified objectives. It is the vision, goals and strategies that govern the organisation, which should be geared towards an efficient utilisation of the competencies and capabilities.

The fourth component in the definition, reflection and integrity, is the key to successful competence development. The ability and will to critically examine one's proficiency is vital in the constant effort to advance the level of competence in the right direction. Periodically one should ask the question of whether one possesses the right kind of competence, and if it is necessary to adjust the direction.

It is worth noting that the overall competence found within an enterprise has an individual, a group and an organisational component. The benefits of individual competencies are determined by context and to what degree the prerequisites for utilisation are optimal. Core competencies are usually made up of several individual competencies that reside within a group. It is necessary to guide, correct and develop the individual competencies within a group towards a mutual goal. The infrastructure, organisational structure and communication across disciplinary boundaries are important for the utilisation of core competencies.

Core competencies must also be seen in relation to the requirements of the market and the competitive situation. It is part of the strategic process to assess these relationships and decide how to pursue the path of competence development in order to meet the market needs successfully. Hamel and Prahalad (1990) describe how core competencies can form the basis of strategic planning. The connection from disciplines and capabilities to markets is illustrated in Figure 4.



*Figure 4: The relationship between disciplines and capabilities, core competencies, core products, organisational design and markets (adapted from Wille (1996)).*

Core competencies emerge as a combination of the disciplines one masters and the capabilities one has. The different core competencies, either alone or in combination, form the basis for core products. By adding various features and properties, the core products result in various designed products that are presented to different segments of the market. In designing the products it is important to have the needs of the specific markets in mind, so that the product, as far as possible, meets the demands of that market.

For a research institute that sells research-based products and services, the challenge can be to develop its own markets. In environmental research the aim can often be to identify a problem a company, a region or an industry sector is facing, but which at the outset is neither defined nor realised. The first step is then to present the problem or environmental threat to society and say whoever is affected by it. Secondly one tries to develop a solution, which eventually can be developed into a product which can then be sold. The challenges in this kind of poorly defined, and partly unaware, market can be slightly different from the more classical approach.

#### *NILU's core competencies and capabilities*

NILU does basic and applied research on topics related to air pollution and offers research-based products and services to a diversified market. The institute has a strong competence base, both on an individual basis and as an organisation, and relies heavily on maintaining and developing its competencies. It is worth noting that today's scientific research, whether basic or applied, constitutes the basis for tomorrow's credibility as a serious contender for the contracting of projects, and the know-how to design and implement new products and services in relation to a defined market.

The basic problem for the kind of institution that NILU represents is, in the short term, to be able to operate on a sound business footing and at the same time be able to meet the long-term challenge of building the competence and experience necessary to handle future environmental problems on a competitive basis. This has as much to do with developing individual competence and skills as it has to creating an organisational environment that will facilitate developments in relevant directions and research areas. The building of competence and experience in prospective fields of research might prove both costly and risky, but is nevertheless a prerequisite for long-term survival.

Using the framework of Hamel and Prahalad (1990) the institute's managers performed a preliminary analysis of NILU's core competencies in autumn 2001. They worked in groups and identified scientific disciplines, capabilities, core competencies and markets. They arrived at the following core competencies:

- Analysis of organic pollutants (e.g. dioxins, PCBs)
- Numerical modelling
- Integrated environmental surveillance systems
- Ground remote sensing

Some of NILU's capabilities are closely related to features that have previously been described under the other strengths (Ch. 4.3.1.2 and 4.3.1.3):

- collaboration
- networking
- alliance building
- good infrastructure
- integration of several disciplines
- responsiveness to customer needs

#### *Competence management and planning*

The discussion has so far been focused on how to use existing competencies to produce products and services that are already in demand. In a proactive organisation it is also natural to try to anticipate future needs in already existing markets or the emergence of altogether new markets. Going back through the chain illustrated in Figure 4, one can define what future competencies will be needed in order to produce products and services one believes will be in demand. This process is all about defining the gap between current competences and capabilities and future requirements in that respect.

The institute is well aware of the need constantly to develop and refine its competence base. The managerial sides have been addressed on several occasions, but the efforts have in many cases fizzled out after a certain time.

The institute has a recognised need to turn some of its individual competencies into group competencies, or at least share the competencies among several individuals. The projects are a good arena for this kind of exchange, and some parts of the organisation could, for that purpose, aim at allocating more people to project teams than is currently the case.

In general, there is a lack of routines for mapping competence already held within the organisation, identifying current and future competence needs and routines for sharing and transferring competence. In addition, a more systematic procedure for gaining access to visiting scientist's competence, some of which is obtained while at the institute, would secure a better pay-off on this kind of visit.

### **4.3.2 Weaknesses**

#### **4.3.2.1 Human Resource Management (HRM)**

The success of an institution like NILU relies heavily on the creativity, skill and competence of its staff. This is the singular most important of the institute's resources and the utilisation of these resources is therefore one of the most important success criteria for the institute. An overview, mainly taken from current literature, of the matrix organisation and factors that influence the performance of professional employees is given, followed by a discussion of NILU's situation as far as HRM is concerned.

#### *The matrix organization*

In a matrix organization, of which NILU is an example, the responsibility for activities is shared between functional managers and project managers. Functional

managers usually determine how a project is to be accomplished and by whom, while project managers determine project requirements and schedules. Direct authority over personnel tends to rest with the functional managers. They also have control over contextual or environmental issues relative to project team members, including those associated with their technical specialties, career development and growth within a discipline (Dunn, 2001). The project manager is responsible for meeting project deliverables, and has little direct authority over the project team members or their managers (Dunn, 2001). In some cases there can be a mismatch between the project manager's responsibility and authority.

In the literature the matrix organization is often described as a rather complex structure that draws on the strength of both functional and product structures, but with potential drawbacks (Kerzner, 1992). The matrix structure can be ineffective and disruptive because it imposes a dual authority, which can permit power struggles and conflicts to develop. In addition, the overhead related to the organizational issues can become unduly high. In order to avoid inefficiency, it is important that both functional and project managers are fully aware of their role and responsibilities and that project managers are given enough authority to negotiate with functional managers (Hamburger, 1985). Staff supervision should be delegated to the functional manager, thereby eliminating the problems of conflicting instructions and staff confusion. Hamburger (1985) also suggested establishing a conflict resolution agent and process, thus avoiding multiple layers of management. An empirical study by Dunn (2001) shows that in a matrix organization, functional managers have control over, or influence the maintenance factors while project managers have significant control or influence over the motivator factors of project team members.

Matrix organizations are, however, flexible and can promote technical consistency and efficient staff use across projects. Various forms of matrix organisations have been widely used in both public and private sector research and development (R&D) organisations since the 1950s (McCollum and Sherman, 1991). Perhaps the key advantage of the matrix is the legitimisation of direct lateral communication (Kerzner, 1992). Other primary advantages of matrix organisations are their utility for coordination or integration, optimal use of technical specialists in project management, and flexibility in creating cross-functional teams to meet project or client requirements. Some have criticized the concept of matrix structure (e.g. Peters and Waterman, 1982), but an empirical study of high technology R&D organisations has found that if the environment was appropriate, the integration requirements were high; if implementation was competently managed, and if the size was not extremely large, matrix structures could be effectively utilized in research and development (McCollum and Sherman, 1993). The size of the organisation was not found to have a negative effect on performance for an organisation with an excess of 600 employees (McCollum and Sherman, 1991).

Employees in a research environment rely heavily on personal motivation and inspiration when performing their work. There are several factors that influence performance, of which some are discussed in the following.

### *Control versus autonomy*

In a working environment like a research institute, it is the scientist herself who decides how to approach a given task or problem, and what methods to use. The manager is seldom involved. This is partly because the department head usually lacks the in-depth knowledge necessary on every topic, since each person's area of research requires a high degree of specialization. Because of this, researchers expect considerable autonomy. They have specialist knowledge that enables them to do the job, and they do not need or want close supervision. Respect for that expertise is an important motivating force. The role of the manager is then more one of clarifying task boundaries or providing support and resources to assist the individual in carrying out their tasks and interacting with one another (Birnbaum, 1989).

One particularly difficult problem in the management of professionals is how to provide them with the right of autonomy while ensuring adequate insight and control on behalf of the organization. A standard approach is to grant professionals control over the means or procedures to be used (operational autonomy), while management control the activities of the organizational unit (administrative autonomy). The executives are responsible for designing the mission of the organization as a whole, selecting the goals and mediating between the institution and the wider community of which it is a part (strategic autonomy) (Raelin, 1989; 1995). There are, however, conditions under which professionals should be granted administrative and strategic autonomy. Management may likewise sometimes legitimately revoke the operational autonomy of the professional.

### *The role of management*

Administrative invasion of practical issues (operational autonomy) is seldom called for. The academic work of scientists generally requires a great deal of flexibility, imagination, creativity, and intellectual analysis, and when faced with difficulties, the inclination of the scientist is to seek help from peers. Many of the traditional supervisory functions of management are therefore transferred to professional employees in the form of self-supervision and peer control (Raelin, 1995). Research managers frequently find their scientific knowledge becoming dated as they are required to move among projects and diverse scientific themes. This can be a major frustration and is an important reason for some to avoid that kind of position.

### *Personal motivation*

One can distinguish between internal and external motivation factors. Scientists are not to any great degree motivated by salaries and other personal bonuses, although they will forever grumble that they are under-paid, over-worked and not appreciated. Scientists are motivated through the acknowledgement of their peers, especially those at the forefront of research in the international community (Gulbrandsen, 2000). Since the specialization is very high, the individual may not have anybody she perceives as a peer in the same organization. Research is so highly dispersed that the approval and recognition of a colleague on the other side of the globe may be of more value than that of one's immediate boss or even the director of the institute.

Another important motivation factor is curiosity and the urge to investigate and find solutions and answers. Scientists normally take a great deal of pride in their work and wish to devote themselves to it full-time. Many researchers refer to an inner drive to find answers as an important motivating force (Gulbrandsen, 2000). One common complaint is the amount of administrative work that has to be dealt with, fragmenting their work hours. The problem is that these kinds of tasks often have a certain degree of urgency and therefore have to be given priority. Although a certain amount of administrative work has to be taken on, it is important that this does not become the main focus.

### *Appraisals*

One role of managers is to control the performance of the researcher. A particular focus may be placed on effectiveness; has the researcher delivered the service that was expected. Unfortunately, in today's bottom-line environment, service effectiveness is often equated with quantitative assessment, focusing more on reports written, or on the number of papers published, rather than quality of contribution to one's field. Although outcomes of professional work are difficult to assess, scientists must be willing to commit to evaluation on the basis of professional standards, such as advancement of the field, in order to be made accountable. The problem is what kind of criteria should be used.

Most performance appraisal schemes are formulated in order to serve the best interests of the employing organization. They are designed to evaluate the scientist's performance in terms of the organization's needs, providing feedback to the employee to correct or reinforce behaviour on the basis of that performance. Rewards, like salaries, promotions and job assignments, are allocated accordingly. This kind of performance appraisal is seldom viewed favourably (Wilson et al., 1994).

The problem is further emphasized in research environments where tasks are so complex and uncertain that it becomes virtually impossible to use objective criteria to measure professional performance. Traits such as analytic ability, communication, attitude, judgment, etc., which are commonly used in appraisal rating scales, do little to capture the complexity of research work. Wilson et al. (1994) propose using a professional development appraisal in addition to the traditional one. The professional development appraisal should be a parallel process, separated from the conventional appraisal, but used to enhance professional growth and facilitate the intergenerational transfer of professional culture. Its two main characteristics would be mastery of one's technical proficiency and development of one's integrity. This kind of appraisal should be carried out by professional mentors rather than by management.

### *Performance and HRM at NILU*

NILU has approximately 140 employees. Half of these are scientists of which almost 60% are doctorates (Norges forskningsråd, 2002c). The other half are engineers, technicians, laboratory assistants, clerical staff, etc., who make up the technical and administrative support staff. The institute's employees are, in general, highly skilled and experienced in their field of expertise and cover a wide array of topics.

NILU is faced with many of the problems and challenges described in the beginning of this section. This is particularly true with respect to management issues. If the institute is to address the future challenges, especially with respect to meeting the government's demands for scientific quality and relevance (see Ch. 2.1 and 3.1), it might prove necessary to place more emphasis on organisational and leadership matters.

These challenges cannot be met by a top-down or bottom-up approach. Given the composition of the personnel and the tasks and activities, a model based on a more extensive and process oriented cooperation between management and research staff seems to be a possible solution. This would entail that the employees are given greater responsibility and increased independence. Since NILU functions as a matrix organisation, this shift would mean a further transferral of responsibility from the hierarchical departmental structure to the projects.

It should be generally accepted that the key to better utilisation of the human resources in research relies more on inspiration than transpiration, especially when dealing with highly competent and motivated people. Increased performance, both on a personal and organisational level, will mostly be based on the following factors:

- Clarification of the distribution of responsibility and authority regarding implementation of activities
- Clarification of the role of management in assessing the actual needs of the individual employees
- Participation in organisational processes both regarding the planning of strategic issues and the follow-up in the form of practical implementation
- Challenging and inspiring tasks
- A transparent and fair appraisal and reward system
- Access to information at all levels of the organisation

The initiative in this respect will have to come from the management. However, it is clear that when it comes to implementation, an equal responsibility lies with the other employees to follow up in terms of involvement and commitment. This should include:

- Active participation in the strategic and organisational processes
- Personal contributions to the organisations development in terms of science, strategy and organisation
- Make the best possible use of available information

The introduction and implementation of a more process oriented development of strategic planning will address some of the above-mentioned issues (see Ch. 4.3.2.2).

There is little or no clash of interest between management and employees when it comes to making the most of the available human resources. A high degree of utilisation will improve the competitive ability and heighten the quality of the

institute's work as well as engaging all levels of the organisation intellectually and practically. In addition, it would be a great benefit for the individual.

For all practical purposes a cooperative effort will have to be based on an overview of the challenges and problems the institute faces and mutual access to all relevant data. This will enable everybody to make qualified judgements regarding the institute's strategies and priorities in a systematic manner. The establishment, and continuous updating, of information could take the form of the following actions:

- Better access to operational data about the institute's ongoing projects related to its short and long term goals and priorities coupled with an overview of future possibilities for funding.
- Individual employee profiles on competence, projects, future plans and priorities.
- Establish an informal arena for suggestions regarding the institute's future activities from management, employees and the organisations.

This would require an interactive database that could in time form the basis for the institute's planning activities. This is also discussed in Ch. 4.3.1.2. Such an open system would give several advantages.

- The institute's management could use it as a tool for announcing future plans and resource allocations as well as short and long term plans.
- The employees could, on the basis of the same information, keep themselves up-to-date on the planned activities, especially regarding their personal tasks. At the same time, one could promote constructive suggestions.
- A system like this could form the basis for a constructive and open cooperative effort between all levels of the institute with the aim of utilising the common resources in an optimal way.

#### **4.3.2.2 Strategic planning**

The aim of strategic planning is to help produce decisions and actions that define what an organisation is, what it does and why it does it (Bryson, 1995). Kotler and Andreasen (1996) distinguish between three approaches to strategic planning concepts:

- Organisational strategy that outlines the planned avenue for process oriented organizational development based on extensive participation.
- Programmatic strategy addressing the management and delivery of services and results based on research activities.
- Functional strategies articulate how to manage administration and support needs that impact the organisation's efficiency

In the following, the third concept will not be touched upon. Some of the tools for the deployment of this kind of planning have to a certain degree been discussed in Ch. 4.3.1.2.

For all practical purposes, NILU has in the past focused primarily on the second concept of strategic planning, which addresses what tasks the institute takes on. These issues have been dealt with extensively and NILU has formulated a strategic plan for the period 2000-2004 (Hov, 1999) based on the institute's vision, which describes the strategic goals for the various scientific topics and areas of research NILU should address for that period. The means for achieving these goals are described in annual activity plans (e.g. Hov, 2001). These activities are very operational and are focused on the scientific undertakings.

NILU also has a need for addressing the first concept of strategic planning, i.e. developing a clear organisational strategy. Organisational strategy is concentrated on how research activities should be carried out, rather than what these activities should be about. The challenges facing an institute like NILU are of a strategic nature in terms of instigating improved performance by ensuring active participation from all levels of the organisation, rather than merely pointing at areas of research one should be focusing on. A major purpose of strategic planning is to prepare an organisation to respond effectively to the outside world before a crisis emerges (Bryson, 1995). It might therefore be that this is the time for NILU to embark on a more extensive strategic planning process than before.

#### *The strategic planning process*

In order to understand strategic planning, one must realise that effective decision making can occur only if one has total control over the organisation and its environment, or through the active involvement of key actors critical to successful implementation of the plan. The first option is clearly not viable and it is therefore important that the organisation gains ownership in the plan through active participation in its development.

Equally important is how the process of involvement takes place. Strategic planning and decision-making should be an orderly sequence of analytical activities that requires information from a number of sources. Involving all levels of the organisation in the process gives the plan credibility and expands the range of ownership. In addition, strategy development should not just be a scheduled event in the course of the calendar year. It is a process that requires constant review, frequent monitoring and occasional reconsideration, which active use of the resulting plan will partly ensure. Strategic planning and decision making is future-oriented and its purpose is to lead change, not react to it. In order to achieve its goals, an organization must anticipate or create change to ensure that opportunities can be exploited and threats avoided.

Strategic planning determines where an organization is going over the next year or more, how it is going to get there and how it will know if it got there or not. Far more important than the strategic plan document, is the planning process itself. There are a variety of perspectives about strategic planning and a variety of approaches used in the strategic planning processes. Bryson (1995) suggests the following steps:

1. Initiate and agree on a strategic planning process.
  - a. The purpose of the planning effort
  - b. Who should be involved

- c. The schedule of the process
  - d. The format and timing of reports
- 2. Clarify organisational mandates and mission
  - a. Identification
  - b. Interpretation
  - c. Stakeholder analysis
- 3. Analyse the environment to identify strengths, weaknesses, opportunities and threats (SWOT analysis)
  - a. Identify key success factors
  - b. Identify core competencies
  - c. Prepare future scenarios
- 4. Identify strategic issues that face the organisation
  - a. List issues according to priority, time or area
  - b. Chose approach: direct, indirect, goals or visions of success
- 5. Formulate and adopt strategies and plans to manage the issues
  - a. Overall strategies and sub-unit strategies
  - b. Programmatic, organisational and functional strategies
- 6. Establish an effective organisational vision for the future
- 7. Implement strategies and plans
  - a. Develop action plans, budgets and implementation processes
- 8. Reassess and revise strategies and plans

Strategic development must be linked to other organizational activities to ensure alignment and motivation of action. Broad scale information gathering and evaluation based on communication and participation is required to foster orderly strategy development, informed decision making, and successful implementation.

Far too often, primary emphasis is placed on the plan document. In current literature it is frequently pointed out that this is extremely unfortunate. It is during the actual planning one learns from ongoing analysis, reflection, discussion, debates and dialogue around issues and goals in the system. History shows that a common failure in many kinds of planning is that the plan is never really implemented. Instead, all focus is on writing a plan document. It can therefore be useful to have a set of guidelines to help ensure that the planning process is carried out completely and is implemented completely. Deviations from the intended plan are then recognized and managed accordingly.

It is critical that all parts of the system continue to exchange feedback in order to function effectively. When planning one should get input from everyone who will be responsible for carry out parts of the plan, representatives from groups who will be affected by the plan and people who will be responsible for review and authorization of the plan.

Some of the initial stages of the strategic planning process have been addressed in this thesis, namely the stakeholder analysis, SWOT analysis and identification of core competencies. This is only a preliminary attempt at analysing these issues but serves as an example and illustration of the importance of setting the stage for the process of planning for the future.

#### 4.3.2.3 *Quality control*

As described in Ch. 2, there is an increased focus on the quality of Norwegian research and the need to improve it. The government wishes to use quality of research as one of the criteria for allocation of public funding. This section starts with a description of quality within research, quality control and quality indicators. This is followed by a discussion of the quality of NILU's performance and finally recommendations on how to improve it.

##### *The concept of quality*

Basic definitions of quality, as found in the literature, are excellence, fitness for purpose, no mistakes and value for money (Harvey and Green, 1993; Doherty, 1994). Typically the definition as 'excellence' will predominate in basic research, whereas in applied research the term 'fitness for purpose' would be more appropriate. In the latter case, projects will, to a great degree, be assessed on the basis of user demands and specifications as well as the ability to find answers to the stated problem (Gulbrandsen, 2000).

Gulbrandsen (2000) defines four overall concepts or quality elements that describe different aspects of good research:

- Solidity (infallibility, stringency, validity, reliability, correctness, truthfulness and consistency)
- Originality (novelty, innovation, creativity)
- Scholarly/scientific relevance (intra-scientific relevance)
- Practical/societal utility (extra-scientific relevance)

It is noted that there can be tension between the different concepts of quality and that there is a lack of literature on the relationship between them.

##### *Quality indicators*

The most commonly used indicators of quality in research are quantitative. They include parameters such as the number of publications, citations and patents (Norges forskningsråd, 2001a). In addition, qualitative ratings by peers are used. The number of publications and patents is first and foremost a measure of productivity and quantity, while the number of citations indicates visibility and impact. However, there is good inter-correlation between these parameters and peer ratings (Gulbrandsen, 2000).

##### *Quality control*

The assurance and control of scientific quality has always been an inherent part of research. The traditional formal mechanism of quality control is peer review of publications. Senior scientists of merit appraise the articles and select them for publication or reject them. Similarly, funding bodies use external reviewers to evaluate project proposals. Resources are usually scarce and quality is maintained when only the highest quality projects are funded. There have been several studies in the literature on how to improve these review systems, but little about alternatives (Gulbrandsen, 2000).

Over the last decades periodic, overall evaluations of research institutions have become more common. These evaluations are generally aimed at offering constructive criticism and praise, and focused on helping the organisation to make future improvements. They are usually based on bibliometric indicators and analysis, site visits and interviews. This kind of process resembles a type of Total Quality Management (TQM) and is aimed at quality improvement as much as control and assurance (Gulbrandsen, 2000).

#### *Quality control at NILU*

The institute has established many procedures with the aim of assuring the quality of its services. These include control of project proposals, guidelines for execution of projects, internal review of articles and reports and procedures for organisational processes. The procedures incorporate many of the elements of quality control previously mentioned. One of the more formal examples is the accreditation of NILU's laboratory for chemical analysis according to the TEST 008 standard. This means that procedures, traceability and documentation fulfil the requirements of what is a recognised system of quality control. The accreditation is very important for the perceived and actual quality of the laboratory services offered by the institute.

When it comes to the more internal systems, however, the problem is that these systems are not acted on as presupposed. The reasons for this are complex and manifold, but perceived lack of time, bad planning, indifference and failure to see the value and purpose of the quality procedures might be part of it. One way of addressing these shortcomings would be to introduce a quality assurance system like ISO 9000, in order to heighten the awareness of these issues and force the organisation to comply to the procedures (Berg, 2002). There are, however, indications that TQM systems do not have a great impact on performance and quality in research (Gulbrandsen, 2000).

NILU has most to gain from observing the need for increased quality assurance of project proposals. Sober estimates of resource requirements and assessments of the competence and experience needed would help reduce some of the stress caused by over ambitious projects.

In addition, there is a lack of documentation of source code and systems produced at NILU, which makes updating cumbersome and hampers correction of errors.

Quality of performance has to do with attitude and focus and is the responsibility of all levels of an organisation. One prerequisite is time in which to ensure sufficient quality of work according to predefined measures. When existing procedures and systems are not followed, one could examine what kind of incentives one could introduce to promote compliance.

Quality in research, as described in Ch. 2, is an overall measure, while quality as defined in this section is a more basic concept. The challenges institutes like NILU are faced with are operational in nature, but are nevertheless based on an understanding and implementation of the fundamental concepts of quality.

### 4.3.3 Opportunities

#### 4.3.3.1 Increased funding

The government has clearly signalled that additional funding will be made available for research in the near future and that one of the areas of interest will be environmental research (see Ch. 2).

NILU's responsiveness towards the needs and requirements of public interest will, to a high degree, determine the institute's success in acquiring its share, and preferably a larger share, of these additional funds. The quality of the institute's research, and how it is recognised by the authorities, will be vital in this respect. In order to obtain the necessary excellence, it might be advisable to refuse projects where competence and experience are known to be lacking, and concentrate activity on a narrower selection of topics than what is currently the case. Another way of securing additional funding in the future could be through entering into cooperative alliances with other national and foreign institutes and enterprises in order to utilize the synergies of supplementary and complementary scientific expertise, in addition to the ones already established. Last, but not least, a strengthening and heightened visibility of the institute's international activity, an area where NILU has been highly successful in the past (see Ch. 4.3.1.3), could lead to an improvement in performance as well as being a goal in itself.

It has been explicitly stated that success in attaining an improvement in quality as well as demonstrating a high degree of internationalisation, will affect the size of the base grants in a favourable way (Norges forskningsråd, 2000a).

As far as NILU is concerned this would imply a more conscious effort to:

- Take deliberate action to raise the quality of the institute's research efforts by:
  - A more stringent evaluation of which assignments and projects to take on.
  - Development and improvement of competence internally.
  - Recruitment and guest researchers.
  - Strengthen the national alliances in order to complement the institute's own competence.
- Internationalisation of the research activity.
  - Strengthen and focus the international project portfolio.
  - Establish temporary positions for internationally esteemed scientist.
  - Give the institute's own researchers the opportunity to spend time at foreign institutions.
  - Strengthen the international alliances with chosen international institutions.
- Prepare a long-term plan in order to build competence and experience in areas where one expects future opportunities systematically.

The government has signalled a need for well founded and scientifically based recommendations for handling future changes in our region of the world. These issues will often have both natural scientific and social scientific aspects and

might require joint expertise to be addressed in full. NILU should, therefore, preferably seek alliances with institutions that have complementary competence in other fields, rather than building new competencies from scratch. The time it might take to attain the necessary level of competence and experience in new fields could prove critical.

#### ***4.3.3.2 New opportunities and needs***

The future success of NILU lies in the institute's ability to meet the needs and expectations of the government and its customers. As described in Ch. 2 and 3, the government has stated quite clearly what it expects in terms of quality and effectiveness and the questions that need to be answered with respect to our regional environment. NILU's research must therefore be relevant to the public needs and give answers to the questions that are viewed as the most pressing. In addition, the results and answers must be presented in a form and at a level of detail that are easily understood by both governmental and private customers.

Consciousness of the requirements of customers concerning what kind of problems they are facing, and showing imagination when suggesting solutions, will also be important.

As noted earlier, offering research-based products and services is, to a large degree, about addressing a non-existing market with solutions to problems the potential customers didn't even know they had (see Ch. 4.3.1.4). This represents a considerable challenge in terms of imagination and innovation when assessing and approaching a potential market.

In order to secure one's competitive advantage, a constant monitoring of the perceived market is necessary. The institute's competence base is under constant adjustment and refinement in order to meet the new opportunities that emerge. In this connection, there are basically two strategies that can be used, namely using already existing competences within new areas, or acquiring new competencies to serve new or existing markets.

In the following, some potential areas of future activities are described, based on the suggestions of Hov (2002).

One of NILU's core competencies is chemical analysis of organic pollutants. This is an area which requires expensive and advanced equipment, highly skilled staff and experience, all of which the institute has acquired in the course of many years of focused attention. This competence can also be used in areas which have little to do with air pollution as samples of various other types of materials can be processed and analysed. The laboratory has, for example, analysed various biological samples such as olive oil, bird's eggs and fish. An emerging market for analysis of organic pollutants is food analysis for which NILU has the necessary competence and capabilities and is currently approaching. At a time when various organic pollutants have entered into the ecosystems, similar new areas of application will probably emerge in the future.

Earth observation based products are an area in which NILU has a high level of competence and some experience, but would have to develop this further in order

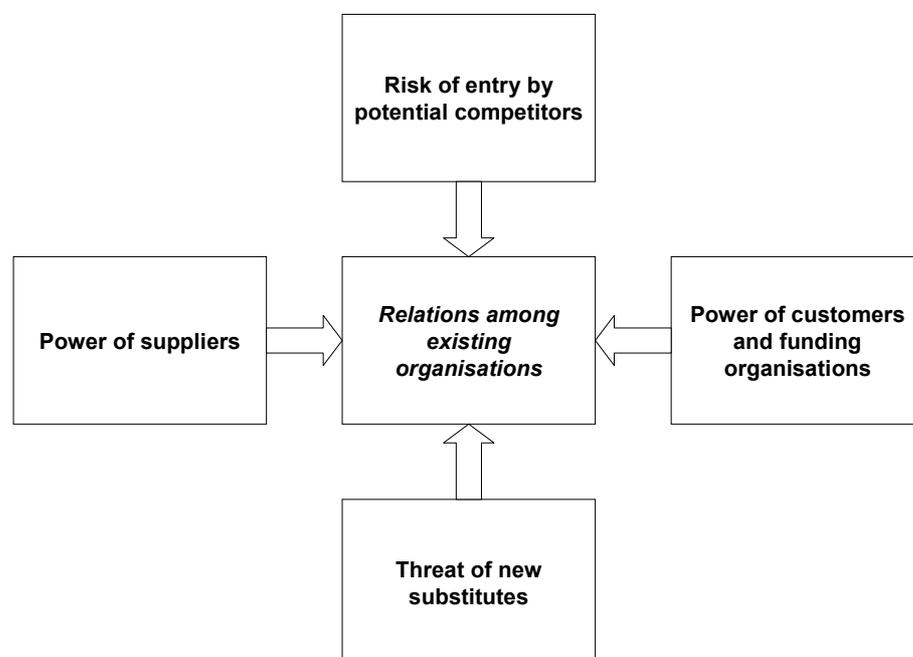
to become a serious contender in the market. The institute would, however, be able to draw on its already existing competencies in atmospheric physics and chemistry as well as technical and numerical know-how. This might prove to be a competitive advantage compared to organisations without a similar scientific background.

One of the institute's core competencies is integrated systems for environmental monitoring, which draws on competence within numerical modelling, observations and analysis. The institute has invested resources in this area over many years and has been able to secure projects and contracts with several international customers. Given the pollution problems facing urban areas over much of the globe, this is a product that, especially with accompanying scientific support, there is a great need for. Here there is also a great potential for customised solutions, something one recognises as a way of heightening the institute's market orientation.

#### **4.3.4 Threats**

##### **4.3.4.1 Competition**

When structuring an analysis of the competitive nature of the market that NILU operates in, it can be useful to organise the discussion of the current conditions by means of the Five Forces Model developed by Porter (1980). This model was designed with the corporate sector in mind. Oster (1995) has adapted the model for competitive analyses of the non-profit sector (see Figure 5) and the following analysis is based on her guidelines.



*Figure 5: Five Forces Chart for non-profit industry analysis (adapted from Porter (1980) and Oster (1995)).*

NILU is part of what one may call the environmental research industry. The participants in this business address different aspects of environmental problems. However, all sub areas are part of a complex system that must be considered as a whole, and this is also how it is viewed from the outside. However, based on the mission statement, NILU's industry could also be defined more narrowly as an 'atmospheric pollution' industry. The market is both domestic and international.

As opposed to the corporate world, the relationship among organisations in the same industry in the non-profit sector is both competitive and collaborative in nature (Oster, 1995). Other agents in the air pollution market are university institutions, both domestic and foreign, research institutes with similar or overlapping expertise, mostly foreign, and private companies that do air pollution monitoring or sample analysis. NILU is in close collaboration with organisations in the first two categories on both a short and long term basis.

#### *Risk of entry*

Entry barriers in the for-profit sector are usually associated with economy. However, one cannot define the entry barriers in the same way within non-profit or even low-profit industries. An entry barrier in the non-profit sector is any phenomenon that prevents new organisations from entering the market and serving it in an economically viable way (Oster, 1995). One very important barrier, which is relevant in NILU's case, is reputation and image. Being a well-established institute, which has served national and international government agencies, private companies and other research institutions for more than three decades, NILU has earned a good reputation in the market. Maintaining that image by continuously offering high quality services is, therefore, of prime importance (see Ch. 4.3.2.3).

Scale economics, which is a very important feature of the for-profit world, can also play a role in the non-profit sector. As the institute has grown, and its operation and economy has expanded, the opportunity to build a more advanced infrastructure in terms of technology, instrumentation and internal services has grown. The advantages of this benefit are described in Ch. 4.3.1.2. For an institute like NILU that offers its services in the form of competence and knowledge, scale economics also offers the opportunity of scientific specialisation. Both on an institutional and individual level this can enhance the performance of tasks and quality of research and is thus viewed favourably by customers of different categories.

New entrants to an industry will have to assess the cost of investment in assets, the risk of failure and potential exit costs. If the industry requires investments in assets that are highly specific and therefore not easily transferable to other areas, this will discourage competition. Potential new competitors in NILU's industry would, depending on what parts of the operation they were planning to compete with, have to make some initial investments in the form of instruments and analytical equipment as well as training and specialisation of personnel. Competence is built over time and is therefore costly to acquire, although hiring highly qualified scientist and technicians, if possible, would help matters. The importance of competence in NILU's operation is discussed in Ch. 4.3.1.4. Very specific knowledge, networks and relationships that have been developed over

time are important assets, which might only be moderately useful in other businesses.

NILU and other scientific institutes are contenders in a highly qualified market, and it is not easy for potential competitors to enter the same arena. NILU's expertise has been built over many years and, apart from the quality this should indicate, one has also secured a name and a certain status. The institutions that could probably compete with this, and which might become serious contenders in time, are the universities and colleges. These institutions also have an increased need to generate income, which might gradually force them towards more applied research.

#### *Substitute products*

In addition to competition from rivals within its own market, organisations can also be affected by competition from related markets. This part of the analysis is dependent on how one has defined one's industry. NILU's industry was earlier in this section defined as air pollution, but could in a broader sense have been labelled environmental issues. When identifying substitute products and services, this is probably the area they would come from. The services and products that NILU offers are, however, highly specific to air pollution. Presuming that these issues are on the public and political agenda, it is therefore unlikely that one would be substituted for another.

#### *Customers and funding groups*

The demand for products and services is represented by the organisations customers and funding groups. The relative importance of the two groups depends on whether the organisation is a commercial non-profit organisation or not. For both customers and funding groups, the share of the organisation's revenue determines their power over it.

In NILU's case, the funding group consists of the government, which has delegated much of its power to the Research Council of Norway. The institute receives a basic grant, which represents approximately 11% of the total revenue (see Ch. 4.3.1.1). This is an important contribution to the institute's building of competence and strategic direction, but is not the sole base of the government's power over NILU. The more important influence is exercised through the board of directors and the institute's articles, which state the foundation's mission operation guidelines.

Apart from that, both the Research Council of Norway and the European Commission fund research projects on a competitive basis. The two agencies accounted for 9% and 8%, respectively, in 2001.

The institute's customer group consists of companies and institutions of varying size and contribution to the institute's income. The largest customer is the National Pollution Control Authority (SFT), which accounted for almost 20% of the institute's income in 2001. Other major customers are the United Nations Economic Commission for Europe (UNECE) and indirectly, the Norwegian Agency for Development Cooperation (NORAD).

Other domestic contenders constitute a threat to certain parts of NILU's business. These can be firms offering, for example, air quality surveillance systems or chemical analysis of samples. In addition, the international competition for projects is quite high, both concerning scientific research projects and contracted research. This means that the bargaining power of buyers is considerable in the international market, but slightly lower in the national market. Local customers can, to a certain extent, approach international suppliers. That is, however, only worthwhile if they think the expertise of these institutes is higher, since the price is more or less the same.

### *Supply*

The traditional view on supplier bargaining power is that they can exert pressure on an organisation by raising their prices or lowering the quality of the products they offer. Depending on the competition in the supplier industry and alternative markets for their products, they will be able pressure the buyer. NILU buys highly specialised equipment and has very specific needs in some areas, and can therefore be vulnerable to the bargaining powers of some suppliers. Other goods the institutes purchases are readily available, and therefore not as much of an issue.

A professional enterprise like a research institute depends heavily on its labour force. A larger part of the institute's employees are highly trained professionals and to the degree that they have other employment opportunities, they wield power over the institute. Their influence will also be affected by the job situation in other alternative markets. This issue relates to the importance of human resource management discussed in Ch 4.3.2.1.

### *Collaboration*

When analysing relations among for-profit organisations, one typically assumes that competition is the predominant mode of interaction (Oster, 1995). The non-profit situation is more complex and the traditional value orientation of non-profits has been more cooperative and inter-organisational in nature (Bush, 1992). One of the reasons is that many non-profits have missions that transcend the boundaries of their particular organisation and they will therefore be more prone to collaborate with others in the same field. Another driving force that encourages cooperation is the efforts of the funding organisations. In many cases organisations write joint grant proposals at the direction of funders.

Rivalry between the traditional environmental institutes is not a big problem since they were established as defined entities dealing with different physical media. Many of the institutes did, for all practical purposes, actually start out in a monopoly situation. There are, however, points of intersection where more than one institute has sufficient knowledge and experience to undertake specific projects, but there is also a large degree of co-operation between the competing institutions.

### *Macro-environmental forces*

Macro-environmental forces have had, and will continue to have, a major impact on the environment and how the resulting environmental effects are viewed. As we experience a rapid technological development, some problems will diminish

whereas others, as yet unknown, may emerge. In general we can expect higher activity and better solutions as far as reduced emissions are concerned.

Closely linked to the technological development is demography. As the Earth's population grows, this will constitute a greater threat to the environment. In addition, the living standard in certain parts of the world will increase. The pattern of human habitation will influence the severity of the problems in certain regions and therefore the social sciences will have an increasingly important role to play in future research.

However, these developments will only have an effect on the environmental research industry as such, if there is social and political awareness of the problems. In fact, the political agenda and the Norwegian legislation have a major impact on the institute's business. Ultimately it is society's and the general public's awareness and willingness to take pollution problems seriously that determine the political agenda. This is why it is so important to offer comprehensive information to the public.

#### ***4.3.4.2 Lack of internal communication and collaboration***

According to the SWOT methodology, threats are usually seen as events and conditions that are external to the organisation in question. It has, however, become clear through discussions with both management and employees at NILU that the most serious threat to future success is seen as coming from circumstances and relations that are internal to the organisation.

If NILU is going to continue succeeding and prosper further over the years to come, it is vital that all levels of the organisation pull in the same direction. This requires open communication and discussions on what that direction should be both in terms of strategic scientific objectives and conceptual understanding of how the institute's activities should be organised and carried out.

Over the years, there have been conflicts and disagreements between management and employees' representatives and the unions regarding organisational issues and a say in the decision making. Without touching upon the content and substance of these disagreements, one can conclude that these conflicts have been damaging to the institute and its internal working relations. The conditions have, however, greatly improved recently due to conscious and focused efforts from all parties, and there is reason to view the future with more optimism.

In order for this positive trend to continue it is important that all members of the organisation cast aside biased opinions and previous conflicts, both personal and those concerning former disagreements. The will to improve the situation will be decisive in the success of future collaboration and communication efforts. The prerequisite for future success in such cooperative efforts, however, is a basis of equality where unilateral decisions are not acceptable as a way of solving disagreements.

The institute's handling of its organisational process can contribute to communication and collaboration internally, assuming everybody is committed to improving the situation. Some of these have been touched upon in earlier sections.

A strategic planning process that secures active participation (see Ch. 4.3.2.2) from all levels of the organisation is an example of this. This also has relevance for competence management (see Ch. 4.3.1.4), the infrastructure (see Ch. 4.3.1.2) and human resource management (see Ch. 4.3.2.1). The main aim is that the organisational processes must be beneficial to the institute and its activities and promote cooperation and understanding between managers and employees.

This is mostly a question of organisation. It is the responsibility of management to instigate value adding processes that can bring everybody aboard. The employees have a responsibility to follow up and close ranks behind positive initiatives.

## **5 Summary and recommendations**

The research sector in Norway has recently been the object of quite considerable attention from the political and administrative authorities. The issues that have been discussed are first and foremost the quality of research activities and the resources that are allocated for research purpose. The authorities have so far drawn the following conclusions:

- The resources that have been allocated for research purposes up to now have been inadequate for maintaining the desired national level of scientific research, and for satisfying the demands and needs for scientifically based results.
- In the future, a greater emphasis will have to be placed on the quality of research activities. Enhanced quality will be a prerequisite for continued activity at the current level, and even more so when it comes to securing future increases in resources.
- Over the next three years additional resources will be allocated to the Norwegian research sector as a whole. The public funding will probably be increased by approximately 1,5 billion NOK annually. The goal is that research financed by industry and trade will increase proportionally.

The environmental research sector should aim at securing at least a proportional part of the additional resources that will be provided in the coming years. That will, however, partly depend on how both the global climate problem and environmental politics develop. In addition, the Norwegian environmental research institutions will have to demonstrate their ability to organise their activities in a way that maintains, and preferably strengthens, an already high international profile, and produce results of both international and regional relevance. The importance of quality of work in this competitive market cannot be overestimated, regardless of whether more resources are made available or not.

NILU, which is a well established and recognised part of the Norwegian environmental research sector, is mostly dependent on securing its income from an increasingly competitive national and international market. The institute will continue to rely heavily on an efficient organisation of research activities and effectiveness and quality in its research-based products and services. This is necessary in order to secure the current level of activity, and to be able to expand into new and interesting areas of research in the future.

In order to achieve these objectives NILU should address the following organisational and administrative challenges:

- Design and implement a plan for competence management and development, based on market needs and future possibilities. NILU relies on its competence on the individual, group and organisational level to maintain its competitive advantage in an increasingly competitive environment.
- Manage the institute's human resources in a way that will contribute to the development of efficiency, effectiveness and high quality of the institute's operation. The employees are the institute's most important resource and the institute's activities must be organised in a way that secures a high degree of utilisation.
- Strengthen the strategic planning process in order to exploit the possibilities and limit the undesirable effects of changing conditions. The strategic planning process should secure the active involvement of all levels of the organisation, based on a mutual understanding of the institute's mission.
- Secure active and committed participation from all levels of the organisation. Both management and employees will have to reach a common consensus regarding organisational issues, and address and handle the institute's internal collaborative problems.
- Secure a future-oriented financial development given the current political and administrative conditions, and taking into account the need for a more market-oriented approach. All levels of the organisation will have to observe sound economic practises.

## **6 Qualitative assessment of the method**

This thesis gives an overview of the current situation for Norwegian research in general and environmental climate research especially, with respect to allocation of resources and demands on quality. This approach was chosen in order to give a background for the analysis of NILU's current situation and future possibilities.

An assessment of the institute is presented in the form of a SWOT analysis, which is used as a framework for the analytical part of the thesis. This, together with the stakeholder analysis, is part of the initial steps in a strategic planning process and, as such, represents an example of this approach to the planning process. There might be disagreements about the result of this analysis, which is natural since there are no given or ready-made answers to the questions raised. The point, however, is not to present a final analysis of the institute's situation, but to initiate the process of identifying and discussing these issues. This attempt can hopefully be the first step in a constructive, future-oriented process, which should involve all members of the organisation.

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