The precautionary principle: between research and politics

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Preface

The National Research Ethical Committees are still young as institutions. As one of the three committees, The National Research Ethical Committee for Natural Science and Technology (NENT) is now at the end of the second period of appointment (1994 - 1996). We present with the following a piece of work on "the precautionary principle" which has occupied us during a large part of the last period of appointment.

The Committee has a special responsibility for an ethical approach to the problems related to industry, our fisheries and agriculture, in addition to approaches of an ethical nature, which scientific research and applied research within areas of natural science and technology generally present.

The Committee has given special emphasis to forwarding the ethical conscientiousness of researchers and users with regard to the application of technology and natural scientific research. This represents a rather wide and complex field of activity. The working methods of the Committee have been to choose specific issues that they consider as vital. The Committee has therefore invited relevant people to co-operate and take part in a dialogue on each actual issue.

In this report NENT has thus put on the agenda the issue of the "the precautionary principle". NENT considers the "the precautionary principle" as an ethical principle in the sense that a consideration of future generations and our future natural environment must be regarded together with the people, society and milieu of to-day. The principle got its breakthrough with the "Rio-declaration". In Norway the principle has gradually been incorporated into legal documents.

We are witnessing the fact that technological interventions become more and more comprehensive, involving great consequences for our future. This is a result of constantly increasing technological productivity and efficiency. The result is that
researchers, experts in public institutions and in trade and industry ought to consider the consequences of their projects, with regard to people as well as society, both of today and tomorrow.

One might think that the principle would have been properly defined, especially so because it has already found its way into legal documents. However, this is not so. NENT feels that this report represents a pioneer work, and trust that it will form a basis for continued debate and reflection.

We have followed our usual procedure in this work, and are greatly indebted to all the people, institutions, organisations and enterprises that have spent time and expertise on participating in meetings and seminars to giving an account of and discuss their special fields with NENT.

NENT wishes to express their thanks for good help and inspiring contributions and discussions with all those who have contributed. We would particularly like to thank the following persons: Uno Abrahamsen, Geir Wang Andersen, Lars Føyn, Bente Herstad, Nils Roll-Hansen, Tora Skodvin, Haakon Thaulow, Asbjørn Aaheim and Jon Teigland.

Members of the Committee and the secretariat have in addition been in contact with many people who have contributed with valuable information.

Without the hard professional work done by NENT’s secretary, Matthias Kaiser, it would have been impossible to carry out this task. He has not only written down the statement, but his proposals to the Committee, based on his own professional work and contributions from our cooperating partners, he has exerted a significant influence on the shaping of the report. The Committee would also like to thank Hilde Storvik for excellent help with the editorial work.

We hope that this work will become important to people and institutions that are working on plans and projects of great importance for our common future. We also hope that it has contributed to a debate and to making the "the precautionary principle" become something more than a vague word of praise that we can treat ourselves to on suitable occasions.

Inge Johansen, chairman of NENT
Introduction

INTRODUCTION:
SUSTAINABILITY AS A GOAL

The problem

Scientific and technological advance has brought many important benefits. The standard of living and average life expectancy in industrial countries have increased considerably, and in important areas increased standard of living has resulted in increased quality of life. With extended knowledge one has received tools to fight need and poverty. Technological development has released many people from hard physical labour. The development of knowledge has also contributed to a social development where democratic structures have been strengthened in many countries. The level of education is very high in the rich countries.

At the same time one has had to realise that this development is a double-edged sword. The environmental problems overshadow our future perspectives, and we must alter our course if we want to secure the safety of the future for our descendants. The world is facing great challenges: our lifestyle and technology have brought us into a development that cannot continue without involving serious threats to the welfare of our own generation and especially that of future generations. The very foundation of life on our planet, developed through millions of years, is threatened. Among the global problems we would like to mention:

a) An increase of CO₂ in the atmosphere and the greenhouse effect
b) Loss of farming acreage
c) Loss of forest areas
d) Loss of the protecting ozone-layer
e) Pollution and impoverishing of water reservoirs
f) Over-exploitation of natural resources (both renewable and non-renewable), and
g) Increased reduction of biodiversity.
These problems must be seen in connection with a rapidly increasing world population. While we, as per today, can calculate the population to a total of about 5.5 billion people, it is reasonable to assume that during a period of 50 years we shall have passed 10 billions, and may get close to 12-14 billions at the end of the next century. It is a food for thought that both increased prosperity and increased poverty are contributory reasons for our environmental problems. Along with prosperity follows higher consumption, which is likely to involve greater strain on our natural resources. Along with increased poverty, illiteracy and lack of competence, environmental considerations are put aside and available resources are rapidly consumed.

Environmental problems attached to our atmosphere are frequently understood as being of a global nature. Several of the environmental problems have a more regional and local character. These may threaten health and environment to the same extent. Large modern cities and the industrial production that takes place locally are examples of this. These are probably one of the reasons for the increase of asthmatic diseases and allergies. The risk of acute environmental catastrophes caused by accidents such as in Bhopas and Seveso are also due to regional and local factors. We must also mention the human-created radio active burden that today first and foremost weigh heavily on the industrialised nations.

And finally, one must take into consideration that until now we do not know of all the environmental problems that industrialisation has created. As an example it is only today that we have started learning about the so-called environmental-oestrogen chloric compounds, which probably involve serious health problems and a "feminisation" of people and higher species of animals. The European countries have recently had to confirm that the "mad cow disease" has been able to spread, without anybody being able to introduce effective counter actions in time.

**Global sustainable development**

Until a few years ago no attention was given to these problems. With the report "Our Common Future" (the "Brundtland report") which the United Nations' World Commission on Environment and Development published in 1987, environment and economic development were seen as connected. The report received great attention all over the world. It also used the expression "sustainable development" to underline that an alteration of the development we have at the moment was necessary. The
expression was already used in certain circles before, but got its central meaning with this report. The concept "sustainable development" means that we must be able to meet and satisfy today's needs without limiting the possibilities of future generations to satisfy their needs.

The United Nations conference on environment and development (See Earth Summit, 1992) was held in Rio de Janeiro in June 1992 as a response to Our Common Future. It was the largest international conference ever held, with about 110 heads of state and heads of government present and a great number of organisations ("non-governmental organisations" = NGO). As a result of the conference five documents were signed by a great number of countries. These documents are:

- **The Climate Convention.** The countries that signed the convention must reduce their emission of greenhouse gases, especially carbon dioxide, to a previous level by the exit of this century. They must give reports of their measures.

- **The Biodiversity Convention.** This convention claims among other things a development of national strategies to protect the biodiversity, and a review of threatened species.

- **The Forest Principles.** These principles have the character of non-binding appeals to certain countries to develop forest areas in a balance between socio-economic needs and a sustainable development, and to strengthen conservation and re-cultivation of lost forest areas.

- **The Rio-declaration.** This is a collection of 27 principles which are normative, but not a legally binding obligation for the future policy of the states. The principles are far-reaching and apply among other things to poverty, responsibility for environmental damage ("Polluter-pays"), and prevention of pollution across country borders. A principle is being set forth that scientific uncertainty must not be used as an argument to postpone important measures to counteract environmental deterioration (chapter 15). In English this principle is called "the precautionary principle" and has been translated into Norwegian as "føre-var-prinsippet". This principle is the main theme of this report and is to be dealt with in detail in the following chapters.

- **Agenda 21.** This is perhaps the most important result of the Rio-conference, as it contains 40 chapters that together give an action plan of a reorientation to a
sustainable development. The plan for action includes strong appeals for economic, social, and international institutional reforms to reach concrete environmental and socio-political goals.

The results of the Rio-conference, and especially Agenda 21, were criticised from many quarters. It is no doubt a compromise between rich and poor countries, industrial interests and environmental considerations, political power-elite and primitive aborigines. Nor have they got the legal binding character one might have wished for in securing effective protection against environmental deterioration and a change to a sustainable development. Vital concepts remain as a rule very vague, or even get a different interpretation in different parts of the documents. This applies not least to the concept "sustainable development".

The Rio-conference has at the same time, in connection with the report *Our Common Future*, created a strong normative basis whose importance for global political action should not be underestimated. In the same way as the United Nations Declaration of Human Rights these documents express a global consensus about central and important values that are easily threatened by narrow and short-termed national interests. The nations are instructed to take responsibility for placing these values as a basis for their strategies to handle developmental and environmental problems. As a foundation value the results of the Rio conference make a compromise between the states. As such they hardly make any particularly radical deviation from traditional views within the ethics or from the foundation value in the law making of modern democratic states. It is claimed, for example by some of the critics that the anthropocentric views of values (see chap. 4) which is repeatedly mentioned in Agenda 21 is insufficient to fight against our environmental and developmental problems. At the same time, however, this foundation of values forms a number of commitments towards action that are altogether difficult to carry through, and which can bring the global development away from its present destructive course. If it is not an optimal point of departure, a consistent follow-up might lead to radical changes in consumption habits, socio-economic structures in different countries, institutional and political mechanisms of making decisions, and finally to substantial improvements in relevant questions of environment and development.

This NENT-report uses as point of departure the normative foundation that is expressed in the documents from the Rio-conference. We have based it on the opinion that each nation has a moral obligation to give concrete contents to the documents in
accordance with their foundation of values and to follow it up in practice. The responsibility lies to a great extent with the administrators whose contributions are necessary for giving concrete local, regional and national content to the concept of sustainable development. At this point the report addresses itself to trade and industry and to the administration. The report is otherwise addressed in particular to the society of researchers

**Research, politics and sustainable development**

Modern society has become more and more dependent on research and science. The dependencies are many. While economists in earlier days considered science and technology as a "black-box" in economic development, modern economic politics are based on the belief that scientific and technological innovation is an important reason for economic development. Modern industrial society therefore looks upon science and technology as integrated elements in its economic and industrial politics.

Similarly scientific and technological research is of great importance to the political regulation of society. Standards for general security and welfare are developed in line with scientific expertise. Food security, environmental standards, official and private health measures, regulation of activities of industry and trade, national and international transport etc. take place on the basis of scientific expertise.

Research has recognised this and become more related to society and more "socially useful". Its usefulness is directly visible when research is applied to develop new products in industry, in farming and in service industries. This takes place when national research policy is based on so-called strategic basic scientific research (adjusted to certain aims of knowledge) applied research directed towards industrial activity and applied research directed towards the administration. More and more researchers are in this way an integrated part of the socio-economic and political development in society. Society's use of resources on research is gradually increasing. In terms of economic resources the use of research money in society will soon be comparable to primary industry.

It is an open question as to what extent the normative basis and methods of research have taken the consequences of this development. One may also claim that science and research ought to reflect this new situation in its education and working methods. This question is central for this report.
Agenda 21 claims explicitly more use of scientific expertise in the struggle for a sustainable society. Among other things it demands extensive use of complex scientific procedures such as toxicological risk estimation to ascertain what chemical substances are dangerous. More use of modern biotechnological methods is also wanted to relieve problems connected to food production and food supply. It is therefore reasonable to assume that decision-makers will be more dependent on getting support from scientific recognition when a certain practice is claimed not to be sustainable. As one must always assume that this will involve social conflicts with interest groups living on non-sustainable production, and as all parties in such conflicts from a starting point will try to take up the positively loaded concept of "sustainability", scientific expertise will often get decisive meaning. Scientific methods will become even more adjusted to politically sensitive questions and questions where the interests of different social groups are involved.

The central meaning of the precautionary principle

 Principle 15 in the Rio-Declaration reads as follows:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

This formulation from the Rio-Declaration is to function as a point of reference of the report as regards the precautionary principle.

It is our opinion that the precautionary principle is the principle related to sustainable development that has greatest importance for scientific activity and methods. In its extreme consequence it involves a fundamentally different direction of scientific research, and a different validation and control of quality (See e.g. Wynne & Mayer, 1993). At the same time the extent and interpretation of the precautionary principle is not clarified. As the other principles it expresses a fundamental set of values and a roof mechanism of action which must be clarified and made operative before it can be used on concrete problem areas by the different actors.

Criticism of the precautionary principle has been put forward from different quarters. Some, for example John Gray from the University of Oslo, are positive to the principle as such, but reject the opinion that it will have consequences for research (See e.g. Gray 1990,1991,1996; See also Roll-Hansen's contribution in The
Precautionary Principle 1991). He sees in the precautionary principle an administrative principle and not a research principle. Others are of the opinion that it is not suitable as an administrative principle either. They think that the principle yields to political pressure from the environmental organisations and sets aside more realistic principles that one has until recently applied in the administration of e.g. the ocean areas. Here the principle of environmental capacity is mentioned. Economists have in their turn put the precautionary principle against a "wait-and-see" or "no regret" strategy, which some people claim give more economic meaning. (cp. e.g. Chisholm & Clarke 1993, Pearce 1994, Ramchandani & Pearce 1991).

The discussion indicates that a clarification of the precautionary principle is needed in science. It also indicates that the distribution of roles and mutual expectations in the interaction between research, administration and politics are fragile and vague.

If the precautionary principle is to play an important role in the efforts to obtain a sustainable development, it is important not to have unrealistic expectations. The precautionary principle does not contain any recipe of how possible risks can be avoided. The non-risk society is an illusion, which neither at the present nor earlier has had any real foundation. We live in a "risk society" as sociologist Ulrich Beck expresses it. It is not the existence of risk in itself that is the challenge, but the distribution of risk and control of it. The fact that a society accepts certain risks, is not the same as accepting all sorts of risks. The risk must be within certain ethically acceptable limits, and these must be the objects of political processes of decision. The risk should be distributed equitably without reinforcing already existing dissimilarities in a society. To be able to master a sustainable development technological development will be at least as important as today. Technology may be able to prevent non-sustainable developments, and replace them with others, which has its own risk potential. And the development of alternative technology should be able to give economic meaning, if it is to have any chance of being exploited. It is within these considerations that the precautionary principle has its place. It gives direction and guidance as to the handling of technological and industrial development, relates risk to the knowledge situation, integrates socio-economic aspects and indicates processes of decision on how to balance between different types of risks.

Critical objections to the precautionary principle will be discussed later in this report. Here we only want to emphasise that the normative validity of the principle is
taken for granted in our report. How the principle should be put into practice in a scientific context, and what consequences it will have for the interaction between research, administration and politics is, however, something we consider an open question. This question is the central theme of the report.

**Short survey of the contents of the report.**

The report starts with a brief review of the historical development of the precautionary principle from its origin in German environmental lawmaking to the North Sea agreements. Then follows a discussion of the legal status of the precautionary principle in Norway today, as a concept of environmental law and in relation to The Gene Technology Act.

In Chapter 2 the report deals with three different examples, which all pose the question whether the precautionary principle ought to be applied. They also have another thing in common, they do not consider it obvious what strategy should be chosen, even if one is of the opinion that the precautionary principle ought to be applied. The examples differ through having a local, regional and global character. This chapter gives a first illustration of the fact that the application of the precautionary principle can hardly be based solely on objective and nature given conditions.

Chapter 3 discusses scientific expertise and uncertainty in science. In this way it gives an important background for interpretation of the clause of uncertainty of the precautionary principle. The point of departure is that scientific knowledge is always encumbered with uncertainty, and that in practice the uncertainty increases the more we are aiming at predictions concerning concrete eco-systems. This is founded both in scientific methods and use of models, and in reality complexity. In concrete contexts of decision making this may lead to the fact that boundaries between professional experts and decision-makers, e.g. between science and politics, become blurred. Two types of expertise are scrutinised critically: clarification of consequences and risk analysis. The main points are summed up in altogether 10 conclusions on the way.

Chapter 4 considers the ethical aspects of the discussion of the precautionary principle. At the beginning it is established that an interpretation of the precautionary principle as a dictation of non-emission is not ethically valid. In the following discussion "spacecraft ethics" is outlined as the way of thinking that seems best suited to basic ideas of the precautionary principle. The question is whether responsibility for
future generations will be actualised by the discounting practice of the economists, towards which critical attention is being directed. The ethical discussions continue with some critical comments on anthropocentric ethics and non-anthropocentric systems of ethics. Here the report follows a cautious conservative approach, by pointing out that anthropocentric ethics gives more guiding to responsible environmental policy and practice than we are able to fulfil today. The chapter concludes by identifying the concept "blameworthy ignorance" as an ethical core concept for the precautionary principle. From this follows a moral obligation to prepare for a "fair", e.g. satisfactory and just process of decision. The process leading to environmentally oriented decisions becomes ethically considered as important as the outcome. The chapter contains altogether six general conclusions.

In Chapter 5 the precautionary principle is discussed in relation to other means that traditionally are discussed in connection with suitability. The core question is the precautionary principle's status in relation to these and other principles. A particularly important question is whether the precautionary principle can be realised by economic means only.

The report concludes with a negative answer, and emphasises regulation and law amendments as types of measures that do not secure a follow-up. Another important question applies to the administration of the environment based on nature's limit of toleration. Here too, the report concludes by stating that the precautionary principle aims at another type of administration of the environment. The chapter contains altogether seven conclusions.

The report is getting closer to more concrete recommendations in chapter 6. The question is what demands we may make for new forms of practice in line with the precautionary principle. The first part of the chapter deals with the consequences of the fact that the precautionary principle not only includes the natural conditions we must consider, but also social conditions and conditions of value. A framework of reference in which four fundamental perspectives each giving a different answer as to what is a well-suited precautionary strategy is outlined. The choice between them is at long last a political choice. At the same time the clarification of their concrete contents is a task where science can make a contribution. The report also concludes that different operators ought to exercise consistency in their choices of perspectives, independent of whether or not they have special interests in certain matters.
Furthermore the precautionary principle is being discussed in relation to economy and risk research. The report emphasises the importance of both, and calls for more explicit and at the same time more reflected integration of both factors in environmental administration. Chapter 6 also discusses the handling of uncertainty in science itself. Critical attention is directed to the lack of willingness and methods in science to describe the points of uncertainty to non-scientific receivers. The report calls for the development of better tools for this purpose, and that it may become integrated in the education of doctors. Finally, statistical methods are discussed in relation to concrete environmental decisions. It is claimed that the common theory of sentences of hypothesis will have its clear limitations, and that more emphasis should be put on a minimising of the so-called type II mistakes.

The final Chapter 7 discusses the precautionary principle in relation to the democratic processes of decision in relation to environmental issues. Threads from earlier chapters, e.g. chapters 3 and 4, are returned to when the question is posed, how limitations in knowledge based on experts can be supplied with other relevant perspectives. The main problem is how to create good forums in order to integrate points of view and views of value of the parties involved from the broader layers of population.

The report gives a thorough account of relevant experiences from Canada with so-called panel discussions. This leads on to a recommendation to establish a trial arrangement with local or regional "environmental parliaments" in Norway. The proposal is inspired by the Canadian model. The recommendation is directed to the authorities in order to give an adequate institutionalisation of the fundamental ideas of the precautionary principle.

Groups that the report is aiming at.

Firstly, the report directs itself to groups of operators who have responsibility and expertise in environmental questions in a broader sense. This includes researchers and those who are professionally involved in environmental issues based on research. It is also desirable to reach research politicians, experts in the administration and industrial leaders. Furthermore, the report poses principal questions that have their natural place in the education of researchers. In addition to this it directs itself to anybody who is actively interested in research and the place of research in society. We hope in particular that the report and its recommendations will stimulate to an official
debate on search material and necessary institutional initiatives. An abridged version of the report is also to be published as a separate publication in order to convey the main contents of the report to broader social groups.

The report aims at a many-sided discussion of the importance and concrete interpretation of the precautionary principle. No attempts will be made in order to replace common formulations of the precautionary principle with new and more precise definitions. We believe that the importance of the precautionary principle is attached to its function as a far-reaching normative premise, and that it in different connections may have different concrete formulations. For this reason, a concrete realisation into action in certain given problem situations ought to be supplemented by a general reflection of the base values and ethical foundation of the precautionary principle. The strong point of the precautionary principle is the ethics behind it, and it is its flexibility towards concrete norms of actions that makes it useable.

* * * *
CHAPTER 1:
The history of the precautionary principle and its legal status in Norwegian environmental policy

In this chapter we give an orientation of the status of the precautionary principle and focus on its history and its role in Norwegian law making. It is in itself interesting how fast the precautionary principle has became a fixed concept that has found its way into international agreements and national law making. Lacking an unambiguous and fixed definition of the precautionary principle, it is important that the principle should be interpreted in the light of the context in which it appears.

In Norwegian law the precautionary principle undoubtedly also plays an important role, among other things at joining the EEC agreement. At the same time it seems obvious that e.g. interpretation and practising of The Gene Technology Act based on an acceptance of the precautionary principle.

The precautionary principle is given different names in different countries. In Denmark and Sweden it is referred to as "forsiktighetsprincip", in English speaking countries it is translated into "the precautionary principle". The principle itself has its origin in German environmental policy and is referred to as "Vorsorgeprinzip". With German environmental protection as a point of departure, the principle has later in the 1980s been integrated as a new element in international agreements.

The precautionary principle may also be found in the following international agreements:


Bergen Declaration of Ministers concerning Sustainable development in the EU region, Bergen 16th May 1990.

The Paris Convention (PARCOM: for the Prevention of Marine Pollution from Land Based Sources), recommendation 89/1, 1989

The Oslo Convention (for the Prevention of Marine Pollution by Dumping from Ships and Aircrafts)

The Barcelona Convention (for the Prevention of Marine Pollution by Dumping from Ships and Aircrafts)

The Maastricht Treaty (EU), article 130 R, section 2.


In addition, the precautionary principle has found its way into national lawmaking in a number of European countries.

**The "Vorsorgenprinzip" in German environmental policy.**

The precautionary principle is one among altogether five central principles in German environmental policy (cp. Boehmer-Christiansen 1994.) The other principles are "the polluter pays", "cooperation" (Kooperation"), "proportionality between costs and profit(Wirtschaftliche Vertretbarkeit") and "joint responsibility" ("Gemeinlastprinzip"). While the principle of proportionality indicates that no enterprise or trade should be imposed higher costs than it is able to bear without going bankrupt, common responsibility is that any enterprise or trade can be subsidised in order to introduce measures to stimulate the environment.

The precautionary principle may be traced back to the first draft of a bill (1970) aiming at securing clean air. This document expressed that the bill aimed at preventing damaging environmental effects. ("dem Entstehen schädlicher Umwelteinwirkungen vorzubeugen"). In the environmental programme of the federal government of 1971 the same idea is expressed as "long term environmental planning" ("Umweltplanung auf lange Sicht") This is with reference to measures preventing concrete dangers that may threaten the environment in the future. The greater the danger, the greater the need for measures taken by the authorities to protect the
people. This also set the legal framework for active measures that were not aiming at repairing damage that had already taken place.

The law was passed in 1974 (as "Bundes-Immissionsschutzgesetz, BimSchG") and covered all potential sources of "air pollution, noise, vibrations and similar processes". It was to protect "people and animals, plants and other substances" not only from concrete dangers, but also from "considerable drawbacks and considerable disturbances".

The bill was first met with political resistance, especially from small southern German non-nation states and Nordrhein-Westfalen. The official debate on the destruction of forests, "Waldsterben", speeded up the debate and led to a broader acceptance of supervision of preventive industrial measures by the authorities.

The German word "Vorsorge" implies preparatory measures in expectance of a difficult future. In official German documents the term occurs especially in connection with early stages of the development of a particular policy. As an example, the expression is used by the German Enquete Kommission (1987-1990) "Vorsorge zum Schutz de Erdatmosphäre". Here it was ascertained that there is a need for measures "as a preventive in our common interest and in the interest of future generations." When one has agreed on a basic policy, in the case for instance "Climate policy", the term is likely to be omitted. The second Enquete Commision therefore only talked about "Protection of the atmosphere of the world". The most unambiguous explanation and definition of the precautionary principle in German environmental policy came in a report from the Ministry of the Interior of the federal parliament (Bundestag) in 1984. Here it was stated that: "Responsibility towards future generations indicates that the natural necessities of life are preserved and that irreversible types of damage, such as destruction of forest should be avoided".

Thus the precautionary principle may be defined as follows:

"The precautionary principle indicates that damage to the natural environment (which surrounds all of us) ought to be avoided prior to the damaging, and in accordance with given possibilities and opportunities. Furthermore, the precautionary principle means an early acknowledgement of dangers towards health and environment through extensive and synchronised (harmonised) research, especially of cause-and-effect relations, …, which involves taking measures already before unambiguous scientific research exists. The precautionary principle means a development of technological processes in all sectors of trade and industry that can
reduce environmental strain to a great extent, especially those that are caused by an introduction of harmful substances." (BMI, 1984, 53).

The following seems to emerge here:

- Elements of danger should be recognised early, research is therefore essential;
- When irreversible effects are expected, measures ought to be taken even if one lacks good scientific knowledge, in other words, clear and unambiguous proof of possible damage is not necessary;
- The authorities must support and accelerate technical development that can reduce the spread of environmentally harmful substances;
- The authorities should contribute to the introduction of cleaner processes and technologies in private trade and industry.

The combination of the precautionary principle with the development of cleaner technologies is typical of the German ideas of environmental protection. By way of structural measures one has given support to the development of technical solutions to environmental problems. In Germany the environment is first of all protected via the use of technology (Stand de Technik", "beste Stand der Technik" respectively). This has created jobs and environmental technology has become a growth area. In many cases the courts have been those who have made decisions as to whether the best technologies have been used. Here the German Association of Engineers (VDI) has often been used as advisers. This shows what a dominating part engineers play in Germany in giving advice on environmental measures. Contrary to a number of other countries, they have greater influence than for instance researchers of natural science.

This principle, however, not only functions as a key concept to developing new technology and new markets, it is also a reason for increased federal environmental policy to influence market economy and to the as regards the small non-nation states.

**The precautionary principle in the North Sea Agreement**

It ought to be mentioned that the German interpretation of the precautionary principle is not necessarily the one that has become integrated in later international agreements, even if that is what the principle historically originates from.
The North Sea Agreements are perhaps the international agreements where the precautionary principle has had its strongest position. In the first North Sea Agreement (Bremen, 1984, cp. Esbjerg (a) 1995) the precautionary principle is not mentioned explicitly as a leading and independent principle. As an example, it is ascertained in points A5, A6, and A7:

"Conscious of the need to conserve for present and future generations this most important marine ecosystem for recreational purposes as well - in view of its importance for fisheries - as a source for wholesome food; Recognizing that the environment is best protected against pollution through timely preventive measures; Conscious that damage to the marine environment can be irreversible or remediable only at considerable expense and over long periods and that, therefore, coastal states and the EEC must wait for proof of harmful effects before taking action".

Further on it says in point C9:

"If the state of knowledge is insufficient, a strict limitation of emissions of pollutants at source should be imposed for safety reasons".

It is reasonable to interpret these statements as substantial obligations in the spirit of the precautionary principle, but without stating explicitly that this is an independent principle. This happens, however, in the declaration from the second North Sea Conference (London, 1987). It says in Point VII of the declaration of ministers:

"Accepting that, in order to protect the North Sea from possibly damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control imports of such substances even before a causal link has been established by absolutely clear scientific evidence."

Here the precautionary principle is being introduced as an independent principle. It is at the same time striking that the clause of uncertainty is marked by reservation ("may require") and unrealistically high expectations to scientific expertise ("a causal link … by absolutely clear scientific evidence"). In the following agreement
(The Hague, 1990) the precautionary principle is being confirmed as an independent principle, at the same time as it is given more specific contents and the clause of uncertainty is formulated more cautiously:

"(The participants to the Declaration…) will continue to apply the precautionary principle, that is to take action to avoid potentially damaging impacts of substances that are persistent, toxic and liable to bioaccumulate even when there is no scientific evidence to prove a causal link between emissions and effects".

There is a striking transition from a lack of ability to establish absolutely clear causal links in 1987, to the absence of evidence of such causalities in 1990.

At the last North Sea Conference (Esbjerg, 1995, cp. Esbjerg (b) 1995) the trend was further strengthened towards more extensive use of the precautionary principle in the declaration, and to give it more specific contents, together with higher environmental aims. The principle occurs at several places in the agreement. For example, it says in connection with a reduction of dangerous substances in the North Sea:

"The guiding principle for achieving this objective is the precautionary principle".

Clear aims are expressed that the application of the precautionary principle should, over long periods, lead to a reduction of non-naturally existing substances in the North Sea:

"The Ministers confirm the goal …. of reducing by the year 2000, discharges and emissions of substances which are toxic, persistent and liable to bioaccumulate … and which could reach the environment to levels that are not harmful to man or nature with the aim of their elimination."

**The environmental perspective in Norwegian law - human beings at the centre?**

Considering future human environment of life is a vital part of the platform of the values of our rules of law and application of laws. No person will any longer accept that we carry out a policy that we know will ruin the environment of life for our descendants on the earth.
Environmental concern has become an integral element among others of political considerations, and their relative importance will of course be dependent on the strength of other concerns. Such considerations do not mean that the environmental argument does not have great intrinsic value. Today it will be problematic in any case to make political decisions that will involve a development where the environment of future generations will be damaged, and it will always be unjustifiable not to attach importance to such considerations.

The question whether the concern for the ecological system in itself has a value of its own in the legal system, is far more doubtful. Our system of values and our legal system are, as has been pointed out above, strongly marked by a view of nature that primarily understands nature as a value that secures the environment of life and the basis of life for human beings. In § 110b, first subsection, of the Norwegian Constitution this is strongly emphasised by taking as a point of departure the human right to an environment of a certain quality. The provision reads as follows: "Everybody has a right to an environment that secures health and a nature whose productive ability and diversity are preserved. Natural resources should be managed from a long-range and many-sided consideration, which takes care of this right also for posterity". This clause of the Constitution from 1992 is in fact more human centred than the decision of the Nature Conservation Act § 1 of 1970. Here it is emphasised that natural resources should be managed "from consideration of the close interdependence between human beings and nature, and that nature's quality should be preserved for posterity". An even more nature centred understanding is expressed in the Wild Life Act §1 of 1981 where it is ascertained that "The game and its habitats should be administered in such a way that nature's productivity and its diversity of species are preserved. §110b of the Constitution must, however, be the one that gives expression to the most representative general view of nature.

The environmental general clause of the penal laws § 152b is an example of a general rule that is based on a more ecologically orientated view of nature. The first clause of the decision introduces penalisation for those who damage nature by pollution. The damage is described as when "the environment of life of a certain area is considerably damaged or threatened by such damage". The maximum sentence is 10 years in prison. Human beings are in addition put more in the centre, when the maximum sentence is increased in the second clause to 15 years in cases where "the
person's death or considerable damage to body or health has been the result of such damage”.

This human centred view is also central in international environmental work. As earlier mentioned, the expression "sustainable development" is defined in relation to the living conditions of posterity. It has, however, occurred that more nature centred opinions have been expressed in legal documents. One example is the Rio Convention on biological diversity in which nature centred and human centred opinions are used as a point of departure, when the introduction begins as follows:¹

"The contracting parties,

Who realise the intrinsic value of biological diversity together with the ecological, genetic, social, economic, scientific, educational, cultural, leisure time and aesthetic values that biological manifold and its components make;
Who also realise the importance of biological diversity for biological development and the preservation of the life-maintaining systems of the biosphere;"

Such rather more nature centred legal norms should be understood from the context in which they occur. What is typical, however, is that the rules according to environmental legislation are based on a human centred view of nature. The consequence of this difference is not as dramatic when one includes future human beings and bases it on a view that our descendants are primarily interested in a preserved nature, such as it appears in the introduction to the Convention on biological diversity. This is also emphasised by Bugge, who in his report on the Convention points out that;²

"Biological diversity is the foundation for life-supporting processes on our planate, and will be of vital importance for future possibilities within the fields of food supply, medicine, forestry, and energy."

Such points of view have led to the following proposal of a definition of the precautionary principle applied to the question of preservation of genetic diversity:³

"Taking precautions means that we should not let any species or ecotype disappear before we have understood its place in the ecosystem and

evolution, so that we can guarantee local and global stability without the existence of that species. This means in practice that we cannot allow any species to be exterminated in the foreseeable future."

One may ask whether one can in practice live up to such an absolute interpretation. A legalisation of such thoughts would result in clear rights for nature at the species level. This has not been discussed at a political or legal level in Norway. The American Endangered Species Act of 1973 has, however, been interpreted in such a way that it opens up for a right to stop encroachments on nature that threaten to eradicate species that are particularly rare. In our legislation administrative authorities have the right to, but are not obliged to stop encroachments on nature from a consideration of threatened species.

The fact that the consideration of future generations implies that nature should be protected is, however, not always as obvious as in connection with biological diversity. In other situations one might definitely discuss whether future generations will be best served by protection or encroachment.

It has also been discussed in Norwegian legal theory whether one ought to introduce a system of rights for nature. The central legal consequence of such a right has been a proposal that persons or organisations may get procedural rights on behalf of nature, almost in the same way as a person incapable of managing his own affairs may be represented by a guardian. Eckhoff in his presentation of the idea of the rights of nature, contrasts this with situations where the circle of interested people getting access to the right of appeal is broadened. He points out that the interests of different persons and organisations can be of varying character and most often only represent some of the interests of nature. He goes on to state that:4

"By considering an area of nature as a holder of rights one could co-ordinate all interests that weigh against encroachments. Environmental considerations will weigh more heavily from both procedural and material point of view if they can be put collectively into the balance. It may also be that the river or the forest collectively may have more reasons for being preserved than all the interested people have together. Because, when it appears as a party it will come out clearly that economic as well as non-economic interests should count,

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3 Inger Nordal, Professor in botany at the University of Oslo in Loss of biological diversity. Biolog 3/4-1991 pp. 88-93 (p.93)
4 Eckhoff, op.cit. p.4
and that one should consider both the present and the future. And if, for example, living landowners or those with grazing rights get a compensation for the losses they suffer, this will not necessarily prevent damage to the river or the forest.

The viewpoint that nature itself has rights has not gained acceptance in Norwegian laws. It is however, a central point that it should be the decision-maker who has the responsibility for looking at the environmental considerations as a whole. On the other hand it is also clear that a consistent idea about rights for nature soon may give results that will be unfamiliar to most of us. It will, for example be so if one were to formulate rights at an individual level for plants and insects.

This report is based on the idea that the aim of environmental thought, as it has gained a foothold in Norwegian law and politics, is to protect the environment in such a way that it may be preserved as well as possible for future generations.

The precautionary principle as a concept of environmental laws.

The precautionary principle is formulated in connection with political work and has later appeared in legal documents such as laws and conventions. This is important with regard to how the principle may be understood. This development has taken place partly to strengthen the political weight of the concept, and partly as a consequence of such political weight. It has not occurred as part of a conscious effort to transfer the responsibility for the implementation of the political principles (sustainable development and the precautionary principle) from the political bodies to the courts and other judicial institutions. One has also transferred political terms to the judicial field without letting the terms go through an analysis, which ideally ought to be carried out before new legal concepts are introduced.

The precautionary principle is often defined precisely as an attitude claiming that "doubt must be to the benefit of nature". This formulation may often be a good point of departure for a description of the principle as a standard in cases where it functions as a balancing factor in an approximate evaluation, when the authorities have the possibility to take into consideration the risk for future damage. Thus we have the

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question of a consideration to which one may, or may not attach great importance based upon a concrete evaluation.

It is also relevant to formulate the principle as an obligation to take action. This is an obligation to take a hypothesis as a basis of fact in the evaluation of what decisions should be made, even if it is not possible to verify it scientifically. In several international agreements, e.g. in the Rio-convention\(^6\), one has tried to formulate such an obligation: "In cases where there is a serious threat or irreparable damage to the environment, lack of scientific certainty should not be used as a reason for not putting into effect necessary measures."

Both these variants of the precautionary principle will be of importance to our discussions. As a collective term of the precautionary principle neither of them seem sufficiently clarifying. The statement that doubt must benefit nature may be understood as if this applies to all doubts. Such an interpretation is hardly a good point of departure for a sensible management of the environment. The formulation that "lack of scientific certainty should not be used a reason for not putting into effect necessary measures" says on the other hand as a starting point something negative, that one should not wait until scientific evidence is found.

The core of the precautionary principle ought to be a claim that the risk of environmental damage should be given heavy weight when decisions with environmental consequences are made, and that this may only be done if one also takes into consideration the uncertainty that often manifests itself when the risk is to be described. The precautionary principle does not primarily involve a re-evaluation of claims of proof, but an emphasis that the danger of environmental damage ought to be taken seriously, even if the effect of environmental damage cannot be proved. Norms should therefore be formed that enable us to make social decisions based on an adequate evaluation of the danger of environmental damage in situations where relying on available scientific knowledge is not sufficient.

This understanding of the precautionary principle as a principle that primarily emphasises the risk of environmental damage will also have consequences for what is justifiable and attentive behaviour for those who run enterprises that may create risks for environmental damage. Those who behave in a responsible way should react in

relation to a broader risk picture than what may be found by a narrow study based on what is scientifically proved.

An important concept of help in this connection is the burden of proof. Generally it may be claimed that the precautionary principle involves a shifting of the burden of proof from the one wishing to prevent an environmentally dangerous action to the one wishing to carry it through.

The precautionary principle used in relevant legal texts.

The precautionary principle was, as earlier mentioned, first introduced as a legal concept in Germany, but has later got great international approval. The concept has also been expressed in legally binding agreements. For us it is particularly central that it is expressed in general terms in the introduction of the EEA-agreement, where it is placed together with the principle of sustainable development:7

"[The contract parties are determined to preserve, protect and improve the quality of the environment and secure a cautious and sensible exploitation of natural resources, especially on the basis of the principle of sustainable development, the precautionary principle and the principle of preventive actions."

It is uncertain as to what legal importance such a statement in the introduction may have. The main rule is that it indicates the political aims of the parties of the agreement, but that it is not legally binding. The introduction may, however, have importance as a source of law. This is commented on in the Preposition (the bill) to the (The Norwegian Parliament) on the consent to ratification of the EEA-agreement:8

"The principles will be of importance for the interpretation of the Agreement and also for the weighing that is to be made between different considerations in the cooperation."

In addition the principle has among other documents been expressed in the Maastricht-agreement ⁹, the UN’s framework of convention on the change of climate ¹⁰

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7 Introduction to the main section of the EEA-agreement, 9. paragraph.
8 Proposal to the Storting, pp. 100 (1991-92)p.269
⁹ Article 130 R point 2, 1. subsection goes as follows: (Her setter jeg inn avskrift av avtalen)
¹⁰ The Convention is reported in Proposal to the Storting 36 (1992-93) The relevant art. 3.3 is reported in point 5.1.
and in the UN’s convention on biological diversity. Considering the great extent to which the principle has gained ground, many people have posed the question as to whether this is to be considered as an international environmental common law.

In Norwegian environmental policy it is considered almost as a matter of course that we use the precautionary principle as a point of departure, without this having been established by formal decisions in the Storting or government or in general rules of law. The most general and authoritative expression of the acceptance of the principle is probably the introduction to the EEA-agreement (see above). The principle was emphasised in a particularly strong way at a political level after the UN's regional conference on environment and development in Bergen in 1990. It was also emphasised in the account to the Storting in spring 1990 by the Minister of Environment at the presentation of the national budget for 1991. Approval of the precautionary principle has later been repeated a number of times in general or in more specific terms by the Minister of Environment and from the rostrum of the Storting.

The principle was also mentioned during the debate at the passing of the new §110 of the Constitution where the spokeswoman, Anne Enger Lahnstein, declared: "Perhaps one could almost put it like this that the precautionary principle has accordingly become a part of our own Constitution."

The wording gives the impression that the spokeswoman is aware of the fact that one can scarcely say that the principle has been introduced into Norwegian law by the passing of § 110b. The 1st subsection of the decision deals, however, with many of the questions that the precautionary principle is to contribute to solving. The decision runs as follows:

“Everybody has a right to an environment that secures health and a nature whose productive ability and diversity are preserved. Natural resources should be managed from a long-range and many-sided consideration, which takes care of this right also for posterity”.

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11 9. paragraph of the Preface (?) as quoted from Proposal to the Storting.56,p.27 "Who also note that when there is an essential threat of reduction or loss of biological diversity, the lack of full scientific certainty should not be used as a reason for postpone measures to avoid or reduce this threat.

12 Negotiation of the Storting 1090-91 p.2721: "I would like to emphasis the cautionary principle. The full consequences of today's emission or other influence in the environment will first appear in many years. The precautionary principle involves that the doubt must benefit the environment and future generations. We must not engage in any gamble with nature's limits of suffering. I want to plan environmental policy according to this.


One may in particular contend that an active application of the precautionary principle is necessary in order to take care of the right to an environment, as described in the first point, for future generations, as the second point emphasises.

**The importance of the precautionary principle in The Gene Technology Act**

Gene-technology is a field where the type of risk considerations mentioned above is very central. Such activity is primarily regulated in The Gene Technology Act.

It is especially the use of gene modified organisms that is regulated by the law. The central concepts are defined in § 4 of the law. The gene-modified organisms are animals, plants and other organisms that have gone through a genetic manipulation and which can multiply or in any other way transfer the modified genetic material. It is these possibilities of transference that create the risk.

The law differentiates furthermore between enclosed use and exposure. The questions of risk are particularly urgent if the gene-modified organisms are to be released into nature. The bio-technological panel define "conscious exposure" as an activity where gene-modified organisms "are placed in the environment of nature for the purpose of filling a function in relation to their particular characteristics". The panel emphasises two reasons why this is particularly risky. Firstly, it is emphasised that the knowledge of how such a release into the environment affects the ecological conditions is relatively small, and it is difficult to predict the effects of such a release into the environment.

"Experiences show so far that it is not yet possible to predict on a scientific basis the environmental and ecological consequences of experiments of release into the environment, neither short-term nor-long term effects. One main reason is that we have at present too little knowledge of the structure and function of different ecological habitats where the organisms are released."

Secondly, it is pointed to the fact that possible effects of the damage caused by "release into the environment" may be great.

"Furthermore, the panel would like to point out that emission/release into the environment of biological material involves risk factors, which are

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15 See NOU 1090;1 p.52,
16 See NOU 1990;1 p.62
17 Op.cit.p.74
qualitatively different from the emission and disposal of biological refuse. This is partly connected with the fact that living organisms have a possibility of increasing in number and spreading after release. In addition, gene material may be spread from one organism to another through vertical and horizontal spreading. This may have particular importance for the spreading of genes as codes for disease developing characteristics in animals and micro-organisms, characteristics of resistance towards pesticides and herbicides with plants or resistance towards antibiotics in animals and micro-organisms."

The opinion that the release into the environment of gene-modified organisms is particularly risky was also expressed during the consideration by the Storting of the Reports to the Storting that were drawn up as a follow-up of the recommendations of the Biotechnological panel. In the first Report to the Storting on biotechnology\textsuperscript{18} the risk picture is summarised in the following way:\textsuperscript{19}

"The Government states the fact that for the time being there is little basis for evaluating the risk of [conscious release into the environment of gene-modified organisms], and that this applies in particular to the effects of a release into the environment on a large scale as seen over time. There is therefore reason to exercise great caution with regard to a release into the environment of new organisms, whether they are genetically modified or not." Moreover, the precautionary principle is not mentioned in connection with the description of risk in this report to the Storting. It is particularly striking when the Government concludes a general description of the risk of modern biotechnology in the following way:\textsuperscript{20}

"Epidemiological data and laboratory experiments may give a good point of departure for evaluating health risks. Possible effects on natural ecosystems are on the other hand far more difficult to predict. This applies in particular to long-term effects. At present, work is being carried out in several countries in order to increase the foundation of knowledge in order to improve the possibilities of evaluating the effects on ecosystems. The most important ways of approaching the problem are a development of mathematical models to describe ecosystems and the effects of gene-modified organisms in such

\textsuperscript{18} Report to the Storting, 8 (1990-91), proposed by the Syse government

\textsuperscript{19} Report to the Storting, 8 (1990-91) p.63

systems, physical experiments where ecosystems are built up and studied in laboratories and finally field studies carried out under controlled environmental conditions.

Safety promoted evaluations of biotechnological activity also involve the need for making a decision on what is an acceptable risk level. The aim of the activity becomes a heavily important force at this point. There is a great difference between the risk that it will be justifiable in making secure essential social values connected with health, food supply and welfare, compared to those that may affect more superficial needs."

This long quotation is an example of how the risk questions may be presented if one is not willing to attach importance to the emphasis of the precautionary principle on the fact that doubt at the evaluation of the risk of environmental damage, ought to be to the advantage of the considerations of the environment. The Department acknowledge first the problem of insecurity. Then they give an optimistic description of how it may best be solved through science and technology. Finally they give a description of the weighing between the risk of damage and what will be gained through risky measures, where this is presented as if the degree of risk can be described with accuracy. As mentioned above, it is remarkable that the precautionary principle is not stressed in this connection. They do not, however, clearly reject the principle, and it can therefore in any case not be interpreted as any strong argument against founding the management of The Gene Technology Act on the precautionary principle.

The Standing Committee on Local Government and Environment draw on their part attention to the precautionary principle in their proposal to the two reports of the Storting.21 A majority22 state the following in their general comments on the matter:23

"Some of the more dubious consequences of biotechnology are that we interfere with complicated ecological connections in such a way that the vulnerability of ecosystems increases and they loose their vitality and the ability to keep their diversity. The point of departure should be that the "precautionary principle" should apply - the activity should not be started unless the consequences are thoroughly clarified."

The minority, who are not willing to support this comment have no comment of their own where they make reservations against the use of the precautionary principle. Seen as a whole it must therefore be correct to understand this treatment by the Storting as a support for the idea that the practical use of The Gene Technology Act should be based on the precautionary principle.

Moreover, the question of application of the precautionary principle is launched in several places in the preliminary work of the law. The law does not apply the term, but it is stated in both §1 and §11 that the aim of the law is that gene-technology should be practised "in accordance with the principle of sustainable development". The precautionary principle is connected to the concept of sustainable development right through the treatment of the law. It was mentioned explicitly in the Green paper of the law, and a number of comments on the Green paper gave support to the application of the precautionary principle. The Department also point out that the emphasis of the law on sustainable development, that involves executive work being based on the precautionary principle, and that this point of view is emphasised at the end of the proposal of the Standing Committee on Local Government and Environment.

"The committee agree that the claim of sustainable development involves that where there is reasonable doubt whether the use of biotechnology may have negative effects on environment and health, the doubt ought to be to the advantage of nature and society."

The Department also points out that other elements of the description of the aims of The Gene Technology Act §1 involve support for the application of the precautionary principle. Firstly, this applies to the claim that production and use of gene-modified organisms should take place in an "ethically justifiable way". It also applies to the claim that production and use of gene-modified organisms should take place "without health- and environmental damage". The Department states in this

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24 Quoted according to §1 of the law.
25 The principle is first mentioned in NOU 1990;1 p.51.
26 See Ot.prp.8 (1992-93 p.28-29 and 46.
"The term "without" damage … is used to emphasise the aim of evaluating health and environmental risks in advance, and that this aim should be based on the precautionary principle."

Seen against this background one may state that all interpretation and practising of The Gene Technology Act should be based on a precautionary principle. The stipulation of objectives read in connection with the preliminary work gives sufficient support to this statement.

On the other hand it is still somewhat unclear what practical consequences it may have that the interpretation and practising of The Gene Technology Act in concrete cases of postponement are based on the precautionary principle.

This chapter has given a short survey of the history and role of the precautionary principle in different works of agreement and texts of law. We could not point to any unambiguous interpretation of the principle that reappears in all the texts. The core of the principle seems to be a claim that the risk of environmental damage should be given heavy weight in concrete questions. The core of the principle expresses perhaps more a fundamental attitude than a precise principle. This attitude has nevertheless been used as a guide in many international works of agreement, and forms the basis of, among other things Norwegian legislation on gene-technology. It will be of importance to further discuss what is meant by scientific uncertainty and risk, but before we move on to this, it may be appropriate to look more closely at possible concrete applications. This is to be the topic of the next chapter.

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CHAPTER 2:
RELEVANT APPLICATION OF THE PRECAUTIONARY PRINCIPLE

30 Or.prp.8 (1992-93) p.67.
The precautionary principle is not only relatively new in political, scientific and legal contexts, it is also so vague that it is not clearly given in what connections it ought to be employed. NENT notes that apparently it may easily come into conflict with other principles of environmental policy, such as the claim to follow the principle of cost-utility.

In the following we are going to give a brief outline of some examples of approaches to the problem that call for the making use of the principle. These examples vary from the starting point in their dimensions, from questions with relevance to national and regional politics, to international and global questions. One point of these examples is, however, to demonstrate how on closer inspection different dimensions are interwoven. Another important point is to show that one can hardly expect unambiguous answers as to what is a sensible strategy of the precautionary principle from objective conditions alone.

Example 1: Farmed salmon and genetic impoverishment

In Norway the breeding of Atlantic salmon (salmo salar) has become a great export trade. About 40,000 people have their income connected with the trade. A problem that has gradually become the object of increased attention is the possible threat farmed salmon represent to the existing breed of wild salmon in watercourses along the coast. The sea-sea-cages are certainly constructed in such a way that it is difficult for the salmon to escape from it under ordinary running circumstances. In return, extraordinary conditions can lead to mass desertion of salmon. It is difficult to prevent such extraordinary conditions. They occur for example during stormy weather and storm, which we have had in Norway several times during the last years. Such weather conditions expose the sea-cages to an extreme strain. The damage occurs and makes desertion possible. Other extraordinary running circumstances are connected with the transport of the sea-cages over longer distances. Not only technical conditions may fail. Incompetent handling of the plant may cause considerable desertion of salmon. The total extent of loss of salmon because of desertion is difficult to estimate exactly. In some years millions of salmon are reported to the insurance companies to have been lost. This is many times the number of wild salmon that yearly swim in towards the Norwegian watercourses. (Cp. NENT 1993)

After the problem has become known, some research has been carried on as to what the farmed salmon do after desertion. Such tasks offer a number of
methodological uncertainties, e.g. in relation to random sampling. The results become correspondingly uncertain. It is, however, obvious that farmed salmon have been observed in a number of places. Farmed salmon that have escaped have been observed both close to the sea-cages in coastal water far away from the place of desertion, and in local fresh water courses. A number of background variables such as time of year, the quality of water, age of the salmon etc. have proved to play an important part, without showing clear patterns.

What has been possible to confirm is that a considerable number of the farmed salmon that have escaped at a sexually mature age seek out watercourses where wild salmon also exist. In a few watercourses one has observed an overweight of farmed salmon in proportion to wild salmon. There are two questions that must be raised in this connection: (i) are the farmed salmon going to spawn together with the wild salmon and obtain offspring capable of surviving? and (ii) if so, what are the consequences and how are we to evaluate these?

The reason why these questions are relevant is that one fears that farmed salmon gradually may be able to threaten the stock of wild salmon by rubbing out its genetic diversity. One may risk that Salmo salar in Norway in a few years will be genetically more a result of a few years human work of breeding than a result of an evolution through millions of years.

Here it appears that we come up against uncertainties in the scientific knowledge that can be supplied. Some uncertainties are presumably due to methodological problems that result in the fact that we cannot know the development until it in fact takes place. If so, one should get relatively certain knowledge at a point of time when it is too late to change the development. Some uncertainty that is relevant from a perspective of a theory of decision, is due to the fact that researchers disagree as to the interpretation of the research results. As the scientist, Thomas Kuhn has pointed out, disagreement among researchers is a phenomenon that is part of a normal scientific phase, even if one may presuppose agreement with regard to fundamental disciplinary "paradigms". The disagreement may in a few cases be solved when better data exist, but in many cases it has a tendency to continue to be converted into new disagreements.

One example of disagreement among researchers is in connection with the desertion of salmon in a few watercourses. Genetic variation always occurs in a natural population, but it may be difficult to find an appropriate measure for
comparison of variation within a population with variation between populations. A few researchers are of the opinion that wild salmon populations through evolution are genetically adjusted to the watercourses where they grow up and spawn and that this leads to very specific and local genetic variations. Others contend that variation between the populations is not greater than what one finds within one population.

Also perhaps one ought to emphasise that the fundamental question whether the farmed salmon do in fact mix with wild salmon cannot be answered with certainty either. Even if the number of researchers rejecting this possibility is smaller today than it was a few years ago, new data have still not occurred proving this directly. The majority seem to assume that it would be "surprising and unnatural" if this were not the case.

**A precautionary strategy?**

NENT is of the opinion that this example contains all the elements needed to claim that the precautionary principle should be applied in the search for an adequate strategy to solve the problem. Four factors are decisive in this connection: Firstly, one is confronted with essential scientific uncertainty concerning the evaluation of how serious the problem in fact is or may become in the future. This uncertainty is connected with the fact that there is scientific disagreement about a number of central questions, and that the view to seeing these disagreements disappear in the near future is small. Secondly, one has sound reasons to fear that irreversible and "disastrous" consequences may occur, i.e. that it is impossible to point to sufficiently fundamental scientific faults in the model estimations of very negative results, so that they are much weaker than alternative models with more "positive" results. Thirdly, the problem is of such a character that there are sensible reasons to believe that human activity (industrial production etc.) is one (among other) determining causal factors. This applies both in relation to the possibility of serious future damage and in relation to the possibility of intervening early enough to alter the cause chain essentially. Fourthly, there are sensible reasons to be of the opinion that a possible extinction of wild salmon deserves to be taken seriously enough to consider limitations and renunciations for people in fields where one would otherwise have preferred not to be subject to such restrictions. Politically this follows among other things from the support to the preservation of genetic diversity of the Rio-agreement.
With these essential elements in place it is reasonable to ask if a concrete strategy of the problem of the desertion of salmon follows, based on the precautionary principle. One may visualise the expectation that the principle could be put into practice and lead to unambiguous strategies of solution. Our answer is that an unambiguous strategy of solution does not exist. Firstly, however, we are to discuss different theoretically possible strategies. We are going to sketch in broad outline four possible fundamental strategies. We give them four names of category, which we shall be returning to later on in Chapter 6 of the report.

**The technologist**

The most obvious strategy would be to claim that the reason for the environmental risk be removed. In this example it would mean preventing desertion of farmed salmon from the sea-cage. In practice, however, this is not so easy. We would first have to recognise all potential possibilities of escape (see risk analysis) and then develop strategies that are clearly better than the practice as pursued today to avoid these possibilities. The simplest escape has to do with physical conditions. One could go in for a development of other types of sea-cages. This has in fact been done and has improved technology considerably. And it is obviously correct to continue to improve technology.

Nevertheless, one has to realise that independent of technical design such a plant in the open sea will always be vulnerable to stress, wear and tear, so that the possibilities of escape cannot be avoided. There will always be some risk remaining. A few accidents during a certain period may have great consequences. If one cannot do enough with the technical design, one might perhaps think that one could move the sea-cage out of the places where they are most exposed to natural forces. One might for example move the sea-cage further into the fjords, in any case in periods when rough weather is to be expected according to previous experience. This will give considerable protection against storm damage. At the same time it may involve an increase in other risks and unfortunate effects. Firstly, it may increase the danger of damage caused by transport. Secondly, it may involve unfortunate environmental burdens for the localities that are chosen, because of worsened current conditions. It is obvious that one may soon get into situations where different disadvantages must be weighed against each other. Furthermore, human misconduct in the handling of the plants cannot be avoided. This problem will remain regardless of how technology is
being developed or where the plants are situated. One may indeed go in for better education and good security routines, something that the trade also does, but there are reasons to believe that the total effect may be small in proportion to the problem.

**Pure technology**

Another possible strategy may be to go in for a fundamentally different technology that does not offer the same problems. One could for example consider moving all farming of salmon on shore. The basic technology has in fact already been developed. This technology has as a point of departure many obvious advantages. For example, one has much better control of all the waste products. These could be isolated in waste water plants, partly circulated, be used for other products, or at least be stored in a secure way where they do not have any negative environmental effects. And one could avoid the problem of escape of salmon more or less totally. This is what is often named as "clean technologies/productions"; (see further on in the report). This is why many experts think that breeding in future ought to be based on land.

This strategy involves problems of a different type. It is more or less impossible to imagine that one could claim a reorganisation of the whole production within a reasonably short time (i.e. before the stock of wild salmon theoretically may be weakened) without resulting in considerably negative consequences for the whole trade, and for the country's economy. Firstly, one has hardly reached the technological level of development that makes it possible to establish the same level of production as today. Secondly, it may be virtually unthinkable to cover large nature- and production areas with new production plants without giving rise to strong protests among the population. The buildings in themselves may be an encroachment upon nature that may have great negative environmental effects by weakening the biological diversity etc. Thirdly, this strategy raises a great problem of finance. Who is going to pay for the high costs that will necessarily arise? There is every reason to believe that these costs cannot be thrown onto the consumers without a considerable reduction of consumption and export. Even if this strategy may be a realistic future scenario, which ought to be further developed, and which ought to be evaluated with all its technical, economic and social aspects, it will offer vast problems if it is to be put forward as a precautionary principle strategy for the problem of the escape of salmon as per today.

A related solution strategy by which a sort of clean technology is being used would be by intervening in the biological rather than the physical and technical
conditions. One could retain the plants at sea, but produce an infertile salmon in preference to salmon that can mix with wild salmon. Infertile farmed salmon will still be able to escape, but this will not cause great and irreversible damage to the wild salmon population. This technology is also, at least partly, already in existence, e.g. as a so-called triploid salmon. Another possibility is gene-modified organisms. Many people will just use the precautionary principle as a strong argument against such technologies, given the present degree of uncertainty regarding such intervention.

**Deep Technology**

In theory one can also imagine a radical solution strategy. If one introduced a prohibition of production of farmed salmon generally, there would neither be environmental problems nor problems of escape and genetic impoverishment. One could for example refer to the fact that not long ago one had to manage nutritionally and in relation to national economy without such production. This shows that it is possible, even if many people interested in the trade and many customers of farmed salmon will protest. It is an erroneous inference to believe that a development in process cannot be stopped - the question is always only what price we are willing to pay. It is obvious that such a stop would involve high costs for society. What is going to happen to the 40.000 people who gain their income from the trade, when already now there is not enough work for everybody? At a closer look it is, however, not only a question of costs. One may, for example argue that a disappearance of production that occurs at one place - in Norway in this case - will soon be compensated by increased production at another place. The form of production will in all probability be about the same, so that as a net result one has probably done nothing else than export the original problem to another place in the world. Norwegian trade is going to add that the chances of relatively responsible handling of the production are after all better in Norway than in other places in the world, so that the extent of the impoverishment of wild salmon may in fact increase. In the last resort such a radical strategy is based on the assumption that society, both nationally and internationally, in the long run is able and willing to carry through fundamental changes in its forms of production and consumption in order to put into practice the objective of sustainable development.

**Political control**
A last solution strategy might be to limit possible damage by regulation measures that lessen production and only permit it where possible damage can be controlled. In practice this would mean extensive use of state regulations. One may use concessionairy claims, extraordinary rules (e.g. limited access to fodder) or tax rules. Furthermore, one may see to it that breeding takes place only in areas situated sufficiently far away from watercourses carrying salmon, and in that way reduce the danger of invasion of farmed salmon in vulnerable areas. Inner Sognefjorden and Trondheimsfjorden are regulated in this way. A few such means are indeed already in use, if not always to reduce genetic impoverishment of the stock of wild salmon. Reducing the increase in the trade and drawing a limit to the total production may also be considered as appropriate strategies in order to obtain a global sustainable development. By the very fact that farming of salmon expends huge quantities of fish resources in terms of fish meal, which on a world basis represents a scant resource (and which may be used directly for nutritional purposes of an increasing world population), one has good reasons to introduce restrictions. Such means may contribute to reducing the difference between developed and developing countries, but they claim political acceptance for regional renunciation.

It should be mentioned that an introduction of gene banks where genetic information from wild salmon populations, such as has been initiated by the Directorate for Nature Management, cannot be considered as a precautionary principle strategy in relation to the approach to the problem. It is reasonable to interpret the precautionary principle in such a way that the measures that have already been initiated ought to be able to lessen present or future problems, so that damage may be avoided. Collection and storing of genetic information in deep frozen condition will on the other hand neither eliminate the threat against wild salmon that comes from farmed salmon that have escaped, nor lessen the problem later. If the existing wild salmon populations have disappeared, we will still not be sure that we can return the stock from the gene banks to the rivers. This is therefore an important measure in order to preserve information about our genetic diversity, but not a measure to preserve the salmon. It also ought to be mentioned that greater genetic variability of farmed salmon may be desirable from several points of view.

Example 2: Transnational administration of the salt nutrients of the North Sea
The salt nutrients nitrogen and phosphorous constitute a natural part of the environment of the ocean. They are necessary for organic growth and affect for example the fish population by the existence of phytoid plankton. One has, however, over the last years found out that the natural existence is strongly affected by manmade activities such as e.g. farming, discharge of waste water etc. This has entailed disproportionately large concentrations of salt nutrients in certain areas. The current conditions along the coast entails long distance transport of these substances and accumulation in certain places. Along the Danish coast towards Sweden investigations were carried out which imply that large areas are eutrophicated, i.e. areas with a substantial loss of oxygen with potentially great consequences for the aquatic milieu. This gave rise to the raising of the problem at the international North Sea conferences that started in Bremen in 1984. During the London conference in 1987 it was decided that the North Sea countries, including Norway, during the period 1985-1995 should work for a substantial reduction (in the order of 50%) of an emission of phosphate and nitrogen in areas where this probably entails a direct or indirect pollution of the environment. In 1989, before the conference in The Hague in 1990, criticism was expressed towards this part of the North Sea Agreement from scientific quarters. The criticism pointed at the fact that reductions according to percentage without considering local conditions could be unreasonable. At the same time such a reduction is in accordance with for example the so-called PARCOM recommendations (88/2, 89/4, and 92/7) and some EU-directives (91/271/EEA and 91/676/EEA). The so-called "Esbjerg declaration" of 8th-9th June 1995, based on a progress report on the follow-up of the agreement so far, confirmed, however, the original aim with some modifications. It states that all countries that have signed, except France, expect to fulfil the intended reduction of 50% of phosphate during 1995. One has, however, reached a similar reduction of nitrogen emission. The participating countries are therefore encouraged to continue the work with effective waste water treatment from municipalities and industry, and with suitable measures to reduce emission of salt nutrients from farming.

It ought to be mentioned that these North Sea conferences from the very beginning tried to put the precautionary principle into practice, first as an extension of the German *Vorsorgeprinzip* which emphasised preventive measures, and after the London Conference as an independent principle: "…This allies especially when there is reason to assume that certain damage or harmful effects on the living resources of
the sea are likely to be caused by such substances, even when there is no scientific
evidence to prove a causal link between emissions and effects ('the precautionary
principle'). The mechanisms to obtain these aims consist of three parts: (i) application
of BAT, i.e. the best available technology (to the extent that this is economically
justifiable), especially in connection with waste water treatment from industry and
municipalities, (ii) state regulations, e.g. with regard to the use of phosphates in the
washing powder industry, and (iii) structural measures for example with regard to
farming in order to obtain better and more adequate forms of production where
emission of salt nutrients are minimised.

There seems to be great unanimity about the more fundamental aspects of the
set of problems connected with salt nutrients. There is agreement that emission from
land (either direct or via rivers) makes a substantial increase of the natural existence of
salt nutrients in the ocean. Furthermore, one agrees that such an increase may cause
environmental damage in the form of eutrophication, growth of algae on a large scale,
etc. Such damage may in turn entail more indirect damage such as a threat towards
higher aquatic species, and a general reduction of the recreation value of the sea for
human beings. There also appeared to be agreement that the high level of emission of
salt nutrients in wastewater from municipalities, industry and farming in the long run
ought to be reduced. Moreover, there is agreement that the North Sea (and the Baltic)
are ocean areas that are strongly exposed to such strains.

Uncertainty is, however, connected with the suitability of the measures. This
applies especially to two factors: Firstly, the undifferentiated aim for all the
undersigned countries without regard to special local conditions, is criticised.
Secondly, it is also criticised that the measures are not put in proportion to national
economic cost-utility calculations.

It has been pointed out that Norway, for her part situated downstream The
coastal current that transports masses of water from the Nordic part of Central Europe
passes the Norwegian southern coast in a loop and moves afterwards northwards. The
total quantity of salt nutrients transported along the Norwegian Coast, is only
negligibly affected by Norwegian emissions. In relative terms the Norwegian
emissions are at about the same level as the emissions from Switzerland (via the
Rhine) and Sweden. As an example, the emissions of nitrogen from farming in
Germany are about 12 times higher, but also Denmark discharges two to three times as
much (see figures 1-3). (Even if these estimations in themselves are uncertain, and
based on estimations from the primary industry, not on concrete measurements, it
shows the problem of not taking local conditions into consideration.)

One may, however, be sceptical to such comparisons between nations, and be
of the opinion that per capita emission ought to form the basis for international
agreements.

**Figure 1, page 51:**
Inputs of nutrients from agriculture. Based on data from the Oslo and Paris
Commissions.
Figure 1 (from Esbjerg (c) 1995 p. 95)

**Figure 2, page 52:**
Inputs of nitrogen and phosphorus from municipal wastewater treatment plants.
Based on data from the Oslo and Paris Commissions.
Figure 2 (from Esbjerg (c) 1995 p. 92)

**Figure 3, page 53:**
Inputs of nutrients from industry. Based on data from the Oslo and Paris
Commissions.
Figure 3 (from Esbjerg (c) 1995 p. 93)

The wastewater treatment that is planned for municipal wastewater treatment
demands a relatively great investment (on a national scale). Here the question is raised
whether these resources could have been used for other purposes that might have given
more environmental gains. One may also pose the question whether a similar
investment in other places than Norway might have given greater environmental gains
also for us, for example if one could reduce emissions from Poland. Furthermore, it
has been pointed to the fact that a possible local increase in the salt nutrients, e.g. in
the Oslo Fjord, could be seen as a "sustainable" measure, as this would imply
increased fishing and in that way contribute to greater food production.

**A precautionary strategy?**
Which strategy follows the explicit support to the precautionary principle? Is
the principle concrete enough to involve certain strategies and to rule out others in this
case? Again the answer is dependent on evaluations that go beyond scientific facts,
Figure 1
Inputs of nutrients from agriculture. Based on data from the Oslo and Paris Commissions.
Figure 1 (from Esbjerg (c) 1995 p. 95)
Figure 2
Inputs of nitrogen and phosphorus from municipal wastewater treatment plants. Based on data from the Oslo and Paris Commissions. Figure 2 (from Esbjerg (c) 1995 p. 92)
Figure 3
Inputs of nutrients from industry. Based on data from the Oslo and Paris Commissions.
Figure 3 (from Esgjerg (c ) a995 p. 93)
and demand comprehensive evaluations of greater connections (cf. also Mac Garwin & Johnston 1993).

("Political control"): One may think that the North Sea Agreement is the optimal response to the knowledge we have on the North Sea according to the grounds on which we must base our policy. It attaches the greatest importance to avoiding any risk in relation to the natural environment (especially through the Esbjerg Declaration). It therefore imposes obligations on the states that involve considerable social and economic costs. The extent of these obligations follows their relative contributions to the problems, and can therefore be said to follow the principle of fair distribution. This simplicity is a strength by the very fact that other ways of measuring actions may complicate the political process and in that way postpone solution strategies. At the same time one must admit that it is a weakness that the measures appear as a result of a process based on merely political principles instead of as a result of knowledge about the natural conditions in the special ocean areas.

("The technologist") Alternatively one may think that an adequate precautionary response ought to use as a point of departure the known areas where eutrophication has been registered or claimed. One may think that the response also ought to use as a point of departure that the salt nutrients do not form any great problem for large parts of the ocean, but may be a serious problem in certain areas. Therefore one could increase knowledge about the special conditions attached to problematic areas, and then with a definite purpose eliminate the factors that cause these problems. This will give varied measures from the different countries dependent on special local conditions. It is for example possible that Norway on her side might find out that one ought to go in for a reduction of the emission of the salt nutrients from the fish farming industry, while waste water cleaning from small municipalities along the coast is not necessary. The precautionary idea would here consist of claiming a total evaluation of environmental, socio-economic and political risks that are involved, and let both aspects count. Here one would also emphasise possible gains, for e.g. in terms of increased fishing in some places, which must be weighed against other disadvantages.

("Pure technology") Furthermore, one may think that the problem ought to be solved by way of better technology in preference to regulations and measures with regard to emission. This is not necessarily contrary to the intention of the agreement, but weighs it somewhat differently. One may go in for pure technology for farming.
and industry, and develop better technology for the treatment of wastewater. The measures would essentially go to investments in such development of technology. The leading idea is then to re-circulate to the greatest possible extent at the production unit.

("Deep ecology ":) Finally, one may also imagine a more radical response that sets limits for the production and consumption at a level that corresponds to the level that the local environmental conditions manage to absorb without long-term negative effects. Urbanisation with high consumption, intensive farming, certain types of industry etc. would be problematic under such a perspective. At the same time one may think that this is the only possibility to obtain a global sustainable development where everybody must adapt their activity to the "ecological room" in which they live.

This example shows that the problem need not be that one is uncertain whether a certain practice is harmful to the environment or not, but that a possible application of the precautionary principle may raise debates as to the uncertainty of the measures that have been proposed. It may be a debate whether the costs that these measures bring upon a country would give greater environmental gains if the resources were used for other problems. Making up one's mind as to this question involves questions of value.

Example 3: The global climate problem, CO² and uncertainty.

While the environmental problems that one was concerned with in the 1970s (e.g. during the Stockholm Conference) were likely to be local and national and of a relatively specific nature and extent, one was during the 1980s gradually more concerned with transnational (e.g. acidic precipitation) and comprehensive global questions of a complex character. The climate debate and the greenhouse effect belong to this last category.

Chapter 9 in Agenda 21 from the Rio Conference deals with the protection of the atmosphere and in that forms part of a long row of important conventions on this topic (The Vienna Convention 1985, The Montreal Protocol 1987, and the London Supplement 1990). From the problems and strategies that are dealt with in Agenda 21 it is obvious that both natural scientific, economic, and ethical approaches to the problem play a central part. Ethical approaches to the problem are for example connected with the evaluation of the legitimate need that developing countries have to obtain economic growth and to overcome poverty.
The problem of fairness plays a central part in the balancing growth on the one hand and consideration of the atmosphere on the other.

The scientific background of the climate problem lies in some apparently simple connections. The foundation is that the (average) temperature on earth is a result of the interaction between the incoming solar energy and the outgoing radiation energy. Some of the incoming solar energy becomes absorbed in the atmosphere, while land, ocean and ice areas absorb the major part of it. The outgoing radiation energy from the surface of the earth cools it down. Human activities may shift this balance. Emission of CO₂, through combustion of fossil sources of energy, emission of methane (CH₄), nitrogen oxide (N₂O), so-called halocarbons, emission of heat, or deforestation and farming will cause less cooling. The short wave radiation will be absorbed by the "greenhouse gases" mentioned above and reflected back to earth, while the long wave incoming solar radiation will remain about the same. The chemicals contribute to the heating of the atmosphere in that they can absorb radiation energy in the infrared spectrum (the long wave), and also because they remain for a relatively long time in the atmosphere. CO₂ is the most important of all the greenhouse gases that one ought to pay attention to, especially because we see few realistic strategies that can limit it.

The greenhouse gases have increased considerably since the industrial revolution (about 1750-1800). CO₂ alone has increased from about 280 ppmv to 354 ppmv ("parts per million volume units"), and increases per year with about 0.5% (the figures are taken from Lemons & Brown 1995). The length of time that the CO₂ remains in the atmosphere is very uncertain, but it is estimated at something between 50 and 200 years. If we look at the development of the total amount of carbon in the atmosphere, this gives us a certain indication of how human activity has shifted the amount of chemicals circulating freely. At present the atmosphere contains roughly 750 Gt carbon compared to 575 Gt at the time before the industrial revolution. Each year about 5 Gt are released by the burning of fossil sources of energy and about 2 Gt are due to deforestation. About 560 Gt should be considered as stored in phytoid mass (plants, plankton etc.) while about 4.000 Gt are stored in accessible oil and coal reservoirs, and 5.000-10.000 Gt in potentially usable fossil stocks. Given such great quantities of stored carbon, it is theoretically possible to shift the atmospheric balance relatively fast through the burning of fossil energy sources.
During the last 100 years one has ascertained a correlation between an increase of CO² content and an increase of global average temperature. Because other factors such as solar eruptions, volcano activity etc can also affect this, it is difficult to claim that there is a causal connection here. A central difficulty is that climate changes occur naturally at all times. Changes because of human activities have to be added to those natural fluctuations, but it is difficult to estimate to what extent they contribute. The International Climate Panel (IPCC) contends that one can be reasonably certain that human activity has caused a certain increase in the average temperature, without being able at the present time to estimate quantitatively how much. It must, however, be mentioned that some researchers - also among those who have contributed to IPCC - are sceptical to such a statement, and that they consider this an open question.

In this situation one is dependent on working with model estimations based on physical connections, expressed in a set of equations. The equations are too complex to be solved analytically, and one must therefore convert them into arithmetical forms to be able to get numerical solutions by way of modern computers. The so-called general circulation models (GCMs) have a central place as regards formulating a system of equation. All relevant GCMs have a clear limitation as regards the degree of the physical, biological and chemical details they can cover. Similarly there are great limitations when numerical solutions are to be developed. Accurate estimations demand that earth's atmosphere is divided into relatively small surface units with height as a third dimension (30 km) It is improbable that one will be able to develop models with a greater solubility than 100 km x 100 km, which is far coarser than the scale of most ecological tendencies and micro atmospheric processes. Consequently they are generally not able to give predication as regards local variation. Furthermore, fundamental processes of circulation are for many substances not sufficiently understood and difficult to integrate into such models. This applies for example to circulations in deep oceans, evaporation, cloud formations, snow, occurrence of vegetation, phytoid plankton, or ultra violet radiation. In addition to these factors of uncertainty, there are fundamental methodological difficulties connected to the testing of the predictions of models in relation to reality. Even if many researchers often talk about "verification" or "validation" of these models, it is misleading to use these concepts. The models may be useful tools by the very fact that there are no other possibilities, but at the same time there should be no doubt that their representation of real atmospheric conditions is in no way confirmed, or can be expected to be tested.
before long. This is a practical model uncertainty that cannot be eliminated. (cp. Oreskes, Shrader-Frechette, Berliz 1994; cp. also Fenstad 1995, Cox 1991) Similarly one makes use of a number of sub models, such as models for the carbon circulation (cp. e.g. Wigley 1994) that introduces further uncertainty.

If one compares GCM retrospective predictions during the period 1861-1989 one gets an expected increase in the global temperature of between 0,5 and 1° C. These values are on the whole somewhat higher than factual observed values. There are a number of possible sources of error that can explain the difference, but even if the predications had hit estimated factual values, it would have said little about the quality of the model.

GCMs produce possible climate scenarios for the future. Dependent on their potentialities these models vary as to how high an increase in temperature they predict. Some studies predict an increase of between 2,8 and 5,2° C during the next century, under the assumption of a doubling of the concentration of CO². Models that take more thoroughly into account end up with values between 1 and 2°C. The international climate panel (IPCC) have as their best estimation of the increase in temperature up to the year 2030 1 to 2° C, and up to a value of 3 C° towards the end of the century. This gives an average increase of 0,2 and 0,6° C per decade, an increase that is substantially greater than it has ever been in human history. In order to stabilise the greenhouse gases one had to reduce emission by 60%. In order to stabilise the level of CO² at the double of the amount before the industrial revolution one must according to the models count on a reduction of the present emission by a factor of 25. The industrial nations will not be able to reach such a reduction, and the developing countries even less. Furthermore, it is vital to be aware of the fact that the longer we continue emissions at the present level, the greater future reductions will have to be in order to stabilise CO² concentrations at an acceptable level.

**Common responsibility, but different burden?**

The potential climate change is a problem that fulfils the criteria where the precautionary principle ought to be applied. There is a danger of disastrous and practical irreversible environmental damage. The climate is a common human concern in that everybody will be affected by it. Consideration for contemporary generations is important, but consideration for future generations is particularly important. Obviously there is therefore a common human responsibility.
At the same time there is a difference as to how much individual groups and societies contribute to climate changes, and how different groups and societies are affected by the consequences.

The problem is far-reaching, all-including and complex. Based on global warming potential (GWP) and national greenhouse gas indexes, one has calculated that an American contributes 8.7 times as much to the strain on the atmosphere as a Chinese, and 14.3 times as much as an Indian. According to the ranging of 1989 the USA gets with its 5% of the world population the responsibility for 18% of the global greenhouse gas emission, the former Soviet Union 14%, EU 11%, China 9%, Japan 5% and India 4.5% with its 18% of the world population. All together this makes almost 50% of the atmospheric emission, while most other nations contribute with less than 1%.

It seems to be certain that the changes of temperature will have a substantial impact on the global ecosystem and the more regional ecosystem. At the same time ecological correlations are at present so difficult that it seems to be impossible to generalise the effects. Specific studies by selected local regions have pointed out a number of possible effects, such as the effects of changes of temperature on the net primary productivity in such systems. Generally one may have reason to assume such correlations based on concrete systems, but lack of a superior theory makes it difficult to give good ecological predictions (cp. Shrader-Frechette & McCoy 1993). The regional predictions are therefore more uncertain than the global ones. In addition, human activity has also other more direct effects on ecosystems, which may be at least as great as the effects on the climate.

There are a number of other than ecological effects that can be predicted, but without anybody being able to come up with certain quantitative predictions. These are, among other things, effects on human health, effects on farming and fisheries, effects on settlement patterns, effects on the melting of polar ice, effects on ocean currents, effects on water resources and an increase of the ocean level. There is for example reason to assume that countries like Bangladesh, Egypt, or the Netherlands may be particularly vulnerable to the effect of a possible increase of the ocean level. Some island states may disappear from the map of the world. Quite generally, there are also reasons to believe that developing countries and countries on the Southern Hemisphere may be particularly exposed to such consequences of a climate change.
An essential reason for this is also that the increase in population, which is highest in these countries, has given a dense settling near the coastal areas.

The responsibility for 1/3 of the total emission of CO² during the 35 years from 1950 to 1985 is attributed to the annual growth of population of 1.9%. It is assumed that the world population will reach about 8.5 billions in 2025 if the growth of population continues at the same rate. Most of the increase will take place in developing countries, i.e. about 95% of the growth will come from poor countries in the South. From countries like Bangladesh this means that the present population of 116 millions will be doubled. Correspondingly, these countries' consumption of energy and with that also their emission of greenhouse gases will increase if no counter measures are initiated.

These circumstances make it clear that there are a number of central, ethical problems behind the climate problem. First and foremost these are connected with the question of a fair distribution of benefits between the rich and the poor societies on earth. It is first and foremost because of the consumption of the rich countries that the problem has occurred, while the present situation is such that everybody must contribute to solve the problem. Here it is difficult to know what is a fair distribution of the benefits and the burdens. It is obvious that the lifestyle from the western industrialised countries is not sustainable on a world basis. Example: It may be presumed that the life quality in Sweden is high, while emission of greenhouse gases per capita is only 40% of what it is in the USA. If one were to aim at an equivalent life quality as in Sweden on a world basis, with a corresponding rate of emission per capita, the global emission would become three times greater. Such a tripling of emission is far greater than even the worst scenarios that have been considered. This reflects the huge mass of population and low emission in developing countries (Lemon & Brown 1995). The example also shows that certain ideas about fairness understood as equality of distribution of benefits, even though it might have been desirable, cannot be a relevant aim.

Other ethical problems are connected with the consideration of future generations, consideration of nature as a proper holder of rights, and the adequate integration of moral considerations in economic cost-utility calculations. Some of these problems will be dealt with later on.

Possible response to the climate problem
The complexity and size of the climate problem are enormous. Nobody can at present ascertain with any reasonable certainty what is an adequate reaction on a world basis. There are no recipes that combine knowledge about the problem with measures that have a reasonable chance of being successful in stopping the development in time, and which are at the same time possible to implement politically without destabilising the measure, i.e. bring about great social and economic crises. An important difficulty is also that international negotiations of the problem may easily emerge as a "prisoner's dilemma" situation, i.e. situation where lack of confidence in the solidary behaviour of the other parties leads to everybody choosing selfish solutions. The political challenge on a world basis lies in the development of an international regime where negotiation partners can feel mutually confidant that the others will follow up rules and measures jointly approved of. A necessary but not sufficient condition for solution strategies is therefore international solidarity.

Questions as to what measures ought to be made in order to be able to solve the climate problem efficiently, are hit by the same type of uncertainty as the one that constitutes the problem initially. This makes it difficult to point out what the precautionary principle will consist of. As in the examples that have been discussed above, this is dependent on opinions, attitudes and values in relation to both nature and social structures. But we are uncertain as to how resistant nature is, and we are uncertain of how flexible social structures are before serious crises occur.

One has to assume that any precautionary strategy entails great costs. One should know where these costs would come, in order to be able to say what is a reasonable measure according to the precautionary principle. It is also relevant to take into consideration how great risk one is willing to undertake in a game (against nature) with an uncertain outcome. And all possible measures suffer uncertainty in relation to whether they will at all be sufficient to prevent the great catastrophes that may follow a climate change, especially when considering that a climate change may also be the result of natural processes that are not affected by human actions.

It is not possible and neither is it our intention to present concrete proposals of possible solution strategies for the climate problem in this report. Still, we would like to outline a few fundamental attitudes that indicate the direction of certain measures. We would assume that one would manage to get sufficient international cooperation, if the measures are reasonable.
("Deep ecology"): A first strategy would correspond to a relatively radical ecological fundamentalism, and concentrate all means on reducing the environmental danger immediately. The main point should be to reduce all emissions of greenhouse gases as much and as quickly as altogether possible. Little weight is laid on the uncertainty that follows the model scenarios, and it is assumed that these represent a real possibility of irreversible damage even if their specific form and contents may well be different from what was assumed in the models. The precautionary principle consists of an immediate phasing out of fossil sources of energy and a reduction of the consumption and use of energy in rich countries. No nuclear power is accepted as a compensation for fossil sources of energy because of other risks than climate related environmental risks. Agriculture would immediately have been reformed along ecological lines. The growth of population should in one way or another be stopped in order to ensure reasonably sufficient provision of food at all. Otherwise one would have to accept hunger. This will entail a considerable reduction of welfare, both for the rich countries and for the developing countries that have started to improve their economic situation. The whole world economy would have to be reformed and adapted, without anybody knowing what it should look like. One would have to assume (somewhat unrealistically) the possibility that this process can be carried out without leading to social disturbances and destabilisation that involve war, crime, political revolutions, national disruption etc. The aversion towards environmental risks that this strategy is based on, finds its counterpart in the relatively great willingness to take risks with regard to human behaviour and human adaptability. This is obviously a precautionary strategy in relation to nature, but it is scarcely precautionary in relation to social structures. It is at the same time clear that the strategy may go wrong, and the climate problem may arrive in full force despite the measures that have been initiated.

("The technologist") Another strategy may use almost the opposite attitude as a point of departure. One may think that the environmental risk is serious enough, but sooner or later, and with slowly adapted patterns of behaviour, one may in all probability be able to avoid the worst horror scenarios. Too great social alterations may on the contrary be contra productive in that they create other disadvantages. A bunch of measures that together represent the precautionary strategy will nevertheless be initiated. First and foremost one wants to set in vast resources in order to gradually remove essential uncertainties in our scientific knowledge of the problem. At the same time (in the rich countries) one wants to support economic growth without an
equivalent growth of the consumption of energy, something which the history of some countries has proved to be possible. The key word is first and foremost more efficient utilisation of the energy sources that we have, at the same time as one wants to support less consumption of energy with technical improvements (e.g. better insulation of houses, less use of petrol in cars etc.) One will have to increase the contribution towards the developing countries, especially with regard to education and the living conditions of women, in order to reduce the growth of population in that way. This may be motivated by solidarity, and by self-interest in the light of the threat that increased world population represents for the climate. At the same time one would be prepared for using nuclear power stations to a larger extent, at least in countries with strong democratic traditions and high technological knowledge. Gas power would also be used to a greater extent, and if possible work as a compensation for oil, which puts a greater burden on the atmosphere. The contribution of science in the rich countries to clean technologies, especially to alternative sources of energy, would have to be increased several times the present contribution in order to give new possibilities of choice in the future if the climate problem proves to be as serious as some people assume.

This strategy may perhaps be described as a "no-regret policy", i.e. one chooses those strategies that it may be most sensible or most economical to choose, even if it might turn out later that the problem was smaller than presumed. The strategy entails that one avoids heavy costs, which perhaps after all would have been futile if the problem is inevitable. At the same time one wishes to work for better updating and better possibilities for measures in the future, if this should prove necessary. In this way one minimises the danger of great social disturbances, but is willing to live with great environmental risks for some time into the future.

("Political control") One can also argue in favour of a strategy by which one is willing to initiate relatively great social upheavals, without these necessarily entailing effective counter measures towards the environmental risk itself. The precautionary idea lies here in the understanding of the fact that the problem may be attacked by the social mechanisms one has best under control, and supports the assumption that in the long run it will entail a reduction of the environmental risk. Here one would first and foremost direct one's attention towards market mechanisms and industrial production. By introducing eco tax, duties for environmental emission, possible quota shares that can be negotiated freely between countries etc. one hopes to reach an
"internationalisation" of external costs. The price must reflect the ecological truth, according to the adherents of a political steering strategy (E. U. von Weizsäcker 1994). This would stimulate to reduced energy consumption and a development of alternative environmentally positive technology. International commerce, especially in farming and raw materials, should be reduced correspondingly. Contribution to developing countries and credits would be connected to the measures against the population growth of the respective countries.

It is obvious that such measures would entail great social changes in developing as well as in industrialised countries. The pattern of consumption would be fundamentally changed, with uncertain consequences for social welfare and unity. When for example transport of benefits and people becomes a luxury benefit, this would undoubtedly have great consequences for the internal social stratification of society. At the same time such measures are very uncertain with regard to their efficiency towards the risk of a climate change. As social uncertainties are connected with these measures, their indirect effects as a hindrance against additional greenhouse gases being released into the atmosphere are also uncertain. But the strategy is based on the idea that one attacks the problem where one has the greatest control and influence, and avoids the extreme consequences of the ascetic lifestyle connected to the first strategy.

("Pure technology":) A fourth strategy, contrary to strategy number three, would attack the environmental risk relatively directly and offensively, but without risking too great social encroachments. This strategy goes in for an optimal adaptation of technology. Coal and oil as sources of energy would be abandoned, all already existing possibilities of renewable sources of energy such as waterpower, wind power, solar energy (in hot countries) etc. would come into use as much as possible. Environmental risks and social problems connected with nuclear power would have to give way to greater problems connected with global warming. Nuclear power would come into use, especially in countries where population growth and economic growth indicate increased consumption of energy. Technical solutions to bind CO² in new compounds and possibly store it would be tried out and possibly be taken into use. One would start huge programs of forest planting on a global scale, in order to counterbalance deforestation. Intensive measures in order to regain desert areas and infertile areas of land for farming would be initiated. Here one presupposes that it is not the social behaviour in itself, as for example the pattern of consumption, that
causes the climate problem, but the technology connected to it. In this way it is also
the technology that offers the most effective counter measures, especially when
considering that these are possible to accomplish within the existing world economy.

None of the four solution strategies can emerge as an answer to everything. But
all of them may to a certain extent be said to include measures that, from their internal
potentialities, may be launched as precautionary strategies. These strategies are as a
whole not compatible with each other, even if certain concrete measures may be
sensible within several strategies.

Furthermore, it ought to be clear that all strategies are preventive, and demand
action. None of them include "business-as-usual" until we know with certainty that the
problem is real. When we know that the problem is real, we need not be precautionary
any longer. It is at this point that we should overcome the problem, if it is still possible
to do something about it.

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CHAPTER 3:
SCIENTIFIC EXPERTISE AND UNCERTAINTY

Introduction

In this chapter we take a closer look at the clause of uncertainty that is the
fundamental basis for the precautionary principle. The precautionary principle is
meant as a means to an end in situations where essential scientific uncertainty exists
concerning the consequences of different measures or practice. To get a better
understanding of the potentialities of application of the precautionary principle we are
therefore dependent on having good understanding of expressions such as "lack of
sufficient scientific certainty". How certain can scientific knowledge be, and how
much uncertainty enough to warrant the application of the precautionary principle? In
this connection we are going to look more closely at the role, function and limitations
of models in scientific knowledge, as much of the predictive knowledge we deal with
results from scientific models. And we are also going to direct attention to the
researchers' role in concrete contexts of solution, where it is reasonable to ask whether
researchers themselves have become political operators. The chapter concludes with
two concrete types of scientific knowledge that are likely to be used in connection with decision making, explanation of consequences and risk analyses. Here we ask for possibilities and limitations as seen in the light of the (un)certainty that may be expected to result from such investigations. An appendix of scientific theory gives some supplementing reflections on some fundamental sources of scientific uncertainty.

Interpretation of "lack of full scientific certainty"

A decisive element in the application of the precautionary principle lies in giving a concrete content to the clause of uncertainty that is a hallmark of all known formulations of the precautionary principle. As an example, it says in § 15 of the Rio-declaration that measures should also be taken in situations where there is "lack of full scientific certainty". In other words, absence of unambiguous scientific findings cannot be used by states as an excuse for not coming up with relevant preventive environmental measures. Doubt should be to the benefit of nature. One among the many questions of judgement one is faced with is to give a concrete content to this clause. It is no obvious task, if one expects the interpretation to be reasonable from a total evaluation.

It is therefore for instance unreasonable to consider such a point of departure for an interpretation of the precautionary principle as an opening for vague, unscientific speculations as a basis for environmental decisions. The negative characterisation of lack of scientific certainty cannot be interpreted in such a way that any speculation that scientifically as per today cannot be proved to be false - should be regarded as the basis for preventive environmental measures. There are a large number of speculations that science is unable to disprove - e.g. hypotheses about UFOs or parapsychological phenomena - that do not deserve to be treated as reasonable hypotheses based on present knowledge. On the other hand, there is also a misleading implication in this expression. It seems to hold out expectations that science in a number of cases - perhaps usually - operates with hypotheses that have the status of "completely certain knowledge". This is misleading, and many philosophers over the years have pointed at the fallibility and fundamental imperfection of science. This insight stands in contrast to a widespread understanding of scientific knowledge. Many people think that science just stands for what we can know with certainty. But if we look at scientific knowledge historically, we find that an overwhelming majority of conceptions that have once been presented as new scientific insight, have later been
adjusted or even completely rejected in the light of new insights. Scientific theorists therefore reckon that scientific facts have a certain "lifetime" that is dependent on the reach, precision, object of research and subject discipline. In certain, particularly active subject disciplines, such as medicine, the lifetime of new findings may be very short. This weakens the conception that science can usually give us the best knowledge that at any time is available. This is a relative and not absolute statement: science gives us better knowledge than alternative sources of knowledge, often with sufficient certainty for a number of applications, but it does not give us certain knowledge. This can also be supported by a number of philosophical arguments. The philosopher, Karl Popper has for instance argued that all scientific insight should in principle be considered wrong, but that we can systematically improve our conceptions and learn from our mistakes. It is of no importance whether we choose to think that science produces conceptions that deal with real conditions with gradually greater precision and probability, or whether we think that science produces conceptions that from the starting point are wrong, but become less so as we learn from our mistakes. In principle science will always be encumbered by a certain degree of uncertainty, even if relatively concrete single hypotheses may get a status as reasonably certain, established knowledge.

In most of the concrete environmental issues the scientific expertise will usually be able to express their opinions on concrete conditions with more or less certainty, never, however, with full certainty. With regard to prognostic knowledge, especially about long-term conditions, the uncertainties may usually be greater than in pure descriptions of existing conditions.

As great importance is connected with the interpretation of the clause of uncertainty in the precautionary principle, the reports deal with this approach to the problem. In this chapter we are first going to discuss scientific uncertainty from general scientific-theoretical considerations, and after that examine the concrete forms of expertise that are usually used in environmental issues. On this background we wish to draw some general conclusions as to the conditions of application of the precautionary principle.

Generally, it ought to be mentioned that the known formulations of the precautionary principle by including this clause of uncertainty indirectly give support for the conception that decisions relevant to the environment always ought to be taken by adequately considering relevant scientific knowledge. The point of the clause of
uncertainty is to open up for the fact that this expertise appears to be insufficient as a basis for decisions, and that decisions should be made before this expertise can be said to be able to present unambiguous and scientifically well-founded recommendations.

**Conclusion 3.1:** The clause of uncertainty of the precautionary principle opens up for an individual assessment that places the existing relevant scientific knowledge between the extreme edges of pure speculation on the one hand and full security on the other. Which degree of certainty that is sought in concrete situations is, however, a question of interpretation, and must be further discussed, based on the decision in question.

**Conclusion 3.2:** The clause of uncertainty in the precautionary principle involves a close interaction between scientific expertise and the decision-maker.

**Uncertainty, scientific method and models**

Many people might believe that scientific method would give reliable predictions about health and environmental effects of different encroachments on nature caused by man, such as for instance emission of a particular chemical substance into a marine or other environment. The main principle is to describe different relevant parameters, so that they may be operationalised and in order to test them experimentally with regard to possible causal connections. If one for instance is interested in knowing to what extent emission of a heavy metal into coastal water is harmful, it may be possible to test the average burden this leads to among organisms (animals) by an intake of certain doses via drinking water over time. It is also possible to test the likelihood of increased occurrence of certain phenomena of disease among the same organisms by varying the doses in a laboratory. Afterwards it is possible to follow up via "environmental supervision" whether the expected changes, or other changes, in the environment take place. In practice, however, there are a number of difficulties and uncertainties connected to this. Let us take emission of potentially poisonous substances into nature as an example.

Numerous artificial chemical substances have become part of our environment. Even if emission of new substances is under severe claims of testing, only a small part of these substances have been tested in animal bioassays with regard to their potential toxic effects. American studies (OTA, 1982) assess the quantity of "manmade"
chemical substances in use to be somewhere between 55.000 and 100.000. In relation to human health there are many ways in which a substance may be toxic. It may be carcinogenic, it may affect the balance and production of hormones, have neurological effects etc. - and in addition it may have harmful effects on the ecosystem with which it comes into contact.

Testing whether a substance may have carcinogenic effects is itself a demanding task. Of the great quantity of chemical substances in circulation OTA assess (1982) that only 6-7000 are tested in animal bioassays, of which only 10-16% in relation to carcinogenic effects. Sometimes one finds indications that the carcinogenic potentials lie in the similarity of structure of known carcinogenic substances, but only a small part of those become tested more thoroughly. The typical method of testing is animal bioassays and large epidemiological assays. All these testing methods represent a type of risk-analysis. It is important to be aware of the fact that such risk-analysis represents a compromise between different considerations, which does not give unambiguous research results. What one gets are probabilities of development of disease. If the control is good and the test statistically significant (usually <5%), the result would be taken as an evidence of causal relationship.

Ideally one would wish for a more precise analysis of damage where the degree of the burden of chemical substances is related to the damaging effects. One could operate with exact surveys of deaths, breaking out of diseases and environmental damage, and relate them to different degrees of burden of these substances. This would give an assessment of the "real risk of damage". Also such "ideal" research conditions will continue to contain some factors of uncertainty, for instance one would not have a basis for predicting which individuals that in reality will be affected by the damage. Furthermore, one will not be able to say with accuracy how this picture may change when other environmental factors are altered, as the damage effects often are due to multi-factors and could be enforced or moderated in interaction with other substances. Such an analysis is, however, always ex-post facto, and therefore does not meet our expectations of having these substances evaluated on a scientific basis prior to their emission into natural environment. It would not be ethically unacceptable to use natural populations (of human beings) as a large-scale experiment for later evaluation. Apart from the fact that in practice it is impossible to reverse such emissions, this would disregard an ethical norm that even Immanuel Kant considered as central: never use fellow beings as a means, but always have the human being as an aim itself.
For this reason one turns to risk analysis. "Risk" is a concept from the Theory of Decision-Making on the basis of the Theory of Probability. Risk means here expected loss of advantage. Or expressed in more technical terms: risk is a weighed average of lost advantage because of different results/consequences, with appurtenant probabilities of the consequences as scales. In the Theory of Decision-Making one operates with the assumption that fixed probabilities between 0 and 1 can be attached to all sorts of results. If the results are mutually exclusive and together complete, their respective probabilities are summed up to the value of 1. Where one has no foundation for such probabilities on the basis of analyses of frequency (e.g. the probability that a newborn baby is a boy/girl can be assessed from statistics of births) one is dependent on assessments of probability based on other evidence. Therefore in the so-called Bayesian Theory of Decision Making one starts from the subjective probabilities where available evidence is weighed in relation to whether it draws the probability up or down. Within this theoretical framework one operates with a prior that is usually set at \( p = 0.5 \) for two mutually exclusive alternative results before other evidence is taken into consideration. There is, however, an intensive professional discussion as regards the adequacy of a Bayesian starting point for practical connections of decision.

In practice one is often met by situations where we not only must put knowledge of probabilities into the scale, but also take into account the uncertainty in relation to several possible results. As regards a choice between uncertain alternatives one has therefore suggested other alternatives as guiding principles. For example one has discussed the so-called Minimax principle which consists of a minimisation of the maximal damage. There is hardly any doubt that practical decision making never exactly follows such models of decision. One would often attach importance just to the knowledge of probabilities one has on the one hand, together with the unknown factors of uncertainty about important possible results on the other. (Cranor 1990)

Scientific expertise may often handle concrete approaches to the problems by formulating scientific models. In most cases this leads to a mathematicalisation of the problem. We see an historically interesting development in the types of models science makes use of. Roughly speaking, we can differentiate between three fundamental types of model (cf. Fenstad 1995).

Firstly, we have the mechanical or deterministic models. These stand in the Newtonian or Cetacean tradition. The standard application is one or more physical bodies that are exposed to known forces. Known connections following a consistent
pattern are expressed mathematically by linear algebraic equations or linear differential equations. By putting initial parameters into the equations the rest is determined. Mechanical or electromagnetic phenomena in physics are produced by way of models, but also many technological applications depend on such a modelling.

Secondly, we have models where either uncertainty or coincidence are integrated. In quantum mechanics for instance one operates with a distribution of probability. But the process is still produced by way of a linear model that makes exact prognoses possible. We can also handle laws that are not exact, but which contain true coincidences. Here one makes use of stochastic equations that have the characteristic that the process is not reversible and that the future is determined by the past only via the present.

Thirdly, we have models that still use deterministic equations, but turn from a linear to a non-linear domain. These models were developed because most natural phenomena only with difficulty can fit into any of the above mentioned types of models. A typical example is a weather forecast (cf. also the informative chronicle by Iversen & Bratseth 1996). All weather forecasts that extend over more than a few hours are based on models of this type.

Today weather prognoses are calculated for one or two weeks ahead. "The main reason why one does not calculate the weather still further ahead in time is that the atmosphere is an unstable dynamic system. Small errors that inevitably exist in the analysis of the weather of the day, grow with the time of the prognosis. It takes on average a few weeks before the errors thoroughly dominate in the prognosis (Iversen & Bratseth 1996). "Chaos" models and equivalent approximations have found more and more applications, and they have great importance for the climate debate and environmental research generally. Their primary characteristic is that they do not allow exact long-term prognoses. On the other hand, we can by means of advanced computers simulate different possible future scenarios. It is important in this connection that a fundamental uncertainty of prognosis in scientific knowledge is being introduced. To the extent that it is indispensable and to the extent that we in many connections have to relate ourselves to long-term effects in an environmental context, we have to develop strategies to handle this uncertainty in a satisfactory way. The precautionary principle emerges thereby as an answer to this situation.

In the main essential scientific uncertainties occur in the following central areas:
• assessments of conditional values (e.g. size of fisheries resources, quantity of pollution)
• survey of relevant, causal connection between different sizes and characteristics
• exact prognoses of long-term effects on complex systems.

Decisions related to environment often involve three types of factors of uncertainty:

• uncertainties as regards the basis of facts (scientific expertise)
• uncertainties as regards the evaluation of strategy
• uncertainties as regards possible "trade-offs" between different strategies.

Scientific ignorance

The definitely most important factor in an evaluation of uncertainty in scientific expertise is ignorance - lack of knowledge. Modern man has become so used to impressive progress of knowledge in science that it is easy to forget the large and important areas where we do not have good scientific knowledge.

Scientific knowledge is always partial and omits many factors. In every discipline one finds many examples of this. In geophysics for instance we certainly have many speculations on the processes that take place in the innermost core of the earth, but we have no knowledge about them. We know that the geomagnetic field is not constant over geological times, but we do not know why it changes.

Many people think perhaps that our ignorance is greatest with regard to either the real macroscopic relations, such as the universe, or the microscopic relations, such as sub-atmosphere processes. It is probably more correct to say that our ignorance is evenly divided on all scales of scientific research. Particularly dominant are probably the ignorance we still have of the human being itself, and its social organisation in societies.

When facing practical problems and decisions of great scope, one is easily tempted to "order" scientific expertise as a relevant basis of decisions and expect that the main aspects of the problems will then appear, at least approximately. Although it must definitely be correct to form a clear picture of the situation of knowledge before making such decisions, it is still appropriate to point to the fact that most decision relevant factors may lie in our ignorance. The strategy for action may appear as a
consequence of ignorance, rather than as a consequence of the knowledge we have. In situations where the consequences may be great or fatal, one always ought to attach most importance to our ignorance.

A fundamental difficulty is attached to the account of our ignorance. On the one hand, one would wish to have a good survey of all the questions that one knows nothing about, but which may have importance for a special problem of decision. On the other hand, one cannot formulate and limit one's ignorance without at least having some positive knowledge about it. In other words, in order to know what one does not know one must already know something about this, and one would still not be able to include what one really does not know anything about.

Scientific experts as political operators; "Post-normal science" as a new challenge?

Traditionally we have got used to attaching terms such as security and neutrality of values to scientific knowledge and expertise, and to differentiate strictly between science and politics. Such opinions are relevant, especially when considering the large quantity of basic academic research carried out at our universities. At the same time one has become aware of new roles and new challenges that science is facing and that seem to break with these traditions. It is a fact that scientific expertise is drawn into contexts where different interests partly maintain contrary views. This applies not least to environmentally related questions. It is interesting to note that scientific expertise may enter as a support for the different points of view that are maintained. The researcher plays the part of consultant for employers of different types (nations, authorities, industry, environmental organisations, etc.) and has as his/her responsibility to give a scientific basis for their negotiations and suggested strategy. They meet counter-experts from other groups, and an important part of the work consists of weakening their scientific credibility and argumentation of these experts. That scientific expertise can function in this way without being completely "unscientific" is usually due to the fact that the questions involve many great factors of uncertainty and the procedure is partially focused on selected aspects.

As regards some of the great approaches to the problem one meets in environmental connection, for instance the climate problem, there may be reasons to maintain that facts and value cannot be kept apart in a meaningful way any longer. Any scientific approach to the problem would have to make choices based on values,
where certain aspects are concealed or set aside as not essential or unlikely. Such choices would, however, seem to be different for operators with other preferences and opinions. To what extent a possible raising of the level of the ocean is understood as alarming, is dependent on different countries’ geographical situation. And to what extent one can afford to wait for more concrete knowledge before dramatic measures are set in, depends on one's own vulnerability and experience.

The researchers Silvio Funtowicz and Jerome Ravetz have introduced a special term for the type of scientific research that is involved in such contexts of decision: "post-normal science". Aspects of the theory of cognition and the theory of values are interwoven in such practical contexts. One uses as a point of departure two fundamental attributes, system-uncertainty and involved values. The quality of the scientific expertise is connected with how one handles the inevitable uncertainty and how the values that are at stake are incorporated in the actual study.

Funtowicz and Ravetz defend that this is a radical new type of science by referring to the fact that in these contexts we cannot hope constantly to reduce or eliminate the essential uncertainty. If we reduce uncertainty by for instance concentrating on selected parts of the system, we usually increase our ignorance and lack of control of the totality.

Graphically one gets the following presentation of "post-normal science" in relation to other scientific expertise (where pure basic research is excluded): (Graphic table)(from Funtowicz 1995, p. 263)
Funtowicz and Raventz discuss different examples of this. A short and simple illustration is the building of water dams. For a long time one looked upon the construction and placing of such dams as a problem for applied science. The task one had to relate to was to control water masses. One maintained that this was a straightforward task of technological design. The uncertainties were not perceived as greater than what could be handled purely scientifically and with the engineers' margins of security. The values that were at stake were essentially left to evaluations of values by the decision-makers, i.e. the authorities. With the increasing discussion of the use and preservation of water resources and with the conflicts involved, professional consultants were engaged. Today the discussion is even more comprehensive, as some people question at the reasonability of dam building at all. Uncertainties exist at all levels, including social and religious, but first and foremost at levels of central theories of cognition and at ethical levels. The values at stake are partly diametrical contrasts on the political arena, and mirror high costs and risk levels. Choice of what scenarios are to be developed, what data ought to be included, what methodological angle of approach one chooses, what disciplines one integrates, are not only methodological choices, but also choices of values within a given context.

In post-normal science the relative importance of the operators, i.e. of those who contribute as researchers and others in the process of evaluation, greater than in ordinary scientific research. Ideally, in evaluations of quality within traditional academic science, characteristics of personality should not interfere. In post-normal science on the other hand it is of great importance which operators are taking part and what aims they represent. This follows directly from the different types of uncertainties that are involved and the manifold of values that are at stake. Therefore Funtowicz and Ravetz - along with others such as Brian Wynne - argue for so-called "extended peer reviews", i.e. a process of evaluation and a strategy for a "democratised" solution of the problem by including not only purely scientific experts. Here "stakeholders", those that are more or less directly affected, professional and industrial bodies, and laymen, become integrated in the phase of preparation and reporting of democratic decisions, rather than being represented only via the ordinary bodies of decision controlled in a parliamentary way.
Funtowicz and Ravetz, together with a number of other theorists in the field put forward a proposal of new structures of decision. The proposal involves not least a challenge for the society of science, as the dialogue with society does not follow after new findings, but is integrated as part of the formation of relevant insight into the problem.

This report considers the contribution from Funtowicz and Ravetz as an interesting contribution to a further debate on these questions. Irrespective of the justification of drawing as far-reaching differentiation as Funtowicz and Ravetz do, it will be an important challenge to relate to the increasing politicisation of scientific expertise that we experience in environmentally related questions today. In concrete decisions it proves difficult to distinguish facts from questions of values, and to eliminate important factors of uncertainties without loss of the overall perspective. It is therefore an interesting consequence of these discussions that the purely professional dialogue is broken up and to greater extent includes different involved groups and laymen.

**Conclusion 3.3:** Scientific knowledge and expertise are encumbered by fundamental and inevitable uncertainties that increase the closer one gets to concrete approaches to the problem. This uncertainty can only to a certain extent be reduced by more intensive research, while substantial uncertainties will always follow scientific methods when they are applied to concrete environmental questions.

**Conclusion 3.4:** The importance of ignorance in concrete situations of decision-making is not set in proportion to its place in the reports of experts.

**Conclusion 3.5:** Important questions of environment and development often claim reports that break with the traditional academic traditions where the certainty of results and neutrality of values are the premises. They ought to involve procedure and processes (in "post-normal science") where professional expertise is included in a dialogue with non-academic groups and laymen.

**Concerning the prediction of environmental impacts: environmental impact analyses**

Environmental legislation in most industrialised countries imposes on the authorities or building contractors planning larger projects with a potential importance for the environment, the carrying out of so-called "environmental impact analyses".
This legislation is also at work in Norway (see the Pollution Law § 13, and The Norwegian Law for Planning and Building Ch.VII-a) It may be imposed on someone who is planning a greater environmental intervention (development) to produce an environmental impact analysis that meets an already defined standard, before the intervention. Many researchers have in one way or another been involved in the great number of environmental impact analyses that have been carried out.

The primary task of environmental impact analyses is to predict different environmental impacts that a planned project may have, and evaluate their importance in a given context. An important function of the environmental impact analyses is therefore to influence actions related to the environment in such a way that harmful effects may either be completely avoided or possibly be prevented by counter actions. They may also lead to strategies for situations of crisis in case accidents or other technical faults should occur.

Predictions have the characteristics that they prove to be correct or incorrect. When it is a question of quantitative predictions they may prove to be more or less correct. It is therefore important that the environmental impact analyses are followed up by studies that make surveys of the factual environmental impacts after the conclusion of the project, and compare them with the predicted values (so-called "postaudits"). These have two important objectives: 1. By means of empirical data one tests the validity of the hypotheses of specific approaches to the problem, in order to interfere in time if it appears that they have been based on false presumptions, and 2. in the long run, methods and models that the environmental impact analyses are based on could be improved and adjusted in a better way to different predictive tasks. One should therefore expect that such an evaluation of the environmental impact analyses takes place systematically and as a routine.

In reality, however, there is little systematic follow-up of the environmental impact analyses. Scientific literature shows surprisingly few such systematic studies. In the USA a few relevant studies evaluating the quality of the environmental impact analyses were carried out. The first quantitative analysis of the accuracy of the environmental impact analyses was carried out in Australia (R.c.Buckley, AMBIO, 1991). The basis of the analysis was 800-1000 environmental impact analyses that contained several thousand predictions. The follow-up data for those, however, did not exist for more than 3% of the studies. This gave about 200 larger and 175 smaller predictions that could be compared with concrete data. By excluding hierarchical
predictions and other irrelevant assumptions one ended up with altogether 68 predictions of which a systematic comparison could be carried out. This study proved that "our predictions are less than 50% accurate on average and over two orders of magnitude out on occasion". Factual impacts varied between 0,05 and >30x predicted effect. "Predictions where actual impacts proved more severe than expected are on average less accurate (33% ± 6%) than those where they proved less severe (53% ± 6%)". The difference was statistically significant with p<0,05.

From the existing professional literature the following conclusions seem a likely possibility:

(i) Most environmental impact analyses are not met with a basic demand for sufficient data or information about physical or biological impacts that make a systematic follow-up possible; (ii) the predictive accuracy of the environmental impact analyses is very low; (iii) the variations of the accuracy of predictions is substantial and unsystematic; (iv) there are no obvious patterns, functions or parameters that explain concrete or incorrect predictions; (v) most environmental impact analyses omit giving adequate scientific information of supervision of critical parameters during the implementation of the project, in order to plan counter actions when necessary (cf. Lemons & Brown 1995, p.29) Furthermore, many environmental impact analyses contain so few details that it becomes difficult to ascertain what parameters and environmental impacts one should consider as particularly significant.

In this connection it should be mentioned that environmental impact analyses often do not have the function of decision preparation that was originally intended. They serve partly as legitimisation of already taken positions, especially as regards publicity, and otherwise often function as a guide for the operators implementing the project with regard to what adjustments that ought to be made eventually in order to gain a greater degree of environmental compatibility.

The conclusion of this ought to be clear. Environmental impact analyses are a necessary, but not sufficient means to prevent encroachments harmful to the environment. Their strength lies in a definition of a point of reference of the parameters one ought to keep strictly under control. They may in some cases point at scenarios of incidents that are recognised as problematic. One may then choose to adjust the plans so that these scenarios are excluded as far as possible, or one may prepare for strategies in order to counteract the most serious acts of damage when the accident has already occurred.
At the same time it is obvious that it is an important failure not to follow up the environmental impact analyses with postaudits. If they are to have the important function of leading to decisions, it is decisively important that their quality and method are prepared systematically. The responsibility for this ought to lie with the contracting units together with The Research Council which has the superior responsibility for the improvement of the method. At the same time it is under the given circumstances important that the uncertainty that generally lies in environmental impact analyses is included as an important factor in the process of decision. This also means that possible public objections against to a project not necessarily need to have the same degree of details and quantification to become important in the process of decision. When the general accuracy of the environmental impact analyses scarcely exceeds the accuracy based on approximate assessments by people who are familiar with the problem, the supposed argumentative strength will disappear.

In 1993 The International Association for Impact Assessment (IAIA) was presented the task of evaluate to what extent environmental impact analyses had reached their aim as an efficient tool in environmental planning. The concluding report from this study was presented at the annual meeting in 1996 in Estoril, Portugal. A great number of conclusions and recommendations were presented. Among the more general results are also included an evaluation of the importance and weaknesses of the Norwegian environmental impact analyses, presented by Arne Tesli (p. 68-69). Here the vaguely positive evaluation of the role that environmental impact analyses play in Norwegian environmental planning is emphasised, but weaknesses such as a neglect of the "no-action" alternative and difficulties in defining "scope" (that includes among other things cumulative effects, socio-economic implications, and relation to sustainability) in environmental impact analyses in a satisfactory way are mentioned explicitly. In the general, global evaluation two observations are particularly relevant to our aims: firstly, that environmental impact analyses often fail in relation to concrete prognoses, especially with regard to cumulative effects, and secondly, that complex approaches to the problem that should be tackled in connection with sustainable development are until now treated in an insufficient way.

**Conclusion 3.6:** Experiences with environmental impact analyses as an environmental political measure in order to prevent encroachments that are harmful to the environment or to health in complex natural connections, show that they are still very
limited and insufficient as a means to achieve this aim. Environmental impact analyses alone should therefore not be considered as an adequate implementation of the precautionary principle.

**Conclusion 3.7:** It is an important task of environmental policy to improve the methods and mode of operation of the environmental impact analyses, among other things by greater emphasis on post audits and greater integration in strategic debates on sustainable development (development of "strategic impact assessments").

**Risk research and cost-utility calculations**

Historically risk research is itself a new phenomenon. It is not long ago that the concept was almost absent in academic and technical education. It is only during the period after World War II, and then perhaps especially during the last 30 years, that this concept has been accepted in scientific curricula and research milieus. Professionally the concept is derived from statistic method and calculation of probability on the one hand (that also has a relatively young academic tradition) and decision and the Theory of Games (John von Neumann, Morgenstern and others; Luce & Raiffa) on the other. A field where elements of risk research have always played an important part is the insurance trade. Risk research has gradually moved from mathematical and economic theory to a number of other disciplines, including social science. At the same time as the concept has become a technical term in research, it is also connected to a certain everyday understanding that is not necessarily identical with the internal scientific use of the concept.

**Definition of risk**

How one may best define the concept "risk" is itself a topic for debate. An accurate and comprehensive definition that covers the different fields of risk research does not exist. In the theory of decision one differentiates between decisions under risk and decisions under uncertainty. While the first is assumed to contain all the functions of probability, the last one is characterised by the fact that these are not known in the situation of decision. Efforts to synthesise the different uses of the concepts usually entail a certain vagueness towards more specific approaches to the problems. Yates and Stone (1992) mention that risk contains three critical elements: (i) possible losses, (ii) the importance of these losses, and (iii) the uncertainty of these losses. Rem (1992) identifies seven different modes of approach to risk thinking, which all differ
considerably from each other and in the comprehension of risk. In epidemiology and toxicology e.g. mortality and morbidity are defined as possible losses, and one tries to develop accurate quantitative causal connections. Risk becomes here the likelihood of mortality and morbidity. In probabilistic risk analyses one is concerned with producing predictions of the probability of failure of security and function of complex technical systems. One produces a "Fault tree" in order to get a grip on the reliability, and examines possible consequences. In an analysis of risk-costs-utility (economic method) one includes probabilistic analyses and supplements them with subjective utilities, i.e. a measure for the degree of (un)satisfaction with the result.

Psychological studies give weight exclusively to perception of risk that becomes action guiding for the individual. And in sociological and anthropological studies of risk one is concerned with social and cultural factors that influence our attitudes towards concrete risks. What one seems to agree about is that "risk" must at any rate be considered as a multi-dimensional concept.

A simple and common definition is the following: Risk is an expected loss of utility. In this way risk becomes a weighed average of lost utility on account of different consequences where the different consequences are weighed together with their appurtenant probabilities.

One cannot presuppose that risk is always known. Occasionally we may know the probability of a result with certainty, as for instance in a Ludo game when the chance of my counter being thrown over in the next move is 1:6 (provided a good dice and given in the correct constellation of the counters). On other occasions we can assess the risk with reasonable certainty based on good statistical data, as for instance the chance of having a child having Down's syndrome. In many cases we will be able to indicate whether certain actions with certainty will entail a strengthening or a reduction of a certain risk, as for instance in relation to smoking and lung cancer. But in many other cases we know too little to be able to assess the probability of result.

**Objective versus subjective risk**

In risk research one differentiates between objective and subjective risk, or real and perceived risk. One wishes in this way to catch the idea that people are likely to range risky activities differently from what factual data should imply. For example, many people may feel that travelling by air is more dangerous than taking a ferry or driving by car, even if statistical data of accident frequency show something different.
In this connection one should mention that the distinction certainly has a certain intuitive meaning as the factors of danger have an objective aspect, but that it is probably useless in most practical connections when one takes it literally. Kristin Shrader-Frechette (1991) underlines that in order to be able to classify something as risk, it must always be based on subjective perception and evaluation. Risk must be perceived by some people to be a risk. If factors of danger existed but were not perceived, we would not recognise them. Risk is a theoretical, constructed concept, and not something that can be read directly from reality. Statistical data, analyses of frequency, are usually far away from the probabilities on which we must base our risk research. As a general rule sufficiently good data do not exist (when we for instance develop an oil platform or evaluate the risk of environmental damage at building a main airport). It is therefore misleading to think that a fixed real risk exists that can be weighed against wrong perceptions about it. Any approach to risk is based on uncertain perceptions, even if some of those compare better than others in the sense that they may be due to better or more comprehensive information.

Facts and values in risk research

This point is closely connected with the fact that risk research is often presented as both descriptive and normative. There are obvious descriptive elements that play a part, such as causal analyses and scenarios of consequences. At the same time there are always normative elements in the picture (quite apart from the fact that parts of the risk research is connected with normative theory of decision). Most generally this follows already from the fact that classification of undesirable result, loss, damage, etc. as fundamental for risk includes a subjective evaluation. This applies even to such "objective" quantities as mortality. When everybody must die in any case, it is not obvious that death at a given point of time necessarily must be considered as an undesirable result. Whether one would have preferred to die from cardiovascular diseases relatively early rather than from for instance Alzheimer's disease somewhat later, is after all a question of evaluation. Similar reasoning applies even more strongly to the more general damage one is concerned with such as environmental damage. Risk research is therefore irretreivably connected the normative aspects.

The normative aspects in risk research are even more evident in the methodological decisions that follow a concrete risk analysis (see fig.1) For example,
there are judgements of value and attitudes connected with the dose-response investigations. We have already discussed that for obvious ethical reasons one is in this case dependent on population models, i.e. animal experiments. In this case one has to come to a decision about the validity of extrapolations from animals to human beings, from higher to lower doses, and from one group of human beings to another. Many such models for such extrapolations, for instance in connection with the radiation hazard (logarithmic, superlinear quadratic, linear quadratic etc.) are in use, and interest groups refer readily to such models of different sorts in their assessments of low dose radiation hazards. For a concrete dose, one model for instance may predict an increase of 560 cases of cancer in a population of 1 million, the second one predicts an increase of 4732 cases, while the third one ends up with 10630 cases of cancer under the same premises (Shrader-Frechette 1991, 60). There is here a difference of a factor of twenty, while it is not unusual to end up with even greater differences. One also finds differences between different disciplines. Usually toxicologists are critical to the assumption of a safe bottom marginal value for such doses, while engineers tend towards assuming such threshold values. At the same time there is apparently no group that is particularly concerned with synergistic effects.
About risk analysis for substances harmful to health

In a guiding technical document from EU (no 1488/94; DG XI, Brussels 1993) concrete instructions of risk analysis are given, and one defines the necessary steps that should be taken:

- Hazard identification
- Dose (concentration) - response (effect) assessment
- Exposure assessment
- Risk characterisation

Risk analysis should describe the following possible toxic effects and populations:

Effects:

- acute toxicity
- irritation
- corrosivity
- sensitization
- repeated dose toxicity
- mutagenicity
- carcinogenicity
- toxicity for reproduction

human populations:

- workers
- consumers
- man exposed indirectly via the environment
RISK ASSESSMENT OF EXISTING SUBSTANCES
General principles

INFORMATION GATHERING

EFFECTS ASSESSMENT
- Hazard identification
- Dose (concentration) - response (effect) assessment

EXPOSURE ASSESSMENT
- Human exposure assessment (workers, consumers, via the environment)
- Environmental exposure assessment (water, soil, air)

RISK CHARACTERISATION

HUMAN HEALTH
Evaluation of effects data and comparison with exposure data

ENVIRONMENT
Evaluation of effects data and comparison with exposure data

OUTCOME OF RISK ASSESSMENT
One or more of the following results

(i) Need for further information and/or testing
(ii) At present no need for further information and/or testing or no need for risk reduction measures
(iii) Need for limiting the risks
It ought to be mentioned that not only the concept of damage itself is influenced by evaluations, but also what is possible damage. In fact, here one has to relate to the question of what types of uncertainties one may neglect. It is for instance accepted that probabilistic risk analyses have difficulties with so-called "commoncauses (situations where a source generates several independent errors) and in particular with the human-technological relationship. In connection with the Tsjernobyl accident one has for instance concluded by stating that there existed "breaches of at least six important rules of operation, of which four times of one and the same rule" and this could "not possibly have been foreseen in the security analyses". At the same time one knows that people often act in an unpredictable way, and that there is a certain probability that having first caused one error, efforts to correct this often lead to more errors. This has to do with the fact that people in situations of crises or panic just do not act rationally. And in the extension to this, there is the fact that risk analysis is difficult to relate to so-called "outrageous events", i.e. events that do not follow ordinary patterns of expectation. Such events may be
natural disasters such as earthquakes or the like, but they may also be social phenomena such as war, social riots, terrorism etc. There is obviously no reason to exclude such events from the possible scenarios, and if one has to do with dimensions of time, it is reasonable to take into consideration that such phenomena will occur. It is, however, extremely rare that such events are included in risk evaluation, and to consider them as not relevant for the task is itself a problematic judgement of value.

One distinguishes frequently between three important elements in risk research:

1. **risk-assessment**, that also contains three important elements:
   - risk identification
   - risk assessment
   - risk evaluation ("acceptable risk?") via for instance analysis of risk-cost-utility

2. **risk management**, i.e. measures to secure acceptable risk levels

3. **risk communication**, with two aims
   - information on existing risks and prevention of damage
   - training in how one may meet possible disasters and situations of damage

With our comments above we have already prevented the misunderstanding where the first part is about purely objective and scientific investigations neutral to values, while the second part, the political one, ministers the prevailing view of values, and the third part works to bring the "subjective" risks in accordance with the "objective". It ought to be clear that it is not so, and that subjective perceptions loaded with values permeate all three levels. It is not that one can clearly distinguish between different roles either. The same persons are often involved in all three types of activities, and there are close institutional connections or dependencies between all units that take care of these tasks. Sheila Jasanoff (1986) has pointed out how cultural differences and characteristics erase the difference between risk assessments and risk management. There seems therefore to be agreement that also in large circles of research (Richardson 1988), such divisions represent at best a heuristic means of describing a very complex activity.

**The value of risk analyses and their limitations**
In the light of our approach to the problem attached to the precautionary principle one must ask how risk analyses are suitable as effective tools for preventing damage and avoiding too technology-optimistic developments. Risk analyses are in many ways a further development of or a supplement to analyses of consequences, and are best suited for giving more concrete contents to these. They are partly included as a routine part of such statements, especially in the USA (cp. Commoner 1990) We have pointed out that risk analyses in no way give us answers to possible developments, unambiguous, objective and neutral to values. It is perhaps correct to describe such risk analyses as an important part of post-normal science.

It would, however, have been wrong to conclude that they are therefore of no value or superfluous. One should rather ask oneself if they could lead to better decisions for instance in environmental policy in comparison to situations where one has to manage without them. And even if one can certainly point to single situations where risk analyses have led to more damage than if one had followed general precautionary measures (possibly in connection with nuclear power), one must, however, admit that the total information they give probably gives us a net gain. Firstly, one would occasionally be able to recognise dangers that one would not otherwise have recognised, (e.g. in connection with emission from industry, farming and household). Secondly, one would be able to do something to keep danger under control and implement the necessary security measures (e.g. in the process industry). And thirdly, risk analyses would occasionally give rearguard cover for unpopular political measures that would otherwise have been met by great opposition from public opinion or from the judicial system (e.g. in connection with the phasing out of chemical substances). Risk analyses are therefore important tools of regulation.

One can therefore conclude that risk analysis is an important link in the implementation of the precautionary principle. At the same time one should warn against understanding it as being itself sufficient. The precautionary idea puts restrictions as to what attitudes and values, and what uncertainties such analyses ought to emphasise. There is nothing in the method that may be understood as a direct realisation of the principle. As we have mentioned above it gives room for very diverging evaluations. One should therefore add that the precautionary principle makes it necessary with frameworks of, and supplementing measures to risk analyses that clearly exceed the existing practice of research methods.
**Conclusion 3.8:** Risk research and analysis are important tools in the improvement of environmental policy within fields where this is meaningful.

**Conclusion 3.9:** Risk analyses are themselves not a sufficient means to realise the precautionary principle.

**Conditions for applying the precautionary principle**

We need not apply the precautionary principle in cases where science is unambiguous and certain. If we for instance are reasonably certain that a given intervention entails great and probably irreversible damage to the natural environment or health, we need not refer to the precautionary principle in order to give reasons for a prohibiting intervention.

Furthermore, it is obvious that we cannot plead the precautionary principle in cases where possible damaging effects may only be understood as vague speculations, without at least being able to express them as scientific mode scenarios supported by some empirical evidence. The precautionary principle is based on the fact that scientific expertise is included as part of the decisive foundation of decision-making.

To the extent that scientific expertise concludes that a given intervention with overwhelmingly high probability and without factors of uncertainty worth mentioning, would not lead to any great damage to environment or health, the existence of a damage scenario of little probability does not automatically justify the application of the precautionary principle, when the intervention has important positive aspects. Dependent on the type of damage that is involved, there would usually be reasons enough for tolerating the intervention, with the reservation that the decision could be reversed or modified when new findings change the situation.

This means among other things that also with the recognition of the precautionary principle one may be willing to accept that certain substances, processes and interventions will entail a certain minimal environmental risk that cannot be completely ignored. In such cases one will roughly assess the factors of uncertainty so that the doubt is certainly presented, but it is not serious enough to be to the benefit of nature. When scientific knowledge is described as generally uncertain, one cannot within the limits of reason expect complete certainty for our environmental interventions. When the precautionary principle opens up for approximate assessments, there should according to our judgement be room for the idea that existing doubt does not automatically entail consequences for action. This seems,
however, to be limited to situations where uncertainty certainly exist, but according to
the best of our knowledge the probability is relatively high that damage will not occur,
and it is not very probable that damage will occur. This presupposes that the lack of
knowledge concerning the actual problem is also small.

An application of the precautionary principle seems therefore to be limited to
situations where a scientifically founded damage scenario exists whose probability is
either not negligibly low or where we generally are faced with an area marked by lack
of knowledge about certain parameters. In such a situation the application of the
precautionary principle means that the existence of other positive scenarios are not
given more weight, even if they, when considered in isolation, scientifically might
have relatively high credibility. The reasonable doubt that exists should be taken as a
foundation of action for strategies to the benefit of nature.

Here quantitative assessments that are difficult to express with greater
precision are involved. The assessments are made even more difficult in that different
parties and institutions may have different approximate assessments of how high the
relevant lack of knowledge or the respective probabilities are. Just this characterisation
may be the object of debate. With what we said above about research in fields with
factors of great uncertainty as a point of departure, it is reasonable to assume that the
precautionary principle in such cases presupposes a broad social consensus between
the groupings. This means among other things that the process of decision to a greater
extent should integrate the parties involved and other social groups that can contribute
to such evaluations. Such an interpretation has also support in section 3 in Agenda 21,
where integration of such groups in consultative processes of sustainable development
is central. It seems therefore natural to put such broad processes of consensus in
connection with the question of adequate application of the precautionary principle.
When such approximate evaluations of the factors of uncertainty are to be reasonable
in relation to the question concerned, these should, however, be weighed against other
considerations that may increase or decrease the meaning of the precautionary
principle. Essentially there are two evaluations that should be added.

The first one is concerned with the assessment and weighing of possible
damage that may occur. In terms of environment or health the damage should be
significantly great. Any loss of bio-diversity for instance is to be reckoned as great
possible damage. However, also loss of unique ecosystems will be considered as great
damage. To the extent that damage may be proved to be irreversible, there is always
reason to count on significantly great damage. It is important to emphasise that this evaluation is made from nature given conditions that define the scale of values, and not as to what extent a given society appreciates this resource.

The second assessment has to do with the point of time of a possible intervention. The application of the precautionary principle is founded on the idea that a hesitant attitude where strategies are postponed until one has greater or better knowledge, can itself contribute to damage, if it should occur, increase or become impossible to combat at a later point in time. The damage scenarios are in other words such that abstaining from preventive measures now means, to a greater or lesser degree, that preventive measures later will be made impossible. When we can ascertain with certainty that the damage scenarios describe nature adequately, it will be too late to prevent them.

With these conditions in place one can ascertain that the precautionary principle does not at all have to be a decisive factor in environmental planning and action. We may for instance have to do with relatively local developmental projects that might possibly disturb an ecosystem that is not unique for its kind, and where it will be possible to reverse potential damage within a number of decades by removing the activity and development in case the damage after all proves to be greater than assumed. It will be appropriate to draw in the precautionary principle as a relevant basis for decisions if the development proves to take place at a unique and important reservoir of ground water, and damage to this may possibly have effects far into the future, and if the uncertainty is substantial.

**Consequence 3.10:** The precautionary principle should always to applied if the following is fulfilled:

1. Scientifically founded damage scenarios and the factors of uncertainties are such that we cannot reduce them without increasing our lack of knowledge about other relevant parameters, and the probability of such a scenario is significantly great.
2. The damage to environment and/or health may prove to be great for present or to future generations, or it may in extreme cases be practically irreversible.
3. The damage scenarios are such that to postpone preventive measures and handling now, makes effective combat of the damage difficult at a later point of time.

* * * * *
CHAPTER 4:
ETHICAL REASONS FOR THE PRECAUTIONARY PRINCIPLE

In this chapter the main theme is the ethics behind the precautionary principle. At the beginning we are going to ask if it may be reasonable to think that the principle commits us to eliminating all possible risks, irrespective of how small they might be. Do we have to aim at a zero risk society? Then we are going to endeavour to clarify roughly what type of ethical thinking the environmental crises demand from us. We are not arrive at any decision concerning the more traditional ethical theories, but we ask to what extent we have a way of thinking that meets the level of the new challenges we are faced with. We shall not conclude with an ethical theory, but with a model that describes essential features of the ethics we think lie behind among other things the Rio declaration. This leads us on to discussion of future generations and our moral obligation towards them. An important problem in this connection is the discounting of the future. We then go on to making a rough survey of the discussion as regards anthropocentric ethics. The point of departure is a criticism that is sometimes directed towards The World Commission on Environment and Development, that they have based their thinking on anthropocentric ideas and in this way ignored the intrinsic value of the animal kingdom and nature. We ask if anthropocentric ethics cannot be a sufficiently good point of departure. At the end of this chapter we raise two aspects that have moral meaning in our connection. One is blameworthy lack of knowledge, and the other one is the moral right of the parties concerned to become involved in the process of decision. Though this ethical discussion we give a relevant background for part of the recommendations we are presenting later in this report.

Looking before you leap appeals spontaneously to most people. To the extent that we can prevent possible damage instead of repairing damage that has already been done, this seems to be the right thing to do. It is probably because of this that most people intuitively think that the precautionary principle refers to modes of action that seem well supported by ethical considerations. However, one ought to be aware of the fact that some of this intuitive appeal disappears if we choose other words. The Danish expression, "precautionary principle" arouses with most people connotations of a slightly different type. It is not at all certain that one always ought to be cautious in
choice of action. Some people may feel that we should occasionally also be daring or that excessive caution may lead to total paralysis. Thus a different use of language asks for reflections to a greater extent than the Norwegian expression "Føre var" ("look before you leap").

The more we move away from the intuitive level connected with positively loaded concepts, and the more we get down to the substantial level connected with choices of action under uncertainty, the more most people would be inclined to admit that one is faced with concrete judgements where the most cautious strategy not necessarily needs to be the one that is ethically correct. This is first of all attached to the costs that it would entail for large parts of society to apply the precautionary principle radically without opening up for judgements. The intuition that prevention is cheaper than repair applies only under important circumstances and with modifications. Ernst Ulrich von Weizäcker discusses this connection thoroughly in the book Erdpolitik (1994). The question he discusses is whether for instance a command will follow, claiming a complete minimum of potentially harmful emission. All experience shows that the costs increase exponentially when the degree of cleaning increases. The typical picture of this connection looks roughly like this:

The minimisation of emission is usually relatively cheap in the beginning and becomes expensive when the degree of purification aims at 0-value. At the same time there is no such single marginal value or critical threshold where no damage will occur when one has reached this value (see also the comments in the report on nature's toleration limit). As seen from a precautionary way of thinking, it is therefore tempting to set this marginal value lower and lower. In many practical connections the accepted marginal values are already set relatively low. EU-directives on drinking water (from 1980) stipulate as an example a maximum limit for toxic and other less harmful pesticides at 0,000001 g/l drinking water. It is made clear that observing such marginal values entails extremely high costs. At the same time one has to accept that even such a low marginal value still entails a certain rest risk. The zero risk is not reached, and possible damage, especially such that we know little about as per today, cannot be
ruled out. If we put in still more resources in order to force the marginal values down, in most cases this would entail that we tie up resources that we might need in order to realise other environmental aims. A consistent and absolute precautionary strategy with regard to this one parameter would in other words entail greater risk in other areas. Put to its extreme form we could risk an environmental disaster just by focusing too much on minimisation in some fields of problems. From a view of consistency it would be difficult to justify such a procedure.

The same would apply if we had solved the problem by an even more radical strategy, namely by simply prohibiting production or use of substances that may be suspected of having effects harmful to the environment. 70,000 or more chemical substances might be affected by such a strategy. The economic costs for society would be insurmountable. What would be the consequences if we, for instance had banned the use of the poisonous metal copper (where it does not occur naturally), or the use of all pesticides that can be broken down only with difficulty? Could this not cause great catastrophes of famine and economic distress? If we take into consideration the connection between environment (nature) and social organisation (human society), it is quite reasonable to think that a possible social destabilisation as a result of a too radical environmental policy, could entail great environmental damage when state control is weakened and individuals or groups take the law into their own hands toward the natural resources in order to fulfil their immediate needs. Political policy towards a vulnerable nature is therefore also towards a vulnerable social structure, and both entities must be considered independent of each other (see also chapter 6, "Scenarios for assessments of measures").

The ethical point in such considerations lies in the fact that the immediate intuitive appeal that the precautionary principle benefits from does not last long. At a too one-sided interpretation of the principle, and by ignoring other relevant considerations, as for instance the costs, we would easily end up in ethically unacceptable situations. To the extent that criticism is directed against the precautionary principle, this often occurs precisely with such simple interpretations of the principle as a point of departure (as an absolute and unconditional strategy of minimisation). It is therefore important that the interpretation of the principle and the foundation of value of the principle are more reflected. In this connection we must admit that an ethical reason for the precautionary principle is indeed more complex and difficult than it might seem at first sight. The reason should correspond to the
substantial aspects connected to situations where the precautionary principle may come into use in practical environmental research and policy. In the following paragraphs the committee is going to discuss some ethical questions of principle connected with substantial aspects of the principle. (The discussion does not claim to be complete, neither does one intend to present a coherent ethical "theory".)

**Conclusion 4.1:** An interpretation of the precautionary principle as an unconditional claim of zero emission without considering the disadvantages this may entail, is ethically unacceptable.

**Lifeboat-ethics or spacecraft-ethics?**

Large parts of the Norwegian public are of the opinion that the world is facing an environmental crisis of which we probably only have seen the beginning. We have become increasingly conscious of the environmental problems during the last three decades. As late as the 1980s many people understood that a number of the problems, such as the climate problem, are global and demand action. Many people have also understood that we must probably change our usual way of thinking, attitudes, and values concerning the relationship between human beings and nature. We have for a long time been directed by the conception that nature has infinite resources for human needs, and that nature has unlimited potential for regeneration. A great deal of the price for our progress has thus been transferred to nature. We have inflicted great burdens on nature in the form of ruthless exploitation of resources and in the form of introduction of substances and garbage harmful to the environment. This is the reason for the environmental crisis. The combination of technological progress and exponential growth of population has opened our eyes to the limitations of nature. The way of thinking that defends an unlimited exploitation of nature for human aims and needs, that ascribes to nature only instrumental value strictly subsidiary to our technological progress, and that constantly breaks new geographical and other frontiers in our use of resources and leaves behind devastation and extermination, cannot any longer function as a guide for development. We must satisfy human needs in accordance with nature's own inherent orderliness and limitations. Even if it is easy to agree as regards the need for giving up old ways of thinking, it is not equally easy to describe ways of thinking that can serve as the guidance of development and that meets fundamental ethical considerations.
A journey into the history of ideas: Condorcet

In 1793, in a cellar in Paris and persecuted by the revolution that he took part in creating, Marie-Jean-Antoine-Nicolas Caritat, Marquis de Condorcet, wrote the book "Esquisse d'un tableau historique des progrés de l'esprit humain" (An outline of a historical presentation of the progress of the human mind) In the last chapter of the book, about the future progress that human beings may expect, he raises an important objection to the outline he has just given, after having optimistically described great technical and scientific progress: Will there not necessarily be some point of time in the future when the increase of the world population exceeds the possibilities of the tools? Will not a necessary material decline occur - or a periodical rise and decline between welfare and need - when we have made maximum advantage of the resources of the earth, and the population - and consequently also the needs - continue to increase?

Condorcet answers this objection in two subsections. Firstly, he points out that at such a point of time undoubtedly lies far ahead in the future, and that nobody can know what technological possibilities one may have arrived at by that time. Then he points out that even if one assumes that such a point has been reached, it is impossible to think that this will lead to catastrophes because one must presuppose that the technical, scientific progress all the time has been followed by a corresponding progress of human common sense. This common sense includes also a further developed morale that among other things is able to see that the obligation of human beings to future generations does not consist of giving birth to as many children as possible, but rather arranging the state of things in such a way that those who are born are met by the prerequisite of happiness and welfare. The moral obligation is directed towards humanity in a global perspective, towards society and the family in which one grows up. Insight into moral common sense will direct human actions in this future. With Condorcet it is thus the common sense and the progress of the morale that will counteract possible disasters and the need that follows the natural limitations of the resources necessary for life.

Lifeboat-ethics

It ought to be food for thought that we are at present able to support astronauts in a spacecraft far away from the Earth, but we cannot afford to give food to the
children of Calcutta, Rio de Janeiro or Khartoum. The explanation of this paradox implies that we are certainly extremely competent at a technical scientific level, but that we are still very helpless and incompetent as regards problems that demand ethical reflection and judgement. This also applies to the interaction of human beings and nature.

The ethics of environment that has been developed during the last years is an expression of efforts that have been made to remedy this. It must be admitted though, that we are still far away from having worked out environmental ethical theories that are strong and precise enough to gain universal acceptance, and at the same time guide our choices of action. Many existing proposals in environmental ethics conflict with other ethical principles that we intuitively find it difficult to give up. For this reason much of the discussion of environmental ethics is therefore marked by an analogy thinking of idealised model situations. The American, Garett Hardin has in 1974 put forward such an analogy that has been discussed as a possible new point of departure of a new environmental ethics. In short, his ethics consists of the idea of turning upside down the set of values that apparently has lead humanity right through history. It is wrong to subordinate nature completely to human needs. Hardin suggests in stead consequently to provide environmentally correct conditions in the world before we possibly consider the needs of individual human beings. He calls this view "lifeboat-ethics".

The point of departure of his analogy (or "ethical model") is that human beings are in different lifeboats where the resources are limited and where the boats have a limited sustainability. The aim to survive in such a system of lifeboats means that the boats must be kept floating at any price, and that each single human being in such a boat must be subject to the necessities that follow this. At the same time certain obliquities are built into such a system of lifeboats. Some lifeboats are in better condition than others, the number of people in them is very varied, and the degree of need is correspondingly different. An ethical dilemma will occur when one asks to what extent passengers in a lifeboat with fewer people and with better conditions have an ethical obligation to help passengers in boats where the conditions are worse. From traditional thinking of equality and simple principles of justice the needs of those outside the boats ought to be considered equally important and justified as the needs of those inside. Everybody should be taken into the boat where the chances of survival
are good. This implies that the situation gets worse for everybody and that the boat sinks. "Full justice, full disaster" is his conclusion.

Instead of letting everybody who approaches the lifeboat get on board, one might also imagine only taking into the boat the number of persons who can find a seat in the boat, and thus ignore margins of safety. Apart from the fact that this would expose everybody to great danger under difficult circumstances, the question arises as to who should be taken on board and who should to be rejected.

Garrett Hardin therefore recommends that the rich lifeboats ought to refuse help to all others, keep their safety margins, and leave other lifeboats to their own fate. An important reason for this is, according to Hardin, that this in the long run will prove to be the most favourable to future generations. The alternative is, according to Hardin, that everybody suffers, and survival is not secured. In the long run those who will be born are to be born into conditions that are able to support them (via a sort of social Darwinism) The utilitarian argument speaks therefore in favour of such lifeboat ethics, if the utility of future generations is to be given weight.

A similar view was furthered by Paul Ehrlich in the book *The population Bomb*. He shares the opinion that the survival of the human being is threatened unless one follows lifeboat ethics. In this connection he also uses examples from war medicine in France during World War I, where one divided the wounded into three categories: 'those who are going to die irrespective of treatment', 'those who are going to survive irrespective of treatment' and 'those who are only going to survive if they get immediate treatment' ("triage"). In a situation of crisis it may be right to treat only the third category, according to Ehrlich. In a serious environmental and population crisis equivalent principles apply, and the rich countries should therefore first of all secure their own survival, stop the population growth, and secure environmental resources. Ehrlich was therefore in favour of encouraging abortion and obligatory family control.

It is immediately clear that both Hardin's and Ehrlich's views radically break with traditional ethical values and principles, at the same time as both represent a radical breach with individual centred and anthropocentric theory that does not ascribe any value to nature. In our connection it is of little importance whether the prime effect of environmental considerations is derived from nature's intrinsic value or from the survival of future generations of human beings. It is, however, important that this
prime effect is used as a reason for setting aside elementary ethical principles in relation to individual human beings.

Such thinking has been criticised from several quarters, even if germs of it certainly can be found among certain environmental activists. Some critics have claimed that such radical environmental ethics approaches the thinking that also characterises German National Socialism under Hitler.

The criticism that carries most weight professionally is, however, attached to the thinking of justice. According to the philosopher John Rawls there will always be a possibility of doubt as to what is the supreme good for society. If the optimal biotic society is set up as the extreme good (as in lifeboat ethics), it will always be possible to put a question mark at its justification. There will be reasons for rational disagreement. On the other hand, there are, according to Rawls, good reasons for preferring the principle of equality before different conceptions of welfare and the extreme good.

In short, the argument implies that it is most rational for any person to choose the most egalitarian ethics, if this person is placed in an imagined situation where specific self-interests are not known. Preferring other forms of distribution of the benefits (e.g. criteria of distribution between different lifeboats) presupposes knowledge of possible personal advantages. When we do not know where in the world we are placed and with what characteristics, we will try to provide a maximum of possibilities for all individuals in society. To the extent that such 'objective' choices form the foundation of acceptable ethics, one would therefore enter into a social contract where the rights of the individuals are equal. If one chooses such an egalitarian ethics as a point of departure, a lifeboat ethics is excluded.

**Spacecraft ethics**

"The spacecraft Earth" metaphor has been discussed since Adlai Stevenson used it in a speech to the UN in 1965. Other authors such as Kenneth Boulding, Buckminster Fuller, William Pollaard, Barbara Ward etc. have since then extended the metaphor further (for references see K. Shrader-Frechette 1981, 45 ff.) The background of the metaphor is that we may imagine the Earth as a spacecraft that flies at high speed around the mother ship, the Sun, that delivers the energy. The spacecraft is a definite and closed system that is left to produce all means of survival itself. The spacecraft is organised in such a complex way that its passengers for a long time are
not even aware of the fact that they are in a spacecraft, until one starts noticing that certain resources are scarce.

The most striking characteristic is, however, that there is no user's manual for the spacecraft. Spacecraft ethics is an effort to write such a user's manual. The manual ought to be made in such a way that it fulfils two purposes at the same time: on the one hand it must secure that the people do not exceed the sustainability of the earth, and on the other hand permit a maximum of personal freedom for the passengers within these limits. It is emphasised that spacecraft ethics should include the principle of limiting the population, industrialisation, and economic expansion. Resources ought to be used to the extent that they can renew themselves, or, if this is a question about practically non-renewable resources, their use ought to be based on re-circulation. With a view to a maximisation of personal freedom it follows that certain living circumstances ought to be fulfilled, for instance an adequate and sufficient basis of nutrition and satisfactory housing conditions. Only when such conditions are fulfilled may it be expected by individuals that they voluntarily agree to limit population growth, economic prosperity, or the use of the resources of the globe. Even if some of the principles are in accordance with traditional ethical principles, others are new ones that were not earlier part of an ethical system. Buckminster Fuller thinks that everybody must participate in preserving environmental resources. It follows that fossil energy resources should be phased out and replaced by renewable resources. From the principles of effective use of resources it also follows that one is willing to discuss whether for instance property can be replaced by conditions of hire. This applies for instance to the use of cars for transport. With such "spacecraft-ethics" it may suddenly appear that private ownership of cars (that are presupposed to be based on running on renewable resources) becomes ethically relevant, possibly unethical, considering that the total number of cars could be reduced by 40% when people hire rather than own their cars. In this respect "spacecraft-ethics" is more clearly radical and more centred on environment than traditional ethical views. Special importance will also be attached to political leadership. A new type of political leader will be necessary within such an ethical system. The environmental crisis has much to do with a crisis in political leadership. Political leaders have for a long time ignored re-circulation, supported economic growth, and used large resources on military activities. At the same time one has argued that there is not enough money to provide
for a cleaner environment, or capital and technology to secure acceptable living standards for all. In this way the aims of the spacecraft could never be fulfilled.

The ability to think globally is quite central in such spacecraft ethics. It is unrealistic to think globally in that the spacecraft may survive at the same time as some groups of passengers suffer from great need. At worst this may lead to revolts and social destabilisation. Survival of an intact social structure is consequently an as important concern in such ethics as the survival of the natural environment. This will almost certainly have consequences for global political leadership.

The chief contents of spacecraft ethics demand both an alteration of living habits and technology - and an alteration of our attitudes, values and supreme aims are demanded. The means such ethics recommends should respect fundamental human rights, the principle of equality and thoughts of justice. It is this dependence on a voluntary follow-up that at the same time is the weakest point of the ethics. Critics would claim that the individuals without outward compulsion will probably not sacrifice self-interests for common benefits. Thus the chance of making a change within a reasonable time is small.

The fact that a strategy may fail will, however, not just make it ethically less acceptable. What is attractive with such ethics is just that it takes care of other fundamental ethical concerns connected to the individuals, and is based on the human ability of rational insight. There is much connected with such ethics that is ambiguous. The user's manual that has to be written, exists only in rudiments and rough drafts. The principles that are fundamental seem, however, to follow from the model. It is also the committee's impression that the environmental ethics that needs to be worked out would profit from using such a model of spacecraft ethics as a point of departure. This model is apparently also the model that is the basis of the political aims of sustainable development, where the fundamental ethical principles of equality etc. are sought to be realised, at the same time as nature's sustainability is respected and social structure and individual welfare are sought to be harmonised with these aims.

Such ethics also has certain implications for our interpretations of the precautionary principle. One consequence seems to be that the application of the precautionary principle in the last resort should always be assessed in accordance with a global standard. Whether preventive measures are necessary at a local level or regional plan seems to be connected with evaluations of the relation between the problem and global environmental conditions. A development of a road through nature
areas need not break with environmental thinking locally, but it may be unacceptable when it at the same time threatens nature resources that are scarce as seen globally, for instance an area of rain forest.

The global standard entails that no general hostility to technology results from the precautionary principle. On the other hand a claim for control of technological development follows, so that the growing independence and global spreading of a technology, e.g. in the fishing fleet, can be stopped when it threatens the resources. Another consequence of the fact that any possible application of the precautionary principle to the greatest possible extent ought to harmonise two important considerations, namely environment on the one hand and social welfare on the other. When the costs become unproportionally high at the one end, the strategy cannot be correct, since it threatens the stability in the spacecraft. The precautionary principle is thus an optimal task for two simultaneous variables, environment and social welfare (social structure). Even if it follows from this that fundamental ethical rights and principles must be taken care of in our attempts at gaining sustainability, it does not follow that we determine all our criteria of social welfare once and for all. Spacecraft ethics invites us to radically new thinking of many important parameters, for instance economy and law, but presupposes that an introduction of new arrangements occurs in an interaction between political leadership and democratic structures. Acceptance of measures is as equally important as their efficiency. Generally, it lies in such ethics that we use and burden our natural resources in a cautious way, especially when we have not quite understood their function and place in the spacecraft. It is ethically indefensible to exhaust resources, lose biological diversity, or not provide for recycling.

**Conclusion 4.2:** The ethical theory that is the basis of the Rio-declaration and the report from the World Commission on Environment and Development has important traits of similarity with this model metaphorically described as spacecraft ethics. This applies no least in relation to the precautionary principle.

**Future generations**

One of the fundamental aspects of the precautionary principle is the consideration of the possible long-term impacts and cumulative effects. This consideration is connected to the damage that future generations will be burdened
with. Storing of radioactive waste from nuclear power stations is an example of this. In this case we talk about a radiation potential lasting ten thousand of years. But how far into the future do our best estimates of security reach and what foundation of data do they have? The American Department of Energy (DOE) has in connection with the storing of radioactive waste in Yucca Mountain, Nevada, apparently found a basis for very precise prognoses, namely 10 000 years with relative certain geological insulation of the radioactive material, and 1 000 years with relative security of container.

The foundation of data of such prognoses is so-called long-term studies with a duration of between 304 days and 9 years, together with studies of much shorter duration. The uncertainty of extrapolation is clearly great. What is relatively certain is, however, that possible radioactive leakage will not affect us or the generation of our children, but the most possible environmental disasters will affect future generations not yet born.

How are we to act towards a risk that lies far ahead in the future? Economists are used to discounting future costs and risks. If one really assumes that loss is calculated at a cost of 6 000 000 N.Kr. - a calculation that is always problematic -, and if one further assumes that the rate of an annual discounting (equivalent to the interest) of is 6%, one arrives at a loss that in 20 years is only connected with a cost of 2 000 000 N.Kr.. With a rate of discounting of 6%, the value and the cost respectively will be reduced to half in 13 years, to 1/3 in 20 years, and after several hundred years the value would sink to under a millionth part, that is under 6 N.Kr.. Can we calculate in this way when it applies to the life of future generations? Or ought they to be seen as equal to our lives?

There are different views as to how far our ethical obligations towards future generations reach. Many people would immediately feel that one has ethical obligations towards coming generations. One finds support for such views in the responsibility many parents feel for securing the conditions of growing up for their posterity. It is also obvious that distance in room or time does not itself make any moral relevant difference. Whether I am able to prevent an accident that may occur in the local environment in a short time, or an accident that may occur far away in a few weeks, is morally equal when everything else is equal. Ethical theories as for instance utilitarianism have therefore operated with an axiom that future is equally as important as the present.
When one is willing to deviate from such an assumption, it is as a rule based on certain conditions that are claimed to be relevant. One such condition is that future generations are not really moral holders of rights in that they are only contingent persons, not real. In other words, future persons are not members of the club of those we are morally obliged to consider. If we for instance arrange the circumstances of the world in such a way that growing up in certain areas is made impossible later on, then there will not exist any persons who will grow up there and can accuse us of having damaged their local environment. The thought of moral rights is likely to be connected with a form of consequencialism, where rights follow from mutual contracts between partners and it is an advantage for everybody to have such a contract rather than be without one. Future generations are, however, excluded from such contracts in that they cannot provide anything for us or threaten us with sanctions. Groucho Marx expressed it once like this: "What has posterity done for me?" (cf. Ariansen 1992)

Thus the moral justification of the discounting of the future apparently follows. Our generation is definitely the last generation that can provide for our getting a good life. Future generations on the contrary have the advantage of getting a certain help from us, from the generations lying between, and that they should help themselves. Thus it seems reasonable that our immediate interests weigh somewhat heavier than future interests when a conflict has occurred. But it is difficult to imagine future generations as equal contract partners. As Per Ariansen adds, the closest we can get to such contract thinking is the fact that we have in fact benefited from what we have received from generations before us. Without this we would have been at a disadvantage. Respect for these circumstances may therefore be one reason why we ourselves should take future generations into consideration, at the same time as it is difficult to defend the reason for this respect being morally binding.

Another circumstance that is mentioned as an objection to our having obligations towards future generations, is that we know less about their future preferences or needs. What we have reason to believe is that their lives in all probability will be very different from our lives. Furthermore, we know nothing about how long humanity is going to exist, or how comprehensive it will be in the future. If the interests of all future generations were to be weighed equal to our own, we risk that keeping all possibilities open for all future generations entails that our present interests get approximate zero weight (apart from those who are concerned with of our children). When we have reasons to believe that their lives will be different from ours,
it is also reasonable to assume that their conceptions of quality of life, of a good life, will be different from our conceptions. Technological and scientific development may be able to produce quite different possibilities of action than those we know today.

The weakness of this argument is that the burden of proof lies with the one who assumes that their needs will be fundamentally different from ours. As a starting point we have today every reason to maintain that future generations will also have elementary interests in a good and healthy environment, fresh air, fertile soil, drinking water, health, houses and safe social conditions etc. Consequently, the morally relevant point is that we are not at all ignorant of future living needs. We also know a good deal, and therefore ought to base our actions on this knowledge. What we do not know anything about, for instance their technological possibilities of repairing our environmental sins, may on the other hand not be a sufficient moral basis for actions. When we are ignorant of a case, it is equally wrong to assume that the case has a certain quality as to assume that it does not have this quality (argumentum ad ignorantiam).

Even if one might think that future generations do not have moral rights that ought to oblige us and our generation to the same extent as for present generations, one may still think that we have certain obligations to them. We have already suggested that respect for the generation before us might be a reason for such an obligation. Another reason is that we in fact in certain cases consider contracts as morally obliging, even if they are entered into by having only one of the partners accepting this obligation. We have such a situation in the relationship between parents and children. This can be seen as a morally binding contractual relationship without one of the partners (the child) having agreed, and without being based on return service. In the same way parents (like present generations) will not always be able to know what is in the child's (like future generations') best interests. In the same way as this uncertainty does not relieve parents of their obligations to the child, neither does it relieve us from our obligation to future generations.

The conclusion of this and similar considerations seems to be that it is difficult for us to consider future generations as equal moral holders of rights, but that despite this we have certain, even if limited moral obligations to them. In cases where our interests seem in conflict with those of future generations, for instance with the present use of fossil energy sources, we are faced with difficult weighing, where known present conditions are given heavier weight than uncertain future conditions.
Generally, considerations of future generations will not be able to justify limitations of fundamental rights of the contemporary generation. Compulsory measures in order to control population growth may for instance be justified by referring to the fact that it is to the advantage of the living conditions of future generations. When we thus deprive part of the world population a right that is fundamental for personal self-determination, this is a more important ethical consideration than future utility. A certain discounting of the future seems in this case ethically well founded. However, in the long term it does not relieve us of an obligation to arrange the conditions in such a way that we will obtain more harmony between our living conditions and the interests of future generations. One could, for instance, claim that an obligation to invest in the education of women in the third world follows, as it has proved to have a moderating effect on the population growth. At the same time this is basically a voluntary measure, in contrast to other means used to combat a high growth of population.

The problem of discounting is, however, that the principle becomes ethically wrong when it is being used as a general rule of decision. To the extent that we use discounting, not for balancing contemporary necessary interests of living or a breach on fundamental individual rights against future utility effects, but in order to give reasons for convenient choices of action against future harmful effects, it seems ethically unacceptable. There is a difficult borderline between the situations where discounting may seem well founded and those where this is untenable. It will depend on the concrete choices one is facing. If for instance it should happen that the use of nuclear energy represents our only path away from the use of fossil energy resources, out of a climate catastrophe, and out of a global welfare crisis, it may seem morally justified to discount the future risks connected with the treatment of waste products. On the other hand our obligation to future generations also means that we must be certain that we have exhausted all our possibilities of action. To the extent that there are other possibilities of action that meet our fundamental interests and those of future generations, we ought not to discount the risks only because they lie far into the future. Likewise, present breaches of ethical principles cannot be defended by great utility in the future. The path out of this dilemma, when discounting is reasonable and when it is unreasonable, does not consist in better economic calculations of the weighing of contradicting interests, but in a process aiming at a harmonisation of our interests and
the interests of future generations. The precautionary principle seems obliged just to this thought.

**Conclusion 4.3:**
Discounting the future may in certain cases be an ethically acceptable strategy in the interests of future generations, but discounting is always in danger of being a strategy of convenience at the expense of future generations. As a starting point the consideration of future generations should always be considered as a moral (mutual) obligation, where future risks and elementary interests weigh equally to ours. The precautionary principle prepares for an ethical obligation to harmonise our interests with the assumed interests of future generations.

**The failure of anthropocentric ethics?**

It is not unreasonable to think that the UN's *World Commission on Environment and Development*, to a great extent bases their report *Our Common Future* on anthropocentric ethics. This is orientated towards human needs. To the extent that other conceptions appear in the report, they play a subordinate role. Thus it says for instance in Chapter 6 about species and ecosystems: "Species and their genetic materials promise to play an expanding role in development, and a powerful economic rationale is emerging to bolster the ethical, aesthetic, and scientific cases for preserving them (Our Common Future, p. 119). Species and ecosystems emerge as worth being preserved, because of human interests, not because of their own moral values.

Some critics see an important limitation in just the anthropocentric orientation of the report. According to some thinkers within environmental ethics such ethics is not suited for securing comprehensive measures in order to protect, respectively bring forth a sustainable environment. Such critics therefore argue in favour of non-anthropocentric ethics.

By way of introduction one ought to clarify what this debate is really about. It is not a discussion as to whether it is correct to take environmental considerations seriously or not. To the extent that it can be said that the Brundtland Report is orientated towards anthropocentric ethics it also shows that anthropocentric ethics can put up very fundamental environmental claims. When it is a matter of showing "respect" for other living beings than the human being or respect for the non-living
nature, already the spacecraft ethics, as outlined above, shows that this may become an ethical claim from a common interest of survival in a dynamic and closed ecosystem. This respect is then, however, connected with the passengers, i.e. the interests of the people. Damage to nature, unlimited use of non-renewable resources etc. emerge as a potential threat to the future survival of humanity in this system. Also within traditional ethics one has known for a long time that for instance causing unnecessary pain is unethically reprehensible. The matter of discussion is, however, to what extent such ethics represents a sufficient basis for securing a sustainable development, respectively whether the environmental crisis we are facing is a sign of a failure of the anthropocentric theory. Do we need to extend our concepts of moral subjects, i.e. recognise other beings than human beings as holders of an intrinsic moral value and as holders of rights?

Anthropocentric theory has also been characterised as a form of speciesism, i.e. ethics where the members of the species *homo sapiens* hold a privileged place, while other species are subordinated their needs. The reasons for supporting such a speciesism could be of two types: either one might think that the species *homo sapiens* has been chosen by God to rule over all other species, or one might think that this species is marked by a moral relevant characteristic that other species do not have. The first reason has for several reasons become less acceptable in our time. One reason is that it can scarcely serve as an ethical basis for global action when religions are different. Another reason is that the industrialised world has become more secularised and even religious thinkers realise that there is a need for an independent reason for their ethical opinions.

This last statement requires a philosophical argument. The problem is to point out such a characteristic that separates human beings from other species. Several such characteristics have been discussed in this connection. One might consider using consciousness, self-conceit, the ability to feel (pain), rationality, etc. as candidates of such a characterising characteristic. As the discussion within medical ethics of the last years has demonstrated, all such criteria have an essential disadvantage: they do not strike where we want to strike, i.e. they come into conflict with certain fundamental intuitions as regards concrete applications. These criteria are either too comprehensive or not comprehensive enough. Irrespective of which of these abilities one applies, one will find that not all human beings will have this characteristic all through their lives, or, if they do, some other animal species may also have the same
characteristic. Self-conceit and the ability for reflected action is apparently not to be found among the animal species, but on the other hand new-born babies, people in coma, and others do not have this characteristic either. When we move to the extreme limits, birth and death, and people with serious congenital brain damage etc. they would lack such characteristics at the same time as other higher species might have the characteristic. And when we have characteristics that are comprehensive enough to cover all human beings, these will also cover other species.

It is possible to draw two different conclusions from this. One is that anthropocentric theory lacks a sufficient philosophical basis and ought to be given up in principle. From here one can conclude that the field of moral subjects ought to be extended with other species that also become the object of moral demanding rights. The Australian philosopher Peter Singer has become known for his defence of such ethics from a utilitarian way of thinking. He connects moral status to the ability to feel. Another conclusion is that anthropocentric theory cannot have the form of strict spesiesism. A continuation of this would be gradualism, which we shall return to.

An interesting variety of non-anthropocentric theory is to be found in the so-called "deep ecology" which, among others, previous professor at the University of Oslo, Arne Næss, is associated with. One ought to look away from the name of this ethics which is itself so loaded with values that it makes any rational discussion difficult. Deep ecology tries to overcome cultural variation and value pluralism by assuming that one can agree on a set of fundamental deep ecological principles that are a common consequence of the basic assumptions. The deep ecological principles would again be the basis of political norms and guidelines. Together with George Sessions he has formulated the deep ecological principles in 8 points. Central in these points is the assumption that development and welfare of all human and non-human life on Earth has a value itself, independent of instrumental value. People have no right to reduce nature's manifold unless it concerns satisfaction of vital needs. It is an open question what should be seen as vital needs of human beings. It seems reasonable to interpret authors in such a way that this concept is meant to be historically variable, and thus connected to concrete living circumstances and experiences. The implication of deep technology is, however, that what we consider as vital needs as per today, are probably not vital, and that one therefore has to try to get rid of many of them. Thus no prohibition against eating meat follows, but there follows a critical attitude to the consumption of meat in modern industrial society.
There are several difficulties connected with such a deep-ecology. One of them is probably that the deep-ecological manifest hardly can be said to be founded on all relevant basic attitudes to ethics and theory of values. Another difficulty is that the guidelines for action that it is claimed to follow from them, are probably not unambiguous as long as the criteria of decision at a conflict with human interests ("vital life interests") are not decided. This becomes particularly urgent when fundamental human rights may come into conflict with deep-ecological principles, such as for instance a demand for a decline in the figures of population weighed against people's rights of self-determination.

The strength of deep-ecology lies in its critical attitude to today's environmental damage and the consumer society. It shows a theoretical possibility that people via their behaviour can live in greater harmony with nature. Deep-ecology shares this strength with other conceptions of less radical or "deep" variants that find expression for instance in The World Commission on Environment and Development.

We indicated above that anthropocentric theory based on characteristics specific to the species is difficult to defend philosophically. This, however, opens up for a hierarchically built gradualism, of which we shall give a brief outline. Such a variant of environmental ethical theory, such as has been put forward by Kristin Shrader-Frechette (1994), recognises inherent value as moral objects of ecosystems and ecological processes. To attribute such a value is, however, not purely objective, but in the last resort always connected with human judgements of value. (For the human being, cutting down an old, "venerable" and still healthy tree may appear to be different than cutting down a young tree) Furthermore, such ethics still takes an anthropocentric point of departure, in that the degree of the consideration of inherent values follows a ranging according to a human scale. The ability to feel pain for instance will therefore become an ethically relevant characteristic and a basis for differentiated attitudes. This gives a foundation for distinguishing between lower and higher species, something which is not possible on a purely scientific basis. As a third link such ethics operates with second order principles that regulate conflicts between human and non-human interests. Such a principle is that respect for fundamental human rights should always come before the consideration of inherent value in non-human systems. At the same time it may be apparent that for instance the possibility of irreversible damage to the ecosystem comes before other rights, as for instance property rights.
The discussion shows that the environmental debate of today has bred an interesting exchange of views about anthropocentric ideas as a basis for our ethical thinking. It is not possible to come to a decision as regards this debate without in one way or another making oneself independent of one's own attitudes and opinions. One is faced with contradicting opinions whether an anthropocentric basis can be sufficient to secure the ethical basic attitudes that are needed in order to implement sustainable development. It is, however, clear that a point of view that is properly reflected, anthropocentric, and that also uses the space-craft ethics as a point of departure, may lead to ethical norms and principles that demand radical rethinking in many fields. We are still far from such attitudes, both in politics and in daily life. To the extent that these attitudes will be suitable for effective protection of nature's manifold, an application of the precautionary principle could be based on them.

What is ethically right cannot be decided by majority decisions. Politics is on the other hand dependent on having the support of a majority of the population. The precautionary principle as a political instrument will therefore be dependent on ethical basic attitudes that have wide support in the population. There are reasons to believe that it will be difficult for more radical variants of non-anthropocentric thinking to gain foothold in today's society. The political consequence of this is to base political action in connection with the precautionary principle on anthropocentrically orientated spacecraft ethics that minimises the space between ethical ideal and reality. Such a recommendation sets a parenthesis around the question of what is the ethically most correct view. This question may perhaps be answered on a better foundation as we get more experience with the ethical re-thinking that such a development demands of all of us.

**Conclusion 4.4:** The precautionary principle is not necessarily obliged to non-anthropocentric ethics. To the extent that there exists no necessity to give up such anthropocentric ethics, it does not seem politically right to do so.

**Uncertainty, ignorance, and process rationality in ethics**

Ethics has to a small degree had to do with uncertainty in choice of action before the treatment of this topic in modern theory of decision. But to make responsible choices of action when the uncertainties are great is perhaps the ethically most central aspect of the precautionary principle. Despite the lack of thorough
discussions about this theme within ethics, there are some related and relevant approaches to the problem that one ought to be aware of. A short discussion of these is to conclude this chapter on ethics.

There exists a concept of "blameworthy ignorance". It has not been thoroughly dealt with within the theory of ethics, and it has not been raised by central figures such as Bentham or Kant, even if one finds relevant discussion on this phenomenon with Aristoteles and Aquinas (in our time with Philippa Foot and Elisabeth Anscombe). In recent time the philosopher Ian Hacking has taken up this concept in connection with risk research (see Hacking, 1986; the following expresses his main thoughts).

The concept "blameworthy ignorance" meets two different functions. Firstly, it can be used in order to blame a person who via his action has caused damage, without knowing that damage was to follow this action. The point is that one thinks that the person ought to have made an effort in order to find out whether the action might have led to damage. His ignorance may be blameworthy even if no damage follows the action, but that this may have been due to complete chance, and the result could have been disastrous. What is blameworthy, is not that one was ignorant, but that one did not do anything about it.

Secondly, the concept may function as an incentive to further investigation. A person finds out that the ignorance about possible consequences is great, and therefore decides to obtain information about what possible damage is likely to occur. The person admits that it would have been blameworthy not to obtain better information in advance.

Thirdly, the concept can be used as a reason for not acting in a certain way. A person may think that it is impossible to provide more information about possible harmful consequences of the action, and that it would be blameworthy to start the planned action on such a poor basis of information. The reason for abstaining from the action is then that acting under the given conditions would be blameworthy ignorance. If one blames this person morally it is because he decides to act, despite this and despite his knowing about it.

It is easy to give illustrations from daily life. A car-driver who owns an old car, and who himself lacks car mechanical knowledge, will make himself guilty of blameworthy ignorance when the car is used for long trips without regular checks at a garage, and when the car-driver on one occasion hits another person because of brake failure. It would also be blameworthy if the car-driver uses the car and no accident
occurs. The knowledge one has that mechanical errors may easily occur after many years of usage, ought to have led him to assure by a check at a garage that the car is in working order. Not knowing that the brakes were bad is in this case no excuse for what has happened or could have happened. We have been given some general, universal knowledge that might indicate that such damage can easily occur in old cars. We can never be quite sure that we have excluded all possible reasons for worry. It may for instance happen that we from the starting point have reason to trust the garage, but that the garage in this case has done a poor job. If so, our ignorance is not blameworthy any longer. This is due to the fact that it is here a matter of particular circumstances that we can never have under control.

The distinction between the universal - knowledge about the working of the Laws of Nature and the particular - occasional and irregular single events - is not easy to apply in all concrete isolated cases. The main thought is, however, that our knowledge of universal conditions should guide us in such a way that we admit that we are ignorant about important aspects of a matter that may have serious consequences. For instance: New technology involves usually (unintentional) side effects. People who are to operate difficult technology, are likely to make more errors when they have first made one error. From our general knowledge of the universal we may either correct our collection of information in special fields, or choose to abstain from the action under these circumstances. To the extent that we have provided this information, but the information proves to be inadequate because of circumstances that cannot be predicted, we cannot be blamed for the consequences of our action.

It is important to emphasise that conditions that cannot be predicted are not synonymous with conditions that are relatively rare. We can have knowledge about the fact that certain circumstances occur with a certain regularity, though seldom. In this case we ought to take such conditions into consideration. Building security measures in areas exposed to earthquakes are examples of this. Other occurrences on the other hand have no natural frequency of events. We cannot be blamed for having overlooked such situations.

It is immediately clear that the concept of blameworthy ignorance is relevant to ethical evaluation of the precautionary principle. The precautionary principle emphasises that (moral) grounds for action in relation to environment is not only what we with reasonable certainty know something about, but also what we are still ignorant about or uncertain about, when the danger of damage is present. If we transfer
this to concrete choices of action in environmental policy, this means that there exists a positive responsibility of collection of information also about the degree of our ignorance. This responsibility lies without doubt with research. Such collection of information exceeds usual practice within environmental research. It is here one is used to giving information about certain probable causal connections and mutual dependencies. What is less common is giving information about whether one may have overlooked other relevant possible dependencies and causes. The uncertainties and the field of relevant ignorance remain usually invisible. Those who can best throw light on these questions, are the researchers. When our environmental policy is to follow the precautionary principle, and we are able to avoid acting from blameworthy ignorance, it is a clear responsibility of research to contribute in such a way that this does not happen. In Chapter 6 we are going to follow up this further.

As a conclusion we want to add a few comments about uncertain results of an action versus the process through to the choice of action. Evidently, even with the best methods and the most extensive evaluations of possible results of our actions in advance, we will never avoid being wrong or overlooking the most relevant aspects. Thus it is the nature of the damage that decides the degree of seriousness, irrespective of how one arrived at the actions that caused the damage. At the same time our moral considerations, as we have seen, are also to a certain extent to be seen in retrospect. To direct accusations of moral or other failure towards somebody, we look back to see how the damage could occur, we try to place the responsibility. Blameworthy ignorance is one example of this. Let us assume that damage occurs, and that one at the relevant point of time of the choice of action has collected the best scientific knowledge that could be provided. The information one got contained in fact an assessment as to what extent just such damage might happen. What the experts, together with the decision-makers did, was, however, that they considered the probability of such damage to be so small that it could be neglected and that it ought not be used as a guide to relevant choices of action. At the same time one found out that the uncertainties of such an assessment were relatively high, for instance because the actual studies they had carried out were done under high pressure of time, because the transferability of model assessments could not be tested, or because a collection of better data was considered to be too expensive. What consequences would this have for our moral (if not legal) evaluation of the placing of responsibility? Should the
experts and the decision-makers be acquitted of the responsibility, or would we feel that they acted on an insufficient basis?

In order to answer such a question we should relate ourselves, not to the actual knowledge that was available at that time, but to the evaluations that were made in relation to it. Such an evaluation is whether such a low probability is low enough to be neglected in the decision. Another consideration is whether relevant limitations such as deadlines or economic limitations for these studies represent a reasonable framework given the potential damage. Who is suited for making such a consideration?

The experts and the decision-makers have obviously competence to raise these questions and to come up with relevant initiatives. Their considerations will be approximate and based on previous experience. At the same time they are usually in such a situation that they themselves will seldom be affected by the consequences of their own considerations in the case concerned. It is reasonable to think that those who can possibly be affected, the parties concerned, would not necessarily make evaluations identical to those of the experts and decision-makers. The fact that they may be exposed to possible mistakes themselves, may entail that they make higher demands on the quality of the existing information, or that they set the threshold of negligible risk factors lower. (This is among other things the background of the Committee's proposal in Chapter 7). They can therefore not in the future feel that their interests have not been taken sufficiently care of in the evaluations that in fact have been carried out. Thus they may feel that there is reason to direct (moral) accusations towards the responsible because of the damage that has occurred on account of the evaluations that were the basis of previous decisions.

It is reasonable to think that such an accusation is ethically justified, just when considering what we said above about blameworthy ignorance. But in this case it does not involve lack of information, but evaluations carried out in connection with it. Here the decision-makers have failed to include other considerations than their own, even if it is prima facie good reason to think that evaluations by the parties concerned might give different results than the experts' and decision-makers' own evaluations. Consequently it is not only evaluations that come in relation to an existing research report that become morally relevant (for instance under a hearing), but also the evaluations that are made on the way when the report work is planned and carried out. In such evaluations there are implicitly already considerations of the degree of
seriousness of the potential damage weighed against (material and immaterial) costs connected to the collection of information.

When the parties concerned have moral reasons for directing accusations against the responsible it is because the process through to the decision has not been satisfactory. There exists no guarantee that the damage could have been avoided if their considerations had been heard. The ethically relevant point in this example is that moral evaluation is not limited to the actual consequences of an action, but is just as much a question whether the process through to the decision has been satisfactory and fair ("fair/due process). There follows from this a prima facie assumption that the parties concerned ought to play a role in the process of decision concerning environmental questions, if these decisions are to be ethically justified.

The precautionary principle prepares for considerations and weighing connected with a relevant situation of knowledge. From the discussions we carried out above it follows that the precautionary principle from ethical considerations thus seems obliged to processes of decision where the parties concerned, laymen, and relevant counter expertise are included from the start.

**Conclusion 4.5**: The ethical basis of the precautionary principle and the responsibility ascribed to it relate to a concept of blameworthy ignorance, and entail a positive obligation to adequate collection of information and competence building.

**4.6**: The precautionary principle involves an ethical obligation to provide for adequate and fair processes of decision where the parties concerned and other laymen are involved early in the process.

This chapter has dealt with the connection between the precautionary principle and ethical thinking. We have been able to point out some connections that we see as central for our further discussion, without claiming a really exhaustive discussion. But in the six conclusions that we have formulated we believe that we have found important elements for a clarification of the precautionary principle. It is important to recognise the ethical foundation that the precautionary principle rests on.

* * * * *
CHAPTER 5:
THE PRECAUTIONARY PRINCIPLE, THE THEORY OF DECISION MAKING AND OTHER CONDITIONS FOR SUSTAINABLE DEVELOPMENT

The precautionary principle is one of the most essential elements in what is to make up a sustainable development. It can, in fact, be discussed what other principles the concept "sustainable" implies. In this chapter we are going to consider some central principles and concepts that are put in close connection with sustainable development and the precautionary principle. We shall throw light briefly on what relationship the individual principles may be thought to have to the precautionary principle, and what role the precautionary principle plays in political connection. This is particularly relevant considering that political priorities seem to be affected by varying emphasis and evaluations, without always bringing forward how far such changes are based on argumentation or reflection. Consequently the precautionary principle functions for instance in the Report to the Storting (The Norwegian Parliament) no. 64 about the follow-up of the North Sea declaration as a central and superior principle. In NOU 1995:4 "Means to an end in environmental policy" on the other hand the precautionary principle is on an equal footing with five other principles, namely:

(i) the principle of nature's toleration limit.
(ii) the principle of the polluter pays
(iii) the principle of "life-cycle-analysis"
(iv) the principle of the best available technology (BAT)
(v) the principle of cost efficiency

One may ask: Is it correct that the precautionary principle no longer functions as a superior principle? What arguments and considerations, and what grounds are there for lowering priorities? Who has made such decisions? Is this legally and politically along the lines of the international agreements with other countries that
Norway has entered into (such as the North Sea Agreement, the Rio-declaration, Agenda 21 and the EEC-agreement)? If the principle is on equal footing with other principles, are these principles then thought to be as supplementing principles or alternative principles? Can the precautionary principle at all be reconciled with these other principles?

NENT thinks that too little importance is attached to such questions today, both within the research milieus and among political authorities. At the same time some of the relevant principles, above all the precautionary principle itself, are still so programmatic and vague that their interpretation allows very different angles of approach and contents. This is, however, no excuse for not following up with detailed conceptual analyses, and creating greater coherence.

NENT has neither the necessary resources nor the professional competence to carry out such a clearing-up process itself. By the very fact that some of these principles first and foremost belong to the economic-political arena, this work is not covered by NENT's mandate either. On the other hand there is already important preparatory work in international literature that one may make use of. And when the precautionary principle has both clear ethical reasons and to a large extent concerns the research that sets the premises for environmental policy, it is reasonable to look at these things in connection.

In the following we are therefore going to give a survey of the different principles and see how these principles relate to the precautionary principle.

Four principles of sustainable development

The Rio-Declaration and Agenda 21 contain a number of central principles that are to function as a guide for national and international environmental and developmental policy. A number of these principles have a history that is somewhat longer than the Rio meeting itself, and they are also incorporated into other international agreements. One finds them for instance partly within OECD or EU, but also within different national sets of laws and regulations. The combination of the following four principles is, however, central in connection with the question of sustainable development:

- The principle of the polluter pays ("Polluter-Pays")
• The principle of the user pays or environmentally correct pricing ("User-Pays or resource pricing")
• The principle of subsidiarity ("Subsidiarity Principle")
• The precautionary principle ("Precautionary Principle")

One finds for instance in *Fair Principles For Sustainable Development*, published by Edward Dommen (1993), a useful collection of articles, published in cooperation with the UN, which discuss the connection between these principles.

The principle that the polluter pays is the oldest of these principles. It states that the polluter takes over the full costs of avoiding and fighting pollution. The costs for such measures should in this way be incorporated in costs for benefits and services. From the general environmental interest connected with the principle it may be thought that the polluter, for instance a firm, would be willing to add these costs to the costs of the product, and let the user pay, or the producer covers them out of his/her own resources. An important purpose of these principles is to stimulate to the development of new and cleaner technology. When old technology becomes expensive, possibly not competitive any longer, and gives little room for profit, it will pay off to invest in the development of technology that reduces pollution costs. The result may hopefully be that the environment remains in an acceptable condition. At the same time this principle alone will not be able to secure that the condition of the environment is optimal. Legislation that regulates the judicial and economic responsibility for environmental damage, such as leakage from industrial plants, is only part of this principle. Ideally all environmental burdens should be altered to concrete costs. In practice, however, it is difficult to ascertain which share a unit has in relation to such environmental burdens. This applies for instance to multi-causal interactions between sources of pollution, or non-linear damaging effects. Such things make it in practice difficult to price all emission from industrial plants adequately. It becomes even more difficult with emission and processes whose damaging effects are not at all given, for instance they lie far away into the future (storing of nuclear waste) or because we do not know if they have positive or negative effects. It is at this point that the precautionary principle enters. It is via the application of the precautionary principle that assumed environmental costs may be handed on to the polluter.
A further development of the principle of Polluter-Pays is the consumer-pays principle. The concept "polluter" already contains not only certain negative associations of a morally doubtful activity and operator, but also an evaluation of the connection between cause and damage. While physical (chemical, biological) food processes may show cause-and-effect connections, they cannot concretise the extent of damage. Consequently we should first connect a value to a resource to be able to apply the principle of Polluter-Pays. When values are to be translated into economic values, one is dependent on demand and competition.

For natural resources, however, this is a result of ways of application and interests. Let us take air as an example. Clean air may become a value for instance in relation to housing and health damage. At the same time air may also function as a medium of silence and an intermediary of noise. Only through the different competing interests of application does the resource get a value. If a source of noise, for instance a factory, burdens a nearby sanatorium with noise, competing interests and noise damage may occur. But it is only the contemporary presence of both units that can cause such damage. The social costs arise from both the source and the receiver in a symmetric way. The question is, what is here the most valuable use of air, and this is in turn dependent on a number of contextual factors. While the principle of Polluter-Pays will put the burden on the source of noise - the factory - the principle that the consumer pays (for instance when the factory was localised there beforehand) imposes the costs on the consumer - i.e. the sanatorium. Both principles may lead to a resource being used in a way that is most highly estimated. But when for instance the polluter is too poor to cover the environmental costs, one will not be able to apply the principle of Polluter-Pays; on the other hand it will be possible with the same effect to apply the principle of User-Pays that places the costs on the party that is richer. Both principles result in equivalent solutions. The first one may be understood as a special case of the latter. (This is an application of Coase Teorem, Coase 1960, cf. also Bonus, in Dommen 1993.) The principle is particularly relevant in relation to competing interests connected with resources between rich and poor countries.

The principle of subsidiarity is well known for instance from EU's Maastricht agreement. In short it involves political decisions being be made at the lowest possible decision level, if the problem does not make cooperation at a higher level necessary. There lies an understanding of democracy behind that emphasises closeness to the citizen in all common matters. In a wider context this may be understood as a principle
that determines the geographical area where the decision is to be taken. It may therefore lead to the fact that different areas specify the same environmental objectives at different regulations and norms. The extension of the principle suggests, however, that decisions on important environmental matters ought to be based on broad participation of the parties concerned and the population in general. Consequently, expressions of interests and values should not be left to established institutions and interest groups alone, but ought to have a broad basis in society. The principle is therefore from the starting point a guiding principle in the political process of decision. At the same time it is closely connected with the previous two principles by the fact that the stipulation of the value of the benefits and so-called Pareto-optima imply a political process. It should be understood as based on broad participation in order to make other values/costs than pure market prices probable, and in order to make adequate priorities. It is also imaginable in certain cases that decisions are transferred from the political room to pure market mechanism, in confidence that consumer attitudes best reflect their true preferences.

Both the principle of User-Pays and the principle of Polluter-Pays are closely connected with economic regulations. The principle of subsidiarity may also be connected with economic regulations. All these three principles may alternatively or in addition be connected with measures of laws and regulations. Consequently they have immediate political relevance. The precautionary principle on the other hand cannot only be connected with economic regulations. It is in the conditions of the principle that any application of the principle does not become relevant until an (economic) incentive is connected with a practice that does not here and now cause or make probable a counter-incentive, i.e. damage that has to be covered. Therefore an implementation of the precautionary principle presupposes a political process by regulation and amendment to an act. It also presupposes that trade and industry are not only expectant to politics and regulation by law, but think ahead on their own initiatives. Without such a follow-up the precautionary principle cannot effectively prevent forms of practice that later may cause great environmental or health damage. The precautionary principle thus differs from the other three central principles of a sustainable development.

It should be mentioned that it does not follow from this that the political dimension is the only relevant or decisive dimension in the precautionary principle, and that the placing of responsibility lies with the authorities alone. NENT would like
to emphasise precisely in this report that other dimensions are attached to the principle, that concern other operators and areas of responsibility (especially science), and other means to an end. It is for instance immediately clear that when one leaves state authority at a national level and talks about international cooperation on environmental issues with the precautionary principle as a point of departure, the driving force behind this must at the last resort be the moral responsibility that governments feel for our common good and welfare. The responsibility may, however, in respective societies be summed up as a political mandate, but is not subject to a common set of laws and regulations. Generally, one may therefore say that the precautionary principle should also count on moral operators. Furthermore, it is clear that the criteria for when the precautionary principle ought to apply, are not generated within the state or political institutions alone. It is here science plays an important role as a responsible supplier of premises and as a source of future-orientated possibilities of action.

**Conclusion 5.1:** As opposed to other central principles of sustainable development the precautionary principle cannot primarily be connected with economic regulations. It is based on the fact that national and international measures are made by regulation or alteration of law. Internationally it is based on the idea that one enters into binding sets of agreements, even if their concrete implementation nationally may vary from one country to another along the lines of the principle of subsidiarity.

**Conclusion 5.2:** Via the principle of subsidiarity circumstances are prepared for a broad popular participation. Such processes may be particularly relevant as regards getting a grasp of adequate balancing of environmental advantages that ought to be protected with a precautionary strategy.

**Minimax or no-regret or wait-and-see or precautionary?**

Within the economic theory of decision making, more precisely the utility theory respectively "expected utility theory", one distinguishes between different strategies in order to make decisions that involve risk. We have in this report characterised risk as expected possible damage in a "game", independent of whether we can assess the quantitative probability of the damage, or whether we are genuinely
ignorant of the probability. We have chosen to look at risk, uncertainty, and indecision as variants of one and the same type of practical problem in relation to environmental decisions.

An important school of thought operates with a fundamental distinction between decisions where one can indicate probabilities of expected results and decisions where one knows about possible results, i.e. possible natural conditions, but without being able to estimate their probability. In the first case a rational choice will result from the sum of the product of probability and the value of the possible results of each choice of action. What becomes the maximum sum is the most rational choice, if no ethical norms demand or prohibit certain choices. In relation to current environmental questions these conditions are, however, difficult to fulfil.

The other case deals with situations where the probabilities cannot be calculated. An important principle that has been proposed for a rational choice is the so-called Minimax principle (i.e. minimising the maximum loss). Alternatively, if one is most inclined towards risk, the so-called Maximin principle (maximising the minimum profit). The intuition behind the Minimax principle is that one will avoid choices of action that may lead to comprehensive and irretrievable catastrophes. One assumes that a risk aversion is sensible in the situations where we may lose much of everything and are ignorant of probability, and one goes in for a relatively certain road. Some people have interpreted the precautionary principle as a direct translation of the Minimax principle. The advantage of this principle is that it seems to be in accordance with people's factual priorities. One has found that most people place more importance on situations with low probability of great damage than common utility theory would involve. Consequently, such situations seem qualitatively subject to other principles, such as Minimax. Objections to this strategy are that it would lead to paralysis in almost all practical situations. In practice we can never exclude with certainty that an action may involve disastrous consequences, especially indirect consequences far into the future. Ideally this presupposes a general view of all possible causal connections. Obviously, this also applies to measures protecting nature. The Minimax strategy wants to aim at a zero risk society (in any case in relation to technological risks), as we cannot rule out that our actions always have a potential of possibly highly improbable, but relatively disastrous consequences. Given that nature may well be chaotic, and that small actions may be provoking factors of much greater
consequences in multi-causal connections, one will tend towards abstaining from most interventions.

A zero risk society is, however, an illusion. The practical problems we face are not how we can get down to zero risk, but how we can reduce the concrete risk after a thorough weighing of the alternatives and costs.

Therefore another school of thought, the so-called Bayesianism or the doctrine of subjective probabilities, gives importance to the idea that one should always operate with probabilities that as a starting point, when we do not know anything, are based on subjective and arbitrary estimates (e.g. p=0.5) and these must be adjusted up or down along the lines of the data we gradually obtain. Mathematically this process will converge towards decisions under risk (where we can estimate real probabilities). There is, however, an intensive debate in the professional milieu about the adequacy of Bayesianism. NENT does not want to come to a decision about this debate, but confine themselves to pointing out that it has relevance for the implementation of the precautionary principle.

One may make pragmatic adjustments of the Minimax principle so that it is only applied in situations where one has a realistic, scientifically based damage scenario with irreversible damage. Here one operates no longer with complete ignorance, but at least one possible course of events with a great loss may be given scientific grounds, even if it is impossible to indicate any quantitative value. This is a rough simplification of the situation of decision. One may get an equivalent situation in cases where the probability may well be estimated with a reasonable degree of certainty, but the weighing of the result is uncertain, i.e. where it is impossible to indicate what is an acceptable risk level. In that case the precautionary principle corresponds to the Minimax principle (one gets a so-called "insurance game". This may, however, change as soon as the efficiency of the measures under the precautionary principle itself is uncertain (one gets a so-called "Lotto-game"). Here the worst possible result will be that irreversible damage occurs in any case, and that one has made great useless investments in order to counteract it.

When one is faced with situations where the efficiency of the counteractions themselves is uncertain, at the same time as the probability of the damage is very uncertain, it therefore does not always seem obvious that every means must be concentrated at once on counteracting the presumptive damage. The so-called wait-and-see strategy may therefore seem as the best alternative. One goes in for gradually
collecting enough information to improve the situation of decision later. This strategy is often understood as more flexible and more economically favourable. The question is how long one can wait before it is too late and too expensive with possibly necessary counter measures. One gets the so-called "optimal stop problem": when is it correct to change from waiting to concrete preventive counter measures? At the same time it is obvious that the wait-and-see strategy without clearly defined milestones where the strategy is assessed, scarcely can be counted as a precautionary strategy. One risks hesitating until it is too late for effective counter measures. Wait-and-see is in fact the strategy in environmental policy one has followed also previous to the precautionary principle. The time for measures was then decided from reasonably certain knowledge of damage and counter measures. Put in legal terms one may describe a wait-and-see strategy as a strategy that tends towards placing the burden of proof on the assertion of possible damage in preference to the assertion of harmlessness of a practice.

A variant (in a utility theoretical sense) of the wait-and-see strategy is the so-called "no-regret policy" or "minimax regret strategy". It may at the same time be understood as a variant of the precautionary principle. Putting it simply, the strategy involves that one choosing at the present time the strategy that one has reason to believe that future generations will have the least reason to regret, irrespectively of how the world in fact proves to be. This strategy seeks then to minimise one's possible regret at perhaps later finding out that one has not made the optimal choices earlier. One chooses the measures now that seem sensible to implement from the fact that they may be a (limited) counter measure to a presumptively great damage in the future, but which are also sensible to implement if the world does not, after all, become as bad as one feared. The American government maintains this strategy (against an unconditional precautionary policy) for instance in relation to the climate problem. Metaphorically it is a strategy of "all sorts of weather". At the same time this strategy is not free of the stop problem either. When one has implemented all measures that are sensible also when all other considerations have been taken into account, and when one is still uncertain about the problematic result, one will have to make a choice whether to intensify the measures or give them up. In proportion to the climate problem the stop problem may turn up relatively soon. One may soon arrive at a "point of no return", where one must either act radically and with great costs or must risk a
disaster without the possibility of counter measures. It is nevertheless possible to
interpret the regret strategy as a first step of a precautionary policy.

**Conclusion 5.3:** A simple application of the decision theoretical Minimax principle is
not suited as a point of departure for the precautionary principle unless approximate
pragmatic idealisations are made so that unreasonable consequences are avoided. A
zero risk society is an impossible Utopia.

**Conclusion 5.4:** A regret strategy may be seen as a first step of the precautionary
strategy if it is understood in such a way that one has to change the strategy at a further
specified point in time where it is not too late for effective precautionary measures.

**Nature's toleration limit**

As human activities in one way or another always burden the environment and
are in addition temporarily or permanently harmful as to certain conditions, it is an
alluring thought to assume that environmental policy cannot be based on the
prevention of environmental burdens. Assumptions that it depends on to what extent
nature may be burdened without long-lasting and unacceptable costs, is relevant here.
It is from such a way of thinking that the concept *toleration limit* (as "assimilative
capacity" or later "environmental capacity"; Cairns 1977) was launched at the end of
the 1970s. The concept has first and foremost been applied to emission of harmful
substances into an environment, especially the environment of the ocean. It is to
indicate the ability that ecosystems have for receiving certain levels of emission
without their being disturbed in their essential ways of functioning and without having
important biological damaging effects. As such one imagines that the concept refers to
an ability that the ecosystems themselves have ("a property of the environment,
defined as its ability to accommodate a particular activity, or rate of activity, without
unacceptable impact"; quoted from Stebbing 1992).

This is based on three premises:

"1. A certain level of some contaminants may not produce any undesirable
effect on the environment and its various uses:

2. Each environment has a finite capacity to accommodate some wastes
without unacceptable consequences.
3. Such capacity can be quantified, apportioned to a certain activity, and utilised" (ibid. 289)

Professor Francis Sejersted says the following about the concept:

"The concept "toleration limit" … is at the starting point based on a conception of the human being as a potential threat to nature in reasonable ecological balance. Through the exploitation of nature by human beings follow erosion, pollution etc. One imagines, however, that nature has a self-healing potential so that it up to a certain point can avert the damage. If one gets past this point, the mechanisms of reestablishment are exceeded so that one gets a cumulative damaging effect. It is such a point we connect with the concept "toleration limit". This may be a useful concept, but it may also have obscuring effect. (Effektstudien, 1992, 18). A little further down in the contribution Sejersted adds the following: "At the stipulation of marginal values it becomes just as much a question about what limit is culturally and socially acceptable as about what nature and health may tolerate. It is perhaps most fruitful simply to look at the marginal value as a social concept" (ibid. 19).

Even if the toleration limit in environmental policy is mentioned occasionally as a supplementary consideration, or perhaps specifying consideration in relation to the precautionary principle, (cf. NOU 1995:4, as mentioned at the beginning), it appears for different reasons most reasonable to interpret the two principles as competing principles. While toleration limits are connected with a dispersing administration of environment and emission ("dilute and disperse"), the precautionary principle runs in the direction of avoiding non-naturally occurring emission and adjustment to natural levels of naturally occurring substances, scientific uncertainty taken into consideration (The Esbjerg Declaration 1995). These contradictions between the two principles become even clearer when one looks at the conditions of both approaches. The precautionary principle becomes, as earlier mentioned, relevant as an administration principle when a relevant danger of irreversible or significantly great environmental and health damage occurs without the existence of sufficient scientific knowledge making it possible to predict this damage positively. On the other hand, the dispersive approach which burdens the environment up to certain values of assumed limits of toleration, presupposes a positive knowledge of these toleration limits, or at any case knowledge of when a critical environmental stress occurs that gives notice of an excess of the toleration limit. Consequently, this approach
presupposes just the type of knowledge that the precautionary principle at the starting point considers as absent. Sigmund Hågvar has illustrated this in the following way:

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<tr>
<th>Level of catastrophe</th>
<th>Trend of development</th>
<th>RED</th>
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<tbody>
<tr>
<td>Level of stress</td>
<td>apparent environmental stress</td>
<td>YELLOW</td>
</tr>
<tr>
<td>Level of safety</td>
<td>Point of view</td>
<td>GREEN</td>
</tr>
<tr>
<td></td>
<td>Warning</td>
<td></td>
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</tbody>
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A condition for effective environmental administration under such a principle is adequate environmental supervision. There is no doubt that environmental supervision takes place on a large scale. Hågvar ascertains: "… We must ascertain that few or none of the trends of development that were mentioned are under control. Reporting annually on how the situation constantly deteriorates is as far as we have got. We keep surveillance. And this seems to reassure many people." (Hågvar, 1991, 61). The reason why some people do not think this is sufficient, is that one does not as a consequence change the development by clearly defined points of view or at sufficiently many warning signals. These are usually not given in advance, not any instructions of how one should react. It is, however, more revealing, that the toleration limits, i.e. the safety and stress levels are under the toleration limits, and in practice are not definable on a scientific basis. A study on toleration limits of pollution from the production of aluminium, carried out as a task set by the Norwegian aluminium industry (Effectstudien, 1992, 1993), had to ascertain that "so-called toleration limits are flexible aims" and that one "will not reach final and universally valid answers through the studies of natural science alone"; and that the question of toleration limits "is also a question of values" (1992,10-11). A certain type of emission in a certain ecosystem will for instance entail that lilies of the valley no longer exist naturally near-by a production plant. They will, however, continue to exist a few kilometres further away. Is this an acceptable consequence? Acceptable for whom? For the children who grow up there, or for the authorities in another town, or for the bees? And what ecological connection will this be integrated into? Do we know enough to be able to exclude indirect damaging effects if other organisms also
disappear as a result of this? Science will be able to examine certain connections of cause and effect, but as a rule only such as are partial, tying a simple cause to an effect, seldom multi-causal connections. But even under optimal conditions it gives no standard of what is an unacceptable burden. Consequently, the concept of a toleration limit, as Sejersted puts it, is a socially constructed concept about nature, and not a characteristic of nature itself.

The problem becomes even more intricate when one accepts that also supervision entails fundamental scientific uncertainties (see above, Chap.2). What degrees of uncertainty we must be able to accept for supervision, and what types of practical and feasible supervision we consider as sufficient for administration and regulation, are important and relevant questions. The more one takes these questions seriously, the more one is pressed in the direction of a precautionary strategy.

In practice the uncertainty of a decision of toleration limits is far greater than suggested here. The dispersive administration strategy and the thought of toleration limits are based on the fact that there exist sufficiently good predictive models and adequate tests of toxic effects. One assumes good approximations to the dose-response relationship, including low dose - long term response relations. We mentioned earlier that these assumptions have to be considered as problematic as the factors of uncertainty are particularly great.

The belief in toleration limits as a useful and central tool in environmental policy is based on the fact that one may overcome the existing scarcity of scientific knowledge based on great scientific contribution. This belief is, however, scientifically naïve. It has expectations that the next improvement of the models that are adopted will overcome the essential weaknesses of the models. Consequently, one ignores the fact that the existing models were originally motivated by just the same aim - and failed. Therefore one sees in many fields a rapid development of models and methods of measurement and supervision, without having reached a reliable basis for scientifically based environmental policy. An example may be models of assessing the fish populations in the ocean. From a pragmatic connection of decision making, the historical development, i.e. earlier successes and errors, is consequently a relevant assessment factor. It gives a certain indication of how the existing uncertainty ought to be estimated. Funtowicz and Ravetz have incorporated such considerations into a concrete proposal of visualising scientific uncertainty, the so-called NUSAP form (1991). Even if the possibility that the really good environmental models lie just
around the corner may never be principally ruled out, and even if the development of improved models is an important research aim, it is most sensible not to base environmental policy on such expectations.

The consequence is that the precautionary thinking represents an important alternative to such thinking based on nature's toleration limits. A further consequence is that the precautionary principle prepares for another type of (post-normal) science. Several researchers have pointed this out as a necessary follow-up of the principle (Taylor1991, Peterman 1990, Peterman & M'Gonigle 1992, Harding & Fisher 1992, Buhl-Mortesne 1996, Hansson 1997, Wynne 1992, Wynne & Mayr 1993). Several concrete methodical measures are mentioned such as avoiding statistical type II errors and widened peer-review processes (see the discussion in Chap.6) Taylor describes such an approach as among other things based on holistic technology assessments where all aspects of chemical substances are in focus, not only their toxic effects. He captures this in a table of key words:

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<tr>
<th>Dispersive Approach</th>
<th>Precautionary Approach</th>
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<tr>
<td>Relies on:</td>
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<tr>
<td>- predictive models</td>
<td>- technology assessment</td>
</tr>
<tr>
<td>- toxicity tests</td>
<td>- chemical persistence</td>
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<tr>
<td>Assumes:</td>
<td></td>
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<tr>
<td>- acceptable detriment</td>
<td>- no easy acceptability</td>
</tr>
<tr>
<td>- tolerable doses</td>
<td>- uncertainty of dose effects</td>
</tr>
<tr>
<td>- ability to turn off &quot;tap&quot;</td>
<td>- unpredictable fate of substances</td>
</tr>
<tr>
<td>Implies:</td>
<td></td>
</tr>
<tr>
<td>- limited technology assessment</td>
<td>- major industrial &amp; consumer changes</td>
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</table>

Others emphasise that science based on precautionary thinking in all circumstances moves the focus from the effect side on the extreme edge of an activity ("end-of-pipe research") to the activity itself and the processes it assumes ("upstream"). In this way one gets the aim of clean production ("clean technology"). The efforts to obtain new solutions for environmentally harmful activities that will eliminate all damage of any dimension, is a characteristic of the precautionary thinking. Clean technology and production are thus an aim that implements the precautionary principle. A condition of this is those so-called cradle-to-grave analyses, where all links in the life cycle to substances in a production process are assessed from
an environmental perspective. This includes the use of resources, production, use, recycling and scrapping after use.

One must certainly understand this as an ideal aim, but at the same time it is an aim with concrete consequences for research and politics. The question crops up whether the aim involves other principles in order to gain partial aims that lie within measures that are feasible at any given time.

We would here like to mention two concepts that seem to have this function of partial aim. One is the ALARA principle, i.e. the principle of aiming at emission thresholds that are as low as conceivably technically possible within the given economic framework conditions (emission "As-Low-As-Reasonably-Available = ALARA) A consistent application of this principle gives up the conception that emission levels can be kept within an objective toleration limit, and replaces it with step-by-step measures towards gradually lower emission. In harmony with this there is the concept of the "best-available-technology" ("Best-available-technology" = BAT). This is also a relative concept, demanding that a source of pollution or burdening should constantly be technologically improved in order to press the emission level down, for instance via improved filters of purification, re-circulation, etc. BAT and ALARA are the foundation of what is now called environmental technology. In countries like Germany this has become a rapid growth industry.

**Conclusion 5.5:** Environmental administration based on nature's toleration limits is not consistent with the precautionary principle, but obscures fundamental uncertainties in scientific knowledge.

**Conclusion 5.6:** The precautionary principle prepares for another use and another type of science than what is usually produced within applied environmental research. In relation to technological research the precautionary principle involves the development of clean technologies.

**Conclusion 5.7:** Concepts such as ALARA and BAT have an instrumental pragmatic value for situations where one must be content with step-by-step improvements in order to reach higher aims.

* * * * *
CHAPTER 6:  
THE PRECAUTIONARY PRINCIPLE TRANSLATED INTO NEW PRACTICE  

One result of the previous chapters is that the precautionary principle cannot be operationalised in the sense that there exist in advance certain fixed procedures that under unambiguous, basic conditions should come into force. One can neither approach a precautionary strategy by doing research nor formalise all necessary and sufficient criteria in order to get a result that may be said to follow the thought of the precautionary principle. The precautionary principle is a normative principle that functions as other norms in society, namely a guide to evaluations and measures that are put forward as interpretations of the principle. It is essential that these interpretations always include both the processes in nature and socially cultural conditions. It is of superior importance that the principle is granted a central place both in national environmental policy and in international environmental agreements, in order to make it possible for the principle to function as normative. A number of other principles such as the principle of nature’s toleration limits might weaken the importance of the precautionary principle to such a degree that it loses its particularly positive contents. Even if the precautionary principle functions as a general norm, rooted in political aims, it is not without concrete consequences. These consequences involve different operators' roles in environmental policy and administration, and it involves the information that should form the basis of decisions and measures. We shall now look more closely at these.
About the precautionary principle and scenarios of evaluation of measures

We have seen previously how one could argue for rather different strategies of measures for the same approach to the problem based on the precautionary principle. All these strategies may, in one sense or another, be able to function as strategies towards a sustainable development. Even if overlapping between the strategies were possible, these strategies run at least for some time in different directions. What is the reason for this? We shall here outline a model that explains and systematises our perspective. The model is mainly inspired by the study “Sustained risks: a lasting phenomenon”, Netherlands Scientific Council for Government Policy, Reports to the Government 44/1995.

As a starting point there are many different conceptions of two fundamental conditions: how we regard nature, and how do we regard society. This applies especially with regard to nature’s and society’s ability for change. Many people may think that nature is in a fragile state of balance that may easily and suddenly turn to a state where usual ways of functioning, circulation, etc. will be irreversibly disturbed and where the conditions of life will be damaged. Others may think that nature certainly aims at balance, but that disturbances are quickly absorbed and that nature will find its way back to a state of balance. Still others may think that nature has a wide spectrum of possible states in which it may, and that balance becomes a relative concept in relation to the interests of the special species. Nature may bring forth a manifold of forms where completely different organisms will find new states of balance. Finally one meets the conception that nature has a certain tolerance towards disturbances, so that these must last for a long time and be relatively great before the state of balance is abandoned. These are descriptive conceptions that are consequently true or untrue. The point is that nobody knows which conception is true or not true. Probably they are so fundamental that one must ask oneself if one will ever be able to give a scientific reason for one or the other conception.

One may have corresponding conceptions in relation to the adaptability of society and human beings to a change of essential relationships in social structures or in natural conditions. In the same way as with nature one may think that society and human beings in their present form are a result of a long lasting evolutionary process, and that adaptation cannot appear in big leaps, but demands a long lasting evolution.
Social institutions and norms may be as fragile as structures we find in nature. Rapid change may entail crisis and social destabilisation (crime, war, poverty, need, etc.). On the other hand, it is not unreasonable either to think that social structures are something very different, by the very fact that they are artificial, and thus perhaps not subject to their own inherent orderliness. One may think that we can create and change such structures consciously, if necessary rapidly, involving social destabilisation. We may have similar scenarios as for nature’s ability to adapt. Such scenarios may be presented graphically (Schwartz and Thompson):

![Nature capricious](image1) ![Nature tolerant](image2) ![Nature benign](image3) ![Nature ephemeral](image4)

It is fundamental that we cannot know which of these scenarios are true/correct/probable. At the same time we must adjust our environmental strategies to the scenarios in which we believe the most. Environmental policy may be understood as a game against nature. In this game the probability of one or the other scenario is unknown. We must put our stakes on one or the other scenario. We risk being wrong in our stakes. The input is different by the very fact that the costs and the profits are different, dependent on which of the scenarios are true. But risk is fundamental for this game.

We saw in the previous discussion that the result is always dependent on both aspects: nature's ability to adjust and society’s ability to adjust. Our social activities are in causal interaction with nature, first and foremost via technology, but in a wider sense through the whole of the social field (settling, consumption, nutrition, etc.). Consequently, both elements are essential factors in the game against nature. Sustainable development never refers to purely scientific phenomena, but to the interaction of nature/human beings as a whole.

It is a well-known fact that people react differently to risk. One may be characterised by risk aversion, so that one tries to avoid great possible losses and supports strategies that minimise such losses. One may also be more optimistic and willing to take risks, and not let oneself being led by what is considered as improbably great losses, but by the benefits one wishes to maximise. This becomes particularly relevant when ethical considerations to present and future generations are involved.
The attitude to risk varies, and it is as a starting point difficult to say which attitude will be most rational. From a democratic way of thinking it may at a macro level be most sensible to acknowledge the plurality in risk attitudes, and use this as a foundation for strategies of action that society must give priority in a democratic process.

Granted the attitudes mentioned above, one gets a four-field table of different attitudes that will have consequences for which scenarios one has most confidence in. This table may be outlined in the following way:

<table>
<thead>
<tr>
<th>Risk in relation to:</th>
<th>high risk aversion</th>
<th>low risk aversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>nature</td>
<td>fragile nature</td>
<td>robust nature</td>
</tr>
<tr>
<td>society/human being</td>
<td>fragile social structures</td>
<td>robust social structures</td>
</tr>
</tbody>
</table>

In a game where we at the same time must concentrate on what nature is like and what society is like, we will thus get four principal attitudes, dependent on what we consider as entities that are most reasonable to change without this having great negative consequences. These are:

Four different attitudes to interventions in nature with social consequences:
These four attitudes represent four fundamental possibilities of translating the aim of sustainable development into social practice. They may be seen as ideal types of environmental political thinking. None of these four attitudes represent the view that environmental problems do not exist to any degree, nor that it is not necessary to do anything about it. All of them acknowledge that the environmental problems are sufficiently serious for a need for measures in order to remedy the problems. But one varies in the view as to where the measures preferably ought to be implemented in order to attain the best possible effect without risking disastrous disturbances. When one for instance assumes that the structure of society is relatively robust, this does not mean that it is unchangeable, but on the contrary that society may tolerate encroachments without getting out of balance. When one assumes that nature is fragile, this does not mean that our encroachments should not be directed towards nature, but on the contrary that we must act in such a way that tendencies away from balance must be counteracted with equivalent counter measures in order to get it back to balance (the state that secures human needs for resources now and later respectively) In other words, we must act in accordance with nature's inherent orderliness.

We get four fundamental perspectives of how sustainable development should be translated into action. As a direct result of this we also get four ideal types of perspectives of how we should act in order to put the precautionary principle into practice. In short, they are described as follows:

**(i) "Deep ecology"**31: Here one is in favour of risking as little loss as possible on the part of nature if nature should be as fragile as one believes, but one is willing to put relatively high stakes on the idea that society may tolerate a number of fundamental changes without being weakened in its essential functions. Therefore one implements the measures primarily against human action and behaviour - against society. Society must be adjusted to nature's balance, in the way one defines this concept. One does not want to withdraw from radical encroachments in and changes of our social and economic structures. One ascribes a higher (survival) value to the state of nature than to social status quo and welfare. We do not have any other choice than to follow the necessities of nature, and the result for human beings and society will

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31 We use this expression in a broad sense and without necessarily limiting ourselves to deep ecology as it is described within environmental ethics.
have to tolerate this adjustment, by the very fact that one assumes that there are many
forms of social organisation that may satisfy human beings. A human practice that
alters nature's position from short-term self-interests is understood as untenable.

(ii) Pure technology: Here one accepts being in a difficult constellation. One must
tackle both the possibility of fragile states of nature and the possibility of fragile social
structures. From this there are few possibilities of radical strategies, given that a
strategy that is radical with regard to improvement of a parameter (for instance nature)
usually may involve great influences on another parameter (society). One would rather
support strategies that are sensible without regard to how the world might be (regret-
strategies). One acknowledges that the existing environmental burdens are untenable
in the long run, and therefore one supports a strategy where one chooses to adjust the
parameter that is least fragile, namely technology. One develops new and cleaner
technologies that fulfil almost the same socio-economic functions as the old ones, but
avoid all burdening of the environment, from cradle to grave. The price will be that
these technologies, at any rate from the very beginning, represent much higher costs -
both in development and in application - and that they presuppose partly new forms of
economic inter-trade, such as consistent recycling etc. In this way one minimises the
environmental burden and the social burden at the same time.

(iii) Political control: Here one is from the very beginning prepared for the idea that
change is possible without having to involve great costs. One believes in a relatively
great potential both with regard to nature's and society's ability to adjust. One
consequence is of course that one probably has better time for the measures one
implements - environmental catastrophes are not just around the corner as others may
believe, but the environmental deterioration is serious enough to seem to justify action
with a definite aim. The other consequence is that one may develop long-term utopias
that one may aim at with a process that changes the state of the world little by little,
but in the long run rather fundamentally. The mechanisms are first and foremost
mechanisms of control initiating a process of change that will gradually lead to
effective improvement. And the change takes place both in relation to our interactions
with nature and in relation to how we organise society. Economic means to an end are
well suited for instance for stimulating other forms of production and to changing the
consumption patterns. The framework conditions for industrial production will
continually be a state concern, where the state to a greater extent is willing to use
regulations, and mechanisms of reward and punishment for environmentally correct
behaviour. Political measures will implement a long-lasting process of conversion of society that in the long run will be more in agreement with the given framework conditions of nature. The precautionary policy becomes a question of political control. The time perspective of the measures is, however, greater than in the two alternatives above.

(iv) **The technologist:** Here one wants to bring society into as little unbalance as possible, while nature probably admits a certain margin and time of measures. The obvious strategy is to keep to the fundamental mechanisms of society, such as democratic structures, a free market, and pluralistic preferences for adequate life style. At the same time one wants to change the technological frames of our cooperation with nature so that they do not produce unfortunate side effects for nature in the long run. For instance one assumes that future generations will also find new technological solutions to their problems just as previous generations have found solutions for their problems. As a starting point one intends to repair the worst damage known at present, prevent possible damage as far as there is an economic and technical basis for it, and develop technologies (cleaning technologies etc.) that reduce the worst environmental problems. It is a matter of adjusting the conditions in such a way that technological innovation in the long run moves in the direction of better technologies that will reduce the environmental problems. As a means to an end here and now the use of the best available technology (BAT) and low thresholds of emission (ALARA= "as low as reasonably available"), means to push technology in the right direction. In the long run they may possibly be concurrent with clean technology, but the time perspectives are longer.

It is NENT’s opinion that the use of the precautionary principle presupposes a clarification of the framework perspectives one uses as a point of departure. Considering as a stating point that precautionary strategies apparently do not exist, it is reasonable to claim that the conditions for possible strategies are brought forth (are made visible) and discussed in a democratic way. The reason for this is a claim for coherence and consequence. Ethics claims explicit argumentation and dialogue. This means that solution strategies for one environmental problem are put in connection with the other environmental problems, in a general view of environment and society. The conditions for this and the follow-up of this are essential for the evaluation of such strategies. Not least one will claim that the measures are in reasonable proportion to the measures one considers necessary in other fields. In this way one wants to
emphasise (as an ethical claim) that the perspectives will not be one-sidedly decided by specific interests, but that one is willing to follow equivalent strategies also in other fields where one does not have the same interests. It would for instance be difficult to be of the opinion that we in relation to CO₂ and the greenhouse problems should not implement particularly radical measures other than supporting long-term improvements of the technology towards better and more effective technologies, at the same time as one claims that the chemical pollution with chloric organic compounds of our drinking water and oceans ought immediately to be stopped because of possible health dangers. If one adopts an attitude to the energy problem from a technological perspective, this will probably also involve looking positively at new technologies, such as for instance parts of gene technology. Similarly it will not be meaningful to argue from deep ecology views against further development and use of gene technology, chemical industry etc., while at the same time ignoring the environmental problems that farming and animal husbandry involve. If one adopts a deep ecology attitude in the first fields, one must probably also be willing to argue for a great reduction of agrarian and meat production, including fisheries, in the industrialised countries, and accept into the bargain the re-adjustment of consumer habits this will necessarily involve. Self-interests ought not to be determining for what type of measures one favours in different fields. In other words, what we think is ethically necessary is not any special strategy for a special approach to the problem, but a commitment to consistent perspectives also in fields where one has no self-interests. It is only in relation to such superior perspectives that it gives meaning to launch a strategy as a precautionary strategy.

There follows from this a special obligation for scientific research. Too often one is preoccupied with cause- and-effect relationships of the one-to-one type. One fails to connect things. In a context of decision-making it is, however, important just to be able to acknowledge certain specific strategies as integrated parts of larger perspectives. For lay people this may be difficult. Here researchers who look for connections and totalities may contribute positively. Research on climate will, in the same way as research on salmon farming or nutritional compounds demand conscious integration and discussion of ideal types of perspectives such as those that are described here. Such connections may be visualisation as a result of research.
**Conclusion 6.1:** Using the precautionary principle demands explicit integration in larger perspectives of sustainable development, and the research must contribute to the visualising of such perspectives. These perspectives should function as normative guides to a consistent evaluation of adequate precautionary strategies in different connections.

**About the precautionary principle and economic limitations**

It is tempting for many people to free the precautionary principle of any economic consideration, almost as a duty to nature. As previously stated, the precautionary principle is not suited for a realisation based only on economic means. We also emphasised that economic consequences for society are ethically relevant in the necessary weighing that has to be made. Political follow-up and regulation are necessary for instance for excluding certain profit incentives of environmentally damaging activities etc. And one may think that the precautionary principle involves a response to environmental problems that ought to be administered from the degree of seriousness of the problem, and not from economy alone.

One must be aware that measures cost money. Measures without costs are an illusion. And costs involve social burdens of different degrees. When the measures at the same time are uncertain with regard to effect and effectiveness, cost considerations are relevant. It is even more important to have a clear relationship to the costs when these are distributed in different ways between the different parties, be it in developed versus non-developed countries or different groups of society. The same applies when the costs are distributed between different generations. Here the costs are an important point of departure for discussing considerations of justice. Discount rates etc. are ethically relevant information that also involves problems of different types.

Therefore it is always an ethically relevant consideration to include economic aspects when evaluating what is a suitable precautionary strategy. This being said, certain limitations still follow.

The first thing is that the cost aspect is subject to the same factors of uncertainty that apply to scientific environmental research in general. It is often difficult to get an overview of the real expenses that social measures involve for society. The costs may be indirect and hidden, and much insight into the respective processes is presupposed in order to be able to estimate them. The costs of future effects that one had not had any experience of are even more uncertain. Here we are
dependent on model estimations that at any rate involve the same degree of uncertainty that the models of natural science do. Looking exclusively at possible numerical quantities is unfortunate. The figures may vary tremendously in order of magnitude. We may seldom arrive at anything but rough, approximate estimates.

Secondly, methods that calculate so-called cost effectiveness are only a relative means to an end. Such estimations may indicate to what extent a given investment may gain a certain effect that we want to gain. In situations where we must choose between different alternative measures to the same purpose, and where our knowledge about these is approximately similar, it may be very useful to undertake a calculation of cost effectiveness. In other situations, on the other hand, for instance where we do not have alternative strategies at our disposal, or where our knowledge of the different, possible measures is qualitatively very different, the benefit of such calculations is very limited. The basis of a decision about the precautionary strategy will then be based on other considerations than cost effectiveness, for instance political considerations.

Thirdly, so-called cost-utility calculations are a questionable tool in an environmental, political connection. Such calculations give us a basis for comparison between different strategies, each of which may be directed separately towards different tasks. In a medical connection this is used for in stance to weigh between measures directed towards a broad group of receivers (for instance vaccination against the flue) versus measures directed towards a small group of receivers (for instance cardiac surgery), as an implementation of all measures is not considered possible because of scarce resources. This is, however, meaningful only when one may assume that there exists a given standard of utilitarian value (for instance mortality and morbidity in medicine). If one considers values that may only be compared with difficulty, this tool as a rational basis of decision-making (in medicine for instance if one wants to take into consideration quality of life and suffering) will fail. Despite persistent efforts to create such a basis for comparison (for instance so-called QALYs in medicine), one must conclude that such attempts have not yet led to convincing results when one is considering environmental questions.

**Conclusion 6.2:** When estimating the precautionary strategies the aspect of costs is always important to take into consideration to the extent that it is possible to form a general view of it. Cost effectiveness is useful where one can compare alternative
strategies in order to attain the same effect. Cost utility calculations on the other hand are usually difficult to apply in environmental questions. They often cover up qualitatively important and morally relevant priorities that must be taken.

**About the precautionary principle and the handling of risk**

It is an illusion to believe that one can attain a society with zero risk. Zero risk is no realistic possibility, neither towards nature nor towards human activity. We are living as the sociologist, Ulrich Beck puts it, in a risk society, where risk has become the great question of distribution besides welfare. This involves among other things that the precautionary principle cannot be interpreted in such a way that any risk deserves to be met by constant minimising strategies. Interpreted in this way the precautionary principle would lead to total paralysis of action, not only should we have to stop all our industrial production, including farming and fisheries, but we could not react to environmental threats with counter actions either. As mentioned previously, this applies not least to the social risks we are facing.

The challenge lies in generating acceptable risk levels, which are reflected in society and are based on the qualitatively different attitudes that people have to different risk sources. If one risk is based on voluntary activity it is as a rule more acceptable to most people compared to risks that one cannot escape and that are a result of other people's action. Consequently the quantitative aspects of risks are only one aspect, the qualitative features weigh usually most heavily. There exist no fixed values given in advance that mark acceptable levels of risk and that may serve as a basis for comparison between different types of risks. Risk is contextual and culturally bound.

Risk research has a positive value in environmental policy and provides an opening to identifying possible sources of problems. By making a survey of the interaction between different factors in generating damage scenarios one gets the possibility of directing measures of control towards certain elements. The positive contribution of risk research thus lies on the analytical side. At the same time it gives premises of risk administration and communication that are constructive. Here, however, there is a danger if one considers risk research as an exclusive supplier of premises for the administration of risk. When all risks are essentially precipitated risks, it is given that those who understand risk and who are affected by it are important operators and suppliers of premises.
This has practical-political consequences for what tools of decision-making it is important to make use of in the administration of risk. The perspective of operators means that scientific expertise only serves as an informer in a process where acceptable risks must be discussed. In many cases it will be unfortunate to leave risk administration to the interaction between an expert culture and an administrative political culture. In environmental questions there will for instance lie a political responsibility for bringing forth forums and processes where concrete environmental questions may be clarified discussed and dealt with on a broad public basis. This is what is sometimes called participatory environmental policy. Such means to an end lie in a direct extension of risk research. They have immediate meaning for the shaping of the precautionary strategies, in that the decision that a problem is serious enough to justify environmental political preventive response is dependent on which risks we are willing to live with and which we wish to combat here and now. In Chapter 7 NENT present a concrete proposal of such a participatory environmental policy.

**Conclusion 6.3:** Risk research gives valuable contributions to an environmental policy under the precautionary principle. However, it ought to be accompanied by participatory environmental political measures in order to reflect factual risk preferences in the population that may give a point of departure for a follow-up with precautionary strategies.

**About the precautionary principle and handling of scientific uncertainty**

It is a heritage from the positivistic view of science to think that scientific research gives objective and reliable points of departure for political action. Much basic scientific research gives us a relatively well-founded world picture and adequate understanding of fundamental natural mechanisms. Without such research that can objectively capture nature's mechanisms, we would not feel any such need for reaction to environmental problems. It is research that brings these problems into daylight. There is every reason to rely on research to be of positive importance for the handling of the work with our environmental problems.

One expects, however, too much from science if one believes that it will be able to give unambiguous answers to all practical, important questions. It is a matter of realising that the contribution of science must be limited. In fields where the problems are the greatest and where interests are diverging, the uncertainty for instance of the
statements is usually quite decisive for the context of decision. Funtowicz and Ravetz have quoted an important trend towards increased politicizing of the research context when they talk about post normal science. Today there is a great span between basic scientific research and research that with a definite aim raises concrete approaches to problems of an environmental political nature. The uncertainties become significantly greater in the last category, even if they are never completely absent in research. At the same time the evaluation of what are serious environmental problems, sensible measures, and how one ought to do research on them, are more dependent on moral attitudes and ethical preferences. Thus it becomes what we considered at the starting point as an objective problem, a question of choice of the right perspectives and of moral legitimacy and adequate administration of profound uncertainties.

Science has in this an important role to play, it is an operator. Consequently, it also has expectations directed towards itself of contributing as well as possible in this complex situation of decisions. A concrete result of this is that research ought to spend much more energy visualising factors of uncertainty in addition to showing relevant co-relations, model estimations and cause-effect relationships. Without such visualisation the contributions become distorted, at least for the receiver. Clarification of consequences and other expertise in advance of environmental projects ought to apply more energy and means to just these aspects.

There lies as a premise for the application of the precautionary principle that scientific uncertainty cannot be attained, in other words that we cannot prove with any reasonable degree of certainty that an environmental deterioration will occur. From what has been indicated about risk and the possibility of realising a zero risk society, there may neither be any reasonable point in letting all conceivable risks be a basis for precautionary measures. A weighing must be made to decide what risks have to be met by measures, even if one does not have sufficiently good knowledge to feel reasonably confident that the risk one prevents, in fact represents a real threat. As mentioned above, this justifies participatory environmental policy, something that will be dealt with more thoroughly in Chapter 7. However, when one relates to such questions and to questions of what threats one must face and combat, it is important that good information is available as regards what uncertainty (respectively what types of uncertainties) one has to consider here.

Scientific research has done little to treat more systematically the uncertainty that is connected with research. One has few tools to systematise this (but see:
Constanza & Cornwell 1992). Most of it is of a qualitative type, and often little established in research circles. Some scientific theoretical research gives certain rudimentary points, but this has attained small effects in research practice. Funtowicz and Raventz have presented a model of systematic visualisation of a certain number of such factors of uncertainty, the so-called NUSAP form. (It has, as far as we know not yet reached the academic milieu.) In economic utility theory one has worked with decisions subjected to uncertainties, but on the whole without taking much consideration of different types of scientific uncertainty and how we may express this in decision relevant contexts. There are great challenges here for further research. This applies to the same extent to research in research ethics. Not least, there is a great challenge in relation to scientific research education. The time one sets aside for the education of future researchers as to how they should visualise the factors of the uncertainties they will meet in their research, is out of any reasonable proportion to the importance this has in relation to a sustainable environmental policy based on the precautionary principle. This is a weakness of our research policy.

**Conclusion 6.4:** Scientific research and education ought to give priority to the new challenges that consist of visualisation of essential factors of uncertainty and questions of value for decision-makers. This activity ought to be in a reasonable proportion to the development of models and other tools in environmental research. In concrete development projects resources ought to be set aside in order to visualise relevant areas where knowledge is lacking or the uncertainty is great. These areas ought to be discussed within an ethical framework of decision.

**About the precautionary principle and scientific methods**

Previously in this report statistical testing has been mentioned as an important tool in order to examine causal relations in nature. At the same time it has been pointed out that a number of uncertainties are connected with this method. One may follow this up further by evaluating standard procedure in statistical testing against alternative procedures.

The point of departure of the discussion is the so-called statistical type I and type II errors that any textbook in statistical testing mentions. There they are also mentioned as "false positive" and "false negative" results of testing. A statistical type I error appears when the zero hypothesis (that denies a causal connection between the
examined quantities) is rejected and the test hypothesis is accepted as true, while in fact it is the zero hypothesis that is true ("false positive"). A statistical type II error appears when one fails to accept the test hypothesis as true, and sticks to the zero hypothesis, when in fact it is the test hypothesis that is true ("false negative").

**EXAMPLE:** Assume that we are interested in finding out whether invasion of farmed fish in watercourses leads to a reduction of the stock of wild fish. Our hypotheses:

**Test hypothesis:** Invasion of farmed fish is a contributary reason for a reduction in the stock of wild fish.

**Zero hypothesis:** Invasion of farmed fish has no effect on the stock of wild fish.

**Type I error:** We endorse the test hypothesis (accept it as true), reject the zero hypothesis, but in reality the zero hypothesis is true.

**Type II error:** We do not endorse the test hypothesis (consider it as not proved), accept for the present time the zero hypothesis, but in reality the test hypothesis is true.

Methodical rules in research are such that one attaches great importance to avoiding type I errors. One would prefer to avoid maintaining something with the support of research that the posterity proves to be incorrect. On the other hand, one is willing to risk failing to maintain a truth, until the statistical data are more convincing. Usually one sets a relatively high threshold for the acceptance of test hypotheses, usually at a 95% level of confidence. The probability of a type I error will thus be set at 0.05 (a). There are less rigid norms when it is a question of avoiding type II errors, but here one often operates - to the degree that this is thematised - with values between 0.05 and 0.20 (b) When this value is set at 0.20 it means that a researcher has an 80% chance of rejecting a zero hypothesis as false when it is in fact false.

These values represent a standard production of evidence by way of statistical testing. It is easy to discover that behind such standards there are important normative decisions that may have great ethical consequences. There are certain "trade-offs" in the different methodical decisions. We wish to illustrate this by way of an example (taken from Lermons et al. 1997):

1. Let us assume that we want to examine whether a certain carcinogen is cause-related to a certain type of cancer. We assume that the frequency of this type of cancer in the population is 1/10,000, and we set $a$ at 0.05 (using the 95% rule of confidence). We want to be reasonably certain that we do not get false negative results, and therefore set $b$ at 0.05. The chances of false positive and negative are equal and small. We assume that a relative risk of 3 represents a serious enough risk that ought to be examined. With these conditions in place, we would have to examine at least 133.191
persons that we exposed to the carcinogen substance, and an equivalent number that are not exposed to the substance, if we want statistically significant results of a relative risk of 3. Practical and economic framework conditions will probably prevent such an examination.

2. If we have the same supposition as above, but are willing to accept a greater risk of type II errors (false negative), for instance with \( b \) set at 0.20 (a chance of \( 1 / 5 \) of committing a type II error), we must still examine 77.087 persons in the test group and an equivalent number in the control group. The practical difficulties are still formidable.

3. Let us now assume that it is practically impossible to study as many individuals as under 1. and 2. What we for practical reasons can study are 2150 in the test group and 2150 in the control group. We still want to avoid type I errors, but we will be 80% certain to discover an increased risk if such should exist. What relative risk could we hope to discover with such a study? At best we could discover a relative risk of 39, i.e. 13 x higher than the risk we considered as serious from a point of view of health policy. With the values that are set, it is not possible to discover the relative risk that at the starting point motivated the examination. If we do not find relationships between carcinogen substance and occurrence of cancer, nothing follows about a relative risk level that is less than what this examination is able to capture (39).

4. We might discover a relatively higher risk level, for instance of 3.8, if we adjust some other values. If the test group is constant (\( N = 2150 \)) and \( a \) is 0.05, we could increase \( b \) to 0.60 (i.e. the test power is \( 1-b = 0.49 \)). In this way we might get the possibility that we because of coincidences only have a 60% chance of overlooking the fact that the carcinogen substance in reality is carcinogenic in the population. The problem of this study is firstly that we can only discover a higher risk level than we consider as serious (3,8), and secondly that we in this case must accept a 60% chance of still overlooking a potentially dangerous substance in the population.

5. As a last variant, we assume that we still have the same number of individuals and that we want to discover a relative risk with 80% certainty, if it exists. We could now increase \( a \) instead of \( b \). If we set \( b \) at 0.20, the corresponding \( a \) would have to be at about 0.33 in order to be able to discover a relative risk of 12. In this situation we can only be 67% certain that we do not get false positive results. We would get statistically significant results for relative risk levels higher than 12 (which is still higher than the threshold of serious health danger), but at the same time we may risk
that we about each third time would have maintained a connection that in reality does not exist. Such studies would probably not be accepted in scientific professional circles, by the very fact that the probability of type I errors is too high, and consequently the risk of passing something on as scientifically proved, that is not correct, is so great that in the long run it will undermine the credibility of science. It should at the same time be mentioned that the results may still be important for health policy.

This survey in statistical methods shows how different sets of examination may place the uncertainties in research in different ways. Dependent on what sort of approach one chooses, one chooses at the same time what one considers as the most important considerations this study should make. The reasons for this choice are, however, not based on scientific facts, but on an ethical judgement of values.

In connection with a discussion of the precautionary principle it is important to bring forth the aspects of value that are the reasons for the methodical choices that follow scientific research. None of the preferences mentioned above are correct or wrong from independent or objective criteria. But all of them may be very misleading, dependent on what contexts the scientific findings enter into. There cannot be any automatics connected with always following the 95% rule. While such a standard has many strong points for purely scientific purposes (e.g. in basic scientific research) it may be unfortunate in connection with clarifications in connection with environment and health. Here such a rule may contribute to lengthening the status quo in situations where quick reaction from precautionary considerations may be necessary. In connections where scientific results are used to determine a set of rules it would be important to minimise type II errors.

For several reasons it is important in certain connections to minimise type II errors in preference to type I errors. In addition to the reasons already pointed out above, the following may be mentioned: (1) Someone who proposes a developmental project that potentially threatens the environment, will normally benefit more from the development than the public will. Increased emphasis on minimising type II errors will contribute to greater justice in the distribution of risks and profits with such projects. (2) More emphasis on minimising type II errors would have given greater protection against threatened species of animals that often fare badly in usual risk-cost-utility calculations. (3) The public ought to be adequately protected against natural encroachments that cause damage that one cannot get a realistic compensation for. (4)
More emphasis on minimising type II errors would not only give more protection to the present generation, but also to future generations in cases where one has to do with long term effects.

It is the Committee's definite impression that these choices of value that follow scientific methods, are not treated in an adequate manner in research circles or in the education of researchers. To the extent that one wants a better interaction between responsible research on the one hand, and an environmental administration and policy led by the precautionary principle on the other, it is absolutely necessary that these aspects become explicitly thematised. The precautionary principle represents a challenge to all parties involved to thoroughly reconsider their own forms of practice, and consider whether the implicit choices of value are in accordance with this principle.

**Conclusion 6.5:** The choices of value that follow scientific methods ought to be made explicitly, ought to be thematised both in education and research, and ought to be adjusted to the concrete tasks that an examination is facing. This applies especially to the preference between statistical type I and type II errors, where one must consider whether one ought to put more emphasis on avoiding type II errors in a number of connections.

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CHAPTER 7:
THE PRECAUTIONARY PRINCIPLE, CONSENSUS, AND THE NEED FOR A NEW INSTITUTIONAL FRAMEWORK

The Committee has in the previous paragraph pointed at some of the complexity connected with the application of the precautionary principle. There exist no readymade recipes that in all cases will lead to a satisfactory result. Efforts to put the precautionary principle into effect will demand knowledge, reflection, creativity, vision, and aim based on values. It goes without saying that such application cannot be
a routine matter of administration. It also appears quite clearly that research alone cannot supply answers to what is a reasonable precautionary response to a given problem situation. Many people will therefore draw the conclusion that this must be left to the political process of decision-making. By the very fact that political bodies of decision-making in a democracy like Norway may be said to represent the majority interests of the population, also that the precautionary strategies are marked by fundamental moral attitudes, it seems natural to delegate the responsibility to the political bodies. Only those bodies have the necessary democratic legitimacy to be responsible institutions of decision-making. With regard to strategies that demand national action, one wants to delegate the responsibility to the Storting (The Norwegian Parliament) and Government. Strategies of a regional or local nature are preferably to be left to the respective bodies at county or municipality level.

In this chapter the Committee promotes a concrete proposal to strengthen the democratic process that may lead to good political decisions.

**The difficulty of political responsibility for precautionary strategies**

The Committee is aware that the authority of decision-making must belong to these political levels. At the same time it wants to point at the fact that a difficulty lies in two essential conditions.

Firstly, the political processes of decision-making based on majority decisions. Such decisions often involve a losing minority. In some matters this minority represents large sectors of the population. With changing power structures the majority-minority conditions might be reversed. The precautionary strategies as an important element of sustainable development are, however, often long-term strategies covering a period of time lasting beyond ordinary periods of election. Furthermore, their efficiency may often depend on whether they in practice are supported by a large number of people, in order not to be undermined or actively opposed. Strategies that are understood as especially closely connected with the existing power structure of a society, may find it difficult to get the broad follow up and support that are often demanded on the ground plan. They will be exposed to changing preferences and changes in the long run that may undermine just the considerations that were determining from the beginning. They may lead so far that the opposition to such strategies becomes an aim in itself to indicate opposition to certain moral attitudes and power structures. This has its background in the fact that different organisations with
regard to their members are dependent on preserving a profile as an organisation fighting for certain matters and interests. It is obvious that this weakens the energy and common contribution that are needed in order to translate strategies based on complex weighing between values and facts, for a sustainable development and to prevent possible environmental and other damage.

Secondly, the political bodies are usually dependent on being presented with possible strategies of action that other parties promote as effective measures in order to respond to a given problem situation. Here the politicians are dependent on good experts. Generally these come from the administrative body, professional and industrial bodies, or from special research milieus. The politicians represent certain moral attitudes and interests. Their qualifications are not as a starting point connected with certain knowledge and analytical abilities. But who is a good expert? In practice it often appears that when certain matters are sufficiently controversial, there is also disagreement as to in which experts one may have confidence. Therefore many organisations have built up their own staff of experts. In reality the panel of experts one listens to will also have consequences for the power structure. The experts cannot conceal their factual political power when, as we have seen, the cases in question are complex and encumbered with great uncertainties. There exists counter expertise that is partly characterised by the fact that it comes from institutions or organisations that are less influential. A certain removal of power and influence prior to the political process of decision-making takes place. This process, independent of whether it is formal or informal, means a weakening of the democratic processes. It also invites to undermining the strategies one agrees to the political bodies. The most fundamental criticism of citizens towards state measures in a democracy is not to have been heard and not to have been considered. These two conditions, dependence of the policy on majority structure and dependence on experts, may contain serious weaknesses in the practical possibilities of carrying through measures that fulfil the precautionary principle and show the way to sustainable social development. They create distance between state and politics and between everyday perspectives and technical-practical context of action.

Previously in this report we mentioned the so-called principle of subsidiarity that in many contexts is promoted as an important girder of sustainable development. The principle consists of the idea that decisions should be made at the lowest possible level of decision-making. The principle is also connected with closeness of citizens in
all common concerns. Such closeness is often sought via processes that are open for broad public participation. The intention is to fasten sustainable strategies with those parts of the population that are affected by the strategy. Our comments above lead one to think that the principle of subsidiarity ought not necessarily be limited to the political level of decision-making relevant to the matter in question. As we have suggested, distance to the citizen may exist independently of this. This makes it reasonable to examine whether one may imagine instruments of decision-making and forums that prepare or supplement the political process and that fulfil the principle of subsidiarity in a better way.

**Consensus and participation as an ideal**

A pluralistic society is characterised by the existence of a majority of interests and moral attitudes. Interaction in such a society results from common concerns being referred to procedures and bodies of decision-making based on democratic principles. State administration and politics become the art of introducing measures that optimise fellowship of existing interests and minimise their mutual conflict in relation to the measures. But interests and moral attitudes become, though only in theory, treated as given quantities, as "black boxes" that form input in the political process. As the American Laird (1993) emphasises, this may be set against the idea of direct forms of democracy that are based on individuals and not groups. In processes with direct participation by the parties concerned one does not only want to emphasise the final results, but also the learning processes on the way, the psychological effects of taking part in a process, and the understanding of other people's divergent values and view that is gradually developed. The by-products of this type of process may be as important as the products themselves. Such processes are therefore not only result-, but also process-oriented. Theorists like Laird who defend such forms of democracy for special approaches to the problem (technology evaluation and development), maintain that while pure pluralistic understanding of democracy presupposes a democracy on the ground plan that functions, the model of direct participation is characterised by the fact that it creates democratic forms of interaction on the ground plan, and thus a living democracy.

Consensus is a tool of decision-making that is principally different from majority decision. Consensus creates no winners and no losers. In the forums of decision-making, also where they have only guiding functions and where no
democratic representation for an electorate is given, internal disagreement of a decision weakens its legitimacy and effect. Where one can reach consensus, it strengthens the platform that is needed to implement the decision. Consensus presupposes in ideal cases a process where relevant alternatives are estimated, essential information collected, arguments for and against weighed, interests and values openly presented, and adjustment to a common good is sought.

Philosophers and others have pointed out that consensus is never any guarantee for truth or morally correct decisions. At the same time the same philosophers have pointed at our fundamental fallibility concerning truth and correctness. Certain schools of thought, such as Charles Sanders Pierce's pragmatism, have therefore made the consensus that shows to be stable in the long run as indicator of truth. In recent times the so-called discourse ethicists (e.g. Jürgen Habermas) has taken advantage of consensus attained under ideal conversation conditions (discourse) as a basic format of the theory of ethics. What gives a special force to the concept of consensus is that it shows a previous process of rational insight. Consensus is usually difficult to attain; it demands frankness to be able to look at the circumstances from different perspectives and adjust one's own views to the arguments that gradually emerge. If the method functions, it gives both strength and stability.

While consensus in principle has its limitations for the political administrative bodies, it is not unknown as an important steering principle in other organisations. While one in larger organisations (or enterprises) will never be able to have consensus about all detailed measures, nor seek to gain it, many organisations are built on the principle that actors share fundamental perspectives, values, strategies and aims. Denominational organisations are one example of this. Industrial enterprises in western countries have in recent years followed the consensus of anchorage in values that characterises many Asian enterprises. One has concluded that such consensus gives efficiency and stability.

In relation to our point of departure, the precautionary principle, it therefore seems natural to ask if one has had concrete experience of bodies of decision-making based on broad public participation and consensus in connection with implementation of the principles of sustainable development. From the considerations we have made above it is reasonable to expect that this might be imparted between (on the one hand) the complicated cases one faces, and (on the other hand) the limitations political authorities of decision-making face in distributing sustainable development. The
committee proposes that we direct our attention to one has had experience with such processes.

**Canadian round table conferences**

The Canadian *Task Force on Environment and Economy* promoted the idea of "multi-stakeholder round tables" first time in a report to *The Canadian Council of Resource and Environment Ministers* in 1987. Such round table conferences were looked upon as "permanent forum where all sectors may meet in order to join forces in preventive strategies and influence on the planning task". Later one has introduced such round table conferences both at international level, in all non-nation states, many regions, and in some municipalities. There are many reports about their activities, and experience from the local conferences was reported in 1994 (see for instance Building Concensus 1993, *The National Round Table on the Environment and the Economy* 1994, *The National Round Table Review* 1995; See also British Columbia Round Table on the Environment and the Economy 1993, the following quotations are taken from these publications.)

The background of the group's recommendation is the report from the UN's *World Commission on Environment and Development* (WCED), led by Gro Harlem Brundtland, who in 1987 wrote among other things the following: "The Commission has noted a number of actions that must be taken to reduce risks to survival and to put future development on paths that are sustainable. Yet we are aware that such a reorientation on a continuing basis is simply beyond the reach of present decision-making structures and institutional arrangements, both national and international" (Our Common Future, 1987, pp. 22-23) The Canadian round table conference is meant as an instrument in order to attain integration of perspectives through broad public participation in an effort to attain development of a sustainable future for society. In her book *Signs of Hope* (1990) Linda Starke writes that "these initiatives in Canada provide one of the few examples of lateral thinking on institutions since Our Common Future was published".

The Canadian round table conferences fulfil five general characteristics that describe a mode of operation and a form of organisation. They are:

1. Local round table conferences have a wide mandate to take care of matters concerning sustainable development and how the results may be translated into local practice. Environmental, economic and social aspects are of the same standing in this connection.
2. Local round table conferences represent the diversity of interests from all sectors of a municipality or region. The parties concerned are represented around the table.

3. Local round table conferences are not formed ad hoc in order to consider short term limited questions. They are of a more permanent character, with the task of dealing with long term perspectives.

4. Local round table conferences function on the basis for the formation of consensus, and develop mutual understanding and agreement between the parties in order to be able to make the difficult weighing of interests and choices of values that are demanded in order to change the course towards sustainable development.

5. Local round table conferences function as guiding units for the government, non-nation states and municipal administration, and for the local interest organisations that are represented and that the round table conferences report to. Starke

There are a number of questions and problems the Canadian round table conferences have raised and dealt with. In many of these cases their influence has been an important link in the following political process of decision-making. They have for instance considered questions about use of areas, developmental projects (for instance water power, golf courses versus the building of houses), regulation of cattle and common grazing land, tourism, parking of bicycles, re-cycling programmes and sorting of waste, water environment and regulation of rivers, etc.

"One key theme heard during the Round Table's public consultations was the need for local participation in planning and decision-making … In every one of the communities visited by the Round Table, people expressed a desire for some mechanism by which local residents could undertake locally-led sustainability initiatives and resolve local sustainability conflicts"
From: "From Ideas to Action: Monitoring Progress Towards Sustainability", British Columbia Round Table, 1993.

The Canadian round table conferences are in many ways a sort of micro-cosmos of the local society in which they exist. The diversity of interests is reflected in them and in the composition of the conference, and everybody around the table has the
same possibility of exerting influence on the process towards consensus. The forms and contents of their work vary with region, experience, composition, and connection with the authorities and the interest organisations. It is, however, typical that one operates at several levels and with several forms of action. Some of the most conspicuous tasks are:

- Outlining a vision, presenting principles, or indicating aims for how the region or the municipality may contribute to global sustainable development. This work may be inspired by generic thoughts of sustainability, adjusted to regional conditions.
- Forwarding information, education and encouragement to implement sustainable measures and living conditions.
- Acting as an appropriate body of comment for government, non-nation state, or municipality policy in relevant fields, and drawing up concrete proposals to the political agenda.
- Expressing one's opinions on specific questions and projects that are in the course of preparation and planning.
- Supervising and evaluating the state of the environment in the region with a view to sustainability.
- Mediate in local interest conflicts and political causes, especially when the combat itself may be a hindrance to effective sustainable measures.
- Strengthening the cooperation between different regions and municipalities at several formal and informal levels through the formation of networks.
- Providing sponsor measures and other support to concrete pilot projects ("hands-on efforts"), with a view to involving untraditional milieus for environmental measures.
- Contributing to increase the consciousness and aims in connection with sustainable development at talks, presentations, shows, publications etc. In particular, it may be important to throw public light on regional success and successful projects that present positive examples.

The Canadian experience shows at the same time that it is not a matter of course getting such local round table conferences to function satisfactorily. Some initiatives were abandoned after a short time, because one did not manage to provide the necessary network, internal cooperation or external support. It is therefore decisively important to well and thoroughly prepare such initiatives. In some cases the preparation has lasted for up to one full year. In several cases one has summoned to
public hearings prior to the establishment of the round table conference, and during the
hearings appointed an interim executive committee that took care of further
preparations. It ought also to be mentioned that members of the Canadian round table
conferences participate on a voluntary basis, usually only travelling expenses and
other expenses (possibly loss of earnings) are refunded. In some cases one operates
with a symbolic fee for the whole period of function. On such a basis it is extra
important that a good foundation for the work is created. Even if there does not exist
any simple procedure that is suitable under all circumstances, and even if there is some
variation between the different local initiatives with regard to both contents, mandate,
composition, reporting, and tasks, the Canadians have developed a straightforward
guide for starting up such initiatives. The central points in this are as follows:

- **Deciding the framework of reference for the activity.** This includes among
  other things the general mandate, aims, reporting, procedures of appointment, criteria
  for membership, duration of membership, media contact, meeting frequency and
  administration of economy. A description of the consensus based process of decision-
  making that indicates clear rules for procedures in case one should fail to come to an
  agreement straight away, is a particularly relevant point. In many cases it is secured by
  the mandate that the round table conference develops its own rules for consensus prior
  to its ordinary activity. It is also important that one indicates clear regional limits for
  the initiative. These limits need not always follow the limits of administration, they
  may also follow physical dividing lines (as a watershed or a valley), but it may often
  be an advantage to attach importance to administration areas.

- **Developing an agenda and fields of priority and strategies.** Round table
  conferences have the liberty to decide for themselves what projects they wish to
  examine. At the same time it is usually useful to be presented with concrete
  expectations and general approaches to problems that are important for the region.
  These give orientation and impulse especially in the first period of activity. Indication
  of partial aims and deadlines may contribute to secure progress in the negotiations, at
  the same time, as it is important to have realistic conceptions of how much time this
  will take. An important first task may in many cases be to provide a survey of existing
  initiatives and projects in the region, and put them in connection with sustainable
  development. The potential of strengthened interaction by consensus ought to be
conveyed. It is particularly important to get positive and active support from certain central organisations in order to link them to the process.

- **Implementing a process of appointing members.** Different parties, for instance a government, may take care of the role as authority of appointment, (council of municipalities or non-nation states), interest organisation, or interim board. It is in any case important that this party takes initiative to reach all individuals and groupings in the region. In certain cases one has advertised in regional papers, summoned to hearings, used placards or official assemblies in order to get hold of persons that might be willing to participate and become candidates at the nomination process. Interest connections, as for instance tasks in particular organisations, become clarified in order to protect against a biased composition of groups. Usually an organisation or a sector is only represented by one member. It is of vital importance that the process is lucid and impartial.

- **Deciding the size of the group.** The number of members such a round table conference requires, is partly dependent on the geographical area they are responsible for, and partly on the diversity of interests in the region. Usually a group of fewer than 12 members would easily overlook important interests, while groups of more than 25 members will have hard work in the process of decision-making. By the very fact that the meetings of the groups may be public and special experts may be summoned to the meetings, and also because some round tables admit ad hoc membership for certain cases, one will usually find an adequate membership between these extremes. It ought to be mentioned that no member needs to be a special expert on "sustainability".

- **Developing format of work and meetings.** The group may take care of this task itself. One should for instance agree as to whether the group should have a leader (some groups have ambulating leadership), deputy leader, or if the group needs a so-called "facilitator", i.e. a person who does not represent interests, but is only concerned with leading the group process and the development of consensus. One should also come to a decision with regard to the frequency of meetings and the need for a secretariat (partly put at the disposal by the nomination authorities, together with meeting rooms).

- **Working out definitions of work and key concepts for further work.** It is important that the group relates itself to self-elected definitions of work of the concepts that give the most important grounds for further work. Here the Canadians
mention sustainable development, consensus, self-sufficiency, social equality and justice, and welfare. Such definitions of work provide gateways to relevant local approaches to the problems.

- **Building up alliances within and outside the region.** To what extent such a round table conference is able to influence decision-makers in the region depends to a great extent on what alliances one is able to gradually build up. These manifest themselves among other things by the fact that organisations and bodies can direct themselves to the round table with concrete proposals, suggestions, and requests.

- **Preparing for a flexible long-term learning process.** The Canadian round table conferences are as a starting point thought of as permanent forums. In order to fulfil these tasks in an adequate way, one must be able to adjust to external changes, and acquire knowledge from one's own experience. It is therefore important that their mandate and working methods are made the object of periodical evaluations, which may form a point of departure for changes. Some of the change arrives automatically by replacement of members.

"The local level is the 'hell's kitchen' of sustainability because that's where most of the problems are felt and the fewest resources are available."

Joy Leach, Chair, British Columbia Round Table, 1994.

It is interesting that the Canadian round table conferences are generally composed according to two principles that to a certain extent are mutually excluding. All round table conferences seek to represent all essential parties concerned, and interests of a region, but the composition and nomination of groups take place in different ways. Here one differentiates between so-called "representation based on interests" and "representation based on values". Representation based on interests stands for a group of persons, each of whom has separately the authority to speak on behalf of an organisation or association. In certain Canadian districts such memberships are used as a supplement to another type of membership in order to secure that important and controversial questions will be treated in a way that secures support from the organisations. In cases where the group is on the whole composed by
such representatives, one is likely to keep one place "free" for the public and interests that are not mirrored by the organisations. "Value based representation" on the other hand involves the members taking part by virtue of their personal characteristics. They are likely to be close to certain organisations and their moral attitudes, but do not act as official representatives that can only promote officially accepted views. In these cases one seeks to recreate a micro-cosmos of the local society where the group as a whole reflects the diversity of interests and the value perspectives.

There are advantages and disadvantages connected with both forms of representation. The first one has the essential advantage that one gets clear lines of reporting between a member and his/her organisation, and that one can link these organisations and associations to decisions at the round table conference. The disadvantage is that all interests that ought to participate in the groups to achieve broad, public representation, are perhaps not present. Furthermore, it may easily lead to members limiting themselves to the officially adopted policy of the organisation and abstaining from more visionary or creative thinking. The process of the group may reach a deadlock and progress arrives slowly.

The other form of representation has the advantage that the members need not seek support from the mother organisation prior to their own decisions in relevant cases. There is more liberty connected with how many members one needs in the group, and what tasks one may consider. The members may to a greater extent develop their own creativity and cooperate more openly and flexibly with the others in the group. The disadvantage lies in the fact that such groups have greater difficulties in keeping in touch with broad groupings of the population, and to keep informed about relevant matters that are getting close to the stage of decision in the region. Furthermore, their consensus statements will not to the same degree bind the relevant organisations to obligatory cooperation. It may also happen that the group develops a tendency to disregard important questions of details and devote themselves to questions of principle at a general level.

Some round table conferences in Canada have therefore developed mixed models of both forms of representation. As an example one has encouraged the members to participate as individuals first (representation based on values), and resort to representation based on interests when one does not reach a consensus or when special cases are particularly controversial.
Canadian round table conferences are cheap measures with important contributions to the political process of decision-making. Financing these measures are, however, treated differently in the different districts so that few activities have a fixed budget granted by the authorities. Only in Manitoba has there been given a basic grant from the non-nation state with orders that equivalent means be granted by the municipality. In other non-nation states financing is more ad hoc, and sometimes limited to grants at an infrastructure level. At the same time contributions have been received from the private sector, from industry, institutions, organisations, certain administration authorities, and others. Most of these means are project based, even if some round table conferences have established more permanent sponsor agreements.

Usually one talks about limited funding. This covers for instance correspondence and the spreading of information;

- Announcements of activities and meetings;
- logistic for the activities (rent for premises, refreshments, child care at evening activities);
- management (copying, post, telephone, computer equipment);
- fees or charges for the use of technical and other consultants, possible education of members for special tasks;
- travelling expenses of members (especially in solitary regions where the members must travel a long distance and transport is expensive);
- access to information (E-mail and Internet, literature search, buying of publications).

Having to engage in obtaining financial support for each individual project may be particularly time consuming. When participation is voluntary the workload may easily become too heavy. It may also entail that the attention of the group is easily focused on the first project that gets external means, in preference to being led by the mandate

"…it is vital to keep people talking. One-off meetings between sectors contribute nothing to real integrated thinking and action on sustainable development. We found monthly meetings essential in the first year, and we were pleased with the amount of understanding and respect that emerged among what had been traditional adversaries."

Prince Edward Round Table on Environment and Economy.
and the more long-term tasks. It has proved to be necessary with more permanent financial arrangements in order to create stable conditions of work. It may often be necessary that the regional or municipal authorities give a basic support that makes the work possible. Canadian experience shows that application for help to organisations, institutions, industry etc. at an early stage when the enterprise is new and unknown, may work against the intention and create a certain reluctance in the organisations that are to become allies later in the process. Therefore, in order to counteract this, round table conferences ought first to produce results that are recognised as important and that give a hint as to the potentiality of the measure.

Some round table conferences have also maintained that they ought to be used as regular consultants for larger developmental projects, and paid (as an organisation) accordingly. This also applies to municipal means that are otherwise used to clarifications of consequences and ad hoc evaluations. Others fear that one may become "bought up" by large concerns or authorities, and oppose such arrangements. They have worked out guidelines for their own efforts to get external support for the activity.

"Many would argue that there are trade-offs with increasing public access and citizen involvement: increasing complexity, delays and longer decision-making timeframes. But bringing the government and the people together can improve not only the quality of decision-making, but also the acceptance and relevance of the decisions."

The round table conference needs management and administrative support. Most of the Canadian round tables seem to have a leader, preferably a relatively charismatic person with lots of energy who can convey visions and aims, and who manages to motivate other persons' commitments. In order not to lose any of the driving force of the group when the working period of some of the key members expires, others ought to be trained gradually for similar functions of leadership, for instance as leader of subgroups or active deputy leader. One may also let chairmanship ambulate amongst the members even if that may cause difficulties for the continuity of the process.
One has in some cases made use of external "facilitators", persons with good experience from the negotiation processes and group-work. They are drawn into it, on a voluntary basis or for fees, especially at the early stages. Facilitators do not themselves participate with their own points of view and are not part of a common process of decision-making, but shall prepare the process in the best possible way. One has also often made use of active secretaries, for instance from the municipality, who are at one's disposal on a part-time basis. In practice, secretary support has often proved a decisive factor in order to increase the efficiency of the group. This is of importance especially in relation to tasks connected with the planning of larger regional projects and enterprises where technical expertise and management of information are needed. Under unfortunate circumstances it may, however, entail that the activities of the group lie too much in the hands of the administration, unless the group from the start develops its own initiative.

**Guiding Principles of Consensus Processes:**

1) **Purpose driven**: People need a reason to participate in the process.
2) **Inclusive not exclusive**: All parties with a significant interest in the issue should be involved in the consensus process.
3) **Voluntary participation**: The parties who are affected or interested should participate voluntary.
4) **Self design**: The parties design the consensus process.
5) **Flexibility**: Flexibility should be designed into the process.
6) **Equal opportunity**: All parties must have equal access to relevant information and the opportunity to participate effectively throughout the process.
7) **Respect for diverse interests**: Acceptance of the diverse values, interests and knowledge of the parties involved in the consensus process is essential.
8) **Accountability**: The parties are accountable both to the constituencies and to the process that they have agreed to establish.
9) **Time limits**: Realistic deadlines are necessary throughout the process.
10) **Implementation**: Commitment to implementation and effective monitoring are essential parts of any agreement.

From: Building Consensus for a Sustainable Future: Guiding Principles.
Round table conferences on sustainable development at a regional or local level remain an experiment in new forms of local management and administration. In Canada the experiment has proved very successful for many regions and levels of management. Some difficulties and mistakes have led to improvements in the next round, and one is in a learning process that is understood as an important link of a future directed regional development. The experience one has had so far has already strengthened the support of the concept, and the round table conferences are set up all over the country. A map from British Columbia shows altogether 40 local round table conferences as per May 1994. The support of the population and the interest organisations is often considerable, and important questions of development are often discussed only after such a round table conference has been preoccupied with them. In 1993 a representative of the United Kingdom's Global Environmental Research Centre made a research journey in order to evaluate the work of the round table conferences at national and local level and at the level of the non-nation states. In the report that was published afterwards he states the following: "...almost all involved (in local round tables) emphasized how important their local round table has been as a way of bringing the community closer together, making it more aware of its own strengths and weaknesses, and of building agreement on the long term future of the community. Local government was seen as a natural partner, which itself benefited considerable from the process. In this context, advantages were seen to be increased credibility and political legitimacy resulting from broader public involvement, greater participation by talented and influential individuals, the mobilization of relatively low cost of a wide range of outside talent to help develop long-term plans and provision of a longer term perspective than local participants could themselves realistically hope to offer." (John Gordon, report to the Local Government Management Board, Global Environmental Research Centre, Imperial College, UK, 1994).

**A proposal from Norway**

This report has proved, if nothing else, that sustainable development, and especially the application of the precautionary principle demand reflections and
support from many quarters. It has disposed of the myth (that some people perhaps have adhered to) that research alone will be able to give us the answers and strategies we need to fulfil our social obligation to follow the precautionary principle, and our aims of sustainable development. At the same time it has not freed the researchers and research institutions from the responsibility of engaging themselves actively in questions of environment and development. It is not always possible to keep clear limits between the supplier of facts, the body of decision-making and discussion of values. Expertise must be brought into social processes characterised by values. The participation of the parties concerned in these discussions becomes decisive in order to secure support for effective strategies. The practical dilemma one is facing is, however, that there are few or no institutional frameworks for these new roles.

It ought to be taken for granted that one in Norway evaluates with an open mind institutional measures that one has reason to believe may become an important tool on the way to sustainable development. It is a matter of securing broad support for effective measures, also measures that it may be difficult for some people to swallow, and it is a matter of getting the experts to arrive at speaking terms with the general public where the values are manifold and the interests are often sharply opposed to each other.

The committee will therefore recommend that the authorities tentatively introduce the Canadian model with round table conferences over a rather long trial period. There are many relevant similarities between Canadian society and Norwegian society, for instance with regard to settlement patterns, type of environmental problems and management of resources, and industrial development. These circumstances indicate that one may expect a certain transfer value with this model. To the extent that one wants to draw attention to dissimilarities between the two societies, these seem rather to point in the direction that the model has a better chance of becoming an effective instrument of processes of decision-making in Norway than in Canada. Norwegian society is for instance more homogeneous and less marked by great group conflicts (between different language groups or in relation to the indigenous groups). Consensus as an ideal has a long and important tradition in Norway, which has generally characterised the political style of debate in this country.

The Committee sees the possibility that one at county and municipal level in certain parts of the country starts trial projects for a five-year period. As a starting point these trial projects ought to be initiated by the respective bodies of management,
i.e. county or municipal administration, that contribute with necessary infra structure and a certain basic grant for the activities. It is important that the management of the process, for instance the appointment of members and composition, already at an early point of time involves the general public. Furthermore, it is important that these units try themselves to establish communication channels to the newly established groups where one actively tries to get them involved in ongoing projects and developmental plans.

The initiative to the concrete establishment of what the committee suggests be called "environmental court", must come from the respective county or municipality. It is important that the interest for these activities is anchored in the local agencies, and that a feeling that the process is being conducted from the top does not arise.

It is also important to stimulate to this type of activity from central national quarters. A means to an end might be to give state grants for activities to the regional administrative units that start such trial projects. After the trial period the initiative ought to be evaluated by national authorities, with a view to expansion, continuation or change of practice.

It is possible that such local "environmental courts" may have educational needs, with a view to the contents of central concepts and approaches. Here one ought to encourage the regional colleges to contribute freely with their expertise. Also The National Committees for Research Ethics might to a certain extent be drawn into this work, as a common point of reference.

The Committee hopes that the proposal will receive support from Government circles and from the Storting. If so, the conditions ought also to be made favourable for propagating local "environmental courts" via specially produced information material, media, and official statements. As such measures will concern fields that are administered by several departments and directorates, it will be important that Government and Storting can subscribe to this collectively, and secure cooperation on the relevant underlying administrative structures.

**Conclusion 7.1:** The Committee recommends measures from state circles in order to stimulate to the establishment of regional and local "environmental courts" in some counties and municipalities for a trial period of five years. They should as a starting point have as an aim, in a guiding function to propose measures of concrete translation of the precautionary principle, and to develop visions for a regional sustainable
development, based on the formation of consensus in the group, and broad representation of the composition of interests and moral attitudes in regional society.

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