Natural Resources and the Environment 2002. Norway

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Preface

Statistics Norway compiles statistics on important natural resources and environmental issues, and develops methods and models for analysing trends in the extraction and use of natural resources and changes in the state of the environment, focusing particularly on relationships between these factors and other socio-economic developments. The annual publication Natural Resources and the Environment gives an overview of this work.

An important objective is to ensure that this publication presents the environmental situation so that it can be readily understood while at the same time including considerable detail. *Natural Resources and the Environment 2002* starts with an updated presentation of indicators that illustrate aspects of the government's priority areas for environmental policy. This is followed by detailed descriptions of various topics, which include both statistics and analyses. Finally, the appendix provides more detailed statistics in the form of tables.

Statistics Norway would like to thank the people and institutions who have supplied data for *Natural Resources and the Environment 2002*.

The publication was produced by the Division for Environmental Statistics, Department of Economic Statistics, with contributions from other parts of the agency. The 2002 edition was edited by Frode Brunvoll and Henning Høie. Alison Coulthard and Veronica Harrington have translated the Norwegian version into English.

Statistics Norway
Oslo/Kongsvinger 7 November 2002

Svein Longva

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1. Status and important trends

The state of the environment is of crucial importance to people's welfare. The management of the environment and natural resources occupies an important place in the public debate and frequently makes the headlines in the media. The World Summit on Sustainable Development in Johannesburg was the largest UN conference ever organized. This illustrates the importance of natural resource and environmental issues, and the need to consider them in conjunction with economic and social developments.

1.1. Introduction

The state of the environment depends on a complex variety of biological and physical processes that interact with human behaviour and the pressures this exerts. One example is provided by greenhouse gas emissions, which are generated by various processes including the combustion of fossil fuels such as coal, oil and natural gas. These gases reduce the amount of thermal radiation (heat) escaping through the atmosphere, thus causing the global temperature to rise. The effects of a rise in temperature will include climate change. This in turn will alter living conditions for all kinds of organisms, including people: some individuals and species will benefit, whereas others will meet more difficult conditions or even become extinct.

Factors that affect greenhouse gas emissions include the consumption of fuel and energy commodities, and how easy it is to control emissions. Consumption and advances in technology are influenced by prices and economic developments, and technological advances in turn help to determine how far emissions can be reduced, resource efficiency and the choice of energy carrier. In order to find effective measures to deal with an environmental problem, we need a thorough knowledge of the processes involved and the links between them. The more serious a problem is, the more important it is to obtain a precise description of cause-effect relationships.

As the examples above show, we are faced with the challenge of compiling environmental statistics that will describe the state of the environment and environmental trends in such a way that the most important processes and linkages between them are clearly illustrated. Environmental indicators are being developed as a tool for this purpose (see box 1.1).

Box 1.1. Environmental indicators

Information on the environment includes a variety of topics, and it can be difficult to interpret trends. Indicators or key figures have therefore been developed that give simplified descriptions of phenomena and problems. Because they are simplified, they may illustrate some aspects of a phenomenon clearly, whereas others are not well described. Often, several indicators are therefore used to describe a phenomenon.

Environmental policy focuses on environmental problems that are caused by human activity. For environmental indicators to be adequate and function as effective tools, they must be linked to socio-economic factors. One way of structuring environmental indicators that is generally recognized is the PSR model (Pressure-State-Response), which was developed by the OECD (e.g. OECD 1994, 1998 and 2001). This has been further developed as the DPSIR framework, which includes the driving forces behind environmental pressures and the impacts of environmental change. This is used for example by the European Environment Agency (EEA). Environmental problems are analysed by looking at:

- *Driving forces.* These include population growth, economic activity, etc., which lead to
- *environmental Pressures such* as emissions to air and water and extraction of natural resources. These in turn result in changes in
- *the State of the environment*, for example changes in water quality or air quality, which cause
- *environmental Impacts* such as fish mortality, adverse effects on human health, reduction in crop yields or species extinction. At some point, society can react by making a
- *Response* to environmental problems, e.g. a CO_2 tax, protection of areas, treatment of emissions. The response in turn results in changes in economic driving forces, environmental pressures and various aspects of the state of the environment.

The figures compiled by Statistics Norway mainly provide a basis for indicators related to *driving forces* and *environmental pressures*. It is important that such indicators also show which types of activities exert pressures on the environment. Indicators are also important in the context of linking environmental statistics to economic models, analyses and projections.

Box 1.2. Priority areas of Norwegian environmental policy

In Report No. 58 (1996-97) to the Storting on an environmental policy for sustainable development, eight priority areas of environmental policy were established. These are:

1. Conservation and sustainable use of biological diversity
2. Outdoor recreation
3. The cultural heritage
4. Eutrophication and oil pollution
5. Hazardous substances
6. Waste and recycling
7. Climate change, air pollution and noise
8. International cooperation on environmental issues and environmental protection in the polar areas

These priority areas provide the basic structure for the result monitoring system used by the environmental authorities. *Strategic objectives* and *national targets* have been set for each of the priority areas. The results are to be monitored by means of key figures for each of the priority areas (see Ministry of the Environment 1999 and 2001).

Natural Resources and the Environment 2002 describes environmental pressures in several of the priority areas of environmental policy and presents several of the key figures that have been selected.

The next two sections of this chapter present some indicators or key figures that can be used to describe the state of the environment and environmental pressures in Norway. In section 1.4, we describe some features of economic developments in Norway and discuss how these affect the environment.

The book continues with statistics and analyses related to Norway's natural resources and resource policy issues in Chapters 2-5. Chapters 6-9 focus on important environmental problems. Finally, the appendix provides more detailed statistics on various aspects of the environment and natural resources in the form of tables.

The statistics presented in this publication are mainly from Statistics Norway, but in some cases we have also used figures from other institutions to give a more complete picture. Much of the information in Chapter 1 has been taken from the white papers on the government's environmental policy and the state of the environment in Norway and the Norwegian Pollution Control Authority's website State of the Environment Norway (http://www.environment.no/).

1.2. The state of the environment in Norway

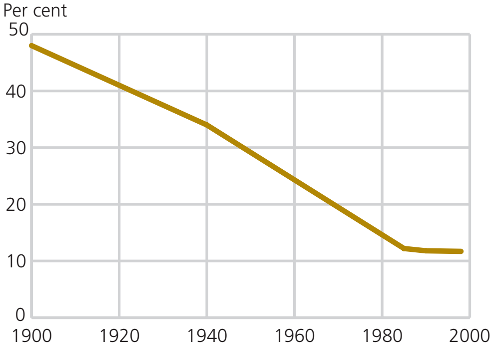
This section is structured according to the priority areas of environmental policy defined by the environmental authorities (see box 1.2). Some of the priority areas are described in more detail than others because more statistical material is available, making it possible to describe the current status using suitable indicators. In other areas, the environmental statistics do not provide an adequate basis for describing the current status or trends.

Sections 1.3 and 1.4 present some indicators for the resource situation in Norway and describe the relationship between economic developments and the environment.

Priority area 1: Conservation and sustainable use of biological diversity

Human activities are influencing and threatening biological diversity in many different ways, and calculations show alarmingly high figures for losses of both species and habitats (SSB/SFT/DN 1994). Such losses may be a direct result of various forms of development or over-exploitation, or they may be caused indirectly when our activities cause pollution or result in climate change, thus altering or worsening conditions for animals and plants. One important way of responding to these problems is to protect areas in some way. At the end of 2001, about 26 300 km^2 or 8.1 per cent of the total area of Norway was protected.

Figure 1.1. Wilderness-like areas[1] as a percentage of Norway's total land area[2]. 1900-1998



[1] Wilderness-like areas are defined as lying at least 5 km from the nearest major infrastructure development. [2] Excluding Svalbard and Jan Mayen.
Source: Directorate for Nature Management

Wilderness-like areas

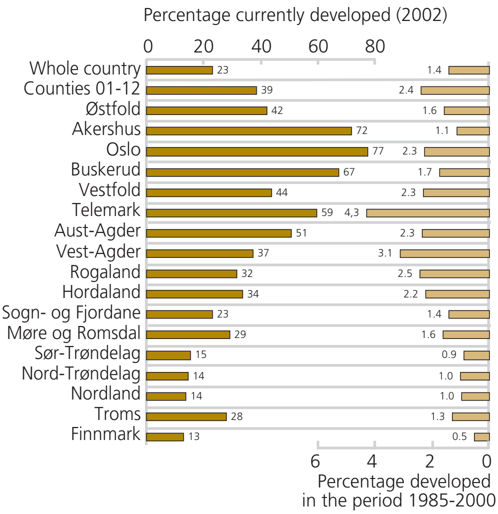
- The size of wilderness-like areas is an indicator of pressure on biological diversity. In wilderness-like areas, pressure from human activity is low, and there is little disturbance of the original biological diversity.
- The extent of wilderness-like areas in Norway fell dramatically from 1900 to 1985, especially in the period 1940 to 1985. Since 1985, the loss of wilderness-like habitat has continued, but at a much slower pace. However, the remaining wilderness-like areas are larger than the proportion of the country that has been formally protected (12 as against 8 per cent of the total area).

For more information, see Chapter 9: Land use.

Priority area 2: Outdoor recreation

Norway's strategic objective is that "everyone shall have the opportunity to take part in outdoor recreation as a healthy and environmentally sound leisure activity that provides a sense of well-being both near their homes and in the countryside" (Ministry of the Environment 2001). Coastal areas offer very valuable opportunities for outdoor recreation. At the same time, there is great pressure to allow development of these areas, which means that public access for recreation purposes is becoming more and more restricted.

Figure 1.2. Proportion of the coastline less than 100 m from the nearest building in 2002. Changes from 1985 to 2002



Source: Land use statistics, Statistics Norway.

Access to the coast

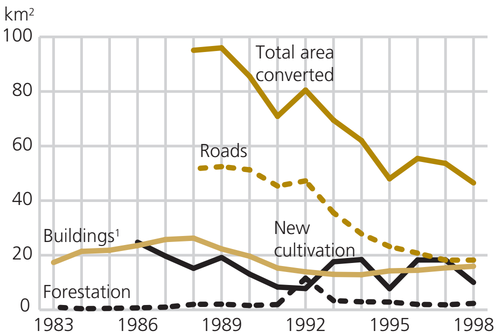
- More than 23 per cent of the coastline is less than 100 m from the nearest building. In the counties around the inner Oslofjord, more than two thirds of the coastline is less than 100 m from the nearest building.
- Since 1965, the Planning and Building Act has restricted developments along the shoreline, and tighter restrictions have been introduced since. Despite this, buildings were constructed or altered along 1.4 per cent of the shoreline from 1985 to 2002.
- The greatest changes have taken place in the southern parts of the country, where the largest proportion of the coastline was already developed (for detailed figures, see Appendix, table H4).

For more information, see Chapter 9: Land use.

Priority area 3: The cultural heritage

Our cultural heritage is a source of knowledge about people's lives and activities throughout history. It can improve our understanding of the links between history and the present day, the natural environment and different cultures. We can use our heritage to rediscover lost knowledge and skills and to find answers to new questions that arise in connection with sustainable development. Cultural monuments and sites and cultural environments are often damaged by changes in land use. The extent of changes in land use can tell us something about the pressure on the cultural heritage.

Figure 1.3. Annual conversion of land for roads, new buildings[1], forestation and new cultivation. 1983-1998



[1] The area of the buildings is multiplied by 5 to take into account the fact that areas immediately around the buildings are also changed significantly.
Sources: Statistics Norway, Norwegian Agricultural Economics Research Institute and Directorate of Public Roads.

Conversion of land for other purposes

- During the 1990s, the area per year converted for other purposes has been reduced. This is mainly because less land has been used for new roads, especially forest roads.
- The area cultivated for the first time has varied a good deal from year to year, while areas built on for the first time have shown an upward trend since the early 1990s.

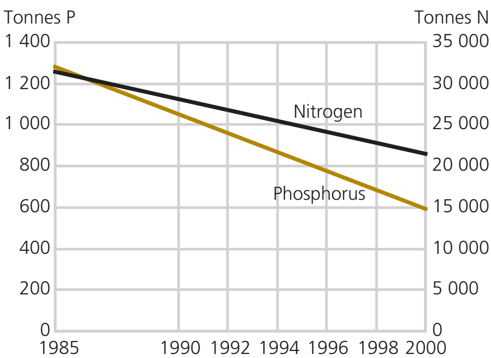
More information: the indicator is not discussed further in this publication, but there is some relevant material on cultural environments in Chapter 3.3 and background material in Chapter 9: Land use.

Priority area 4: Eutrophication and oil pollution

Eutrophication is caused by excessive discharges of nutrients to water, and results in a deterioration of water quality. The most important nutrients involved are phosphorus and nitrogen, and the main sources are industry, agriculture, fish farming and private households. Both marine areas and fresh water bodies are affected.

Discharges of oil and chemicals from shipping, petroleum activities and onshore activities can damage organisms and ecosystems in the open sea, on the sea floor, in the littoral zone and on land. Pollution of coastal areas also reduces their value as recreation areas and for other purposes. The authorities have adequate data on discharges of oil from petroleum activities, but the figures for discharges from onshore sources and shipping are incomplete, particularly as regards illegal discharges.

Figure 1.4. Trends[1] in anthropogenic discharges of phosphorus (P) and nitrogen (N) to the North Sea (from the border with Sweden to Lindesnes at the southernmost tip of Norway). 1985-2000



[1] The curves are interpolated between the 1985 and 2000 levels because of a change in method and uncertainty as to the actual annual trend.
Source: Norwegian Institute for Water Research.

Eutrophication of fjords and marine waters

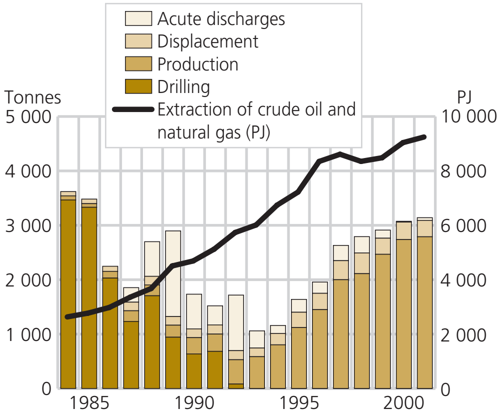
- In the North Sea region (from the border with Sweden to Lindesnes at the southernmost tip of Norway), where extensive measures have been put into effect to reduce discharges, calculations show that inputs of nitrogen and phosphorus to the North Sea have been reduced by 32 and 54 per cent respectively from 1985 to 2000.
- The reduction in phosphorus discharges is mainly a result of more efficient treatment of waste water from industry and private households, but measures in the agricultural sector have also had some effect. It has proved more difficult to reduce nitrogen discharges.

Eutrophication of lakes

- In fresh water bodies, inputs of phosphorus from agricultural activities are the main cause of eutrophication. Conditions in over 90 per cent of all the lakes in Norway are classified as "good" or "fair" with respect to the phosphorus concentration. Conditions are only classified as "bad" or "very bad" in about 2.5 per cent of all the country's lakes. Nevertheless, around 800 lakes are in these two categories.

For more information, see Chapter 8: Water resources and water pollution.

Figure 1.5. Discharges of oil from petroleum activities. Tonnes. Extraction of crude oil and natural gas. PJ. 1984-2001



Sources: Norwegian Pollution Control Authority and Energy Statistics, Statistics Norway.

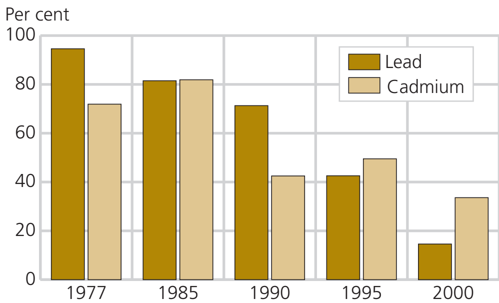
Oil pollution

- Oil production results in both uncontrolled (acute) discharges and legal, licensed (operational) discharges.
- Operational discharges are the largest category. They have risen considerably since 1992, and have been rising more rapidly than oil production.
- Acute discharges from oil production and other activities vary widely, but there has been an overall decrease in recent years. There has been little change in total discharges during the past year.

Priority area 5: Hazardous substances

Our use of hazardous chemicals and emissions of these substances are responsible for one of the most serious environmental threats facing the world. A number of chemicals break down very slowly in the environment and can therefore accumulate in food chains. They are a serious threat to biological diversity, food supplies, our health and the health of future generations. The most harmful chemicals, including persistent organic pollutants (POPs) such as PCBs and dioxins, can cause damage even at very low concentrations. Emissions of the most dangerous chemicals from Norwegian industry have been reduced, but the total consumption of chemicals is rising, and it is therefore uncertain whether the overall impact on health and the environment has been reduced.

Figure 1.6. Lead (Pb) and cadmium (Cd) in the moss *Hylocomium splendens* in Norway. Area (percentage of the total) where concentrations exceed the background level[1].

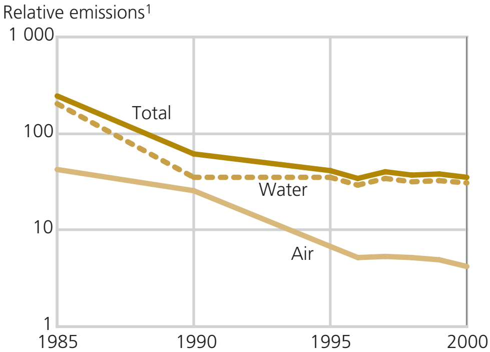


[1] The background levels are 5 ppm (lead) and 0.1 ppm (cadmium)
Source: Norwegian Pollution Control Authority.

Hazardous chemicals in the environment

- A substantial proportion of the hazardous chemicals that are found in the Norwegian environment originate from long-range pollution carried by winds. Mosses absorb their nutrition from the air and precipitation, and the heavy metal content of mosses is therefore a good indicator of trends in long-range transport of pollutants.
- The highest concentrations of heavy metals are found in the southern half of Norway. In the period 1977-2000, the area where the concentration of lead in moss exceeds the background level dropped sharply. There was also a drop in the cadmium concentration, but the reduction was not as marked as for lead.

Figure 1.7. Index for emissions of chemicals on the priority list weighted by how dangerous they are



[1] Logarithmic scale
Source: Norwegian Pollution Control Authority.

Emissions of POPs and heavy metals

- Emissions of chemicals that are on the Norwegian environmental authorities' priority list show substantial reductions in the last 15 years, but emissions must be further reduced to meet the authorities' targets.
- In 1985, emissions of lead from leaded petrol made the largest contribution to the index for emissions to air, whereas in 2000 PAHs and mercury made the largest contributions.
- In 1985, emissions of lead and cadmium from manufacturing industries and emissions of organotin compounds from antifouling preparations used on ships and in the fish farming industry made the largest contributions to the index for emissions to water. In 2000, organotin compounds from ships and copper from ships and the fish farming industry were important sources.

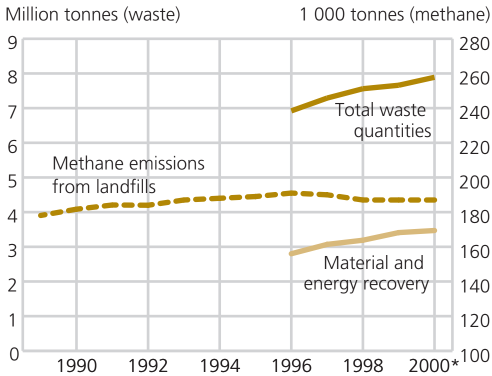
For more information, see Chapter 6: Air pollution and climate.

Priority area 6: Waste and recycling

Waste gives rise to environmental problems because waste treatment releases pollutants. Landfilling of waste generates emissions of methane, which is a greenhouse gas. Landfills, particularly the older ones, also contain various kinds of POPs and heavy metals, and other substances that can pollute air and water. Waste incineration eliminates methane emissions and other problems associated with landfilling, but generates emissions of various pollutants to air and produces dust and ash that must be treated as hazardous waste. However, new incineration technology has made it possible to reduce such emissions considerably.

Waste contains both energy and materials that can be recovered and replace other energy sources or virgin raw materials. One of Norway's targets as regards waste is that the growth in the quantity of waste generated is to be considerably lower than the rate of economic growth (Ministry of the Environment 2001). Another is that the quantity of waste delivered for final disposal (i.e. landfilling or incineration without energy recovery) is to be reduced to about 25 per cent of the total quantity of waste generated by 2010.

Figure 1.8. Methane emissions from landfills, total quantity of waste generated[1,2] and waste delivered for recovery[3]. 1989-2000*



[1] Waste quantities are based on the most recent calculations in the waste accounts, and the time series cannot at present be continued further back than 1996.
[2] Hazardous waste is not included.
[3] The estimated percentage for recovery is uncertain.
Sources: Waste statistics, Statistics Norway and emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Waste generated, waste recovery and methane emissions

- The quantity of waste generated rose by about 13 per cent from 1996 to 2000.
- The quantity of waste delivered for material recovery and energy recovery has risen by 22 per cent in the same period. In 2000, at least 44 per cent of all waste was dealt with by material or energy recovery. Norway's goal is to reach an overall recovery rate of 75 per cent.
- Methane emissions, which are considered to be one of the most serious environmental problems associated with waste management, have changed little since 1989.

For more information see Chapter 6: Air pollution and climate and Chapter 7: Waste.

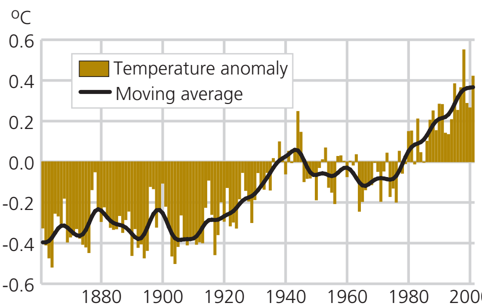
Priority area 7: Climate change, air pollution and noise

Climate change

Concentrations of greenhouse gases in the atmosphere are rising as a result of human activity. The most important reason for this is emissions of carbon dioxide (CO_2) from combustion of fossil fuels, which have already resulted in the highest CO_2 concentrations in the atmosphere for 160 000 years. As concentrations of greenhouse gases rise, the atmosphere retains more of the thermal radiation from the earth, which will cause the global mean temperature to rise and result in climate change. This phenomenon is called the anthropogenic greenhouse effect.

If greenhouse gas emissions continue to rise, we risk extensive and damaging climate change in the course of the next 100 years. To solve the problem will require a complete reorganization of world energy use, which is the most important source of greenhouse gas emissions. The countries of the world are trying to organize emission reductions within the framework of the Kyoto Protocol (see Chapter 6, box 6.5).

Figure 1.9. Global mean temperature[1] 1861-2001

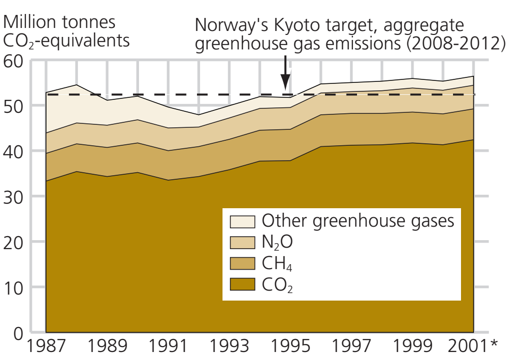


[1] Deviation from the normal value for the period 1961-1990
Sources: University of East Anglia and Norwegian Meteorological Institute.

Global mean temperature

- The global mean temperature has risen by between 0.3 and 0.6 °C since accurate measurements began in 1861. Some of this rise may be explained by natural variations, but the UN Intergovernmental Panel on Climate Change (IPCC) has concluded that there has been a discernible human influence on the global climate. 2001 was the second warmest year registered in the whole of this period.

Figure 1.10. Greenhouse gas emissions in Norway. Historical figures and Kyoto target. 1987-2001



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Greenhouse gas emissions in Norway

- Norwegian greenhouse gas emissions rose by more than 8 per cent from 1990 to 2001, and are now higher than ever before. According to the Kyoto Protocol, Norwegian emissions may only rise by 1 per cent between 1990 and the period 2008-2012 when the Kyoto mechanisms (see box 6.6) are taken into account.
- In 2001, CO_2 accounted for three quarters of Norway's aggregate greenhouse gas emissions.

For more information, see Chapter 6.1.

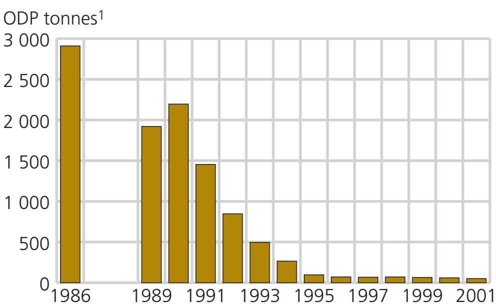
Depletion of the ozone layer

Emissions of gases containing chlorine and bromine, such as CFCs, HCFCs and halons, deplete the atmospheric ozone layer, which protects the earth against harmful UV radiation from the sun. Excessive UV radiation may damage people, plants and animals and marine ecosystems. Polar marine ecosystems are found in the areas where UV radiation is expected to rise most as a result of depletion of the ozone layer.

Measurements throughout the world have shown depletion of the ozone layer in the past 20 years. The largest reductions in ozone concentrations have been registered over the Antarctic. Over Oslo, records have shown an average annual reduction of 0.26 per cent in the thickness of the ozone layer in the period 1979-2001.

In 1987, an international agreement, the Montreal Protocol, was drawn up with the aim of reducing global production and consumption of ozone-depleting substances. If all countries comply with the requirements of the agreement, the ozone layer is expected to return to normal in 2050.

Figure 1.11. Imports of ozone-depleting substances to Norway. 1986-2001



[1] The ozone-depleting potential (ODP) varies from one substance to another, and the figures are totals weighted according to the ODP of each substance (ODP factors).
Source: Norwegian Pollution Control Authority.

Imports of ozone-depleting substances

- Imports of ozone-depleting substances to Norway have been very low in recent years. Nevertheless, emissions are still being generated in connection with the use and replacement of old products that contain ozone-depleting substances. But these emissions are dropping as old products are phased out.
- Norway is well on the way to achieving the targets for phasing out ozone-depleting substances both under the Montreal Protocol and under the new EU directive that entered into force in September 2000.

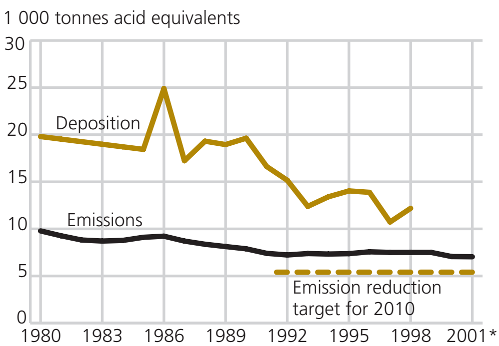
For more information, see Chapter 6.3.

Long-range air pollution

Acid rain is still one of the most serious environmental problems in Norway, even though reductions in emissions have reduced the extent of acidification. Acid rain is caused by emissions of sulphur and nitrogen compounds to air. In the atmosphere, sulphur and nitrogen react chemically with water vapour to form sulphuric acid and nitric acid. Acid rain can be transported over long distances, and emissions from other countries in Europe account for about 90 per cent of acid deposition in Norway. The southern half of the country is particularly severely affected by acid rain, but its impacts can also be seen in some areas of the eastern part of Finnmark county. The most obvious effect is damage to fish stocks, but acidification can also cause forest damage. Inputs of nitrogen oxides and ammonia can also cause eutrophication.

The areas of Norway where critical loads for acidification are exceeded have been reduced by more than 30 per cent since 1985. In 1994, critical loads were exceeded across 19 per cent of the total area of Norway. The situation has improved further since 1994. Both the area where critical loads are exceeded and the degree to which they are exceeded have been reduced. The greatest improvements have occurred in Eastern Norway.

Figure 1.12. Emissions and deposition[1] of acidifying substances (NO_x, SO_2 and NH_3) in Norway. 1980-2001*



[1] Figures for deposition in 1999 and 2000 were not available in August 2002.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority and Norwegian Meteorological Institute.

Acid deposition and emissions

- The international agreements on reductions in emissions of long-range pollutants are now showing results. The deposition of acidifying substances in Norway has dropped considerably in the last 10 years.
- However, Norway's emissions have not been significantly reduced over the past few years, and the authorities' target for 2010 has not yet been reached. Nevertheless, acidification has been reduced, mainly as a result of lower inputs from abroad.

For more information, see Chapter 6.2.

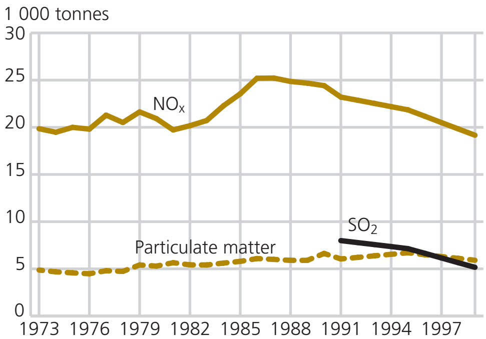
Local air quality

Clean air is important for people's health and quality of life. At times, local air pollution causes serious health and welfare problems in the largest towns and urban settlements in Norway. In the largest towns, a substantial proportion of the population is exposed to concentrations of pollutants that increase the risk of premature death and health problems such as respiratory infections, lung disease and cancer.

Some important pollutants that contribute to local air pollution are particulate matter (PM_{10} and $PM_{2,5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ground-level ozone (O_3), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), benzene (C_6H_6) and other aromatic compounds.

Several hundred thousand people in Norway are exposed to levels of air pollution that entail a health risk. The socio-economic costs of the resulting health problems are estimated to be several billion NOK a year (Rosendahl 2000).

Figure 1.13. Emissions of particulate matter, SO_2 and NO_x in the 10 largest towns in Norway. 1973-1999



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Emissions of harmful substances in urban settlements

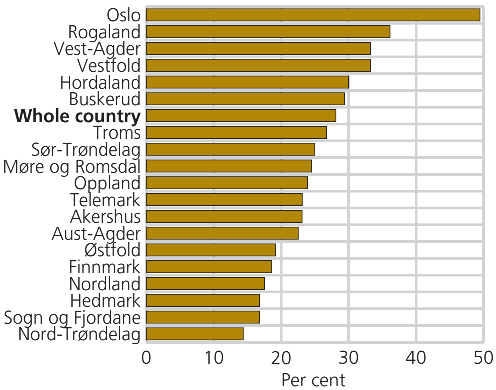
- There has been a certain reduction in emissions of NO_X and SO_2 in the last 10 years. Emissions of particulate matter are about the same as 10 years ago.
- The most important causes of local air pollution today are road traffic and fuelwood use. Even with the projected growth in road traffic, emissions from this source will probably be gradually reduced in future because considerable reductions in emissions from individual vehicles are expected. Nevertheless, it may be difficult to achieve the national air quality target for nitrogen dioxide (NO_2) in 2010 in certain towns unless measures are introduced to reduce traffic.

For more information, see Chapter 6.6.

Noise

Noise is one of the environmental problems that affects the largest number of people in Norway. Statistics Norway has developed a new model for calculation of noise exposure and noise annoyance. The "noise annoyance index" is an indicator of noise annoyance from various sources. According to this, about 73 per cent of noise annoyance is caused by road traffic. Industry accounts for 14 per cent and air traffic and railways for 4 per cent each. Surveys of living conditions carried out by Statistics Norway show that 5 per cent of the population have sleep problems as a result of noise.

Figure 1.14. Proportion of the population exposed to road traffic noise levels exceeding 55 dBA, by county. 2001*

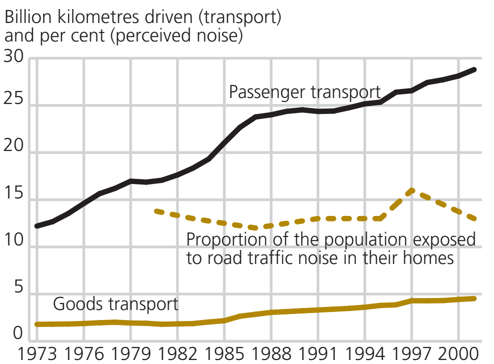


Sources: Haakonsen (2002) and Directorate of Public Roads.

Distribution of road traffic noise by county

- About 28 per cent of the Norwegian population (1.3 million people) are exposed to road traffic noise exceeding a 24-hour average of 55 dBA (decibels). In Oslo, half the population is exposed to noise exceeding this level.
- More than 36 000 people in Norway were exposed to noise levels above 70 dBA in 2001. Well over half of these, 21 000 people, lived in Oslo.

Figure 1.15. Growth in transport work by road and proportion of the population exposed to noise. 1973-2001*



Sources: Surveys of living conditions from Statistics Norway and Institute of Transport Economics.

Sources of noise and perception of noise

- Even though the volume of road traffic has increased substantially, people's perception of how much noise they are exposed to in their homes has remained fairly constant over time. However, the figures for noise perception are uncertain, and efforts are being made to improve statistics on noise annoyance caused by road traffic.

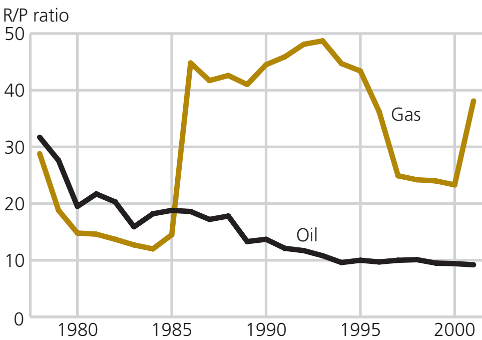
1.3. Natural resources

Natural resources are society's raw materials. Some of them - and the way they are used - are also of crucial importance for biological diversity. It is therefore essential that natural resources are managed sustainably and are not over-exploited. In this section, we consider some important natural resources that Norway is responsible for managing - oil and gas, hydropower, fish stocks, agricultural land and forests.

Oil and gas resources

In 2002, Norway's oil and gas reserves corresponded to just under 1 per cent of the world's petroleum reserves. However, Norway accounted for 4.5 per cent of the world's oil production and 2.3 per cent of gas production. The estimates of reserves are revised regularly and the figures may change markedly from one year to another. In addition, new fields are added to the list almost every year. The length of time that the remaining oil and gas reserves will last (at the current rate of production) is expressed as the R/P ratio, i.e. the ratio between the estimated petroleum reserves (defined as the remaining resources in fields that are already developed or where development has been approved) and production in a particular year.

Figure 1.16. R/P ratio[1,2] for Norwegian oil and gas reserves. 1978-2001



[1] The R/P ratio, or the ratio between reserves and production, indicates how many years it will take before the reserves are exhausted.
[2] Because of a change in the classification system for petroleum resources, there is a break in the time series between 2000 and 2001.
Sources: Energy statistics from Statistics Norway and Norwegian Petroleum Directorate.

R/P ratio for oil and gas reserves

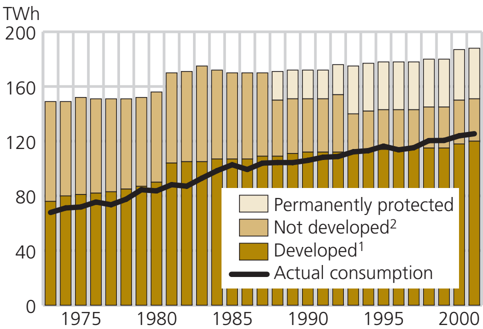
- The length of time that Norway's oil and gas reserves will last at the current rate of production, expressed as the R/P ratio, is calculated to be 9.2 years for oil and 38.1 years for gas.
- BP (2002) quotes the following R/P ratios for the whole world at the end of 2001: oil 40.3 years and natural gas 61.9 years.
- These figures do not include the total petroleum resources, which are much larger. They are defined as including all more or less certainly proven finds.

For more information, see Chapter 2: Energy.

Hydropower resources

Unlike petroleum resources, hydropower resources are renewable. Norway has Europe's largest hydropower resources, and hydropower was an important basis for the industrialization of the country. The rich supplies of hydropower have a great influence on the energy mix. Almost 100 per cent of electricity consumption in Norway is based on hydropower, and in 2000, electricity accounted for 42 per cent of total energy use (see Appendix, table A4). This is the highest percentage in the world.

Figure 1.17. Hydropower resources: developed[1], not developed[2] and protected. Actual electricity consumption. 1973-2001



[1] Includes the categories under construction and licence granted.
[2] Includes the categories prior notification submitted and licence application submitted.
Source: Norwegian Water Resources and Energy Directorate.

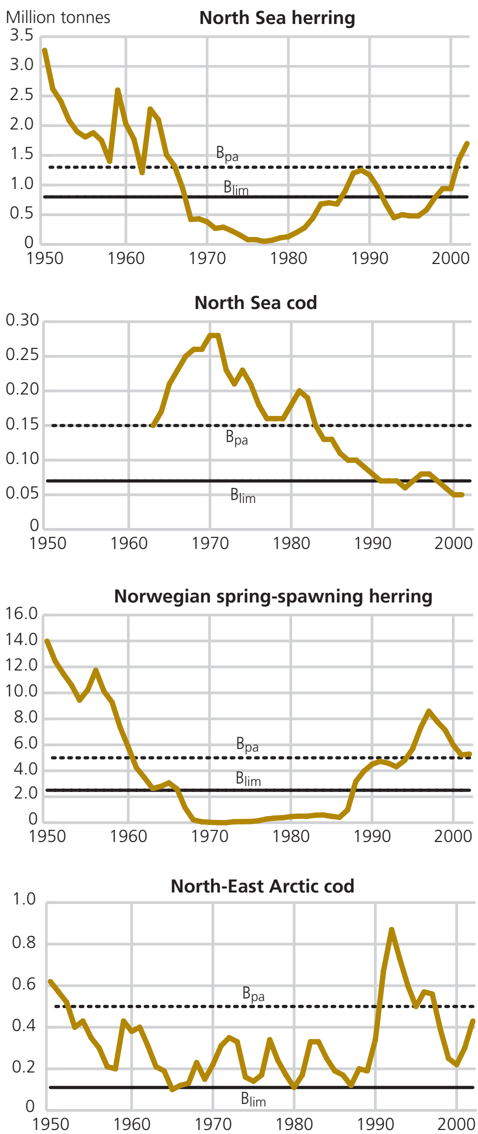
- Norway's hydropower potential is evaluated on a continuous basis and depends on technological and economic factors. The calculated hydropower potential may therefore change from year to year.
- In the last 30 years, electricity consumption has risen faster than power supplies, and is now higher than production in a normal year.
- Of Norway's total hydropower potential, about 36 per cent has not been developed, and rather more than half of this is protected.

For more information, see Chapter 2: Energy.

Fish stocks

In its annual report on marine resources (Iversen 2002), the Institute of Marine Research states that great caution must still be shown in harvesting several of Norway's important fish stocks. This is particularly the case for demersal fish stocks: the pelagic stocks are generally in a better state. The North Sea cod stock is at a particularly low level. This stock has been and is still being very heavily exploited.

Figure 1.18. Actual spawning stocks and critical (B_{lim}) and precautionary (B_{pa}) reference points for four important fish stocks. 1950-2002



Sources: ICES and Institute of Marine Research.

Spawning stocks

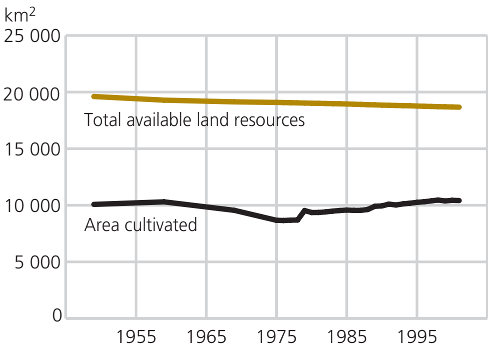
- The North Sea herring stock is growing, and the spawning stock is currently within safe biological limits.
- The North Sea cod stock has been greatly depleted, and the spawning stock is well below safe biological limits.
- The spawning stock of Norwegian spring-spawning herring has dropped somewhat in recent years, but is considered to be within safe biological limits.
- The spawning stock of North-East Arctic cod has shown weak growth in the past year, but is still below the precautionary level. However, this appears to have been the case for most of the period after 1950.

For more information, see Chapter 5: Fisheries, sealing, whaling and fish farming.

Agricultural areas

Norway has only limited land resources that are suitable for agricultural production. About 3 per cent of the country is cultivated, as compared with over 10 per cent in the world as a whole. The scarcity of land resources means that the current self-sufficiency rate is between 40 and 50 per cent.

Figure 1.19. Cultivated land and available land resources in Norway. 1949-2001*



Sources: Agricultural statistics, Statistics Norway and Grønlund and Høie (2001).

Available land resources and cultivated land

- In the past 100 years, the cultivated area of Norway has varied between 11 200 km^2 at the end of the 1930s and 8 700 km^2 in the 1970s.
- The available land resources (cultivated and cultivable area) have dropped by almost 1 000 km^2 or 5 per cent from 1949 to 2001 as a result of irreversible conversion of agricultural land for non-agricultural uses. The proportion of the available resources actually cultivated was 56 per cent in 2001, as compared with 51 per cent in 1949.

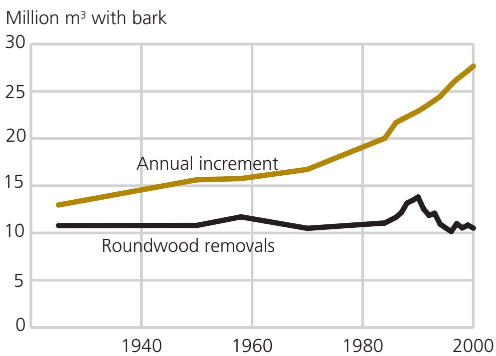
For more information, see Chapter 3: Agriculture.

Forest resources

The volume of the growing stock of forest has risen a great deal in the past century, resulting in an increase both in timber resources and in the potential value of forest as a CO_2 sink (this is not included in the Kyoto Protocol). The type of forest has also changed greatly during this period. Clear-cutting, silviculture, drainage, the construction of forest roads, the introduction of alien species and pollution are some of the factors that have had an impact on the forest as a natural resource and on biological diversity in forests.

The Norwegian monitoring programme for forest damage shows that in recent years, there has been a slight improvement in the health of forests measured as crown condition.

Figure 1.20. Roundwood removals and annual increment in Norwegian forest. 1925-2000



Sources: Statistics Norway and Norwegian Institute for Land Inventory.

Roundwood removals and annual increment

- Since the national forest inventory was started in the early 1920s, roundwood removals in Norway have been less than the annual increment.
- In recent years, only 50 to 60 per cent of the annual increment has been harvested. As a result, the volume of the growing stock has more than doubled since the 1920s.

For more information, see Chapter 4: Forest and uncultivated land.

1.4. Environment and economy - indicators for selected sectors

There is a close relationship between economic activity and many environmental problems. Pollution and disturbance of the natural environment are often side effects of production and/or consumption, and such effects result in growing pressure on the environment as the economy expands. For example, energy use and greenhouse gas emissions show a tendency to rise with economic growth. However, this relationship is not at all clear-cut (Bruvoll et al. 2000a). Certain kinds of technological progress lead to a reduction in resource consumption and emissions: for example, electronic communications can be used to replace physical journeys. This type of technological progress can both result in economic growth and help to reduce pressure on the environment.

Moreover, with economic growth there will be changes in the needs to which people give priority. As income levels rise, it is possible to give priority to more environmental measures. Analyses show that environmental problems that can be dealt with relatively easily at local level, for example local water pollution, tend to increase with economic growth as long as economic activity is fairly low, but are then reduced once economic growth exceeds a certain level.

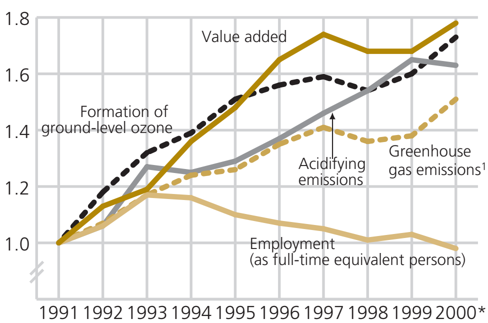
General economic developments

Measured in constant prices, Norway's gross domestic product (GDP) has grown every year for the past ten years. The Norwegian economy passed a cyclical peak in 1998, and since then growth has been weaker than it was in the mid-1990s. According to preliminary figures from the national accounts, mainland GDP expanded by 1.2 per cent in 2001.

Extraction of crude oil and natural gas

Extraction of oil and gas rose by an average of 3 per cent per year in the period 1999-2001, and this in itself will tend to cause a rise in emissions. In 2000, this sector generated 13 per cent of Norway's emissions of acidifying substances, 20 per cent of its greenhouse gas emissions and accounted for 13 per cent of Norway's total value added (Statistics Norway 2002). For more information, see Chapter 2: Energy and Chapter 6: Air pollution and climate.

Figure 1.21. Economic trends and trends in emissions to air for the extraction of crude oil and natural gas. 1991-2000*. Index: 1991=1



[1] The calculations for greenhouse gases include only CO_2, CH_4 and N_2O.
Source: Statistics Norway (2002).

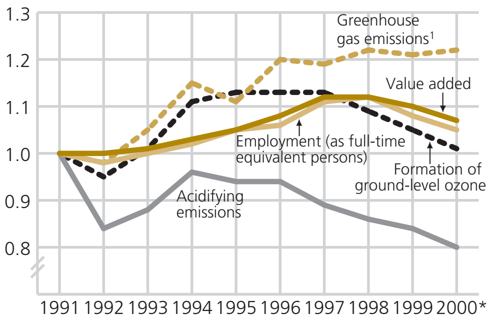
Extraction of crude oil and natural gas: Environmental and economic indicators

- In this sector, which accounted for 13 per cent of Norway's total value added in 2000, greenhouse gas emissions have risen less than value added. These developments are related to advances in technology and a rise in the value of oil.
- Other emissions have risen in pace with value added (see box 1.3).

Manufacturing industries

Production in manufacturing and mining dropped in 1999, 2000 and 2001. This in itself may have reduced some environmental problems associated with emissions of pollutants. In 2000, manufacturing generated 10 per cent of Norway's emissions of acidifying substances, 26 per cent of its greenhouse gas emissions and accounted for 12 per cent of Norway's total value added.

Figure 1.22. Economic trends and trends in emissions to air for manufacturing industries. 1991-2000*. Index: 1991=1



[1] The calculations for greenhouse gases include only CO_2, CH_4 and N_2O.
Source: Statistics Norway (2002).

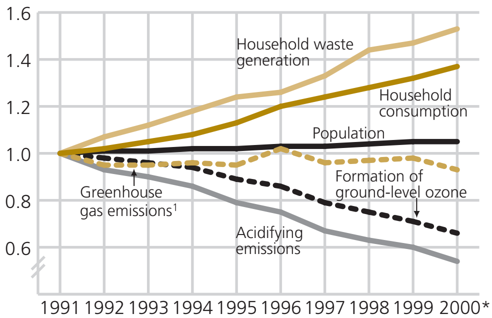
Manufacturing: Environmental and economic indicators

- In the manufacturing sector, acidifying emissions are dropping, whereas greenhouse gas emissions are still rising, both in absolute terms and in relation to value added.
- The drop in acidifying emissions is largely explained by lower SO_2 emissions brought about by technological improvements and the use of fuel with a lower sulphur content.
- Until now, manufacturing industries have not been subject to the CO_2 tax. The introduction of an emissions trading scheme that will also apply to manufacturing industries will make it necessary for them either to reduce their emissions or to buy emissions quotas.

Households

Some environmental problems are closely related to household consumption, but the relationships are not clear-cut. In 2000, households accounted for 4 per cent of acidifying emissions and 9 per cent of greenhouse gas emissions.

Figure 1.23. Trends in household consumption, waste generation and emissions to air. 1991-2000*. Index: 1991=1



[1] The calculations for greenhouse gases include only CO_2, CH_4 og N_2O.
Source: Statistics Norway (2002).

Households: Environmental and economic indicators

- Household consumption has risen throughout the period 1991-2000. Generation of household waste has also risen throughout the period, and at a faster pace than consumption.
- Emissions of pollutants that cause acid rain and the formation of ground-level ozone are showing a downward trend. Greenhouse gas emissions have been relatively stable and are not following the rise in consumption. Because population growth has been slower than the growth in consumption, emissions per unit consumption have shown a sharper decline than per capita emissions.

Box 1.3. Why is the economy growing more rapidly than emissions?

Two general developments are mainly responsible for the fact that emissions to air have not grown as rapidly as the economy (measured as GDP). One is that technological developments are improving the resource efficiency of production and enabling us to make greater cuts in emissions. As a result, emissions per unit produced are dropping. The other is that industries that are not pollution-intensive have been growing faster than the general rate of GDP growth. For example, service industries accounted for 38 per cent of total value added in 1991, rising to 43 per cent in 2000, but the sector's share of emissions has not risen correspondingly.

The remaining chapters of this publication and the appendix of tables provide further information on Norway's natural resources and the environment and describe how they are affected by the activities of various economic operators.

Box 1.4. Conflict between trade and environment?

During the WTO Ministerial Conference in Seattle in autumn 1999, the streets were filled by demonstrators protesting against the liberalization of world trade and demanding stronger environmental policies. The opponents of globalization appear at first sight to have a number of good arguments. If stricter environmental standards increase operating costs for companies, surely they will move to countries where environmental standards are lower? And then the authorities will presumably feel obliged to lower environmental standards for polluting export industries. This type of policy has even been given its own name, eco-dumping.

However, eco-dumping is based on the assumption that stringent environmental standards really do weaken a company's competitive position. Not everyone agrees that this is the case. In several articles, Harvard professor Michael Porter, alone or together with Claes van der Linde (Porter and van der Linde 1995), has proposed an alternative hypothesis. This states that strict environmental standards do not weaken competitiveness. On the contrary, they strengthen it, and the authorities should therefore apply particularly strict environmental standards to export industries.

Porter and van der Linde consider that all emissions are wasteful. As a result, if a company is forced to reduce emissions, it will operate more efficiently. Next, they point out that the demand for "green" products is growing. This means that companies that have to reduce their emissions can take higher prices for their products. However, both these mechanisms violate fundamental assumptions of microeconomic theory. For example, if it is profitable to recover pollutants that would otherwise be emitted, why is it that companies do not start to do this independently of environmental policy?

Porter's hypothesis has met a great deal of opposition from economists, including Palmer, Oates and Portney (1995). Nevertheless, microeconomic theory can be used to explain some aspects of the hypothesis. Greaker (2001) shows that an industry's market share can be improved if the authorities introduce high environmental standards rather than low standards. This result depends on imperfect competition in the export market and on scale economies in emissions reduction.

Furthermore, Greaker (2002a) shows that a credible threat to move production out of the country may result in stricter environmental controls. If a company moves, the country it leaves will no longer receive pollution from its plant, while the owners will still be able take home the untaxed proportion of their profits. On the other hand, the governments of other countries that the company may move to will take the same considerations into account. The result may well be, therefore, that all the countries involved introduce more stringent standards, and the company does not move. Thus, a threat to move production can result in stricter environmental policies and improve welfare in all the countries involved.

It can also be difficult for companies to supply "greener" products despite the fact that consumer demand for them is rising. If consumers cannot themselves identify which products are more environmentally friendly, an equilibrium may develop where consumers do not trust the companies and the companies do not offer "greener" products. One way of avoiding this is to offer an eco-labelling system. Both Rege (1998) and Greaker (2002b) discuss this in relation to international trade. They show, in agreement with the Porter hypothesis, that eco-labelling can improve a company's competitive position and increase exports.

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2. Energy

Norway has rich energy resources, particularly in the form of oil, gas and hydropower, and energy extraction is far higher than the country's energy consumption. The production, transmission and use of energy cause various pressures on the environment. A large proportion of global air pollution is generated by the combustion of coal, oil and gas.

In 2001, extraction of energy commodities in Norway was 9 times higher than consumption. Most of this is extraction of oil and gas, which accounted for 95 per cent of the total. Given the current rate of extraction, the calculated crude oil resources on the Norwegian continental shelf will be exhausted in 9 years' time and the gas resources in 38 years' time. The lifetime of the remaining resources depends both on the rate of extraction and on new finds. Norway has less than 1 per cent of the world's oil reserves, but accounted for 4.5 per cent of world oil production in 2001. The Norwegian oil reserves are thus being exhausted more rapidly than those in the rest of the world. The high rate of extraction makes this the country's most important industry. Petroleum extraction accounted for about 21 per cent of GDP and 43 per cent of Norway's export revenues in 2001. This is only a small change from the year before: prices have dropped slightly, while extraction has risen by about 2 per cent.

Hydropower is Norway's other major energy resource, although in terms of gross energy content, electricity production from this source corresponded to only about 5 per cent of petroleum extraction in 2001. However, hydropower is a renewable energy source and therefore "everlasting", unlike petroleum resources, which are depleted as they are extracted. In 2001, Norway produced 122 TWh electricity. This was a drop of about 15 per cent from 2000, but nevertheless 3 per cent higher than can be expected in a year when precipitation is normal. Despite this, Norway imported 3.6 TWh.

Consumption of energy commodities is continuing to rise, and consumption in 2001 will probably be the highest ever recorded. However, energy use has only grown a little more than half as fast as general economic growth (measured as mainland GDP).

The energy sector exerts heavy pressure on the environment. In 2000, extraction of oil and gas generated 11 million tonnes of CO_2, about 27 per cent of Norway's total emissions. Hydropower developments in watercourses have a significant impact on biological diversity, the cultural landscape and outdoor recreation. About 63 per cent of Norway's hydropower potential has now been developed.

This chapter focuses on Norway's three most important energy resources, i.e. oil, gas and hydropower.

2.1. Resource base and reserves

Table 2.1. World reserves of oil and gas as of 1 January 2002

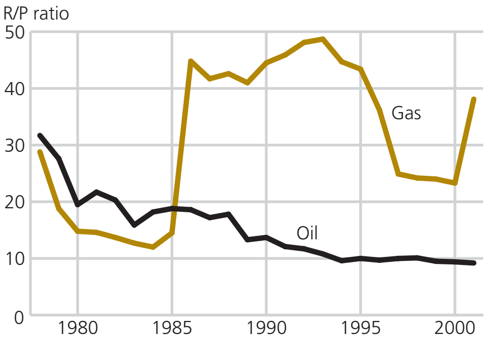
	Oil		Gas	
	Billion tonnes	Per cent	Billion tonnes o.e.	Per cent
World	143.0	100	139.6	100
North America[1]	8.4	5.9	6.8	4.9
Latin America	13.7	9.6	6.4	4.6
Europe (not former Soviet Union)	2.5	1.7	4.4	3.1
Former Soviet Union	9.0	6.3	50.5	36.2
Middle East	93.4	65.3	50.3	36.1
Africa	10.2	7.1	10.1	7.2
Asia and Oceania	5.9	4.1	11.0	7.9
OPEC[2]	111.8	78.2	..	..
OECD	11.2	7.8	13.4	9.6
Norway	1.3	0.9	1.1	0.8

[1]Including Mexico.
[2] Figures for gas not available in the source used.
Source: BP 2002.

Petroleum reserves

- *Resources* include all estimated petroleum deposits, whereas *reserves* include only recoverable resources in fields that are already developed or where development has been approved. Norway's reserves correspond to 0.9 per cent of the world's oil reserves and 0.8 per cent of the gas reserves.
- Since extraction began, a total of 3 258 million Sm^3 oil and gas has been sold and delivered from the Norwegian continental shelf in the North Sea, and the remaining reserves are calculated at 4 031 million Sm^3 (Norwegian Petroleum Directorate 2002).

Figure 2.1. R/P ratio[1,2] for Norwegian oil and gas reserves. 1978-2001



[1] The R/P ratio, or the ratio between reserves and production, indicates how many years it will take before the reserves are exhausted.
[2] Because of a change in the classification system for petroleum resources, there is a break in the time series between 2000 and 2001.
Sources: Energy statistics from Statistics Norway and Norwegian Petroleum Directorate.

R/P ratio for Norway's remaining petroleum reserves

- The estimates of reserves are revised annually, and new fields are included in the estimates almost every year (see Appendix, tables A1 and A2). The estimate for the length of time that Norway's gas reserves will last at the current rate of production, expressed as the R/P ratio, was increased from 2000 to 2001, mainly because the Oseberg and Troll gas deposits were defined as reserves instead of resources.
- BP (2002) quotes the following R/P ratios for the whole world at the end of 2001: oil 40.3 years and natural gas 61.9 years. Using the figures from the Norwegian Petroleum Directorate as a basis, the R/P ratios for the Norwegian reserves were 9.2 and 38.1 years respectively.

Box 2.1. Energy content, energy units and prefixes

Average energy content, density and efficiency of energy commodities[1]

Energy commodity	Theoretical energy content	Density	Fuel efficiency: Manufacturing and mining	Fuel efficiency: Transport	Fuel efficiency: Other consumption
Coal	28.1 GJ/tonne	..	0.80	0.10	0.60
Coal coke	28.5 GJ/tonne	..	0.80	-	0.60
Petrol coke	35.0 GJ/tonne	..	0.80	-	-
Crude oil	42.3 GJ/tonne = 36.0 GJ/m^3	0.85 tonne/m^3	..	..	..
Refinery gas	48.6 GJ/tonne	..	0.95	..	0.95
Natural gas (2001)[2]	40.2 GJ/1000 Sm^3	0.85 kg/Sm^3	0.95	..	0.95
Liquefied propane and butane (LPG)	46.1 GJ/tonne = 24.4 GJ/m^3	0.53 tonne/m^3	0.95	..	0.95
Fuel gas	50.0 GJ/tonne	..	..	..	..
Petrol	43.9 GJ/tonne = 32.5 GJ/m^3	0.74 tonne/m^3	0.20	0.20	0.20
Kerosene	43.1 GJ/tonne = 34.9 GJ/m^3	0.81 tonne/m^3	0.80	0.30	0.75
Diesel oil, gas oil and light fuel oil	43.1 GJ/tonne = 36.2 GJ/m^3	0.84 tonne/m^3	0.80	0.30	0.70
Heavy distillate	43.1 GJ/tonne = 37.9 GJ/m^3	0.88 tonne/m^3	0.80	0.30	0.70
Heavy fuel oil	40.6 GJ/tonne = 39.8 GJ/m^3	0.98 tonne/m^3	0.90	0.30	0.75
Methane	50.2 GJ/tonne	..	..	..	..
Wood	16.8 GJ/tonne = 8.4 GJ/solid m^3	0.5 tonne/solid m^3	0.65	-	0.65
Wood waste (dry wt)	16.8 GJ/tonne	..	..	..	..
Black liquor (dry wt)	14.0 GJ/tonne	..	..	..	..
Waste	10.5 GJ/tonne	..	..	..	..
Electricity	3.6 GJ/MWh	..	1.00	1.00	1.00
Uranium	430-688 TJ/tonne	..	..	..	..

[1] The theoretical energy content of a particular energy commodity may vary. The figures therefore indicate mean values.
[2] Sm^3 = standard cubic metre (at 15 °C and 1 atmospheric pressure).
Sources: Energy statistics, Statistics Norway, Norwegian Petroleum Industry Association, Norwegian Association of Energy Users and Suppliers, Norwegian Building Research Institute.

Energy units

	PJ	TWh	Mtoe	Mbarrels	MSm^3 o.e. oil	MSm^3 o.e. gas	quad
1 PJ	1	0.278	0.024	0.18	0.028	0.025	0.00095
1 TWh	3.6	1	0.085	0.64	0.100	0.090	0.0034
1 Mtoe	42.3	11.75	1	7.49	1.18	1.052	0.040
1 Mbarrels	5.65	1.57	0.13	1	0.16	0.141	0.0054
1 MSm^3 o.e. oil	36.0	10.0	0.9	6.4	1	0.89	0.034
1 MSm^3 o.e. gas	40.2	11.2	1.0	7.1	1.12	1	0.038
1 quad	1053	292.5	24.9	186.4	29.29	26.19	1

1 Mtoe = 1 million tonnes (crude) oil equivalents

1 Mbarrels = 1 million barrels crude oil (1 barrel = 0.159 m^3)

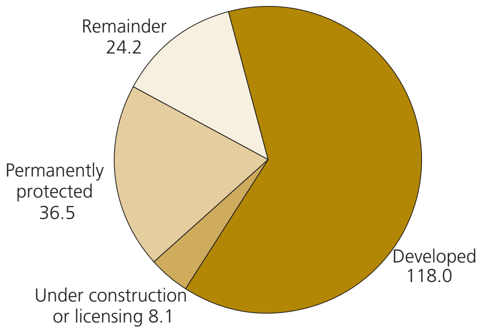
1 MSm^3 o.e. oil = 1 million Sm^3 oil

1 MSm^3 o.e. gas = 1 billion Sm^3 natural gas

1 quad = 10^{15} Btu (British termal units)

Source: Energy statistics, Statistics Norway and Norwegian Petroleum Directorate.

Figure 2.2. Norway's hydropower resources as of 1 January 2002. TWh per year



Source: Norwegian Water Resources and Energy Directorate.

Hydropower resources

- As of 1 January 2002, Norway's hydropower potential totalled 186.9 TWh per year (see Appendix, table A3), and 63 per cent of this has been developed.
- Hydropower accounts for almost 100 per cent of electricity production in Norway, as compared with 19 per cent for the world as a whole (World Energy Council 2001).
- Hydropower developments have a significant impact on biological diversity, the cultural landscape and opportunities for outdoor recreation. The only large river in Norway that is untouched by hydropower developments is the Tana in Finnmark.
- Environmental restrictions and the need to consider profitability make it uncertain how much of the remaining hydropower potential is likely to be developed in the future.

Box 2.2. Commonly used prefixes

Name	Symbol	Factor
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

2.2. Extraction and production

Table 2.2. World production of crude oil and natural gas in 2001

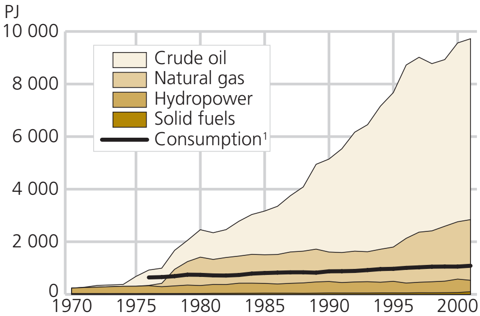
	Oil		Gas	
	Billion tonnes	Per cent	Billion tonnes o.e.	Per cent
Regions				
World	3 584.9	100.0	2 217.7	100.0
OPEC[2]	1 459.7	40.7	..	..
OECD	1 006.9	28.1	972.3	43.8
North America[1]	657.4	18.3	686.0	30.9
Latin America	354.0	9.9	90.0	4.1
Europe (not former Soviet Union	323.7	9.0	263.1	11.9
Former Soviet Union	424.2	11.8	609.6	27.5
Middle East	1 075.6	30.0	205.3	9.3
Africa	370.7	10.3	111.7	5.0
Asia and Oceania	379.4	10.6	252.0	11.4
Individual countries				
Saudi Arabia	422.9	11.8	48.3	2.2
USA	351.7	9.8	499.9	22.5
Russia	348.1	9.7	488.2	22.0
Iran	182.9	5.1	54.5	2.5
Mexico	176.6	4.9	31.3	1.4
Venezuela	176.2	4.9	26.0	1.2
China	164.9	4.6	27.3	1.2
Norway	162.1	4.5	51.7	2.3
Canada	129.1	3.6	154.8	7.0
Iraq[2]	117.9	3.3	..	..
UK	117.9	3.3	95.2	4.3
United Arab Emirates	113.2	3.2	37.2	1.7
Nigeria	105.2	2.9	12.1	0.5
Kuwait	104.2	2.9	8.6	0.4
Algeria	65.8	1.8	70.4	3.2
Indonesia	68.6	1.9	56.6	2.6
Netherlands[2]	..	..	55.2	2.5
Uzbekistan	7.3	0.2	48.2	2.2
Denmark	16.9	0.5	7.5	0.3

[1] Including Mexico.
[2]Figures not available in the source used.
Source: BP 2002.

World production of crude oil and natural gas

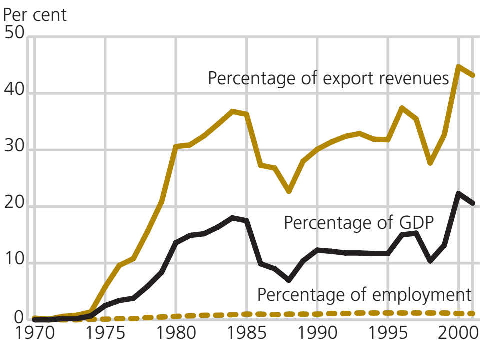
- The world's largest oil producer is Saudi Arabia, and the largest gas producers are the USA and Russia.
- In 2001, Norway accounted for 4.5 per cent of world oil production and 2.3 per cent of gas production. These figures are substantially higher than Norway's share of the world reserves (see table 2.1). This indicates that the remaining lifetime of the Norwegian reserves will be considerably shorter than for the world as a whole (see figure 2.1).
- Denmark, the only other Nordic country that produces oil and gas, accounted for 0.5 and 0.3 per cent respectively of world oil and gas production.

Figure 2.3. Extraction and consumption[1] of energy commodities in Norway. 1970-2001*



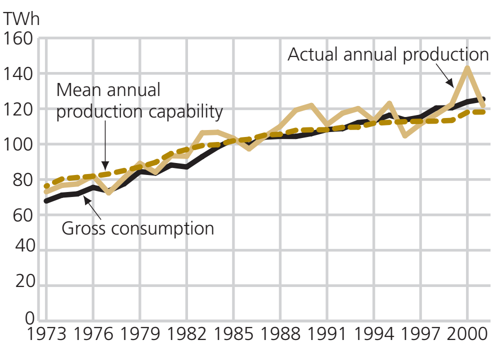
[1] Including the energy sectors, excluding international maritime transport.
Sources: Energy statistics, Statistics Norway, Norwegian Petroleum Directorate and Norwegian Water Resources and Energy Directorate.

Figure 2.4. Oil and gas extraction. Percentage of exports, gross domestic product (GDP) and employment. 1970-2001*



Source: National Accounts, Statistics Norway.

Figure 2.5. Mean annual production capability, actual hydropower production and gross electricity consumption in Norway. 1973-2001



Source: Norwegian Water Resources and Energy Directorate and Energy statistics, Statistics Norway.

Total extraction of energy commodities in Norway

- Total extraction of energy commodities in Norway rose by 1.7 per cent from 2000 to 2001. Gas extraction showed the strongest growth, increasing by 5.8 per cent. Oil and gas extraction accounted for 95 per cent of the total in 2001.
- Hydropower production dropped by 15 per cent after reaching an extraordinarily high level in 2000.
- In 2001, extraction of primary energy commodities was 9 times higher than consumption (see also Appendix, table A4).

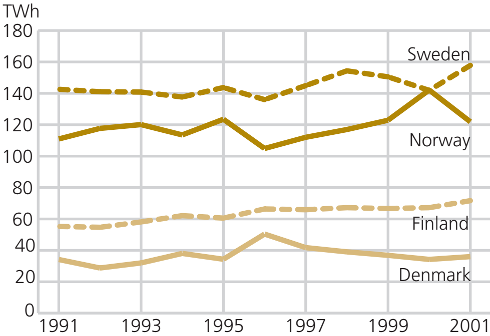
Crude oil and natural gas in an economic perspective

- Extraction of oil and gas is Norway's most important industry measured in terms of export revenue and value added (proportion of GDP). In 2001, oil and gas accounted for 43 per cent of the country's total exports. The volume of exports rose by 5.2 per cent from the year before, while the value dropped by 6.5 per cent.
- Value added in the petroleum sector corresponded to 21 per cent of GDP, but only about 1 per cent of total labour input was directly related to oil and gas extraction.

Electricity

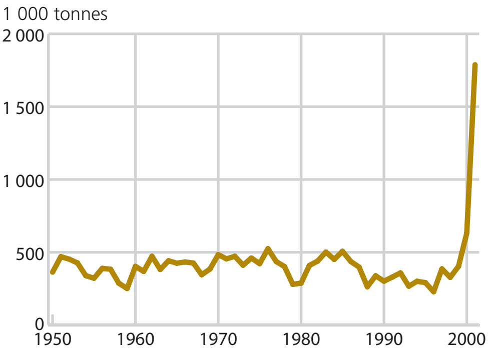
- Electricity production in Norway in 2001 totalled 122 TWh, a drop of 14.8 per cent from the year before (see Appendix, table A8). In 2000, high precipitation resulted in an extremely high level of production.
- Production was 3.7 TWh higher than the mean annual production capability (i.e. production in a year with normal precipitation). The mean annual production capability rose by only 0.11 TWh from the year before.
- Net imports of electricity totalled 3.6 TWh.

Figure 2.6. Electricity production in the Nordic countries. 1991-2001



Source: Nordel's secretariat (various years).

Figure 2.7. Extraction of coal in Svalbard. 1950-2001



Sources: Historical Statistics, Statistics Norway and Store Norske Spitsbergen Kulkompani.

Electricity production in the Nordic countries

- The energy balance in Norway influences electricity production in the other Nordic countries. Electricity production in Denmark, Finland and Sweden rose from 2000 to 2001, when Norway became a net importer instead of a net exporter.
- The total net import of 3.6 TWh in 2001 consisted of 2.3 TWh from Sweden, 0.85 TWh from Denmark and 0.2 TWh from each of Russia and Finland.

Extraction of coal in Svalbard

- Until recently, coal extraction in Svalbard has been dependent on government support. In autumn 2001, the Storting approved plans by the company Store Norske Spitsbergen Kulkompani to start permanent production at the new mine Svea Nord. This will make it possible to operate at a profit and government support will therefore be unnecessary. This will result in a higher level of extraction.
- Environmental groups have protested against these plans, both because of the adverse environmental impact of using coal and because of the risk that pressure on the environment in Svalbard will be increased.

2.3. Environmental impacts of production and use of energy

Box 2.3. Environmental pressures caused by the extraction and use of energy

Emissions to air occur during the extraction, transport and use of oil and gas products. These can result in climate change, acidification, the formation of ground-level ozone and local air pollution (see Chapter 6: Air pollution and climate). Emissions to air from the energy sectors in 2000 are shown in table 2.3.

Discharges of oil and chemicals to the sea occur during the extraction and transport of oil and gas products. They may for example injure fish, marine mammals and birds and fish.

Infrastructure development takes place during the development of new capacity for energy generation, and includes the construction of dams, roads, onshore installations and transmission lines. Hydropower production also results in variable water levels in reservoirs and changes in discharge volumes in rivers. These developments can have an impact on biological diversity and the value of cultural monuments, the cultural landscape and recreational areas.

Box 2.4. Green certificates for environmentally friendly energy generation

In practice, it has not been easy to introduce taxes or emissions trading to deal with pollution problems. Another approach that has been proposed is to focus more on instruments that can give direct support to the use of green technologies in energy production. A green certificate scheme is one example of such an instrument, and can be introduced to stimulate the generation of power based on renewable energy. Producers who generate energy using green technologies (i.e. from renewable sources) receive green certificates for each unit of energy generated. A market is then created for the certificates by requiring energy consumers to buy certificates in proportion to their purchases of ordinary energy.

Green producers sell energy in the ordinary market, and certificates in the financial market created by the obligation to buy a certain proportion of green energy. The sum of the value of one unit of energy and one certificate should correspond to the cost of increasing production of green energy by one unit.

There are several reasons behind the introduction of green certificate schemes in the energy markets. One is that they can be used in efforts to meet environmental targets (such as reducing emissions to air) as effectively as possible. Another is that such schemes can be used as incentives for the development of new technologies, for instance if it has been decided in advance to make exclusive use of green technologies as a strategy for achieving environmental targets. Other arguments that are put forward for green certificate schemes as a means of increasing the use of green energy are that they can result in greater reliability of supplies and higher employment, and stimulate research and development, even though it is not possible to find clear support for these claims from the literature.

Preliminary analyses show that the introduction of green certificate schemes may have surprising and counter-intuitive effects on prices and quantities in energy markets. For example, the purchase price of ordinary energy may drop and the total quantities of energy sold may rise, even though energy produced using green technologies is more expensive than other energy. This in itself shows the need to analyse new instruments before they are introduced in a market.

Based on: Bye, T., O.J. Olsen and K. Skytte (2002): *Grønne sertifikater - design og funksjon* (*Green certificates - design and function*), Reports 2002/11, Statistics Norway..

Table 2.3. Emissions to air from the energy sectors as a proportion of total Norwegian emissions. 2000*. Percentages

Greenhouse gases	**27**
Carbon dioxide (CO_2)	33
Methane (CH_4)	9
Nitrous oxide (N_2O)	1
Acidifying substances	**20**
Sulphur dioxide (SO_2)	12
Nitrogen oxides (NO_x)	29
Ammonia (NH_3)	0
Heavy metals	
Lead (Pb)	7
Cadmium (Cd)	6
Mercury (Hg)	6
POPs	
Total PAH	1
Dioxins	11
Other pollutants	
Non-methane volatile organic compounds (NMVOCs)	66
Carbon monoxide (CO)	2
Particulate matter	1

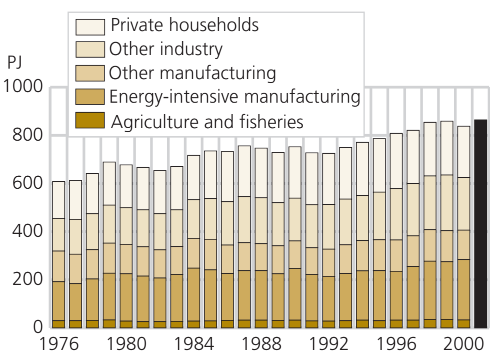
Sources: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Emissions to air

- The energy sectors are responsible for a large proportion of emissions to air in Norway, particularly in the case of CO_2, NO_x and NMVOCs (see Chapter 6: Air pollution and climate).
- The most important source of NMVOC emissions is evaporation during loading of crude oil offshore. These emissions rose a great deal during the 1990s, and now total about 220 000 tonnes.
- Gas turbines on offshore installations are the most important source of CO_2 and NO_x emissions in the energy sectors. Every year, 7-8 million tonnes CO_2 and about 30 000 tonnes of NO_x are emitted from this source.

2.4. Energy use

Figure 2.8. Domestic energy use by consumer group. 1976-2001*

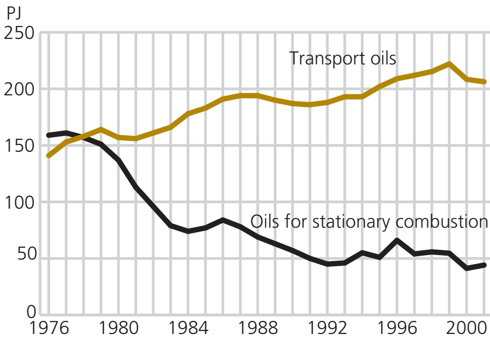


Source: Energy statistics, Statistics Norway.

Energy use split by consumer group

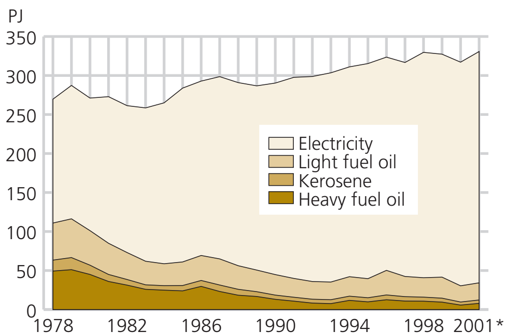
- In 2001, Norway's total energy use (excluding international maritime transport), was 1 086 PJ, including 222 PJ in the energy sectors.
- Consumption of energy commodities, excluding the energy sectors and international maritime transport, totalled 838 PJ in 2000 and 864 PJ in 2001 (preliminary figures). The 2001 figure is the highest ever recorded (see Appendix, table A5).
- Energy use rose by an average of 1.4 per cent per year from 1976 to 2001. In the same period, GDP excluding the oil and gas sector expanded by an average of about 2.4 per cent per year.

Figure 2.9. Consumption of oil products. 1976-2001*



Source: Energy statistics, Statistics Norway.

Figure 2.10. Electricity consumption (excluding energy-intensive manufacturing) and sales of fuel oils and kerosene as utilized energy. 1978-2001*



Sources: Energy statistics, Statistics Norway and Norwegian Petroleum Industry Association.

Oil consumption

- Total oil consumption, excluding the energy sectors and international maritime transport, dropped by about 16 per cent in the period 1976-2001, despite a rise of 46 per cent in the consumption of oil for transport in the same period.
- Transport now accounts for almost 82 per cent of total oil consumption, as compared with 47 per cent in 1976. The drop from 1999 is mainly explained by a reduction in air traffic and maritime transport.
- Consumption of oil for stationary purposes had dropped to less than one third of the 1976 level by 1992. Since the mid-1990s, it has again shown a downward trend.

Electricity consumption

- General consumption, i.e. net domestic electricity consumption minus consumption by energy-intensive manufacturing and spot power (non-contractual electricity supplied for electric boilers) totalled 77.2 TWh in 2001 (see Appendix, table A8). This is the highest level ever recorded.
- If the figures are corrected for normal temperature conditions, which are taken to be the average for the period 1961-1990, consumption shows a slight drop (0.4 TWh) from 2000 to 2001.

Box 2.5. Deregulation of the power market and the California electricity crisis – what is the situation in Norway?

California deregulated its electricity market in 1998. The objective was to replace low efficiency and over-capacity with a liberalized market - efficient, with market-driven prices and optimal capacity. In practice, chaos ensued, and in 2000 supply shortages led to an electricity crisis. Consumers experienced power cuts, the wholesale prices of electricity reached record levels, and the large electricity suppliers suffered huge losses.

Norway deregulated its electricity market in 1991, and although the market seems to have functioned well until now, there are certain similarities to the situation in California. Investments in new capacity have slowed, while demand is still rising. Weather conditions have a major impact on the balance in the Norwegian electricity market as well. For example, if the weather is extremely cold and demand therefore high, electricity can be in short supply. In view of the crisis that California experienced, there is good reason to ask whether a similar crisis could affect the Norwegian electricity market.

Aune and Johnsen (2002) argue that this is not very likely because there are several important differences between the Californian electricity market and the situation in Norway. In California, the power companies were forced to sell a large proportion of their production capacity to prevent any one company from acquiring too dominant a position in the market. Nevertheless, their obligations to deliver electricity were maintained, and the difference had to be made up by purchases in the wholesale market. At the same time, end-user prices were capped at the 1996 level, but this did not apply to the wholesale market. A number of factors, including economic growth and weather conditions, contributed to a growth in demand. At the same time, production costs were rising, which meant that prices in the wholesale market also rose. Since the companies were not permitted to raise prices to end-users, price could not be used to influence demand. The power companies were unable to meet their costs, and at a later date were also unable to meet demand. The California Power Exchange (CalPX) went bankrupt on 9 March 2001.

There are two main reasons why Aune and Johnsen consider it unlikely that a similar crisis will develop in Norway.

Firstly, the p*rice mechanisms* have functioned as intended, in that variations in supply and demand have resulted in price fluctuations. When prices are higher, consumers will reduce consumption and/or find alternative energy sources. Imports will rise. Technological developments that are expected to take place may make the demand side even more sensitive to price changes in the long run.

Information on possible water shortages due to low snow volumes during the winter is available as early as February-March the year before. If shortages are expected, it will be attractive for power companies to store water in the reservoirs. Prices will rise, and power shortages are relieved through the market mechanisms of higher imports and reduced consumption, cf. Johnsen and Lindh (2001).

Based on: Aune, F.R. and T.A. Johnsen (2002): Kraftkrise i California: Hvordan står det til i Norge (Deregulation of the power market and the California electricity crisis: What is the situation in Norway?), *Økonomisk Forum* 2, 2002.

More information: Lisbet Høgset, Trond Sandmo and Henning Høie.

Useful websites

Statistics Norway - Electricity, gas and water supply: http://www.ssb.no/english/subjects/10/08/
Statistics Norway - Energy balance and energy accounts: http://www.ssb.no/english/subjects/01/03/10/energiregn_en/
Statistics Norway - Extraction of oil and gas: http://www.ssb.no/english/subjects/10/06/
Statistics Norway - Petroleum sales: http://www.ssb.no/english/subjects/10/10/10/petroleumsalg_en/
Norwegian Water Resources and Energy Directorate: http://www.nve.no/
Norwegian Petroleum Industry Association: http://www.np.no/
Ministry of Petroleum and Energy: http://www.odin.dep.no/oed/
Norwegian Petroleum Directorate: http://www.npd.no/
British Petroleum (World Energy Review): http://www.bp.com/centres/energy2002/

References

Aune, F.R. and T.A. Johnsen (2002): Kraftkrise i California: Hvordan står det til i Norge (Electricity crisis in California: What is the situation in Norway?), *Økonomisk Forum* 2, 2002.

BP (2002): Statistical Review of World Energy (downloaded from http://www.bp.com/centres/energy2002/).

Bye, T., O.J. Olsen and K. Skytte (2002): *Grønne sertifikater - design og funksjo*n (Green energy certificates - design and function), Reports 2002/11, Statistics Norway.

Johnsen, T.A. and C. Lindh (2001): Økende knapphet i kraftmarkedet: Vil prisoppgang påvirke forbruket? (Greater shortages in the electricity market: will a price rise influence consumption?) *Economic Survey* No. 6/2001, Statistics Norway.

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World Energy Council (2001): Survey of Energy Resources 2001. London: World Energy Council.

3. Agriculture

The total size of agricultural areas in use has remained stable at a time when the importance of agriculture to the national economy is declining, and when there have been major structural changes in farming. This has also affected the relationships between agriculture and the environment.

Agriculture interacts with the environment in many ways. Farming results in environmental changes both to farmed land, such as alterations in biotopes and landscapes, and to adjacent areas in the form of runoff of nutrients into water bodies and emissions to air from agricultural processes. There has been a particular focus on eutrophication of water bodies caused by nutrient enrichment. The open cultural landscape has largely been created by farming, and is affected by the farming methods used. The agricultural sector manages substantial biological and cultural assets in the form of cultivated animal and plant resources, buildings and types of landscapes. These represent environmental qualities that most people perceive as positive, but that modern farming methods can put at risk. Consequently, agricultural policy has given more weight to these factors in recent years, while the focus on production objectives has been toned down.

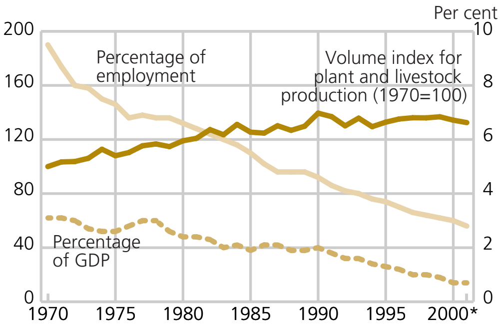
At the same time farming areas are also affected by outside environmental pressures such as pollution, including ozone and heavy metals, and pressures to convert farmland for development, resulting in conflicts over land use.

One of the most important objectives of farming is to safeguard the national food supply (Report No. 19 (1999-2000) to the Storting). Food production in Norway is primarily restricted by the availability of land resources suitable for farming. Consequently, protecting agricultural land resources has high priority. The impact of farming methods on the quality of farm products and thereby on human health, whether in the sense of the nutritional content of food, pesticide residues or animal diseases transmissible to humans, must also be taken into consideration in agricultural policy.

This chapter gives a brief summary of the economic importance of agriculture as an industry, followed by a closer look at the natural resource base (land resources) and activities in the agricultural sector that have an environmental impact in the form of changes in the landscape and emissions to water and air.

3.1. Main economic figures for agriculture

Figure 3.1. Trends in agricultural production volume (index 1970=100) and share of employment and GDP. 1970-2001*



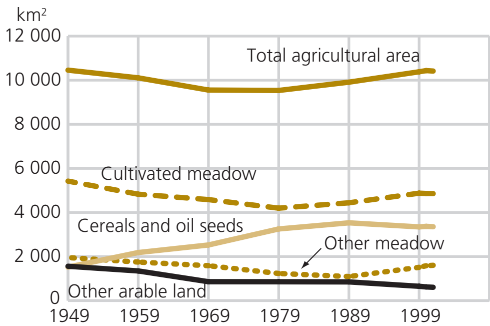
Sources: Budget Committee for Agriculture (2002) and Norwegian National Accounts, Statistics Norway.

Agriculture in an economic perspective

- From 1970 to 2001, employment fell by almost one third (from over 140 000 to 56 000 normal full-time equivalents). In comparison, manufacturing employment fell by approximately 23 per cent.
- Agriculture's share of GDP fell from 3.1 to 0.7 per cent. In comparison, manufacturing declined from 19 to 9 per cent.
- Overall agricultural production has increased by about 32 per cent (Budget Committee for Agriculture 2002). However, production volume has not increased since 1990.

3.2. Land resources

Figure 3.2. Agricultural area in use. 1949-2001*

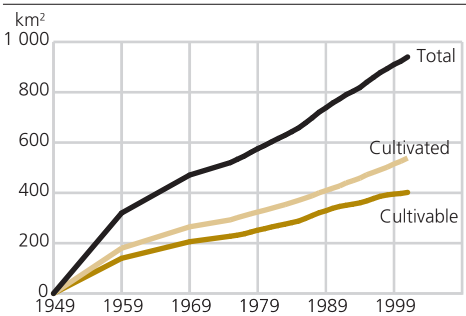


Source: Agricultural statistics, Statistics Norway.

Agricultural area in use

- Since 1949, total agricultural area has varied between 8 700 and 10 500 km^2.
- The increase in agricultural area over the last few years consists of surface cultivated meadow and fertilized pasture. This is probably related to stricter requirements with regard to the minimum area for manure spreading and the transition from support based on production to support based on the area farmed.

Figure 3.3. Accumulated conversion of cultivated and cultivable land[1]. 1949-2001*



[1] For the period 1949-1976 data is only available for cultivated areas that were converted. The area of cultivable land converted in this period has been estimated on the basis of the ratio between cultivable and cultivated land converted 1976-97.

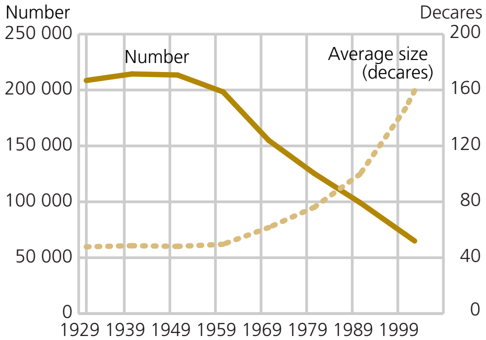
Source: Agricultural censuses, Statistics Norway and the Ministry of Agriculture.

Conversion of cultivated and cultivable land

- The most important threat to agricultural land resources is its conversion for purposes that prevent future agricultural production, such as roads and housing.
- An estimated 940 km^2, or about 4.8 per cent of the total area suitable for agriculture, has been converted for such purposes since 1949.

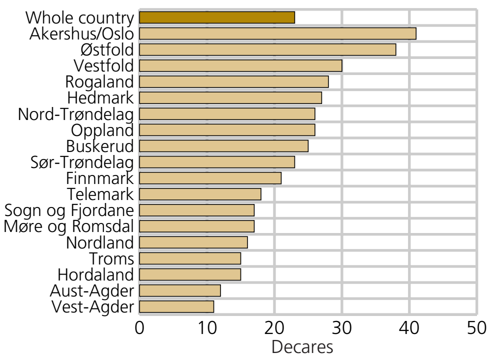
3.3. Size of holdings and cultural landscape

Figure 3.4. Number of holdings and their average size (decares). 1929-2001*



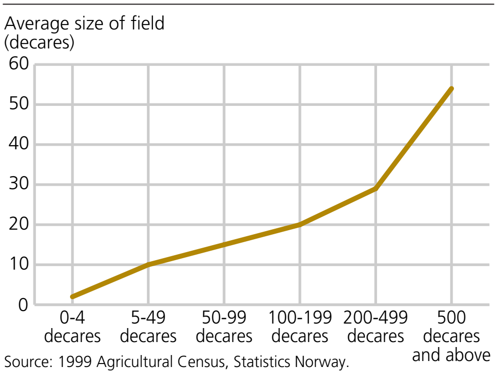
Source: Agricultural Censuses, Statistics Norway.

Figure 3.5. Average size of fields by county. 1999



Source: Agricultural statistics, Statistics Norway.

Figure 3.6. Average size of fields by size of holding. 1999



Source: 1999 Agricultural Census, Statistics Norway.

Holdings – number and size

- The number of holdings in Norway has been reduced to nearly a third since 1960; this is equivalent to a loss of 9 holdings a day.
- The average size has almost tripled, as the total agricultural area in use shows little change. Much of the land on abandoned holdings has been taken over as additional land by the remaining holdings, often as rented area. Over 30 per cent of agricultural area in use is rented.

Field size

- On average, the counties around the Oslofjord have the largest fields, giving a more open agricultural landscape. In Akershus and Oslo, fields are on average almost 4 times larger than in the Agder counties.
- Southern Norway has on average the smallest fields. In hilly areas such as Agder in southern Norway, most of western Norway and northern Norway, the size of fields is naturally delimited by the terrain.
- There is a clear connection between holding size and field size. Currently, there is no trend data, but to the extent the size of fields depends on operational organization in addition to terrain, the trend towards holdings that are fewer in number and larger in size will play a role in increasing the size of the fields.

Box 3.1. Structural changes and the cultural landscape

Major structural changes have taken place in agriculture over the last few decades, and they have followed three distinct trends:
- the agricultural area is divided among fewer and larger holdings
- each holding produces fewer products (specialization at holding level)
- production of important products is concentrated to a greater extent in certain regions (specialization at regional level).

All these trends have changed the conditions for nutrient cycles in the agricultural system and the way farming shapes the cultural landscape. Requirements relating to the means of production have also been affected, including buildings, which are an important part of Norway's cultural heritage.

Increasing the size of holdings improves the organizational basis for more efficient operations. Coupled with today's technological advances and greater pressure to increase earnings, this may lead to an increase in the size of fields. An increase in the size of fields will reduce the length of ecotones and result in less variation in the landscape within a given area. This will reduce biological diversity and give the agricultural landscape a more monotonous appearance. Questions on the division of holdings into fields were included for the first time in the 1999 Agricultural Census.

3.4. Pollution from the agricultural sector

Table 3.1. Emissions to air from agriculture. Greenhouse gases and acidifying substances. 2000*

	Emissions from agriculture. 1 000 tonnes	Percentage of total emissions in Norway
Greenhouse gases	5 153[1]	10[1]
Carbon dioxide (CO_2)	517	1.3
Nitrous oxide (N_2O)	8	50
Methane (CH_4)	98	30
Acidifying substances	1.5[2]	21[2]
Ammonia (NH_3)	23	91
NO_X	5.6	2
SO_2	0.2	1

[1] CO_2-equivalents.
[2] Acid equivalents.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Emissions to air

Sources:

- *Nitrous oxide* (N_2O): use of commercial fertilizer and manure, livestock, biological nitrogen fixation, decomposition of plant material, cultivation of mires, deposition of ammonia and runoff. Calculations of nitrous oxide emissions from agriculture show a high level of uncertainty (see Chapter 6).
- *Methane* (CH_4): livestock. Between 80 and 90 per cent is released directly from the gut.
- *Ammonia* (NH_3): animal manure (about two-thirds), the use of commercial fertilizer and treatment of straw with ammonia.

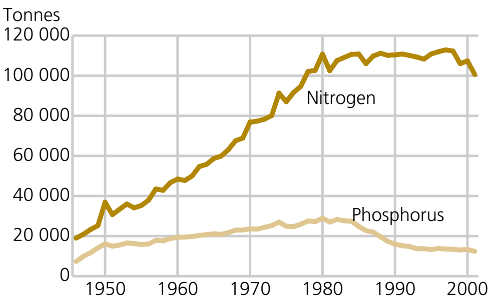
Box 3.2. Pollution from the agricultural sector

Farming results in air and water pollution. Agriculture is a major source of discharges of nutrients to water (nitrogen and phosphorus) (see further details in Chapter 8). Agriculture accounts for about 10 and 35 per cent respectively of anthropogenic phosphorus and nitrogen inputs to the coast (Norwegian Institute for Water Research). These inputs are described in more detail in Chapter 8. Eutrophication is a particularly serious problem locally in water recipients where much of the surrounding land is agricultural.

Measures to limit runoff of nutrients can be divided into three main groups:
- better fertilizer management to reduce the surplus of nutrients in soils
- better cultivation systems to protect soils against erosion
- technical measures, such as improving drainage, enlarging manure storage facilities, etc.

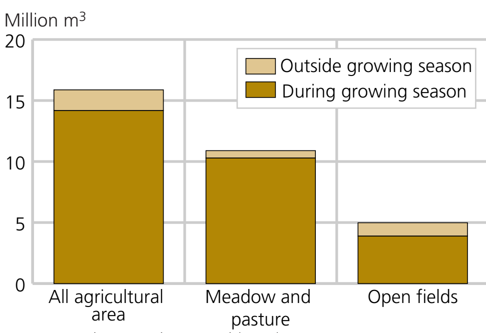
Farming also makes a substantial contribution to emissions to air, in the form of ammonia (NH_3) and greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) (see paragraph below and Appendix, tables E3-E5). Emissions of ammonia result in acid rain, while methane and nitrous oxide are greenhouse gases (see also Chapter 6). No measures have as yet been implemented to reduce emissions to air. The use of pesticides in farming also results in emissions of hazardous substances.

Figure 3.7. Sales of nitrogen and phosphorus in commercial fertilizers. 1946-2001



Sources: Agricultural statistics, Statistics Norway, and Norwegian Agricultural Inspection Service.

Figure 3.8. Amount of manure spread, by area treated and time of spreading. 2000



Source: Gundersen and Rognstad (2001).

Application of commercial fertilizer

- Heavy application of fertilizer results as a rule in poor utilization of the nutrients and may therefore increase pollution in lakes and rivers. The amount of fertilizer applied is therefore increasingly determined on the basis of soil samples and recommended standards.
- Since the early 1980s, the use of phosphorus fertilizer has been halved and the use of nitrogen fertilizer has also declined over the past couple of years.

Application of animal manure

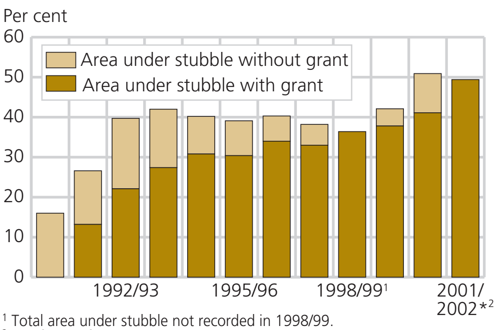
- Application during the growing season reduces runoff because the nutrients can be absorbed by the plants. About 89 per cent of animal manure is spread in the growing season, (meadows 94 per cent, open fields 78 per cent). Manure spread on open fields must be worked into the soil to prevent runoff.
- About twice as much manure is spread on meadows as on open fields because meadows are largely to be found on holdings with livestock production.

Box 3.3. Measures to prevent soil erosion

A large proportion of pollution from the agricultural sector is a result of erosion, i.e. transport of soil with surface water runoff from fields. Most erosion takes place on fields that are ploughed in autumn. When ploughed in autumn, fields are left for up to three-quarters of the year with no plant cover to protect the soil from rain and melt-water. In the long term, erosion also reduces the production capacity of the soil.

To reduce soil erosion, the authorities provide grants for areas that are vulnerable to erosion on condition that the farmers leave them under stubble during the winter, i.e. do not till these areas in autumn. Support is provided because crop yields are expected to be lower in the following season without autumn tillage. In the long run, however, reducing soil loss will help to maintain soil quality, with a potentially positive impact on future crop yields.

Figure 3.9. Proportion of cereal acreage left under stubble in autumn. 1990/1991-2001/2002*

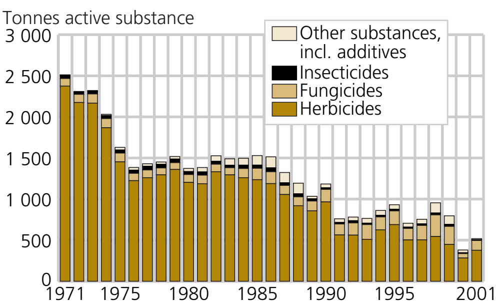


[1] Total area under stubble not recorded in 1998/99.
[2] The figures for total area under stubble in 2001/02 were not available by October 2002.
Source: Agricultural statistics, Statistics Norway, and Ministry of Agriculture.

Soil management

- The area under stubble increased from 16 per cent in 1990-1991 to 42 per cent in 1992-1993, and then remained at about this level until it increased to approximately 50 per cent in 2000-2001.
- The proportion of the area under stubble for which support is granted rose year by year up to 1999-2000 (90 per cent).

Figure 3.10. Sales of chemical plant protection products, measured in tonnes of active substance. 1971-2001

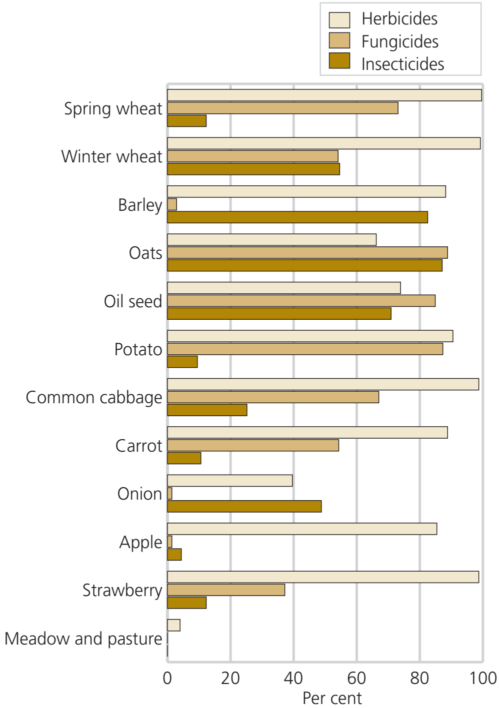


Source: Norwegian Agricultural Inspection Service.

Use of plant protection products

- Sales trends over the last three years must be seen in the context of an increase in taxes on plant production products in 2000. This probably meant that stocks were built up before the year 2000, and that these stocks were subsequently used.

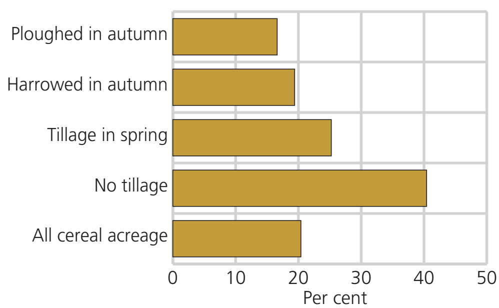
Figure 3.11. Percentage of various crops[1] sprayed with plant protection products. 2001



[1] Does not include ecologically cultivated area.
Source: Gundersen, Rognstad and Solheim (2002).

- Chemical pesticides are used on most arable fields, but to a limited extent on meadows and pasture.
  - herbicides: used in cultivation of all crops, particularly cereals and vegetables
  - fungicides: used mostly in cultivation of potatoes, fruit and berries
  - insecticides: most common in fruit and berry growing, some use in cereal and oil-seed cultivation.
- Other chemicals used widely:
  - potato vine killer: used on 59 per cent of the area used for potatoes in 2001
  - growth regulator: used in cereals, particularly winter wheat (21 per cent) and oats (16 per cent).

Figure 3.12. Percentage of cereal acreage sprayed for couch grass after various forms of soil management. Average for the period 1992/93-2000/2001

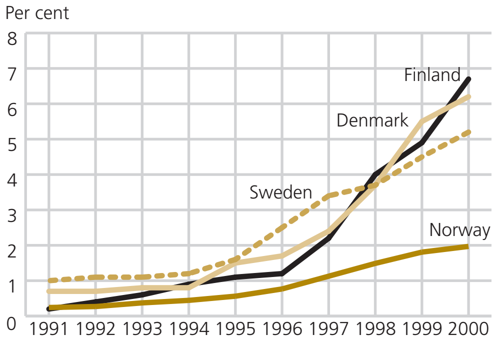


Source: Result Control Agriculture, Statistics Norway.

- There is a clear relationship between the soil management regime and spraying against perennial weeds. The more tillage of the soil is reduced or postponed, the larger the proportion of the area that is sprayed.
- With current agricultural practice, the environmental cost of reducing soil loss by limiting tillage is greater use of pesticides.

3.5. Ecological farming

Figure 3.13. Areas farmed ecologically or in the process of conversion in the Nordic countries. Percentage of total agricultural area



Sources: Debio (Norway), KRAV (Sweden), Statistics Denmark (Denmark), KTTK Plant Production Inspection Centre (Finland).

Ecologically cultivated area in the Nordic countries

- Ecological farming increased in all the Nordic countries in the 1990s. Norway, with about 2 per cent (198 km^2, see Appendix table B4), has the lowest percentage, as against 5-7 per cent in the other Nordic countries.

Box 3.4. Ecological farming

Ecological farming is a collective term for various farming systems based on some common principles:
- no use of commercial fertilizer or chemical/synthetic pesticides
- cultivation of a variety of crops and diversified crop rotation
- cultivation systems should have a preventive effect on disease and pests
- organic material recycled as far as possible
- balance between livestock numbers and areas of farmland with respect to fodder production and use of manure.

Ecological agriculture has certain environmental advantages over conventional farming systems:
- less loss of nutrients and thus less pollution
- more varied agricultural landscape and therefore greater species diversity in and around agricultural areas
- no pesticide residues in soils or products
- product quality often perceived as higher.

Ecological agriculture is considerably more labour-intensive than conventional agriculture, and yields are generally lower. Product prices are higher, but there are fewer sales channels.

The Agricultural Agreement has included support schemes for ecological farming practices since 1990. Requirements relating to ecological agricultural production are laid down in regulations issued by the Ministry of Agriculture, and the organization DEBIO is responsible for inspection and control. Each holding run on ecological principles must be approved by DEBIO and must be inspected at least once a year.

More information: Henning Høie, Anne Snellingen Bye and Svein Erik Stave.

Useful websites

Statistics Norway agricultural statistics: http://www.ssb.no/english/subjects/10/04/
Statistics Norway national accounts: http://www.ssb.no/english/subjects/09/01/
Norwegian Agricultural Economics Research Institute: http://www.nilf.no/
Norwegian Crop Research Institute: http://www.planteforsk.no/
Norwegian Agricultural Inspection Service: http://www.landbrukstilsynet.no/
Norwegian Agricultural Authority: http://www.slf.dep.no/
Debio: http://www.debio.no/
Centre for Soil and Environmental Research: http://www.jordforsk.no/
Norwegian Institute for Land Inventory: http://www.nijos.no/

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Gundersen, G.I. and O. Rognstad (2001): *Lagring og bruk av husdyrgjødsel* (Storage and dispersal of domestic animal manure). Reports 2001/39, Statistics Norway.

Gundersen, G.I., O. Rognstad and L. Solheim (2002): *Bruk av plantevernmidler i jordbruket* (Pesticide use in agriculture). Reports 2002/32, Statistics Norway.

Report No. 19 (1999-2000) to the Storting: *Om norsk landbruk og matproduksjon* (Norwegian agriculture and food production). Ministry of Agriculture.

4. Forest and uncultivated land

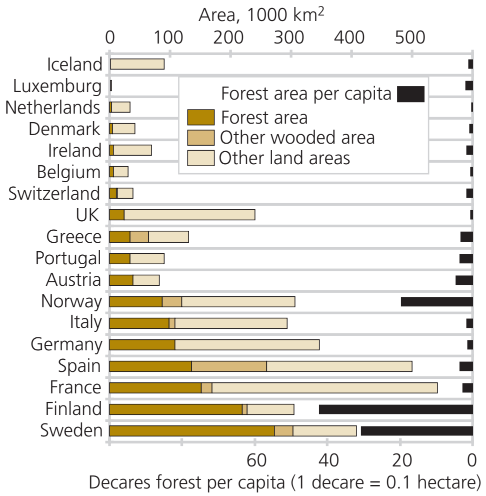
The Norwegian forest contains a wide variety of resources and environmental qualities. In terms of the economy, forests are primarily important as a source of raw materials for the sawmilling and pulp and paper industries. The forest, with its biological diversity, also has considerable intrinsic value as an ecological resource and as an outdoor recreation area for an increasingly urbanized population. This provides a basis for utilizing the resources of uncultivated areas for tourism as well.

Interests in forests and forest resources continue to lead to conflicts between different groups of forest users. In order to reduce the adverse effects on ecology of timber production and its disadvantages to recreational users, the forestry industry itself and the authorities have in recent years placed greater emphasis on multi-use considerations.

This chapter describes the forestry industry and at the importance of forest and uncultivated areas in a wider perspective. The growing stock in Norway has increased considerably for many years because the rate of roundwood removals has been lower than the natural increment. This accumulation of wood capital has resulted in an annual uptake of CO_2 by forest that is equivalent to about 45 per cent of Norway's total anthropogenic CO_2 emissions each year. This is one of the topics described here, together with the biological diversity of forests and their sensitivity to environmental pressures such as climate change and air pollution. Game species, the large predators and reindeer husbandry are also discussed.

4.1. Distribution of forests in Norway and Europe

Figure 4.1. Forest area and total land area in EU and EFTA countries



Source: UN-ECE/FAO (1995).

Forested area

- There is about 75 000 km^2 of productive forest in Norway (Norwegian Institute for Land Inventory 1999), or 24 per cent of the total land area of Norway. Almost half of this forested area is managed in combination with agricultural operations.
- About 1.1 million km^2 or 36 per cent of the total area of the EU countries is forested. Sweden and Finland have the largest areas of forest. With Norway, these countries have the largest area of forest relative to population.
- Forestry and forest industries employ 2.2 million persons in the EU area today (UN/ECE-EC 2000).

Box 4.1. Protection of forest in Norway

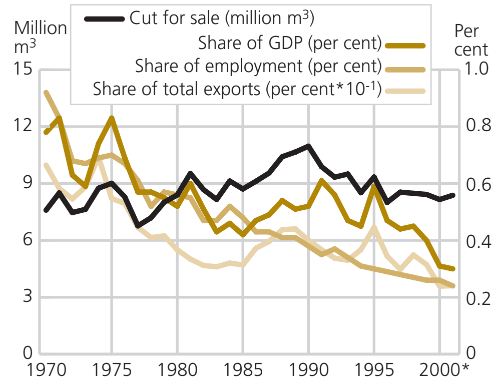
Norway's forests need protection even though both the total area of forest and the amount of timber forests contain are rising. Modern, efficient forestry has made large areas of forest more uniform, and has reduced the area of forest that is allowed to develop without human intervention. Different habitats contain specially adapted species of insects, plants and other organisms. Forest protection is therefore necessary to maintain diversity in forests and rare types of habitats.

An estimated 22 000 plant and animal species are associated with forest in Norway, and about 900 of these are rare or endangered (Directorate for Nature Management 1997). Norway has ratified the Convention on Biological Diversity, which was adopted by the UN Conference on Environment and Development in 1992, and is therefore required to take steps to identify and monitor its biological diversity.

At the end of 2001, a total of 2 203 km^2 of forest in Norway was protected, of which 668 km^2 was productive forest. Included in this figure is 500 km^2 of productive coniferous forest or just less than 1 per cent of the total productive coniferous area. According to Report No. 17 (1998-1999) to the Storting, a total of 1.06 per cent of all coniferous forest is to be protected. In addition, some broad-leaved and mixed forest is protected, and some forest areas are situated where they will naturally be included in new national parks. By way of comparison, 3.6 per cent of the total area of productive forest in both Finland and Sweden was protected in 1996 (National Board of Forestry, Sweden 2000 and METLA 2000).

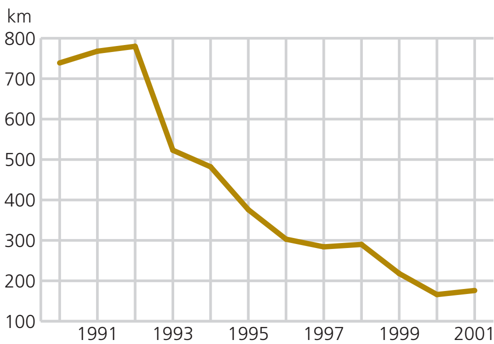
4.2. Forestry

Figure 4.2. Forestry: share of employment and GDP. Annual roundwood removals. 1970-2001*



Sources: National accounts and forestry statistics, Statistics Norway.

Figure 4.3. Annual construction of new forest roads for year-round use. 1990-2001



Source: Forestry statistics, Statistics Norway.

Roundwood removals and economic importance

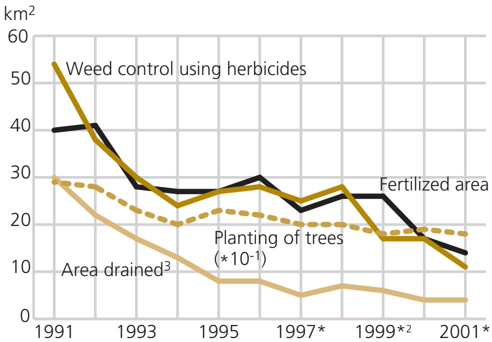
- In 2001, forestry's share of total employment was 0.24 per cent. This is equivalent to 4 800 full-time equivalents, down from 13 700 in 1970. Employment declined in relative terms by about the same as in agriculture.
- Forestry's share of Norway's GDP dropped from 0.78 per cent in 1970 to 0.30 per cent in 2001. Forestry's share of GDP has declined less sharply than that of agriculture.
- The gross value of the roundwood removed for commercial purposes in 1999 was NOK 2.67 billion, and wood and wood products worth NOK 16.8 billion were exported from Norway.

Forest roads

- For many years, the construction of forest roads has been an important contributory cause of the reduction in the size and number of wilderness-like areas in Norway (SSB/SFT/DN 1994).
- However, the rate of construction of forest roads has dropped from 768 km forest roads for year-round use in 1991 to 176 km in 2001.
- A total of NOK 148 million was invested in forest roads in 2001, and NOK 55 million of this was in the form of public grants.

For the size of wilderness-like areas, see Chapter 9 Land use.

Figure 4.4. Silviculture measures[1] that have an environmental impact. 1991-2001*



[1] The figures refer to silviculture funded by Forest Trust Fund and/or government grants.
[2] No figures are available for the county of Troms.
[3] Forest drainage. New ditches.
Source: Forestry statistics, Statistics Norway.

Silviculture

- There was a decrease in all projects receiving public funding in the 1990s. The planting of trees is the largest single silviculture investment. A total of NOK 140 million was invested in planting in 2001, and 183 km^2 were planted.
- There may be several reasons for the decline in the use of chemical herbicides: increased focus on environmental considerations in forestry, restrictions on the use of spraying and reductions in grants.
- The county of Nord-Trøndelag accounted for 56 per cent of all forest drainage in 2001.

Box 4.2. Forest certification schemes

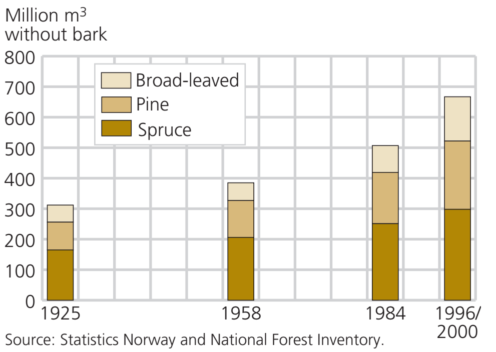
Forest certification schemes are designed to ensure that operations are run in accordance with predetermined standards for sustainable forestry. Control is the responsibility of an independent third party such as Det Norske Veritas or Nemko Certification.

The period 1995-1998 saw a great deal of work being carried out in Norway to devise realistic criteria for sustainable forest management and to develop systems for documenting and monitoring the state of the environment in forests. This work was done as part of the "Living Forests" project, and included representatives of forest owners, the forestry industry, the authorities, trade unions, and environmental, outdoor recreation and consumer organizations. At least 70 per cent of all Norwegian timber that is sold today is from forest properties that have been approved by a certification scheme.

More than 90 per cent of all certified forest in the world is in the ECE region (Europe, North America and the former Soviet Union). Little forest has been certified in the developing countries, where the problems related to forest management are most serious (UN/ECE 2000). The largest market for certified products is still in Western Europe. Supplies of certified forest products are rising faster than the demand for them, and the demand is mainly from intermediaries, not from consumers. Some German publishing houses and British supermarket chains require that all the paper they buy is produced from timber from environmentally certified forests.

4.3. Increment and uptake of CO_2 by forest

Figure 4.5. Volume of the growing stock. 1925, 1958, 1984 and 1996/2000

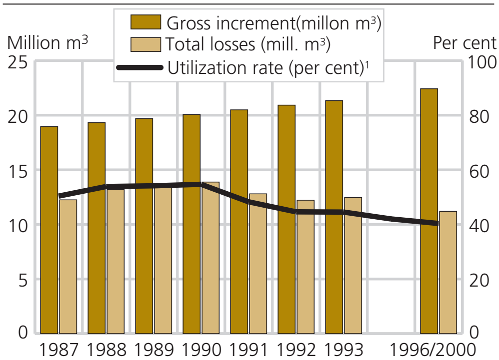


Source: Statistics Norway and National Forest Inventory.

Total growing stock

- Data from inventories carried out by the Norwegian Institute for Land Inventory and calculations carried out by Statistics Norway show that in the period from 1996 to 2000 the volume of the growing stock in Norway was 666 million m³.
- The volume of the growing stock below the coniferous forest line has more than doubled since 1925.

Figure 4.6. Gross increment, total losses and utilization rate of the growing stock[1]. 1987-1996/2000



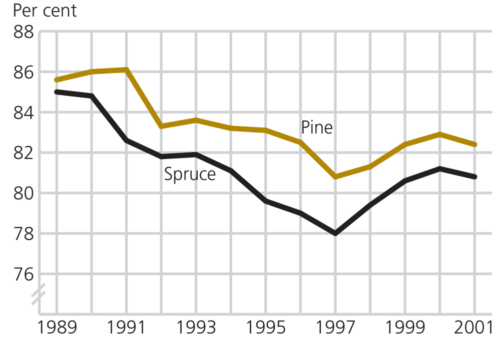
[1] Utilization rate is defined here as the volume of roundwood removals in relation to gross increment.
Source: Forestry statistics, Statistics Norway.

Increment and utilization rate of the growing stock

- In 2000, the net increment (annual increment minus roundwood removals and calculated natural losses) in the growing stock was 12.3 million m³, or 1.8 per cent of the total volume (Appendix, table C1).
- The increase in the biomass of forests in 2000 resulted in an uptake of CO_2 by forest that corresponded to about 45 per cent of the total anthropogenic CO_2 emissions in Norway.

4.4. Forest damage

Figure 4.7. Mean crown condition for spruce and pine. 1989-2001



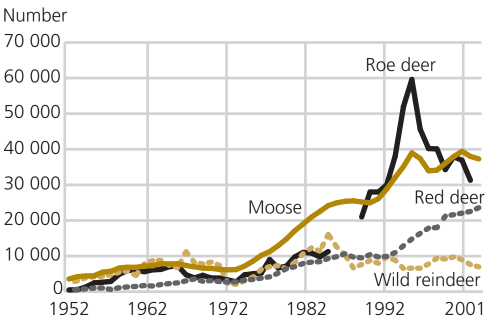
Source: Norwegian Institute for Land Inventory (2002).

Forest damage in Norway

- Crown condition is an indicator of the forest's state of health. The crown condition for both spruce and pine improved in the period from 1997 to 2000.
- A slight decline was recorded for both species in 2001. Mean crown condition for spruce was 80.8 per cent and 82.4 per cent for pine.
- There are regional differences in the state of health of the forest. There has been an improvement in the crown condition of spruce in forest areas in Eastern and Central Norway since 1997. The improvement in crown condition for pine has occurred throughout the country.

4.5. Game species

Figure 4.8. Number of moose, red deer, wild reindeer and roe deer killed. 1952-2001

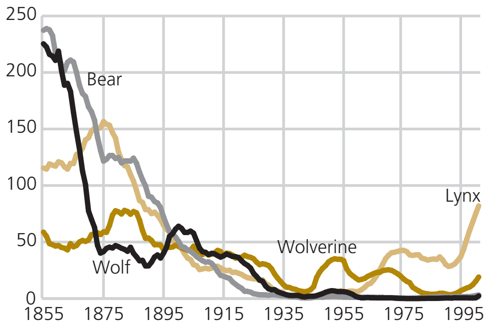


Source: Hunting statistics, Statistics Norway.

Cervids

- The numbers of forest-living cervids have risen considerably in the last 20-30 years, particularly as a result of clear-cutting and selective shooting.
- The grazing pressure exerted by large populations of cervids influences the vegetation, and this can affect the landscape and biological diversity.
- The total yield in 2000 was 5 043 tonnes of moose meat, 1 329 tonnes of venison and 259 tonnes of wild rein-deer meat (see also Appendix, table C3).

Figure 4.9. Number[1] of predators killed. 1885-2000



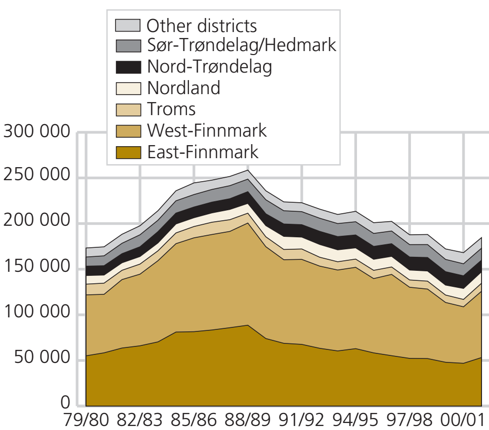
[1] Average number past ten years.
Source: Hunting statistics, Statistics Norway.

The large predators

- Relentless hunting of all four species of large predators had almost exterminated wolves and bears by the middle of the 20th century. Wolves and bears were protected throughout Norway in 1971 and 1973 respectively.
- In recent years, wolf numbers have recovered again in Scandinavia. It is uncertain whether they have spread southwards from northern Scandinavia and Russia or whether reproduction by the few resident animals that were never exterminated has raised their numbers.
- Today, licensed hunters are permitted to take wolverines in Norway, and lynx hunting is regulated by means of quotas (see also Appendix, table C4).

4.6. Reindeer husbandry

Figure 4.10. Trends in the size of the spring herd. 1979/80-2001/02

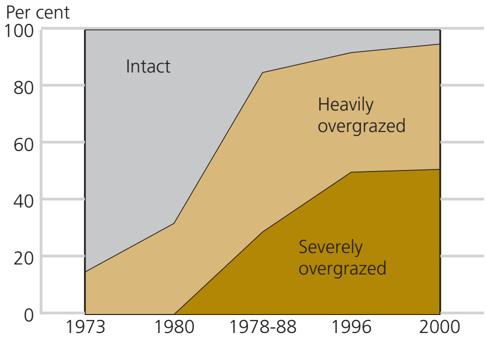


Source: Norwegian Reindeer Husbandry Association.

Geographical scope and economic importance

- Reindeer husbandry is a small sector in national terms, but shares user interests with others in an area equivalent to 40 per cent of the total area of Norway.
- There has been a large reduction in the size of the spring herd (animals that have survived the winter, before calving starts) in Finnmark since 1988-89. There is great pressure on reindeer owners to reduce the size of their herds because of overgrazing.
- The increase in the size of herds in Finnmark in the past year is due to a combination of a good calving season and low numbers of reindeer slaughtered.

Figure 4.11. State of lichen resources in Finnmark. 1973-2000



Source: NORUT.

Reindeer husbandry and the environment

- Parts of Finnmark have been so overgrazed that both the environment and the future of the industry are threatened.
- In 2000, half of the grazing areas were defined as severely overgrazed, more than 40 per cent as heavily overgrazed and only 5 per cent as intact. This indicates a dramatic deterioration compared with previous measurements, although the methods used are not entirely comparable.

4.7. Motor traffic in uncultivated areas

Table 4.1. Approval of applications for motor traffic in uncultivated areas, according to number of applications in municipality. 2001. Per cent

Number of applications processed by municipality	Number of municipalities	Share approved	Share of area in these municipalities	Share of pop. in these municipalities
All reporting municipalities	399	94	87	94
300-479	11	91	9	2
100-299	24	96	13	4
49-100	27	94	13	4
20-49	45	95	13	5
5-19	80	92	19	30
1-4	84	95	10	22
0	118	.	9	27
No response	46	..	13	6

Source: Statistics Norway (2002).

Motor traffic

- Motor traffic in uncultivated areas is in principle prohibited. However, under the Act relating to motor traffic on uncultivated land and in watercourses, local government authorities may grant exemptions from the Act, allowing the use of motor traffic for certain purposes. No data on actual traffic is available, but KOSTRA (a system for reporting and publishing local government information) provides information on the use of exemptions by local government authorities.
- In all, 94 per cent of all applications for exemption were granted in 2001. The number of applications processed was unevenly distributed among the municipalities, but this had little effect on the share of exemptions granted.

More information: Britta Hoem (forest balance), Astri Kløvstad (forest and game) and Svein Homstvedt (reindeer).

Useful websites

Statistics Norway forestry statistics: http://www.ssb.no/english/subjects/10/04/20/
Norwegian Institute for Land Inventory: http://www.nijos.no/
Norwegian Forest Research Institute: http://www.nisk.no/
The Living Forests Project: http://www.levendeskog.no/Engelsk_Default.asp

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UN-ECE/FAO (1995): *Forest Resource Assessment 1990*. Rome: Global synthesis, United Nations Economic Commission for Europe / Food and Agriculture Organization of the United Nations.

5. Fisheries, sealing, whaling and fish farming

The fisheries are based on conditionally renewable natural resources. Sound management of fish stocks is therefore of crucial importance for a high, stable long-term yield. Stocks of several important fish species in the North Sea are now low. This is particularly the case for stocks of demersal species such as cod and whiting. In the Norwegian and Barents Seas, the situation is less uniform. The capelin stock has been very low for a number of years, but has grown substantially in recent years. The spawning stock of Norwegian spring-spawning herring is now at a relatively high level. There has been a decline in the Northeast Arctic cod stock in recent years, and the spawning stock is now believed to have dropped below safe biological limits.

The Ministry of Fisheries' environmental action plan 2000-2004 (Ministry of Fisheries 1999) states that "Norway has the rights to and is responsible for some of the world's most productive fjord, coastal and marine areas. This provides a unique basis for economic growth based on nature's own production processes, the use of marine areas for aquaculture activities and the development of coast-based industries." The action plan emphasizes the importance of developing a coherent management system for marine resources and the aquaculture industry that takes the whole ecosystem into consideration. This means that interactions between different species (multispecies perspective) and environmental factors are taken into account, and that the precautionary principle is systematically incorporated. There are also other factors in the administration and distribution of fisheries resources - apart from the management of marine stocks - that must be considered by the authorities in the formulation of fisheries policy. These factors include the industry's need for raw materials, the structure of the fishing fleet and the distribution of quotas both geographically and among the various vessel classes.

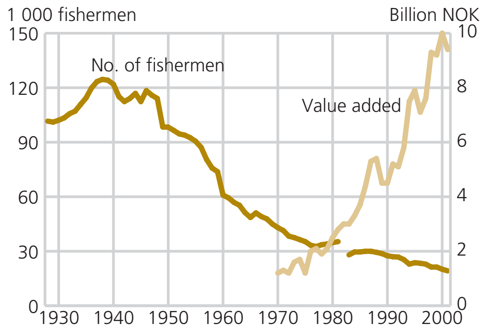
An important target for the fisheries authorities is to ensure that the marine environment is clean, and in particular to focus attention on radioactive pollution and various environmentally hazardous substances. These problems are often global or regional, requiring binding international cooperation.

The reasons behind the estimated stock trends for different fish species may be many and complex, but heavy fishing pressure and discards have been a problem for many years. Pollution from the petroleum industry and releases of radioactivity from Sellafield are other factors that may in the long term influence recruitment and thus stock trends. We do not have reliable information on the degree to which different pollution factors influence stock sizes (see Fosså 2002). Another important consideration is that such factors may have a negative effect on the reputation of Norwegian seafoods as first-class products, and thus in turn have economic effects.

In addition to environmental pressures caused by human activity, natural variations in climatic conditions have a major impact on stock trends. Often, fluctuations in one direction will be favourable for one species and fluctuations in the reverse direction for others. For example, lower water temperature in the Barents Sea is an advantage for capelin, whereas a rise in water temperature favours cod and herring.

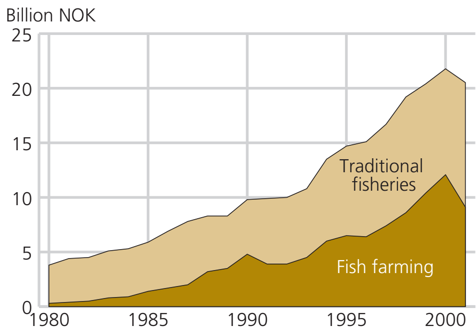
5.1. Principal economic figures for the fisheries

Figure 5.1. Value added in fisheries, sealing, whaling and fish farming in 1970-2001 and number of fishermen 1926-2001



Sources: Directorate of Fisheries and National Accounts, Statistics Norway.

Figure 5.2. First-hand value of catches in the traditional fisheries and fish farming. 1980-2001



Sources: Directorate of Fisheries and fisheries statistics, Statistics Norway.

GDP and employment

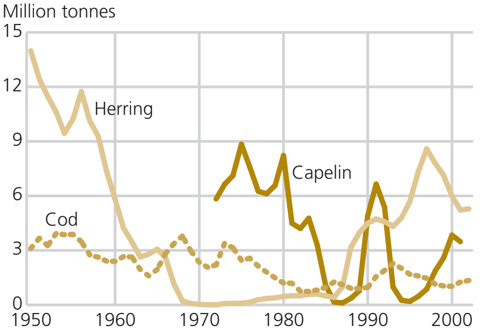
- According to the Norwegian National Accounts, fishing, sealing and whaling and fish farming contributed NOK 9.4 billion or 0.7 per cent to Norway's gross domestic product (GDP) in 2001. This is a slightly lower figure than in 2000.
- The fishing industry accounted for 0.7 per cent of total employment in 2001. At the end of 2001, about 19 000 fishermen were registered in Norway. The number of fishermen has dropped by about 85 per cent since the late 1930s. The fish farming industry employs about 4 000 people.

Production and prices

- Total production declined by almost 1 per cent in 2001. The prices obtained by the industry were also lower. In the fish farming industry, prices were about 20 per cent lower than in 2000, and problems arose particularly in the key EU market (Statistics Norway 2002a).
- In 2001, the first-hand value of catches in the traditional fisheries rose by 17 per cent, whereas it fell by almost 25 per cent in the fish farming industry.

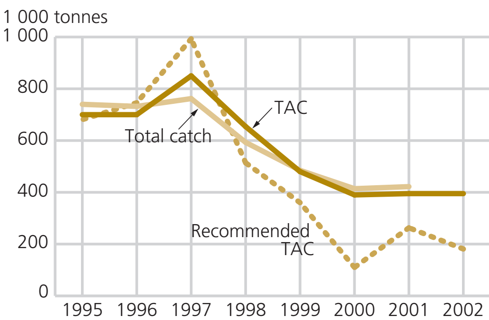
5.2. Trends in stocks

Figure 5.3. Trends for stocks of Northeast Arctic cod[1], Norwegian spring-spawning herring[2] and Barents Sea capelin[3]. 1950-2002



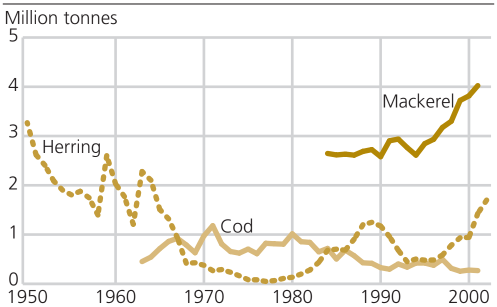
[1] Fish aged three years and over. [2] Spawning stock
[3] Fish aged one year and over.
Sources: International Council for the Exploration of the Sea (ICES) and Institute of Marine Research

Figure 5.4. Recommended TACs, TACs actually set and catches of Northeast Arctic cod. 1995-2002



Source: Institute for Marine Research.

Figure 5.5. Trends for stocks of cod[1] in the North Sea, North Sea herring[2] and mackerel[2,3]. 1950-2002



[1] Fish aged one year and over. [2] Spawning stock.
[3] Southern, western and North Sea mackerel.
Sources: International Council for the Exploration of the Sea (ICES) and Institute of Marine Research.

Barents Sea-Norwegian Sea

- The herring stock has shown a positive trend in recent years. In 2002, the spawning stock was estimated to be approximately 5.3 million tonnes, which is about the same level as the year before.
- The total stock of capelin in the Barents Sea as of 1 August 2001 was estimated to be 3.5 million tonnes. This is slightly lower than the year before.
- The total stock of Northeast Arctic cod was estimated to be a little over 1.3 million tonnes in 2002, about 100 000 tonnes higher than the year before.
- Since 1998, the TAC (total allowable catch) for Northeast Arctic cod has been considerably higher than the level recommended by marine scientists. The recorded catches correspond fairly closely to the TACs.
- The Norwegian-Russian Fisheries Commission has set an annual TAC of 395 000 tonnes for three years from 2001.
- The TAC for 2002 is more than twice as high as the recommended level.

North Sea

- In recent years, the North Sea herring stock has developed satisfactorily. The spawning stock in 2002 was calculated to be about 1.7 million tonnes.
- The cod stock is still low. The total stock is estimated to be just under 300 000 tonnes.
- The total spawning stock of mackerel has developed satisfactorily in recent years. It is now estimated to be about 4 million tonnes.

Box 5.1. Reference points for spawning stocks of some important fish species

The International Council for the Exploration of the Sea (ICES) and its Advisory Committee on Fishery Management (ACFM) have defined reference points for the levels of different species' spawning stocks. These are an important tool for the authorities in their efforts to take a precautionary approach to fisheries management. The critical reference point (B_{lim}), is the lowest of these, and is considered to be a danger level below which there is a high probability of poor recruitment to the spawning stock. The precautionary reference point (B_{pa})is somewhat higher, and can be interpreted as a warning level: if a spawning stock falls below this level, it is considered to be "outside safe biological limits", and the authorities should consider taking steps to allow the stock to recover to a higher and safer level. The table below shows B_{lim} and B_{pa} for some important stocks, and their estimated spawning stocks in 2001.

Stock	B_{lim} (critical reference point) 1 000 tonnes	B_{pa} (precautionary reference point) 1 000 tonnes	Estimated spawning stock 2001 1 000 tonnes
Northeast Arctic cod	112	500	300
Norwegian spring-spawning herring	2 500	5 000	5 220
North Sea herring	800	1 300	1 430
North Sea cod	70	150	50
North sea saithe	106	200	230
Mackerel (total stock)	*No biological basis for defining this*	2 300	4 020

Sources: Institute of Marine Research and ICES.

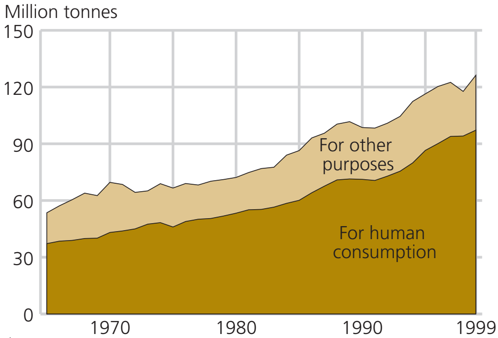
Box 5.2. More about stock trends

- In 2002, the stock of Norwegian spring-spawning herring was at about the precautionary level defined by marine scientists. The stock is well above the critical level of 2.5 million tonnes. The relatively strong 1998 year class is expected to make a substantial contribution to the spawning stock in the next few years.
- A continued decline in the total stock of capelin in the Barents Sea is expected as a result of weak recruitment. The 2002 year class can be characterised as medium (Institute of Marine Research 2002).
- The spawning stock of Northeast Arctic cod is around 400 000 tonnes, which is still somewhat below the precautionary level. Its future development will depend not only on catches in the fisheries, but also on interactions between the key species herring, capelin and cod in the ecosystem in the Barents Sea and on conditions in the marine environment. The stock of coastal cod is declining.
- After remaining at a low level for many years, the stock of North Sea herring rose steadily from 1980 onwards. However, from 1990 to 1996, the spawning stock dropped to considerably less than the 800 000 tonnes that is regarded as the critical level. In recent years, the trend has been positive, and the current spawning stock is well above the precautionary level.
- Several of the stocks of demersal fish in the North Sea have remained low for many years. However, more recently the saithe and haddock stocks have shown a positive trend. The cod stock in the North Sea has been heavily fished, and the spawning stock is about 50 000 tonnes, which is an all-time low. The spawning stock of whiting is also outside safe biological limits.
- For management purposes, the spawning stocks of mackerel from the three spawning grounds (the North Sea, south-west of Ireland and off Spain and Portugal) are now considered as one stock (North East Atlantic mackerel). These stocks mix on feeding grounds in the North Sea and Norwegian Sea. The largest component of the stock is found off Ireland. The North Sea component, which is the smallest of the three, has reached an all-time low.

Source: Iversen 2002. See also Box 5.1 and Appendix, table D1

5.3. Fisheries

Figure 5.6. World fisheries production[1], by main uses. 1965-1999



[1] The production data does not include marine mammals (seals, whales, etc.) or plants. Aquaculture is included.
Source: FAO.

World catches

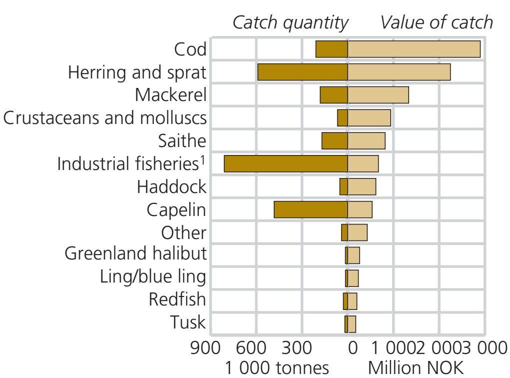
- Production in the world's fisheries, including both inland and marine catches and aquaculture production, has increased substantially: from slightly more than 50 million tonnes in 1965 to about 126 million tonnes in 1999.
- The proportion used for human consumption was 77 per cent. Table 5.1 shows production split by type.

Table 5.1. World fisheries production. 1999

	1 000 tonnes	Per cent
Total production	126 177	100
Capture fisheries, marine	84 606	67.1
Capture fisheries, inland	8 260	6.5
Aquaculture (fish, crustaceans, etc.) in marine waters	13 287	10.5
Aquaculture (fish, crustaceans, etc.) in inland waters.	20 023	15.9

Kilder: FAO (2001a, 2001b, 2001c).

Figure 5.7. Norwegian catches by groups of fish species, molluscs and crustaceans. 2001

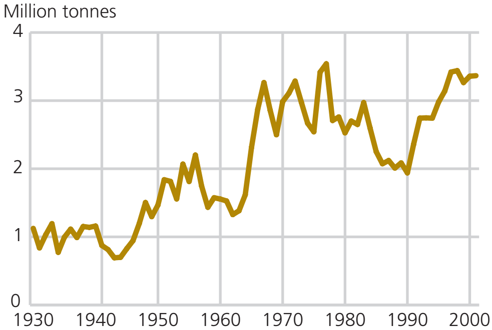


[1] Includes greater and lesser silver smelt, Norway pout, sandeel, blue whiting and horse mackerel.
Source: Directorate of Fisheries.

Norwegian catches

- In 2001 the total catch in Norwegian fisheries (including crustaceans, molluscs and seaweed) was 2.85 million tonnes, and the value of the catch was NOK 11.4 billion. The total catch was about 40 000 tonnes lower than in 2000, but the value was about NOK 1.6 billion higher.
- Cod is the species with the highest catch value.
- Measured by catch size, industrial fisheries for species such as Norway pout, blue whiting and sandeels dominated. The catch of blue whiting totalled 573 000 tonnes.

Figure 5.8. Catches[1] in Norwegian fisheries. 1930-2001



[1] Including fish farming.
Source: Fisheries statistics, Statistics Norway and Directorate of Fisheries.

- The total catch in Norwegian fisheries is now 2-3 times higher than in the 1930s.
- Total production in the fisheries and fish farming in 2001 was about 3.4 million tonnes.
- The highest production level in the period 1930-2001 was 3.5 million tonnes in 1977. In the same year, more than 2 million tonnes capelin was caught.

Box 5.3. World catches and Norwegian catches

Catches in the world's marine fisheries rose by almost 6 million tonnes (7 per cent) from 1998 to 1999, while inland fisheries rose by about 300 000 tonnes (4 per cent). The rise in the yield from marine fisheries is explained by the fact that several stocks in the Southeast Pacific have increased again after being affected by the atmospheric phenomenon El Niño in 1997-1998. Total landings of anchoveta and Chilean jack mackerel rose from 3.8 million tonnes in 1998 to 10.1 million tonnes in 1999. In 1999, catches of these two species corresponded to a little less than four times the total catch in Norwegian fisheries. There were no dramatic changes in catches in other marine areas. World aquaculture production (excluding plants) rose by about 1.5 million tonnes (7 per cent).

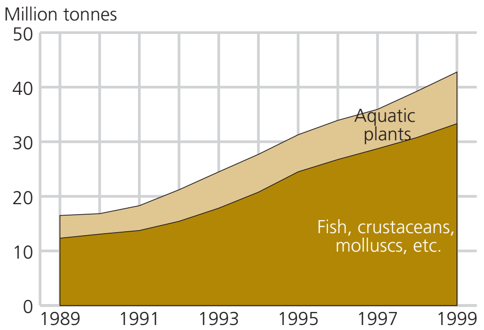
Norway ranks as number 10 among the world's largest fishing nations (excluding farmed production), with a total catch of 2.62 million tonnes in 1999. At the head of the list are China (17.2 million tonnes), Peru (8.4 million tonnes), Japan (5.2 million tonnes), Chile (5.1 million tonnes), and the United States (4.7 million tonnes). See Appendix, tables D7 and D8.

In the Norwegian fisheries, there was a considerable drop in the catch of herring (rather more than 200 000 tonnes), but the value of the catch nevertheless rose by about NOK 800 million to NOK 2.2 billion. The catch of cod was about 10 000 tonnes lower than in 2000, and the value of the catch dropped by about NOK 20 million to NOK 2.9 billion. The mackerel catch rose by about 6 000 tonnes and its value was NOK 1.3 billion. The catch of capelin rose from 375 000 tonnes to 480 000 tonnes. The shrimp catch was 62 000 tonnes and its value was NOK 840 million.

See figure 5.8 and Appendix, table D2.

5.4. Aquaculture

Figure 5.9. World aquaculture production. 1989-1999

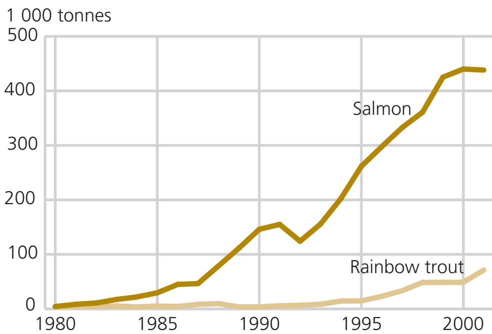


Source: FAO.

World aquaculture production

- In 1999, world aquaculture production totalled 33.3 million tonnes of fish, crustaceans, molluscs, etc., or about 36 per cent of total catches in marine and inland fisheries.
- World aquaculture production has more than doubled since 1989.

Figure 5.10. Fish farming. Sales of slaughtered salmon and rainbow trout. 1980-2001



Sources: Fisheries statistics, Statistics Norway and Directorate of Fisheries.

Salmon and trout farming in Norway

- Production of farmed salmonids has increased dramatically since the industry was established in the early 1970s. However, there was a moderate decrease in the quantity of slaughtered salmon sold from 440 000 tonnes in 2000 to 438 000 tonnes in 2001. Prices were generally poor in 2001.
- Sales of trout rose to about 71 000 tonnes in 2001.
- Norwegian production of Atlantic salmon in 2000 accounted for about half the total global production of this species (884 000 tonnes). Over 80 per cent of farmed salmon is exported.

Box 5.4. More about aquaculture production

Globally, freshwater production accounted for 58 per cent (19.4 million tonnes) of total aquaculture production of animal species in 1999 (see also table 5.1). Production of aquatic plants totalled 9.5 million tonnes, mainly in marine waters. China is by far the largest aquaculture producer, accounting for almost 70 per cent of total production (animals and plants) in 1999. The species farmed in the largest volume in 1999 was the Pacific oyster (3.6 million tonnes), followed by a number of species of carp. On a list of 29 farmed species of which over 100 000 tonnes were produced in 1999, Atlantic salmon ranked tenth and mussels fifteenth (FAO 2001a).

Although salmon is the dominant species in Norwegian fish farming in terms of both volume and value, there is also increasing interest in several other species. *Mussel farming* is gaining ground: after remaining at 300-400 tonnes for some years, annual production rose to 1 200 tonnes in 2001. There is a very large potential for the production of mussels in Norwegian waters, both from a biological and environmental point of view and in terms of resources. Some very optimistic analyses suggest that mussel production could approach 200 000 tonnes as early as 2010 (Karlsen et al. 2000 and Glette et al. 2002). On a global basis, 500 000 tonnes of mussels were produced in 1999 (FAO 2001a). Other bivalve species of interest to Norwegian aquaculture are *scallops* and *oysters* (European oyster (*Ostrea edulis*) and Pacific oyster (*Crassostrea gigas*)), although current production of these species is modest.

Sea urchins - a group not exploited at all in Norway so far - are also attracting interest in the aquaculture industry, although activities in Norway are still at the research and testing stage. Sea urchins have been in focus in Norway mostly because of increasing stocks causing depletion of kelp forests, one of the most biologically diverse habitats along the Norwegian coast.

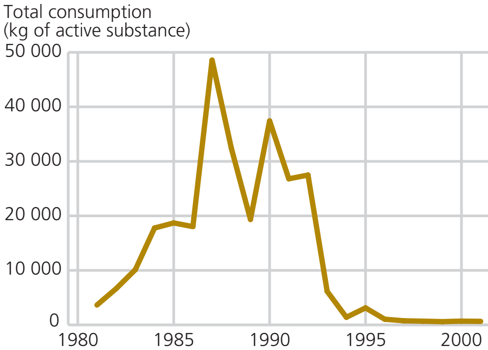
Other species of fish, such as cod, halibut, turbot, wolf-fish and Arctic char, will probably become more important to the aquaculture industry in the years ahead. However, production of these species for human consumption is still relatively modest in volume. In 2000, 282 tonnes of farmed Arctic char, 170 tonnes of cod and 560 tonnes of halibut were sold in Norway (Statistics Norway 2002b).

Box 5.5. Some important diseases and health problems associated with fish farming

The information on the incidence of these diseases in salmon farms in 2001 is based on figures from Glette et al. 2002. Serious diseases include the following:
- Furunculosis, caused by the bacterium *Aeromonas salmonicida* (new cases registered in 2001: 3 fish farms).
- Bacterial kidney disease (BKD), caused by the bacterium *Renibacterium salmoninarum* (new cases registered in 2001: 3 fish farms).
- Infectious salmon anaemia (ISA), a virus disease (new cases registered in 2001: 21 fish farms).
- Infectious pancreatic necrosis (IPN), a virus disease (IPN), (new cases registered in 2001: 46 fish farms).
- Winter ulcers, a common disease caused by bacteria: no figures available on its incidence.

The *salmon louse* (a parasitic crustacean which lives in salt water and drops off the salmon after a short period in fresh water) is still the most important cause of losses in the salmon farming industry. Annual losses can be as high as NOK 500 million. The parasite is controlled by chemical means using delousing preparations (e.g. hydrogen peroxide), by means of medicated feed, or biologically, using wrasses (goldsinny, corkwing, ballan wrasse and rock cook are species commonly used). Salmon lice can cause poor growth, injury to salmon and secondary infections followed by outbreaks of disease. The parasite can also be a threat to wild salmon and sea trout stocks (Karlsen et al. 2000, Kristiansen et al. 1999). It is particularly dangerous to smolt (young salmon) as they migrate from the rivers into the fjords. According to fisheries statistics (Statistics Norway 2002b), sea-water rearing units lost 7 million fish (salmon) to disease in 2000. Total losses were 17 million fish, and the other main causes were escapes (0.3 million) and other reasons (including injury, predators, discards due to wounds or defects, theft, etc: 10 million).

Figure 5.11. Consumption of medicines (antibacterial agents) in fish farming. 1982-2001



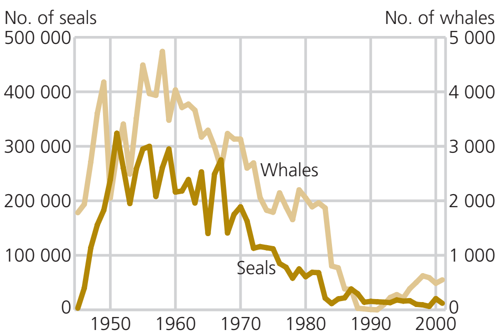
Source: Norwegian Institute of Public Health.

Fish health in salmon farming

- There has been a considerable improvement in the salmon health situation, and the use of medicines has been dramatically reduced over the last few years (see Appendix, table D3). New vaccines and improved operational procedures are probably the main reasons for these improvements.
- The consumption of antibacterial agents was highest in 1987, when it reached 49 tonnes. In 2001, consumption was 645 kg.

5.5. Sealing and whaling

Figure 5.12. Norwegian catches of seals and small whales[1]. 1945-2001



[1] 1988-1992: scientific whaling only.
Source: Directorate of Fisheries.

- According to preliminary figures for 2001, the total catch was 12 020 animals (8 192 harp seals and 3 828 hooded seals). The catch in the West Ice includes both hooded seals and harp seals (2 992), whereas in the East Ice it consists entirely of harp seals (5 200). The value of the catch in 2001 was NOK 2.9 million.
- The quota for the small whale hunt in 2001 was 549 animals, and the catch was 552 animals. The quota for 2002 was set at 674 animals. The value of the small whale catch in 2001 was about NOK 27 million.

Box 5.6. Sealing and whaling

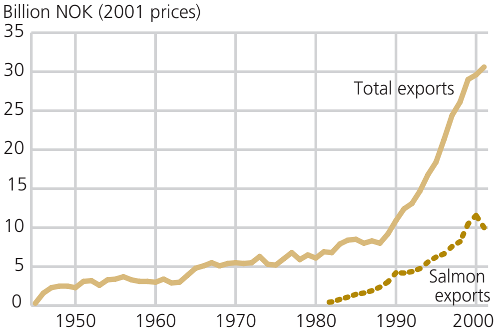
Norwegian *sealing* has essentially been based on two species, harp seals and hooded seals, and has taken place in the Newfoundland area (until 1983), the West Ice (off Jan Mayen) and the East Ice (drift ice areas at the entrance to the White Sea). The most recent estimates for stocks of harp seals are 360 000 year-old and older animals in the West Ice and about 1.7 million in the East Ice. The stock of hooded seals in the West Ice is about 100 000 animals (Iversen 2002). Since the early 1980s, catches of seals have been small, varying between 10 000 and 40 000 animals per season.

Norwegian catches of *small whales* have consisted mainly of minke whales. The traditional commercial hunt was discontinued after the 1987 season, but was resumed in 1993, when 226 whales were taken.

The *Northeast Atlantic minke whale stock* (which includes animals on the whaling grounds in the North Sea, along the Norwegian coast, in the Barents Sea and off Svalbard) is calculated to be 112 000 animals. The *Central Atlantic minke whale stock* (Central Atlantic, Iceland, Jan Mayen) is calculated to be 72 000 animals, 12 000 of which are in the Jan Mayen area (Iversen 2002).

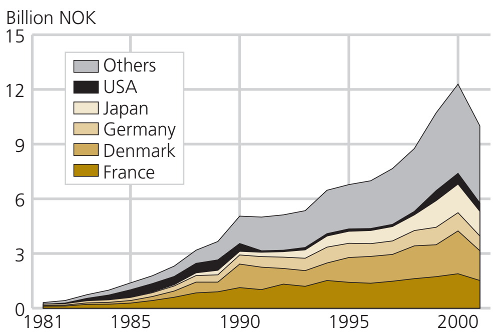
5.6. Exports

Figure 5.13. Value of Norwegian fish exports. 1945-2001



Source: External trade statistics, Statistics Norway.

Figure 5.14. Salmon exports[1], by main purchasing countries. 1981-2001. Current prices



[1] Mainly farmed salmon, but other salmon is also included.
Source: External trade statistics, Statistics Norway.

- In 2001, Norway exported about 2.0 million tonnes of fish and fish products to a value of NOK 30.6 billion (see Appendix, tables D4 and D5). Exports to EU countries accounted for 55 per cent of the total.
- According to the FAO, Norway was in 1999 the world's next largest exporter of fish in terms of value behind Thailand, and ahead of Denmark, China, and the United States. The value of Norway's fish exports corresponded to about 7 per cent of the value of total world fish exports (see Appendix, table D7).
- Salmon exports totalled NOK 10.0 billion in 2001. This is a drop of NOK 2 billion from 2000 (see Appendix, table D6).
- For many years, France and Denmark have been the most important purchasers of Norwegian farmed salmon, but exports to these countries and to the rest of the EU dropped considerably in 2001. Exports to Denmark totalled NOK 1.6 billion in 2001, as compared with NOK 2.3 billion in 2000. Exports to France totalled NOK 1.5 billion in 2001.

More information: Frode Brunvoll.

Useful websites

International Council for the Exploration of the Sea: http://www.ices.dk/
FAO - UN Food and Agriculture Organization: http://www.fao.org/
Directorate of Fisheries: http://www.fiskeridir.no/
Institute of Marine Research: http://www.imr.no/
Statistics Norway - Fishery statistics: http://www.ssb.no/english/subjects/10/05/

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6. Air pollution and climate

Norwegian emissions to air contribute to a variety of environmental problems. One of the most serious of these is climate change as a result of the enhanced greenhouse effect. Norway's greenhouse gas emissions have risen by 8 per cent since 1990, and have now reached the highest level ever recorded. Other problems related to emissions to air are acidification, depletion of the ozone layer and the formation of ground-level ozone. Norway is a party to a number of multilateral environmental agreements, and under these has agreed to reduce its emissions of the most important pollutants.

Many substances that are emitted to air can contribute to environmental problems or be harmful to health. Emissions may have effects locally where they occur, but may also have effects across national borders (see boxes 6.2 and 6.3). Multilateral environmental agreements are very important as a means of reducing emissions that have regional or global effects. Various protocols under the Convention on Long-range Transboundary Air Pollution (LRTAP) apply to a number of substances that have regional effects. The Gothenburg Protocol, for example, is intended to reduce acidification, eutrophication and the formation of ground-level ozone by introducing emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x) and NMVOCs (non-methane volatile organic compounds). Climate change and depletion of the ozone layer are serious global environmental problems. The Montreal Protocol has helped to bring about substantial reductions in the use of ozone-depleting substances in the industrial countries. The Kyoto Protocol (see boxes 6.5 and 6.6) may be a first step on the way to reducing global emissions of greenhouse gases. Norway has ratified the Kyoto Protocol, but before it can enter into force, the protocol must be ratified by industrialized countries that accounted for at least 55 per cent of the world's CO_2 emissions in 1990. The Storting has also decided that emissions are to be limited by means of a combination of a domestic emissions trading system to be introduced from 2005 onwards and a continuation of the current CO_2 tax (see box 6.7).

Under multilateral environmental agreements, Norway has undertaken commitments to limit or reduce emissions of most of the pollutants listed in box 6.2. Air quality guidelines have been drawn up for pollutants that have local effects on health, and the local authorities are responsible for ensuring that these are respected. An emission inventory (box 6.1) makes it possible to identify the major sources of each pollutant and to follow emission trends over time. This information is important when considering which measures to implement and evaluating their effects.

Greenhouse gas emissions in Norway are now rising again after dropping briefly in 2000. Since 1990 (the base year for the Kyoto Protocol) they have risen by 8 per cent, and are now higher than ever before. This is mainly due to a rise in CO_2 emissions.

NO_x and NH_3 contribute to acid rain, and NMVOCs and NO_x are involved in the formation of ground-level ozone. Emissions of all these gases must be substantially reduced by 2010 if Norway is to meet its commitments under the Gothenburg Protocol.

Emissions of persistent organic pollutants (POPs) and heavy metals to air were lower in 2000 than in 1990. There has been a particularly large reduction in emissions of lead as leaded petrol has been phased out of the market. Emissions of dioxins in Norway were also considerably reduced in the period 1990-2000, mainly because stricter emission standards brought about cuts in industrial emissions and a few enterprises where emissions were high were closed down. Two protocols under the LRTAP Convention apply to POPs and heavy metals. They include specific obligations for polycyclic aromatic hydrocarbons (PAHs), lead, cadmium, mercury and dioxins.

Box 6.1. The Norwegian emission inventory

Norway's emission inventory is produced by Statistics Norway and the Norwegian Pollution Control Authority. The inventory includes all the most important pollutants that cause environmental problems such as climate change, acidification and the formation of ground-level ozone, and also includes several persistent organic pollutants (POPs) and heavy metals. The inventory covers only anthropogenic emissions, not natural emissions for example from oceans and forests.

Emission figures are compiled partly from data reported by industrial plants, based on measurements or calculations at these plants, and partly from calculations using activity data and emission factors. Activity data may include consumption of energy commodities (e.g. fuel oil consumption by manufacturing industries and households) or other data such as the number of sheep put out to pasture, the quantity of waste landfilled, the quantity of ferro-alloys manufactured, etc.

In 2002, national emission figures for 2001 were published. These were preliminary figures based on last year's calculations, in addition to emission figures reported by large enterprises and the activity data available in 2002. Experience shows that these emission figures are good estimates for most pollutants at national level.

The 2000 figures are also considered to be preliminary figures. This is because auditing of the energy accounts, which are a very important source of data for the emission inventory, takes about eighteen months to complete. However, we would normally only expect minor adjustments between the preliminary figures for 2000, which are being published now, and the final figures, which will be published in 2003.

Time series for the national emission figures and emissions split by source, sector, county and municipality are also available on Statistics Norway's website at: http://www.ssb.no/english/subjects/01/04/10/

For documentation of the emission inventory, see Flugsrud et al. (2000).

Box 6.2. Harmful effects of air pollutants

Component	Important sources[1]	Effects
Ammonia (NH_3)	Agriculture	Contributes to acidification of water and soils.
Ground-level ozone (O_3)	Formed by oxidation of CH_4, CO, NO_x and NMVOCs (in sunlight)	Increases the risk of respiratory complaints and damages vegetation
Benzene (C_6H_6)	Combustion and evaporation of petrol and diesel, fuelwood use	Carcinogenic, toxic effects on acute exposure to high concentrations.
Lead (Pb)	Road traffic, air traffic, waste incineration, mineral production	Environmentally hazardous. No damage to health at concentrations currently found in air in Norway, but because lead accumulates in living organisms, formerly high emissions still constitute a health hazard.
Dioxins	Metal production, pulp and paper industry, fuelwood use, shipping and waste incineration	Becomes concentrated in organisms and food chains. Carcinogenic.
Non-methane volatile organic compounds (NMVOCs)	Oil and gas activities, road traffic, solvents	May include carcinogenic substances. Contribute to formation of ground-level ozone.
Hydrofluorocarbons (HFCs)	Cooling fluids	Enhance the greenhouse effect.
Hydrochlorofluorocarbons (HCFCs)	Cooling fluids	Deplete the ozone layer.
Cadmium (Cd)	Pulp and paper industry, mineral production, metal production, fuelwood use	Liable to bioaccumulate. Delayed effects such as pulmonary emphysema, cancer, reduced fertility in men and kidney damage.
Carbon dioxide (CO_2)	Combustion of fossil fuels, changes in land use anddeforestation	Enhances the greenhouse effect.
Carbon monoxide (CO)	Combustion (fuelwood, road traffic)	Increases risk of heart problems in people with cardiovascular diseases.
Chlorofluorocarbons (CFCs)	Cooling fluids	Deplete the ozone layer.
Mercury (Hg)	Pulp and paper industry, mineral production, metal production, fuelwood use	Becomes concentrated in organisms and food chains. Causes kidney damage and harms nervous system. May cause cellular changes.
Nitrous oxide (N_2O)	Agriculture, fertilizer production	Enhances the greenhouse effect.
Methane (CH_4)	Agriculture, landfills,production, transport and use of fossil fuels	Enhances the greenhouse effect and contributes to formation of ground-level ozone.
Nitrogen oxides (NO_x)	Combustion (industry, road traffic)	Increase the risk of respiratory disease (particularly NO_2). Contribute to acidification, corrosion and formation of ground-level ozone.
Perfluorocarbons (PFCs: CF_4 and C_2F_6)	Aluminium production	Enhance the greenhouse effect.
Polycyclic aromatic hydrocarbons (PAHs)	All incomplete combustion of organic material and fossilfuels, solvents, aluminium production	Several are carcinogenic.
Particulate matter ($PM_{2,5}$ and PM_{10})	Road traffic and fuelwood use	PM_{10}: particles measuring less than 10 μm in diameter, $PM_{2,5}$: particles measuring less than 2.5 μm in diameter. Increase the risk of respiratory complaints.
Sulphur dioxide (SO_2)	Combustion, metal production	Increases the risk of respiratory complaints. Acidifies soil and water and causes corrosion.
Sulphur hexafluoride (SF_6)	Magnesium production	Enhances the greenhouse effect.

[1] The table indicates important anthropogenic sources. There are also major natural sources for several of these components.

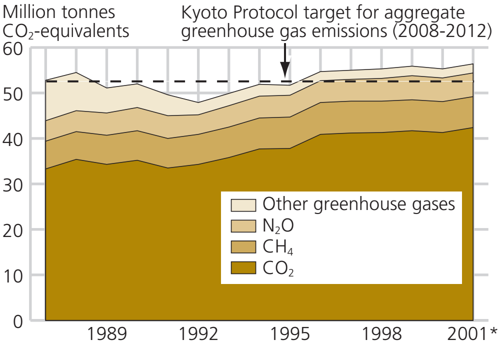
Box 6.3. Environmental problems caused by air pollution

Enhanced greenhouse effect	As a result of the natural greenhouse effect, the global mean temperature is about 15°C instead of -18 °C. But anthropogenic emissions of gases such as CO_2, CH_4, N_2O and fluorine-containing gases can cause further warming. Since 1750, concentrations of the three most important greenhouse gases, CO_2, CH_4 and N_2O, have risen by 31, 151 and 17 per cent respectively (IPCC 2001). (Norway's total direct greenhouse gas emissions are shown in figure 6.1.)
Climate change	Anthropogenic emissions of greenhouse gases, SO_2 and particulate matter can alter the natural chemical composition of the atmosphere. This in turn may accelerate changes in the global climate system. It is difficult to quantify what proportion of climate fluctuations is a result of human activity. However, the evidence that most of the global warming that has been observed in the last 50 years is anthropogenic has become stronger (IPCC 2001). Variations in global mean temperature are shown in Chapter 1.
Depletion of the ozone layer	The atmospheric ozone layer is found in the stratosphere, 10-40 km above the earth, and prevents harmful ultra-violet (UV) radiation from the sun from reaching the surface of the earth. Episodes when the ozone content of the stratosphere is very low and the levels of UV radiation reaching the earth are high have been observed above Antarctica. Observations have also shown that the ozone content of the stratosphere above middle and northern latitudes has dropped. The causes of ozone depletion include anthropogenic emissions of CFCs, HCFCs, halons and other gases containing chlorine and bromine, all of which can break down ozone in the presence of sunlight. Depletion of the ozone layer increases the amount of UV radiation reaching the earth, and may result in a higher incidence of skin cancer, eye injury and damage to the immune system. In addition, plant growth both on land and in the sea (algae) may be reduced (SSB/SFT/DN 1994). (For imports of ozone-depleting substances to Norway, see figure 6.13.)
Ground-level ozone	Ozone in the lower atmosphere is a pollution problem because it has adverse effects on health, vegetation and materials. Ground-level ozone is formed by oxidation of CH_4, CO, NO_x and NMVOCs in the presence of sunlight. It may also be transported to Norway from other parts of Europe. The number of pollution episodes[1] was low in 2001 compared with figures for the previous ten-year period. The highest hourly mean concentration in 2001 was 144 µg/m^3 (Norwegian Institute for Air Research 2002a). No measuring station recorded above 160 µg/m^3, which is the Norwegian Pollution Control Authority's population warning threshold.
Acidification	Total emissions of SO_2 and NO_x are lower in Norway than in most other European countries. Sulphur and nitrogen compounds acidify soils and water, and are also transported for considerable distances with air currents. The extent of the damage depends on the type of soil and vegetation. Lime-rich soil can for example withstand acidification better than other soil types because it weathers to release calcium. Many parts of Norway have lime-poor soils and sensitive vegetation, and the impact of acid rain is greater than in many other areas where deposition of acid components is higher. Fresh-water organisms have suffered the most serious damage, and the effects have been observed particularly in Southern Norway, the southern parts of Western Norway, and Eastern Norway. Sør-Varanger municipality in Finnmark suffers the effects of acid rain from sources in Russia. Acid rain increases leaching of nutrients and metals (especially aluminium) from soils and can cause corrosion damage to buildings. (For deposition of sulphur and nitrogen compounds in Norway, see section 6.2.)

[1] Number of days when one measuring station records a maximum hourly mean concentration of 200 µg/m^3 or several measuring stations record an hourly mean concentration of more than 120 µg/m^3.
Sources: IPCC (2001) and Norwegian Pollution Control Authority/Directorate for Nature Management (1999).

6.1. Greenhouse gases

Figure 6.1. Total emissions of greenhouse gases in Norway. 1987-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Aggregate greenhouse gas emissions

- After dropping briefly in 2000, greenhouse gas emissions rose by 2 per cent in 2001. The overall rise since 1990, the base year for the Kyoto Protocol, is 8 per cent.
- Emissions in 2001 were the highest ever registered, and oil and gas extraction and road traffic contributed most to the rise from 2000 to 2001.

Box 6.4. Greenhouse gases and global warming potential

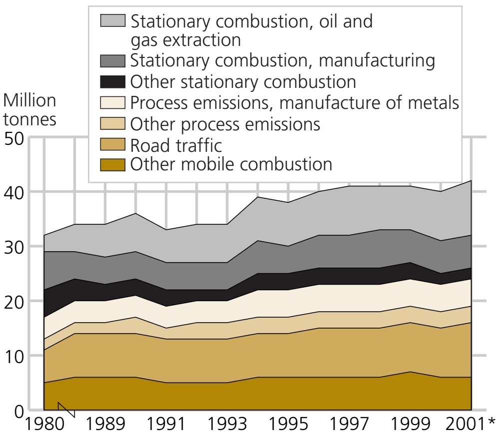
The three most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Anthropogenic emissions of CO_2 are mainly associated with the combustion of fossil fuels, but are also generated by various chemical processes in manufacturing industries. Methane is formed mainly by decomposition of biological waste in landfills and by livestock (agriculture). Manure and the use and production of commercial fertilizers are the main sources of N_2O emissions in Norway.

The GWP value (Global Warming Potential) of a gas is defined as the cumulative impact on the greenhouse effect of 1 tonne of the gas compared with that of 1 tonne of CO_2 over a specified period of time (usually 100 years). GWP values are used to convert emissions of greenhouse gases to CO_2 equivalents. The list below shows GWP values for greenhouse gases emitted by Norway to which the Kyoto Protocol applies. The time horizon used here is 100 years.

Substance:	GWP value:
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFC)	
HFC-23	11 700
HFC-32	650
HFC-125	2 800
HFC-134a	1 300
HFC-143a	3 800
HFC-152a	140
Perfluorocarbons (PFC)	
CF_4 (PFC-14)	6 500
C_2F_6 (PFC-116)	9 200
C_3F_8 (PFC-218)	7 000
Sulphur hexafluoride (SF_6)	23 900

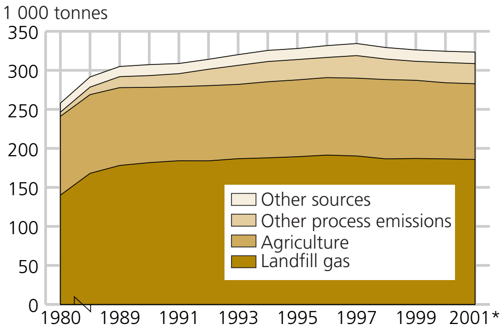
The Kyoto Protocol sets out binding targets for greenhouse gas emissions by industrialized countries (see box 6.5). In addition to CO_2, CH_4 and N_2O, the Protocol applies to sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Figure 6.2. Emissions of CO_2 by source. 1980-2001*



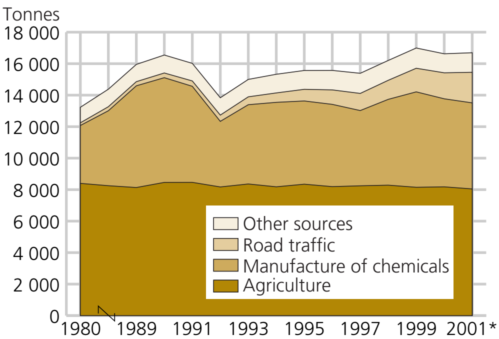
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.3. Emissions of CH_4 by source. 1980-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.4. Emissions of N_2O by source. 1980-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Carbon dioxide (CO_2)

- In 2001, CO_2 emissions totalled 42.4 million tonnes: this is a rise of almost 3 per cent from 2000 and somewhat more than 20 per cent since 1990.
- The most important sources of CO_2 emissions are road traffic, oil and gas extraction, combustion in manufacturing industries and process emissions from metal production.
- In 2001, CO_2 accounted for three quarters of Norway's aggregate greenhouse gas emissions, and the proportion has risen since 1990.

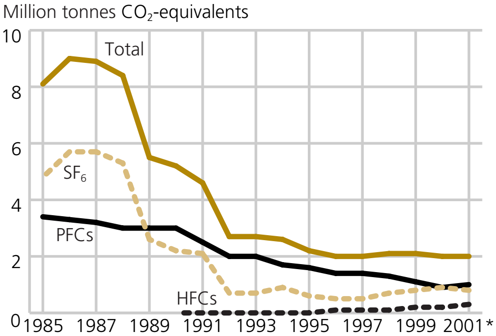
Methane (CH_4)

- In 2001, CH_4 emissions totalled 323 400 tonnes, which is about the same as the year before. There has been a moderate rise in emissions since 1990.
- The most important sources of CH_4 emissions are landfills, which account for more than half of Norwegian emissions, and agriculture (livestock and manure).
- In 2001, CH_4 accounted for 12 per cent of Norway's aggregate greenhouse gas emissions.

Nitrous oxide (N_2O)

- In 2001, N_2O emissions totalled 16 700 tonnes, which is about the same as the year before and in 1990.
- The most important sources of N_2O emissions are agriculture and the manufacture of commercial fertilizer. The marked drop in emissions from 1991 to 1992 is explained by a cut in emissions from fertilizer manufacturing as a result of technological improvements.
- In 2001, N_2O accounted for 9 per cent of Norway's aggregate greenhouse gas emissions.

Figure 6.5. Total emissions of other greenhouse gases (HFCs, PFCs and SF_6). 1985-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Other greenhouse gases

- In 2001, emissions of sulphur hexafluoride (SF_6) totalled 32 tonnes, which is a drop of 14 per cent from 2000. Emissions of perfluorocarbons (PFCs) rose by 11 per cent to 151 tonnes. Emissions of hydrofluorocarbons (HFCs) totalled 135 tonnes, a rise of 21 per cent.
- The most important sources of SF_6 and PFC emissions are the process industry (magnesium and aluminium production). The most important source of HFC emissions is leakages from cooling equipment.
- Measured in CO_2 equivalents, these pollutants accounted for 4 per cent of Norway's aggregate greenhouse gas emissions in 2001.

Box 6.5. The Kyoto Protocol

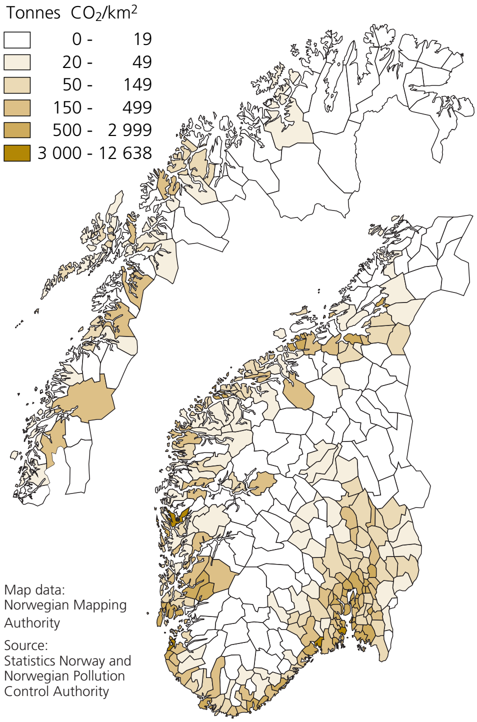
The Kyoto Protocol sets a ceiling for greenhouse gas emissions from industrialized countries for the period 2008-2012. Emissions from developing countries are not limited in this period, but negotiations on commitments for the period after 2012 are to start by 2005 at the latest. The Protocol sets out an emissions target for each industrialized country, in effect an annual quota. This also entitles each country to issue the corresponding number of tradable emissions permits. If a country wishes to emit more than its quota, it can buy emissions permits from another country (this is known as emissions trading). In addition, industrialized countries can acquire further permits by funding approved emission reduction projects in developing countries. Finally, emission permits can be obtained from projects to enhance carbon sinks in forests.

Norway ratified the Kyoto Protocol on 30 May 2002. The Protocol will enter into force when it has been ratified by industrialized countries that accounted for at least 55 per cent of total emissions from the industrialized countries in 1990. Now that the Protocol has been ratified by parties including the EU, Japan and several Eastern European countries, only ratification by Russia is needed for it to enter into force. It will probably become clear whether Russia will ratify the Protocol in the course of 2003. The US President has declared that the USA will not ratify the Protocol.

Under the Protocol, Norway has an annual emission allowance of 52.5 million tonnes CO_2 equivalents. According to Report No. 54 (2000-2001) to the Storting, Norway's annual emissions in the period 2008-2012 may in fact be as much as about 63.5 million tonnes CO_2 equivalents. Instead of taking steps to reduce domestic emissions, Norway has the option of buying emission permits for 11 million tonnes CO_2 equivalents. Given a permit price of NOK 40 per tonne CO_2 , which is used as a basis for discussion in the white paper, Norway could meet its commitments at a price of NOK 440 million per year. This corresponds to less than a thousandth of Norway's national income.

Now that the USA has withdrawn from the Kyoto Protocol, it seems unlikely that the quantitative commitments set out in it will have a significant effect on overall emissions. This is because Russia, Ukraine and other countries in Eastern Europe and the former Soviet Union have experienced a sharp drop in energy use, and therefore in greenhouse gas emissions, since the collapse of Communism. However, the emission ceilings these countries were assigned for the first commitment period (2008-2012) were not correspondingly reduced. For Russia and Ukraine, for example, the Kyoto commitment is the same as their 1990 emissions. These countries will therefore be able to sell a large number of emission permits without having to make any emissions reductions themselves (see e.g. Böhringer 2002). The emission projections from the IEA's World Energy Outlook 2000 show that the surplus credits available on the market will be more than enough to make up the shortfall in the EU, Japan and Norway, so that these countries will not need to reduce their emissions either. On the other hand, the reference and high economic growth scenarios in the most recent emission projections from the US Department of Energy indicate that the surplus permits will not be sufficient to make up the shortfall even though the necessary net emission reduction is at most two per cent of global emissions.

Figure 6.6. Emissions of CO_2 in 1999, by municipality



Map data:
Norwegian Mapping Authority

Source:
Statistics Norway and Norwegian Pollution Control Authority

Greenhouse gas emissions at local level

- CO_2 is the most important component of greenhouse gas emissions in all counties, although methane accounts for a substantial proportion of emissions in certain agricultural counties.
- Manufacturing, road traffic, agriculture and landfills are the largest sources of greenhouse gas emissions in most municipalities.
- Emissions of CO_2, CH_4 and N_2O have risen by an average of 15 per cent in Norwegian municipalities from 1991 to 1999.
- More than one third of Norway's CO_2 emissions take place at sea and in its airspace, and are generated mainly by the oil and gas industry and shipping.

Box 6.6. The Kyoto mechanisms and a Norwegian emissions trading scheme

Emissions trading

Countries that have undertaken commitments may trade emissions credits among themselves. A country that can reduce emissions to below the target set out in the Protocol at relatively low cost may sell credits to countries where the cost of achieving the target is relatively high. Countries that sell credits must reduce their emissions *more* than the Protocol requires, and purchasing countries can reduce them *less*.

Joint implementation

Two countries that have undertaken commitments to reduce emissions may agree that reductions financed by one country and carried out in the other are to be credited to the investor's emission inventory. Since the cost of reducing emissions varies widely between countries, this is a more cost-effective solution than requiring all countries to carry out emission reductions within their own borders.

The clean development mechanism (CDM)

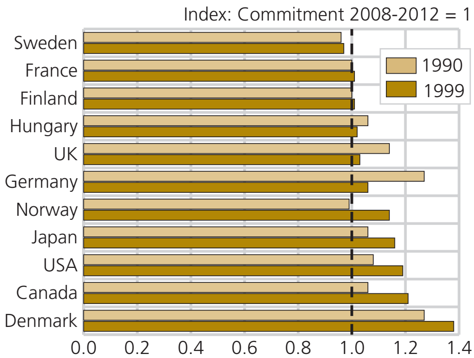
Similar to joint implementation, but CDM is applicable in cases where one party has undertaken a commitment to reduce emissions and the other has not.

Domestic emissions trading scheme for Norway

The Storting has decided that Norway is to reduce its greenhouse gas emissions by means of a combination of a domestic emissions trading system for some branches of industry from 2005, a continuation of the current CO_2 tax, and a number of measures targeted at specific branches and sectors. The domestic emissions trading system is to include emissions of CO_2 and other greenhouse gases from energy- and emissions-intensive industries and possibly other entities. Together, these account for about 30 per cent of total Norwegian emissions. The emissions trading system will initially apply to emission sources to which the CO_2 tax does not apply. The overall ceiling for quotas is to be based on a reduction of total emissions by 20 per cent from 1990. If the Kyoto Protocol enters into force, the Norwegian emissions trading system can be linked to an international market. It would also be possible to link the Norwegian system to the proposed EU emissions trading scheme from 2005.

Sources: http://www.cicero.uio.no/(30-07-02), and the Standing Committee on Energy and the Environment (2002).

Figure 6.7. Emissions in 1990 and 1999 and emission reduction commitments under the Kyoto Protocol[1] for the period 2008-2012



[1] Commitments under the Kyoto Protocol apply to 6 gases, but the changes shown here include only CO_2, CH_4 og N_2O.
Sources: UNFCCC (2002) and EEA (2002).

Greenhouse gas emissions in other countries

- CO_2 emissions have risen in most industrialized countries in recent years. However, this does not apply to countries with transition economies (the former Soviet Union and Eastern Europe).
- Aggregate greenhouse gas emissions have risen substantially in Norway, Japan, the USA, Canada and Denmark in the period 1990 to 1999.
- According to the Kyoto Protocol, overall emissions from the EU states are to be reduced by 8 per cent. This overall commitment has been divided among the various countries.

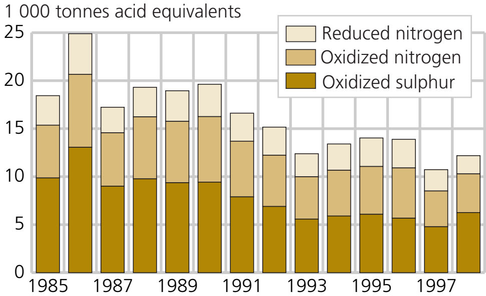
Box 6.7. Greenhouse gas emissions in Norway: do carbon taxes work?

In the last ten years, Norway has pursued an ambitious climate policy. The main policy tool is a relatively high carbon tax, which was introduced as early as 1991. Data on trends in CO_2 emissions since then provide a unique opportunity to evaluate carbon taxes as a policy tool. To reveal the driving forces behind the changes in the three most important greenhouse gases, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), in the period 1990-1999, we decomposed the actually observed changes in emissions, and used an applied general equilibrium simulation to look into the specific effect of carbon taxes. Although total emissions have increased, we found a significant reduction in emissions per unit of GDP over the period due to reduced energy intensity, changes in the energy mix and reduced process emissions. Despite considerable tax and price increases for some fuel types, the effect of the carbon tax has been modest. The partial effect of lower energy intensity and changes in energy mix was a 14 per cent reduction in CO_2 emissions, whereas the carbon tax contributed only a 2 per cent reduction. This relatively small effect is related to extensive exemptions from the tax and relatively inelastic demand in the sectors to which the carbon tax applies.

Read more in: Bruvoll, A. and B.M. Larsen (2003): Greenhouse gas emissions in Norway: do carbon taxes work?, in prep., *Energy Policy*.

6.2. Acidification

Figure 6.8. Deposition[1,2] of acidifying substances in Norway. 1985-1998



[1] Calculations for 1997 and 1998 were made using a different model and the figures are therefore not directly comparable with those for earlier years.
[2] Calculations for 1999 and 2000 had not been completed at the end of August 2002.
Sources: Norwegian Meteorological Institute and EMEP.

Deposition of acidifying substances

- Sulphur compounds make up the largest proportion of acidifying substances deposited in Norway, but the importance of nitrogen oxides has been rising in recent years.
- Total deposition has been reduced, but critical loads are still being exceeded in large parts of the southern half of Norway.
- Emissions from Norway are largely deposited in Norway or over the sea (Norwegian Meteorological Institute 2001). A substantial proportion of Norwegian emissions is also deposited in Sweden.
- The UK, Germany and Russia are the countries outside Norway that make the largest contributions to the total deposition of acidifying substances in Norway.

Table 6.1. Emissions and emission targets for SO_2 and NO_x. 1 000 tonnes

	SO_2			NO_X		
	Emissions		Target	Emissions		Target
Country:	1990	1999	2010	1990	1999	2010
UK	3 754	1 187	612	2 756	1 603	1 167
Germany	5 321	831	550	2 706	1 637	1 081
Russian Federation[1]	4 460	2 003	2 343	3 600	2 494	2 653
Sweden	119	63	67	338	261	148
Denmark	183	56	50	271	210	127
Norway	53	29	22	219	230	156

[1] The figures apply to the European part, within the EMEP area.
Source: Norwegian Meteorological Institute (2002).

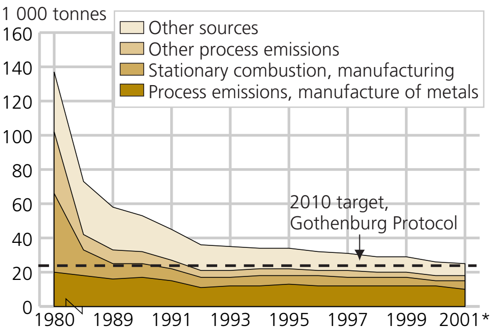
Box 6.8. Acidification; a brief explanation of causes and effects

Acid rain is caused mainly by emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and ammonia (NH_3). These substances can remain in the atmosphere for several days before being deposited as acid rain or as dry deposition. Nitrogen and sulphur compounds can be dispersed over long distances. Most of the deposition of acidifying substances in Norway (about 85 per cent) originates from emissions in other countries.

Acid rain has a number of impacts. Acidification of soils results in leaching of nutrients and metals. Acid rain also damages trees directly, causing loss of foliage. In Norway, acid rain has its most serious impact on freshwater organisms. Rivers and lakes in Southern Norway and the southern parts of Eastern and Western Norway are most severely affected. In addition to its impact on the flora and fauna, the deposition of acidifying substances results in corrosion damage to buildings and cultural monuments.

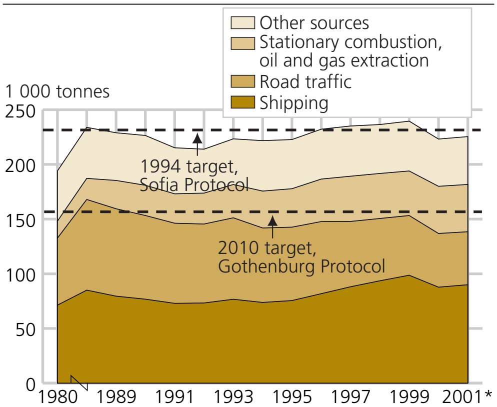
Deposition of nitrogen compounds also adds nutrients to soils and water, and in excessive amounts this can lead to eutrophication of lakes and coastal waters and alter natural ecosystems. However, in Norway the acidification caused by airborne inputs of these substances is still considered to be more important.

Figure 6.9. Emissions of SO_2 by source. 1980-2001*



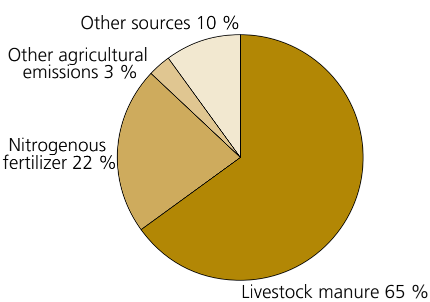
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.10. Emissions of NO_x by source. 1980-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.11. Emissions of ammonia by source. 2001



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Sulphur dioxide (SO_2)

- In 2001, SO_2 emissions totalled 25 400 tonnes, a drop of 3 per cent from the previous year. SO_2 emissions have been more than halved since 1990. Under the Gothenburg Protocol, Norway has undertaken to ensure that its emissions do not exceed 22 000 tonnes in 2010.
- The most important sources of SO_2 emissions are process emissions from metal manufacturing (40 per cent of the total) and stationary combustion in manufacturing industries (21 per cent).

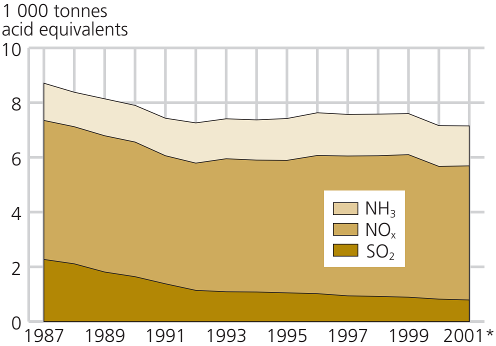
Nitrogen oxides (NO_x)

- In 2001, NO_x emissions totalled 225 000 tonnes, which is a rise of 1 per cent since 2000. This is explained by an increase in combustion of oil and gas.
- The largest sources of NO_x emissions are shipping (40 per cent), road traffic (21 per cent) and stationary combustion in the oil and gas industry (19 per cent).
- Total emissions must be reduced to 156 000 tonnes if Norway is to meet its commitment under the Gothenburg Protocol. Norway exceeded its emission ceiling under the Sofia Protocol in the period 1997-1999.

Ammonia (NH_3)

- In 2001, NH_3 emissions totalled 25 000 tonnes, which is a drop of 2 per cent from 2000. The level of emissions has been relatively stable in the last few years.
- Manure is the main source of ammonia emissions, but the use of commercial fertilizer is also important. The distribution of emissions by source has remained largely unchanged since the 1980s.
- Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 23 000 tonnes NH_3 in 2010.

Figure 6.12. Emissions of acidifying substances in Norway. 1987-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Aggregate emissions of acidifying substances

- In 2001, Norway's aggregate emissions of acidifying substances, expressed as acid equivalents, amounted to 7 150 tonnes. NO_x accounts for almost 70 per cent of the total.
- The level of emissions is almost unchanged from 2000, but has been reduced by 18 per cent since 1987.
- The dispersal potential of SO_2 and NO_x emissions is greater than that of NH_3 emissions.

Box 6.9. Emissions to air from Norwegian air traffic

Emissions from air traffic, like those from all other sources, are implicated in environmental problems. Emissions of nitrogen oxides (NO_x) are particularly important, and together with other types of emissions they contribute to acidification, the formation of ground-level ozone and eutrophication. The greenhouse gas CO_2 is released during all combustion of fossil fuels, and air traffic accounts for just under 3 per cent of Norway's total CO_2 emissions.

Statistics Norway makes annual calculations of emissions to air from Norwegian air traffic. Emissions are calculated on the basis of total sales of fuel, numbers of LTO (Landing and Take-off cycles) and average emission factors. Emission factors change over time with new information and as the aircraft fleet is replaced, and must therefore be updated at intervals. In 2001, emissions from Norwegian air traffic for the period 1989-2001 were therefore calculated using a new internationally recommended method. The work was commissioned by the Norwegian Pollution Control Authority and carried out by Statistics Norway in cooperation with Norwegian Air Traffic and Airport Management.

The calculations showed that CO_2 emissions from domestic air traffic rose sharply in the period 1989-1999. Emissions of nitrogen oxides (NO_x) doubled in the same period. The steep rise in emissions was a result of a higher level of activity. During this period, the aircraft fleet has been almost entirely replaced. DC9s, older Boeing 737s and Twin Otters have been replaced with larger modern aircraft. There was a break in the trend of rising emissions from 1999 to 2000, when emissions of both CO_2 and NO_x dropped by 9 per cent. This was explained by a reduction in the number of flights in order to reduce over-capacity.

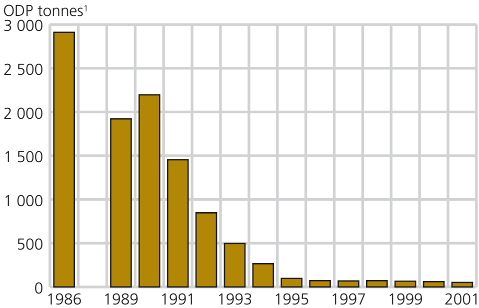
Emissions of NO_x from air traffic are 30 per cent higher than previously calculated. The largest change is for emissions during the cruise phase of flights.

International air traffic accounts for about one third of CO_2 and NO_x emissions at Norwegian airports. About two thirds of the emissions from this source are generated at Oslo Airport Gardermoen. The number of international air traffic departures from Norwegian airports has also risen sharply in the last ten years.

Based on: Finstad, A., K. Flugsrud and K. Rypdal (2002): *Utslipp til luft fra norsk luftfart* (Emissions to air from Norwegian air traffic). Reports 2002/8. Statistics Norway.

6.3. Depletion of the ozone layer

Figure 6.13. Imports of ozone-depleting substances to Norway. 1986-2001



[1] The ozone-depleting potential (ODP) varies from one substance to another, and the figures are totals weighted according to the ODP of each substance (ODP factors).
Source: Norwegian Pollution Control Authority.

- Norway imported a total of 51 ODP tonnes ozone-depleting substances in 2001.
- Various HCFCs still dominate imports of ozone-depleting substances to Norway, and accounted for more than 90 per cent of the total (expressed as ODP tonnes) in 2001.
- It has been calculated that the thickness of the ozone layer above Oslo has been reduced by an average of 0.26 per cent per year since 1979.

Box 6.10. The ozone layer and ozone-depleting substances

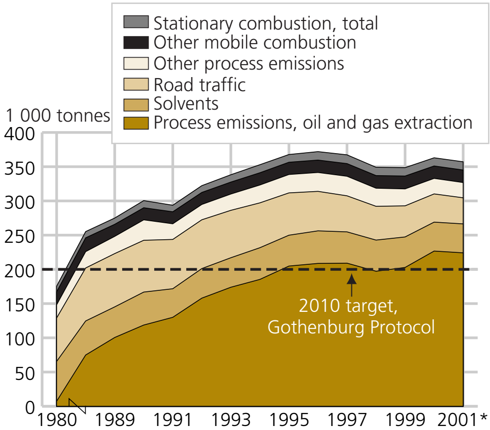
Substances that deplete the ozone layer include hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs) and other gases containing chlorine and bromine. Such gases have been used as cooling agents, propellants in aerosols and in the production of foam plastic. In new products, they are being replaced with hydrofluorocarbons (HFCs), which are greenhouse gases, but not ozone-depleting.

In accordance with the Montreal Protocol, the consumption of ozone-depleting substances in Norway has dropped steeply since the mid-1980s. Emissions take place largely during use of equipment containing these gases, not during production, and only small amounts are collected and destroyed. In accordance with the revised Montreal Protocol, Norway has eliminated imports of newly-produced halons and CFCs, and there is a general prohibition against imports of CFCs (small quantities of CFCs, ca. 3 tonnes per year, are imported for necessary purposes such as laboratory analysis). In addition, Norway has undertaken to keep to a timetable for reductions in consumption or prohibitions against the use of several other substances that deplete the ozone layer.

An analysis for the period 1979-2001 based on measurements at ground level in Oslo shows a reduction of 0.26 per cent per year in the thickness of the ozone layer (Norwegian Institute for Air Research 2002b). In winter 2000-2001, unlike the year before, no large reduction of the ozone concentration over the Arctic was recorded. This was because temperatures in the stratosphere remained relatively high, which slows down ozone depletion.

6.4. Formation of ground-level ozone

Figure 6.14. Emissions of NMVOCs by source. 1980-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

NMVOCs

- In 2001, Norway's NMVOC emissions totalled 357 000 tonnes, which is almost 2 per cent lower than in 2000.
- The most important source is process emissions from oil and gas activities (63 per cent), primarily evaporation during loading of crude oil offshore. Other important sources are emissions from solvents (12 per cent) and road traffic (11 per cent).
- Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 195 000 tonnes NMVOCs in 2010, which corresponds to a reduction of about 45 per cent from the current level.

Box 6.11. Ozone precursors

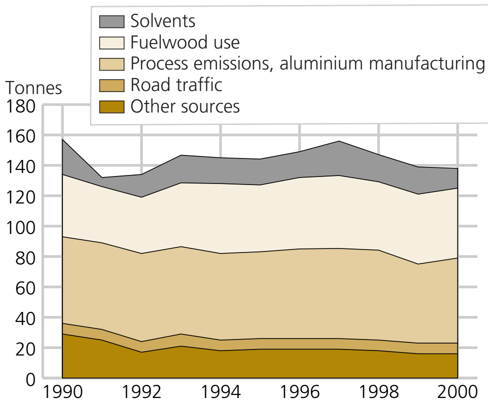
Ground-level or tropospheric ozone is formed by the oxidation of CH_4, CO, NO_x and NMVOCs in the presence of sunlight. A weighting factor is defined for each of these precursors according to how much ground-level ozone it forms during a specific period of time. These are known as TOFP (Tropospheric Ozone-Forming Potentials) factors, and NMVOCs are used as the reference component.

Substance:	TOFP factor (de Leeuw 2002):
NO_x	1.22
NMVOCs	1
CO	0.11
CH_4	0.014

Aggregating Norwegian emissions of these gases, weighted with the appropriate factors, we find that total TOFP emissions have risen by 3 per cent in the period 1990-2001.

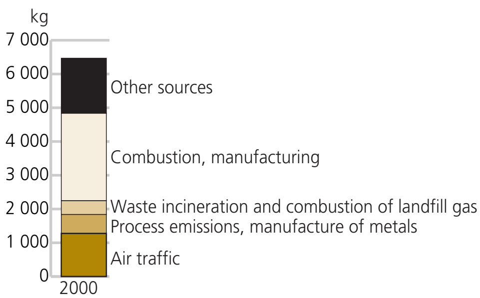
6.5. Persistent organic pollutants (POPs) and heavy metals

Figure 6.15. Emissions of total PAH to air by source. 1990-2000



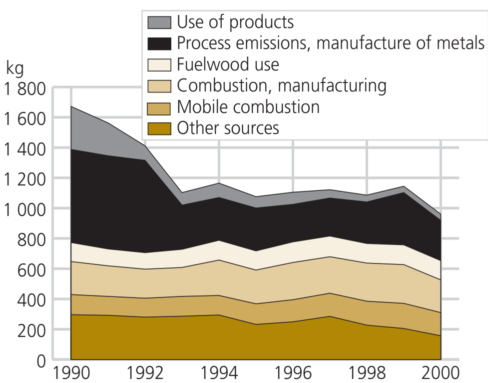
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.16. Emissions of lead to air by source. 2000



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 6.17. Emissions of mercury to air by source. 1990-2000



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

PAHs

- In 2000, Norway's emissions of "total PAH" were 137 tonnes (PAH-4, which is the component regulated by the POPs Protocol (LRTAP-POPs), accounted for 13.5 tonnes of this). PAH emissions have shown small variations with no clear trend since 1990.
- The largest sources of PAH emissions are fuelwood use in households and process emissions from aluminium production. These two sources accounted for 34 and 41 per cent respectively of the total in 2000.

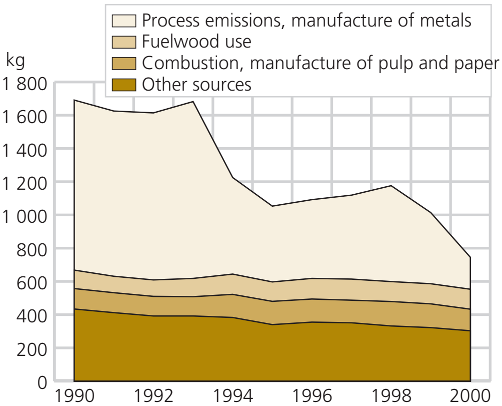
Lead

- Lead emissions were reduced by 98 per cent in the period 1985 to 2000.
- In 2000, emissions totalled 6.5 tonnes, 17 per cent below the year before.
- 40 per cent of the total is generated by the manufacture of iron, steel and ferro-alloys, and 25 per cent by domestic air transport.

Mercury

- In 2000, mercury emissions totalled 960 kg, a drop of 16 per cent from the year before.
- The largest sources of mercury emissions to air today are process emissions from the manufacture of iron, steel and ferro-alloys, and combustion sources such as combustion in manufacturing industries and fuelwood use in households.
- The main explanation of the drop in emissions since 1990 is a reduction in emissions from the manufacture of ferro-alloys, but emissions from the use of products (e.g. mercury thermometers) have also been substantially reduced.

Figure 6.18. Emissions of cadmium to air by source. 1990-2000

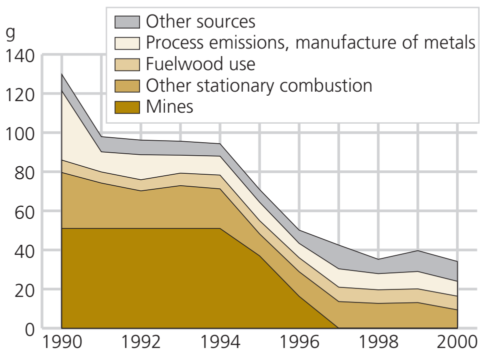


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Cadmium

- In 2000, cadmium emissions totalled 745 kg, a drop of 26 per cent from the year before. This was explained by a reduction in process emissions from the manufacture of iron, steel and ferro-alloys.
- The most important sources of cadmium emissions today are the manufacture of iron, steel and ferro-alloys and combustion sources such as fuelwood use by households and combustion in the pulp and paper industry.

Figure 6.19. Emissions of dioxins to air by source. 1990-2000



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Dioxins

- In 2000, emissions of dioxins totalled 34 g I-TEQ (see box 6.12). This is 74 per cent lower than in 1990. The large reduction is mainly explained by the closure of an ore production plant in Syd-Varanger in Finnmark and the reduction of emissions from magnesium production.
- Various combustion sources now account for 62 per cent of all dioxin emissions to air. Important sources are fuelwood use by households and combustion in the pulp and paper industry. Emissions from shipping are the largest mobile combustion source. Process emissions from metal manufacturing are also important.

Box 6.12. Dioxins

Chlorinated dioxins and furans are on Norway's priority list of environmentally hazardous substances. Norway's national goal is to reduce emissions of these substances substantially by 2010 (Ministry of the Environment 2001). Dioxins are also regulated by the POPs Protocol to the Convention on Long-range Transboundary Air Pollution (LRTAP-POPs).

Dioxins refers to a group of hazardous substances with the chemical designations polychlorinated dibenzo-para-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). The group includes 210 different compounds of varying toxicity. The compound 2,3,7,8- tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD) is considered to be the most toxic. A toxic equivalency factor (TEF) has been calculated for each compound on the basis of its toxicity relative to that of TCDD. The TEFs are used as weighting values in calculating the toxicity equivalent (TEQ) of a mixture of dioxins, which expresses the toxicity of the entire mixture in "TCDD equivalents" (TEQ = $\text{quantity}_{\text{dioxin-like compound}} * \text{TEF}_{\text{dioxin-like compound}}$).

The Norwegian Pollution Control Authority has previously compiled statistics for dioxin emissions, mainly from point sources. In autumn 2001, dioxins were for the first time included in the emission model used by Statistics Norway and the Norwegian Pollution Control Authority. The data were based on emissions reported directly by large enterprises and incineration plants, and calculations based on activity data and emission factors for other sources. The calculations by Statistics Norway show that emissions were higher than previously assumed. This is mainly because more sources have now been included in the calculations.

The most important sources of dioxin emissions today are metal production, shipping, industrial incineration of wood waste and fuelwood use. Uncontrolled combustion such as house fires and burning of straw is also important.

There is generally a high degree of uncertainty associated with estimates of dioxin emissions. Data on some sources of emissions is poor, the results of measurements vary widely and the weighting factors are uncertain. The level of uncertainty is higher for 1990 than for more recent years.

Based on: Finstad, A., G. Haakonsen and K. Rypdal (2002): *Utslipp til luft av dioksiner i Norge.* (Emissions of dioxins to air in Norway.) Reports 2002/7. Statistics Norway.

Box 6.13. Emissions of particulate matter to air

At present, Statistics Norway calculates emissions of PM_{10} in Norway from combustion and from road traffic (dust). Other process emissions are not included. In addition, emissions of $PM_{2,5}$ from road traffic are calculated. These calculations form part of Statistics Norway's national emission model.

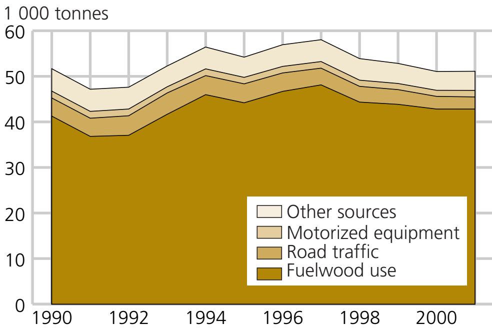
In cooperation with Norwegian Pollution Control Authority, Statistics Norway is carrying out a project to allow emissions of $PM_{2,5}$ and TSP (total suspended particles) to be included in the calculations. In addition, industrial emissions will be included, based on reported emission data from enterprises. This is because particulate matter is to be included as a new component in reports to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention), and Norway will be required to report emissions of all three size fractions ($PM_{2,5}$, PM_{10} and TSP).

From 2002, emissions of all three size fractions of particulate matter from all known sources will be calculated.

6.6. Emissions of substances that particularly affect local air quality

Particulate matter and carbon monoxide (CO), together with NO_x, are the pollutants that are most important for local air quality in towns and urban settlements.

Figure 6.20. Emissions of particulate matter (PM_{10}) to air by source in Norway. 1990-2001*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Particulate matter

- In 2001, emissions of particulate matter to air in Norway totalled 51 100 tonnes. Emissions have been relatively stable throughout the period since 1990.
- New revised figures show that emissions of particulate matter are twice as high as previously estimated.
- Emissions from fuelwood use account for 84 per cent of total emissions of particles.

Box 6.14. Emissions to air from fuelwood use

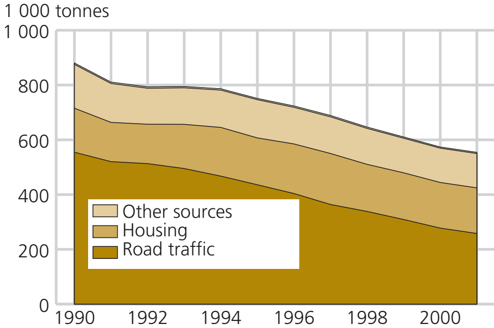
Emissions from fuelwood use are an important source of Norwegian emissions of particulate matter, heavy metals, PAHs and dioxins. However, emissions from wood-burning stoves and open fireplaces are very difficult to quantify, because they are often dependent on factors such as combustion technology, wood consumption (kg wood/hour) and draught characteristics. For calculations of emissions locally, information on how national wood consumption is split between the municipalities and preferably also on its geographical distribution within in each municipality is needed.

The emission factors previously used to calculate emissions to air from fuelwood use were mainly based on analyses from the 1980s. In 2001, Statistics Norway was therefore commissioned by the Norwegian Pollution Control Authority to carry out a project to improve the quality of national and municipal figures for emissions from fuelwood use. The project resulted in new emission figures for traditional closed stoves, modern, cleaner stoves and open fireplaces. Better data on stoves and fireplaces in use in Norway was also obtained: for example on wood consumption, patterns of use and what fuel is actually burned in stoves and fireplaces.

The new emission factors were included in Statistics Norway's emission calculations for the first time in January 2002. Overall emissions from fuelwood use in Norway were adjusted steeply upwards with the use of the new calculation method, since the average emission factor (g particulates/kg wood) was higher than that previously used.

Based on: Gisle Haakonsen and Eli Kvingedal (2001); *Utslipp til luft fra vedfyring i Norge. Utslippsfaktorer, ildstedsbestand og fyringsvaner.* (Emissions to air from fuelwood use in Norway. Emission factors, numbers of wood-burning stoves and open fireplaces, and heating habits). Reports 2001/36. Statistics Norway.

Figure 6.21. Emissions of carbon monoxide in Norway. 1990-2001



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Carbon monoxide

- In 2001, emissions of carbon monoxide to air totalled 550 000 tonnes.
- The largest sources of CO emissions are road traffic and heating of housing, especially with fuelwood.
- Emissions of CO have been reduced by about 35 per cent from 1990 until the present. The main reason is reduced emissions from road traffic due to catalytic converters in cars.

Box 6.15. Benzene

In spring 2002, emission factors for benzene emissions were developed for use in calculating local emissions to air (calculations of emissions per basic unit). Non-methane volatile organic compounds (NMVOCs) include emissions of a number of compounds including benzene. Benzene emissions may be low compared with total NMVOC emissions, but benzene is highly toxic and is therefore an important component. It is also carcinogenic.

The emission factors used to calculate benzene emissions were developed by using the emission factors for NMVOCs specified in the emission model used by Statistics Norway and the Norwegian Pollution Control Authority together with emission profiles for NMVOCs taken from the literature.

Calculations show that the main sources of benzene emissions at national level are shipping, household fuelwood use and road traffic. Next in importance are emissions from industrial biofuel combustion and other mobile combustion. The relative importance of different sources will vary according to the municipality for which calculations are being made.

Based on: Anne Finstad (2002): *Utslippsfaktorer for benzen*, (Emission factors for benzene), Notater 2002/48. Statistics Norway.

More information: Gisle Haakonsen, Ketil Flugsrud, Anne Finstad and Britta Hoem.

Useful websites

Center for International Climate and Environmental Research: http://www.cicero.uio.no/index_e.asp
Norwegian Meteorological Institute: http://met.no/english/index.html
State of the Environment Norway: http://environment.no/
Norwegian Institute for Air Research: http://www.nilu.no/
Norwegian Pollution Control Authority: http://www.sft.no/english/
Statistics Norway - Greenhouse gas emissions: http://www.ssb.no/english/subjects/01/02/
Statistics Norway - Emissions to air: http://www.ssb.no/english/subjects/01/04/10/

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Norwegian Institute for Air Research (2002b): *Overvåking av ozonlaget og naturlig ultrafiolett stråling*. Årsrapport 2001 (Monitoring of the ozone layer and natural ultraviolet radiation). Report 852/02.

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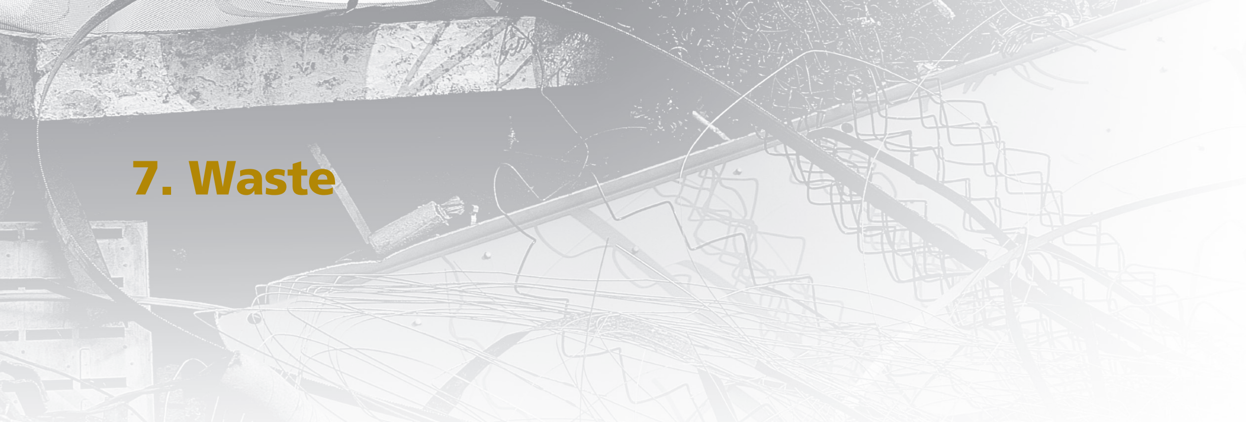


7. Waste

The total quantities of waste generated in Norway are rising. The environmental and social impacts of waste depend partly on how it is managed. Waste can cause serious health and environmental problems, but if soundly managed, it can provide valuable resources and the environmental problems can be reduced. However, hazardous waste that is not dealt with through the proper channels is still considered to be a substantial environmental problem.

Waste consists of anything that is discarded after production and consumption. Various problems arise if waste is not managed appropriately, including pollution of soil and water, greenhouse gas emissions, health problems, littering and locally, unpleasant smells (see box 7.2). One of the objectives of Norway's legislation on waste management is to prevent such problems from arising. The authorities also set standards for waste management facilities through the mandatory licensing system. Licences include requirements to collect and control seepage from new landfills and set upper limits for permitted emissions from incineration plants. A general prohibition against landfilling of wet organic waste (food waste, slaughterhouse waste, etc.) has been introduced, and the government is considering a general prohibition against landfilling of all biodegradable waste (Report No.15 (2001-2002) to the Storting). Voluntary agreements have also been established between various sectors of industry and the authorities to ensure sound management of selected waste types.

Certain types of waste are particularly dangerous to human health and the environment, and special legislation applies to these waste fractions to ensure that they are managed properly and in a way that can be controlled. These include hazardous waste, radioactive waste, infectious waste, medical waste and explosive waste. Hazardous waste is by far the largest of these categories and contains the widest variety of materials. With few exceptions, the authorities require hazardous waste to be treated at separate, specially designed treatment facilities. Detailed reports on such waste are also required to ensure control of the waste stream. Nevertheless, in 1999 about 8 per cent of the hazardous waste generated was dealt with outside the proper channels, and may in the worst case have been dumped in the environment.

Waste can also be a resource. A large proportion of what is discarded as waste contains materials that can be re-used, or can be processed to manufacture new products (material recovery) or used as a source of energy (energy recovery). In 2000, more than 8.5 million tonnes of waste was generated in Norway, including 630 000 tonnes of hazardous waste. About 44 per cent of the non-hazardous waste was utilized in some way within the country. The objective is to increase this proportion to 75 per cent by 2010 (see box 7.1).

The authorities are using a wide range of policy instruments and measures to reach this target. There is a tax on all final disposal (see box 7.4) of waste. Voluntary agreements have been concluded with various branches of industry to ensure that priority waste fractions such as waste electrical and electronic equipment (WEEE), packaging and car tyres are dealt with properly. In these agreements, the industries have agreed to specific targets for the percentages of the relevant waste fractions to be recovered, for example by means of return schemes. The municipalities have established schemes to encourage separation of waste at source by households and small businesses. Support has also been provided for research programmes to find ways of reducing waste generation and new and better ways of making use of waste. At the same time, a new branch has grown up in the private sector - companies that make a profit from waste management.

Box 7.1. The environmental authorities' targets for waste and recycling

Strategic objective

Damage to people and the environment caused by waste is to be minimized. To achieve this, waste problems are to be solved by means of policy instruments that ensure a good socio-economic balance between the quantity of waste generated and the quantities recycled, incinerated or landfilled.

National targets

1. The growth in the quantity of waste generated shall be considerably lower than the rate of economic growth.
2. The quantity of waste delivered for final disposal is to be reduced to an appropriate level in economic and environmental terms. Using this as a basis, the target is for 25 per cent of the total quantity of waste generated to be delivered for final disposal in 2010.
3. Practically all hazardous waste is to be dealt with in an appropriate way, so that it is either recycled or sufficient treatment capacity is provided within Norway.

7.1. Some environmental problems related to waste management

Table 7.1. Emissions from waste incineration and landfills. Percentages of total Norwegian emissions in 2000 and change since 1990

	Percentage of total Norwegian emissions	Percentage change since1990
Incineration plants:		
Quantity of waste incinerated	.	+ 36
Sulphur dioxide	0.9	- 35
Nitrogen dioxide	0.5	+ 1
Carbon dioxide	0.4	+ 47
Particulate matter	0.1	+ 54
Lead	6.3	- 69
Cadmium	4.4	- 66[1]
Mercury	3.4	- 67[1]
Total PAH[2]	0.3	- 56[1]
Dioxins	6.2	- 88
NMVOCs	0.1	+ 47
Landfills:		
Methane (greenhouse gas)	7.1[3]	+3
Seepage: heavy metals[4]	1	..
Seepage: nitrogen[4]	2	..
Seepage: phosphorus[4]	1	..

[1] Change since 1991. [2] According to NS9815 with the exception of emissions from fuelwood use, where NS3058-3 has been used. [3] Calculated as a percentage of total greenhouse gas emissions in CO_2 equivalents. [4] Figures from 1996.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority (emissions to air) and Report No. 8 (1999-2000) to the Storting (seepage).

Environmental problems

- Emissions of methane (a greenhouse gas) from rotting waste in landfills make a substantial contribution to Norway's total emissions.
- Landfills accounted for 57.5 per cent of total methane emissions in 2000.
- Emissions from waste incineration plants account for a relatively small proportion of national emissions. For example, emissions of cadmium, mercury and dioxins from fuelwood use are 3-4 times higher than those from waste incineration (see Chapter 6 Air pollution and climate).
- Seepage from landfills may contain heavy metals, organic material and plant nutrients such as nitrates and phosphates. These pollutants may have marked local effects.

Box 7.2. More about the impacts of non-hazardous waste and waste management on the environment and natural resources

Methane (a greenhouse gas), dioxins and heavy metals released from waste contribute significantly to Norway's total emissions of these substances. Of these pollutants, methane is considered to have the greatest negative impact on the environment because of high total emissions. The authorities are using a range of policy instruments to reduce methane emissions from landfills, including a prohibition against landfilling of wet organic waste, a requirement to extract landfill gas from landfills that are still in use, a general tax on final waste disposal, and support for a research programme on the utilization of organic waste. The degradation of organic waste to methane takes many years (Report No.15 (2001-2002) to the Storting). Extraction of landfill gas is therefore the only measure that has a rapid effect on emission levels. All new landfills must have facilities for the extraction of landfill gas. In practice, only about 25 per cent of the gas can be extracted (Report No. 24 (2000-2001) to the Storting). In 1999, about 60 per cent of this potential was utilized (Statistics Norway 2001). It will take quite some time before other measures that have been introduced give results. Stricter standards have been introduced for incineration plants so that emissions of pollutants such as dioxins can be reduced even further. The management of hazardous waste and the environmental problems it poses are discussed in boxes 7.7 and 7.8.

To consider the environmental impacts of waste in a wider perspective, factors outside the actual waste management process must also be considered. If large amounts of waste are generated during a production process, this means that substantial resources are escaping from the production chain and being lost. One possible reason is that production methods are inefficient and consumption of factor inputs is unnecessarily high. *cont.*

box 7.2 cont.

One reason for a rise in waste generation by private households may be that people buy more new products and do not maintain and repair the products they already own to the same extent as before. Waste, like products, originates from raw materials that are extracted and processed. And extracting and processing raw materials requires energy, in some cases large amounts of energy, and adds to pollution. As energy use rises, so do emissions of the greenhouse gas CO_2, unless measures to reduce emissions are implemented at the same time. Thus, even though the environmental effects of waste management in itself are limited from a national perspective, a rise in the quantity of waste generated may represents a risk of substantial serious environmental problems.

Waste is generated when products are discarded and as production waste during their manufacture. Resources are used both in manufacturing products and when production waste is generated. However, there are many ways of making resource use more efficient. The most obvious approach is to reduce waste generation, for example by improving product design and making products more durable, by changing consumption patterns or by improving production methods. Another is to encourage the re-use of various products.

If waste cannot be re-used directly, materials can be recovered from it to make new products. This often requires far less energy than manufacturing the same products from virgin raw materials, but in some cases the recovery process can add to pollution (DeLong 1994 and Bystrøm and Lønnstedt 1997). If the costs of material recovery are so high that this is not economically viable, one alternative is to make use of the energy in the waste. This can for example be done by connecting incineration plants to district heating systems or by using waste as fuel in industrial processes. However, the amount of energy released in such processes is much smaller than that needed to replace the original product using virgin raw materials. In addition, it is difficult to recover all the energy. On average, Norwegian incineration plants utilize just over 70 per cent of the energy in waste.

Box 7.3. An assessment of the contribution of waste management policy to solving environmental and natural resource problems

Statistics Norway was commissioned by the Ministry of the Environment to assess whether waste policy instruments, particularly requirements for waste reduction, are suitable means of resolving problems related to waste management and the extraction of natural resources.

There are already political targets for limiting Norway's total emissions (from all sources) of the pollutants associated with waste management. Current policy instruments include taxes and requirements to reduce emissions. The analysis concluded that because emissions from waste management processes make up such a small proportion of the various types of emissions, a separate policy to deal specifically with emissions from waste is probably not very effective compared with more general measures to reduce emissions. The project also included an assessment of how far which waste management policy reduced the extraction of raw materials. A review of the markets for timber, oil and metals did not indicate that these resources are over-exploited or that waste management policy can contribute much in the way of emissions reductions. The quantities of paper, board and wood waste generated in Norway correspond roughly to the annual removal of timber. Beverage cartons make up only 1.0 per cent of this. Efforts to reduce waste generation or increase waste recovery must be considered in conjunction with the fact that the volume of Norwegian forests has more than doubled in the last 80 years. Nor is recovery of plastic an effective means of conserving petroleum resources. Converted to the equivalent in petroleum, plastic waste corresponds to about 1 per cent of the quantity extracted from the North Sea each year. The quantities of plastic waste delivered for material and energy recovery correspond to 0.001 and 0.01 per cent respectively of the amount of petroleum extracted.

The project concluded that if it is necessary to make the political emission reduction targets more stringent, or if it is found that some resources are in fact being over-exploited, more direct and cost-effective instruments should be used. Requirements to reduce waste generation do not appear to be sufficiently clearly targeted to achieve their environmental objectives.

Based on: Bruvoll, A. and T. Bye (2002): *En vurdering av avfallspolitikkens bidrag til løsning av miljø- og ressursproblemer* (An assessment of the contribution of waste management policy to solving environmental and natural resource problems), Notater 2002/36. Statistics Norway.

Box 7.4. Waste and waste statistics - terminology and classification

According to the Pollution Control Act, waste is defined as discarded objects of personal property or substances. Waste water and waste gases are not defined as waste.

Waste can be classified in many ways, for instance according to its origin, composition or environmental impact. The result is a wide variety of terms, some of which have overlapping meanings. The Norwegian General Standardizing Body has now drawn up a new standard for waste classification (NS 9431). The objective is to encourage uniform use of categories when registering and reporting waste quantities.

In the Pollution Control Act, waste is divided into three categories: consumer waste, production waste and special waste (including hazardous waste). The Government is now considering whether to propose a change in this classification. This would mean dividing waste into the three categories household waste, industrial waste and hazardous waste, which is in accordance with the classification system used by Statistics Norway in its waste statistics. In addition, the term *municipal waste* has been used for waste treated or administered in the municipal system. Often, *waste fractions* consisting of particular materials are discussed separately (paper, glass, metal, etc.). These may form part of any of the previously mentioned categories. Waste may also be classified according to *product type* (packaging, electrical and electronic products, household appliances, etc.). These may also belong to any of the above-mentioned categories.

Consumer waste: Ordinary waste, including large items such as fittings and furnishings from private households, shops, offices, etc.

Production waste: Waste from commercial activities and services which is significantly different in type or amount from consumer waste. Includes all waste that is not classified as consumer waste or hazardous waste.

Household waste: Waste from normal activities in private households.

Industrial waste: Waste generated by economic activities, both private and public. Includes both consumer waste and production waste. In its waste statistics, Statistics Norway further subdivides industrial waste according to the branch of industry from which it originates. The degree of aggregation in the classification varies. Includes all waste that is not defined as household waste or hazardous waste.

Municipal waste: All waste treated or administered in the municipal system, in practice the same as consumer waste. Municipal waste includes almost all household waste and a large proportion of industrial waste.

Hazardous waste: Waste which cannot appropriately be treated together with municipal waste because it may cause serious pollution or a risk of injury to people and animals. Hazardous waste is governed by separate regulations under the Pollution Control Act.

EEE waste (or WEEE): Waste electrical and electronic equipment. EEE items require an electric current or electromagnetic field to function, and need batteries, transformers, wires, etc. to generate, transmit, distribute and measure the current or field, and parts to cool, warm, protect, etc. the electric and/or electronic components. Means of transport and cooling equipment containing CFCs are not included in this definition.

Wet organic waste: Readily degradable organic waste, e.g. food waste and slaughterhouse waste.

Waste management: Usually defined to include all operations from the moment when an object or substance is discarded until all treatment, recovery and disposal operations are completed.

Waste recovery: Includes re-use, material recovery, incineration combined with energy use and composting.

Re-use: Use of the waste in its original form. For example, discarded clothing may be sold in second-hand shops or sent abroad as emergency relief.

Material recovery (or recycling): Use of the waste in a way that wholly or partly retains the materials of which it consists. One example is the production of writing paper from recycled paper.

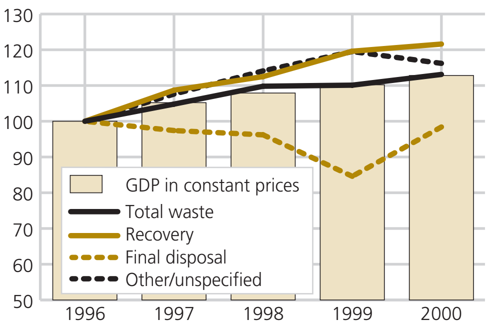
Energy recovery: Use of the energy released by waste incineration, for example to heat buildings.

Final disposal: Means that the resources in the waste are not utilized: either landfilling or incineration without energy recovery.

Landfilling: Final disposal of waste at an approved landfill.

7.2. Waste accounts for Norway

Figure 7.1. Waste according to method of recovery or disposal and GDP. 1996-2000. Indices, 1996 = 100



Waste accounts

- From 1996 to 2000, annual waste generation rose from 7.5 to 8.5 million tonnes, a rise of 13.1 per cent. In the same period, GDP grew by 12.8 per cent. The rise in waste generation was considerably larger than population growth, which was 3 per cent in the same period.
- The quantity of waste recovered rose by 21.6 per cent from 1996 to 2000, and the recovery rate is now 44 per cent. In the same period, the quantity of waste delivered for final disposal dropped by 2 per cent.

Box 7.5. Waste accounts

The waste accounts are being developed on the basis of traditional principles for natural resource accounting, as a material balance between annual waste generation and the quantities treated or disposed of each year. In practice, the accounts may be regarded as a multidimensional matrix, where the dimensions are represented by a few selected characteristics of the waste. These are:

- material type
- product type
- origin
- form of treatment/disposal

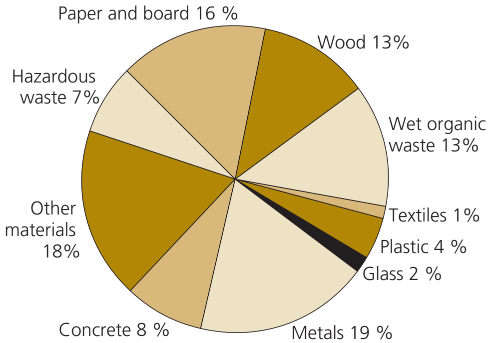
As a general principle, existing data sources such as statistics on external trade, production and waste have been used wherever possible, and new costly investigations have thus been avoided so far.

Two different methods have been used to estimate waste quantities. One is called the "supply of goods method", and is a theoretical method of estimating waste quantities. It is based on the assumption that waste quantities are equal to the supply of goods after correction for the lifetime of the products. The supply of goods is calculated from statistics on import, export and production of goods. The second method is called the "waste statistics method": existing waste statistics are collected and harmonized, and waste quantities are estimated in cases where the existing statistics are inadequate.

The two methods use different points in the waste stream as their starting points. The supply of goods methods estimates the quantities of waste that are generated, while the waste statistics method shows the quantities delivered for various types of treatment. There may be a real difference between these quantities.

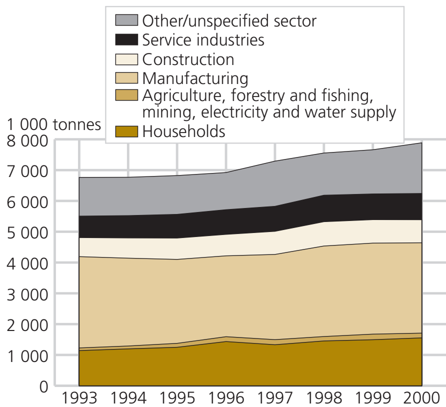
A complete set of waste accounts for Norway has now been published for the first time. However, the calculation methods will be further developed in the years ahead, and time series and already published figures may be revised.

Figure 7.2. Waste by material. 2000



Source: Waste statistics, Statistics Norway.

Figure 7.3. Waste by origin. 1993-2000



Source: Waste statistics, Statistics Norway.

Figure 7.4. Waste by product type. 2000

Source: Waste statistics, Statistics Norway

Materials

- Although the quantity of waste generated has risen each year, the proportions of different materials have remained fairly constant.
- However, there has been a small drop in the quantity of wood waste because the amount of production waste generated by the pulp and paper industry has been reduced.

Origin

- The main explanation for the rise in total waste quantities is that the amounts of paper and metal waste have increased.
- Waste generation by households is rising at about the same pace as GDP, and now accounts for 18 per cent of total waste. Waste from other sectors, except manufacturing industries, also seems to be following the same trend as GDP.
- Manufacturing waste accounted for 34 per cent of the total in 2000. Of this, more than 80 per cent was production waste.
- Wholesale and retail trade generates about half the waste from the service industries.

Product type

- The largest waste fraction by product type is *residues from manufacturing*, which make up 30 per cent of the total.
- The category *other products* include large quantities of hazardous waste and of metal piping that has been used as oil and gas pipelines, etc.
- *WEEE* (waste electrical and electronic equipment) makes up only a small proportion of the total, but often contains substances that are classified as hazardous waste.

Box 7.6. More about the classification of waste by product type

Residues from manufacturing are generated by manufacturing industries and consists mainly of slag, wood, food and slaughterhouse waste and mixed waste.

Buildings and building products: this waste contains various types of hazardous waste, including insulating windows and capacitors containing PCBs, fluorescent tubes, switches, etc. containing mercury, asbestos and asbestos cement, and impregnated timber. Most of this waste is generated by the construction industry, where waste management used to be poorly organized. A growing focus on environmental impacts and various political instruments are improving control of this type of waste.

Packaging is in many cases regarded as redundant, and is rapidly discarded as waste. However, packaging plays an important role in protecting products. Using less packaging can result in more breakages and damaged products. Life cycle analyses show that with only a relatively small increase in the frequency of damage, the costs may exceed the benefits of using less packaging (Barkman et al. 2000).

New calculations show that about 169 000 tonnes of *EEE waste* was generated in 2000, as compared with about 140 000 tonnes in the mid-1990s. About 1.4 per cent of this was previously classified as hazardous waste. Since 1 January 2003, other dangerous components such as circuit boards containing brominated flame retardants and lithium batteries, which are highly reactive, have also been classified as hazardous waste. Separate return schemes have been established for EEE waste to prevent dangerous substances from being released to the environment during incineration or after landfilling. Nevertheless, it has been found (Norwegian Pollution Control Authority 2002) that more than half of all EEE waste is not channelled through these return schemes, which may result in releases of heavy metals, PCBs and waste oil to the environment.

7.3. Hazardous waste

Box 7.7. Hazardous waste

In Norway, hazardous waste is normally handled by a chain of approved authorities and companies (municipalities, transport firms and waste treatment firms). New regulations relating to hazardous waste entered into force on 1 January 2003, and apply to all types of dangerous waste. However, some industrial enterprises are permitted to deal with their own hazardous waste. The waste in question consists mainly of slag containing heavy metals, and the arrangements apply to about one sixth of all hazardous waste that is generated. Some companies hold permits to export hazardous waste. In 1999, about 8 per cent of all hazardous waste was exported, somewhat more than half of it directly from the enterprise where it was generated. Waste is most commonly exported by the petroleum extraction and manufacturing sectors.

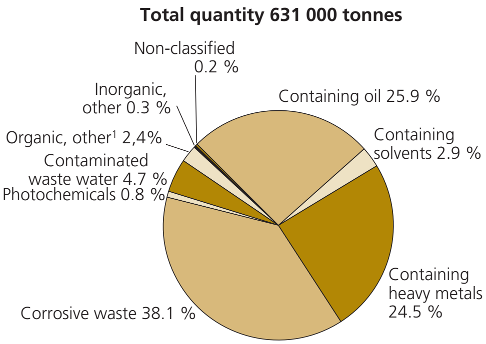
Calculations show that in 1999, 50 000 tonnes of hazardous waste was not dealt with in a way that could be controlled by the authorities. Some of this may have been handled in an environmentally sound way, but not reported to the authorities. However, it is possible that much of it was not dealt with appropriately. Following the precautionary principle, the pollution control authorities assume that the entire amount of 50 000 tonnes was not dealt with through the proper channels. Waste containing oil, waste containing PCBs and waste containing organic solvents are the largest components of this waste.

Waste containing oil includes waste oil, bilge water, emulsions and various types of oil-contaminated materials (oil filters, oil booms, rags, earth, etc). Oily waste as a whole contains roughly equal proportions of oil and water, and about 8 per cent of other pollutants and solid matter. A tax refund scheme has been introduced for the cleanest waste oils to increase the proportion collected. The political target is for at least 90 per cent of waste oil to be collected. The proportion collected rose until the mid-1990s, reaching 78 per cent (Norwegian Pollution Control Authority 1999), but had dropped back to 70 per cent in 1999. Waste containing oil originates mainly from petroleum extraction, but manufacturing and service industries (especially wholesale and retail trade and transport) are also major sources. Petroleum extraction, manufacturing, wholesale and retail trade and transport generate 87 per cent of all reported hazardous waste containing oil.

Waste containing PCBs makes up almost 50 per cent of the waste category "Other organic hazardous waste". The concentration of PCBs varies widely from one type of waste to another.

Waste containing organic solvents consists of solvents and waste paint (including water-based paints). Chlorinated solvents are particularly hazardous to health and the environment. They are used mainly in dry-cleaning and surface treatment of metals. In 1999, waste containing chlorinated solvents made up 5 per cent of all waste containing solvents not managed within the authorities' control.

Figur 7.5. Hazardous waste by material. 1999

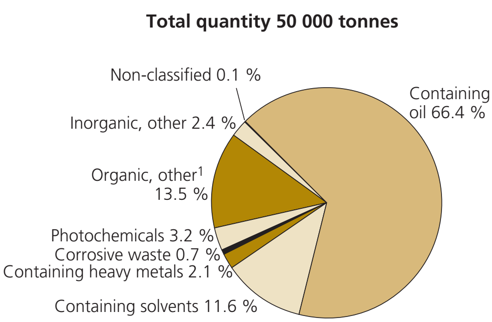


[1] Uncontaminated concrete attached to concrete containing PCBs is defined as hazardous waste if the two cannot be separated. Uncontaminated concrete is not included in this figure. Frames from insulating windows containing PCBs are treated as hazardous waste, but not defined as such, and are not included in this figure.
Source: Waste statistics, Statistics Norway.

Origin and management

- 581 000 tonnes of the hazardous waste generated was dealt with through the proper channels.
- About 2/3 of all hazardous waste is generated by manufacturing industries. This includes almost all corrosive waste, most waste containing heavy metals and substantial proportions of other types of hazardous waste.
- Oil-contaminated waste is generated mainly by petroleum extraction, but manufacturing and service industries (especially wholesale and retail trade and transport) also account for substantial amounts.
- In 1999, 8 per cent of Norway's hazardous waste was exported.

Figur 7.6. Hazardous waste dealt with outside the proper channels, by material[2]. 1999



[1] See footnote to figure 7.5.
[2] The figures are uncertain, but the estimates are conservative.
Source: Waste statistics, Statistics Norway.

Unknown treatment/disposal method

- Calculations show that 50 000 tonnes of hazardous waste - almost 10 per cent of the total - was dealt with outside the proper channels in 1999.
- Of this, 33 000 tonnes was oil-contaminated waste.
- Insulating windows and concrete containing PCBs make up most of the category "other organic hazardous waste" and a substantial proportion of the hazardous waste that is not dealt with through official channels. They are a serious environmental problem.

Box 7.8. Hazardous waste outside the proper channels - impacts on health and the environment

PCBs (polychlorinated biphenyls) are oily liquids that are resistant to heat and are physically and chemically highly stable. They provide very good heat and electrical insulation, are flame-retardant, and improve the resistance of certain materials to wear. They were used in a wide variety of products, particularly in the 1960s and 1970s, but their use was prohibited from 1980 onwards after their adverse effects were recognized. Total consumption of PCBs in Norway was about 1 230 tonnes, and about 730 tonnes of the total has been withdrawn from use. Of this, 330 tonnes has either been landfilled or released to the environment, and 400 tonnes has been destroyed (Norwegian Pollution Control Authority 2000). Today, PCBs can still be found in insulating windows, in capacitors (especially ballasts in light fixtures), in concrete and filling compounds, and in smaller amounts in ships' paints and electricity lead-ins.

PCBs break down very slowly in the environment and can be transported over long distances. PCBs are readily absorbed by living organisms and stored in fatty tissue. They become concentrated in food chains, so that animals at higher trophic levels such as polar bears, seals, whales, white-tailed eagles and humans are particularly vulnerable to these pollutants. Their acute toxicity is not very high, but chronic exposure to PCBs, even at relatively low concentrations, can impair reproduction, disturb behavioural patterns, weaken the immune system and cause cancer. In Norway, the authorities have advised people not to eat fish and shellfish from a number of fjords and restricted commercial fishing in certain areas because of the presence of PCBs. PCBs spread through the environment by evaporation and with runoff, for example from landfills. This means that landfilling is not a suitable way of disposing of waste containing PCBs. Once PCBs have entered the environment, their removal is a very costly process. The costs of removing PCBs from the bottom sediments in a fjord can easily reach several hundred million NOK.

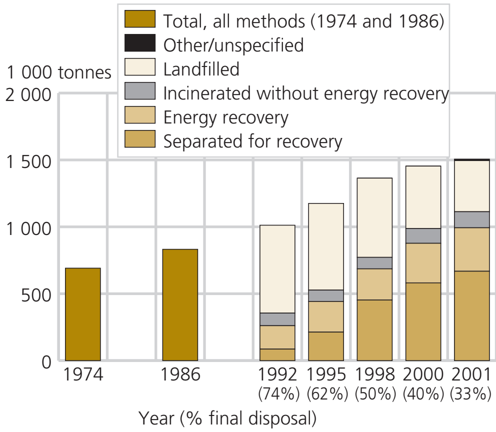
Waste oil contains carcinogenic tars (PAHs) and small quantities of heavy metals. Degradation of waste oil in the environment is fairly rapid if the oil is finely divided, but after major oil spills, it may take many years before the process is completed. In general, hazardous waste containing oil that is not dealt with through the proper channels is in a finely-divided form. Nevertheless, persistent discharges of oily hazardous waste can result in local pollution of sediments. Some harbour basins in Norway have become polluted in this way. Oil spills from underground storage tanks can cause local pollution of the soil. If oil emulsion escapes from overloaded oil separators into drains and enters municipal waste water treatment plants, the quality of the sewage sludge may be so poor that it is unsuitable for many purposes. Waste oil can also spoil the taste of drinking water and is suspected to affect the taste of farmed fish.

Organic solvents are highly flammable and it is therefore dangerous to mix them with ordinary waste. In most cases, their acute toxicity is not very high and they are easily broken down in the environment. This means that they are not generally very harmful to the environment, but persistent emissions can result in local pollution. Waste containing solvents also includes paints, and may contain various other substances as well, for example aromatic compounds. Waste containing solvents may therefore also contain both heavy metals and POPs. Chlorinated solvents are particularly hazardous to health and the environment. They break down slowly in the environment, become concentrated in food chains and have a variety of toxic effects. For example, they may be endocrine disruptors, carcinogenic or impair reproduction.

Brominated flame retardants are a group of substances that are increasingly being used for various purposes, for example in electronic circuit boards, curtain textiles and fittings for vehicles. Some of them are chemically similar to PCBs, but we still have only limited knowledge of the health risks associated with them and the extent to which they become dispersed in the environment. The concentrations of some of them in human breast milk have risen by a factor of 50 in the last 25 years. Some of them are suspected to be endocrine disruptors and to impair reproduction. The annual global consumption of brominated flame retardants is estimated at 200 000 tonnes (National Institute of Public Health 2002). The brominated flame retardants that are believed to be most dangerous have been included in the new regulations on hazardous waste.

7.4. Household waste

Figure 7.7. Household waste by method of recovery or disposal. 1974-2001

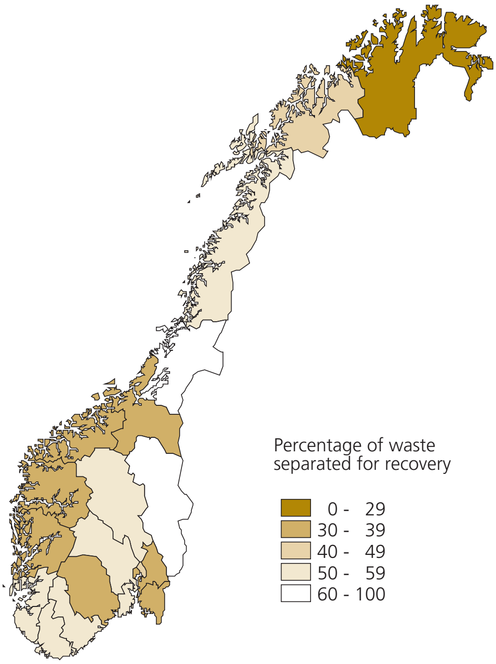


Source: Waste statistics, Statistics Norway.

Quantities and methods of disposal

- In 2001, per capita generation of household waste was 335 kg, 100 kg more than in 1992 and almost twice as much as in 1974. Per capita generation has risen by an average of 11 kg per year since 1992.
- 2001 was the first year when more household waste was incinerated than landfilled.
- In 2001, the proportion of household waste delivered for final disposal (incineration without energy recovery and landfilling) was 33 per cent.

Figure 7.8. Percentage of household waste sorted. 2001



Source: Waste statistics, Statistics Norway.

Recovery

- In 2001, each person in Norway separated 148 kg of household waste for recovery, 128 kg more than in 1992. This corresponds to 44 per cent of all household waste.
- The highest proportions of household waste were separated in Nord-Trøndelag and Hedmark counties, 63 and 62 per cent respectively. The lowest proportion, 6 per cent, was in Finnmark.
- In 2001, the largest fractions of separated waste were paper and board and wet organic waste (food waste). These materials accounted for 35 and 20 per cent respectively of the total sorted. Plastic accounted for only 1 per cent of the total. However, new technology has made it possible to separate different types of plastic automatically.
- More and more municipalities are introducing collection schemes for separated waste. In 2001, 385 municipalities had collection schemes for paper and 278 for wet organic waste. There were only 27 municipalities that had no collection schemes for separated waste in 2001, as compared with 136 in 1997. In these municipalities, only the residual waste is collected, and people must deliver separated waste to collection points themselves.

More information: Øystein Skullerud, Håkon Skullerud and Svein Erik Stave.

Useful websites

Statistics Norway - waste statistics: http://www.ssb.no/english/subjects/01/05/
State of the environment Norway: http://www.environment.no/

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8. Water resources and water pollution

Water resources are used in almost all forms of economic activity, and this makes them vulnerable to over-exploitation and degradation. In many parts of the world, there is a growing shortage of clean water supplies, due to the increasing withdrawal of water for various purposes and discharges of waste water and environmentally hazardous substances. Although the overall situation in Norway is good as regards both quantity and quality, there can be substantial problems at the local level.

Drinking water is of vital importance to life and health and to society as a whole. Good water and sufficient water is therefore a primary objective in the supply of water. The drinking water regulations (Ministry of Health and Social Affairs, 1995) require all water works supplying more than 50 persons or 20 households or holiday homes, or supplying water to food manufacturers, health institutions, etc. to be approved by the authorities. At present a large number of water works still do not meet the requirements of the drinking water regulations and many do not have the water disinfection facilities required by the regulations (Norwegian Food Control Authority 2000).

Almost 90 per cent of the population in Norway receive their water supplies from surface sources. These water sources are vulnerable to acid rain, which has been regarded as one of the greatest environmental problems in Norway for several decades. However, a substantial reduction in sulphur and nitrogen discharges in Europe has reduced the acidification of Norwegian inland waters since 1980. Nonetheless, there is still a long way to go before the natural ecosystems in the most vulnerable areas have recovered, and new international agreements, such as the Gothenburg Protocol, have already been concluded to reduce discharges of harmful substances even further.

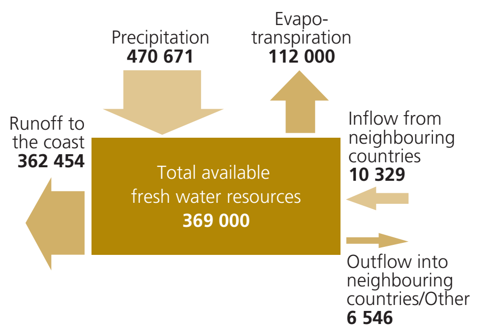
Discharges of phosphorus and nitrogen from the waste water treatment sector have been a matter of concern for many years, because these plant nutrients play an important role in the eutrophication of rivers, lakes and coastal areas. Eutrophication causes excessive growth of algae and oxygen depletion. Agriculture and aquaculture are also important sources of large nutrient inputs to inland waters and coastal areas.

In recent years, both Norway and other countries that drain to the Skagerrak and the North Sea basin have invested substantial resources in waste water treatment. The main reason has been that the heavy pollution load in these waters has resulted in eutrophication and periodical algal blooms. In addition, Norway has signed the North Sea Agreements and the OSPAR Convention, thereby undertaking to halve inputs of phosphorus and nitrogen compared with the 1985 level.

During the past 20 years, Norway has achieved a satisfactory level of treatment efficiency for phosphorus, mainly by building waste water treatment plants providing chemical or chemical-biological treatment. Nitrogen removal measures have been given priority over the last few years in areas where discharges from Norway have a major impact on eutrophication (as defined in the EU waste water directive and the nitrate directive), i.e. areas from the border with Sweden to Strømtangen lighthouse near Fredrikstad (Hvaler/Singlefjorden in Eastern Norway) and in the Inner Oslofjord. Discharges of nitrogen and phosphorus from Norway are relatively modest in comparison with discharges from the other countries bordering the North Sea and the Baltic Sea. As is the case in many other contexts, cooperation across national borders is important to achieve the objective of reducing pollution in these marine areas.

8.1. Availability and consumption of water

Figure 8.1. Annual available water resources in Norway. Million m³

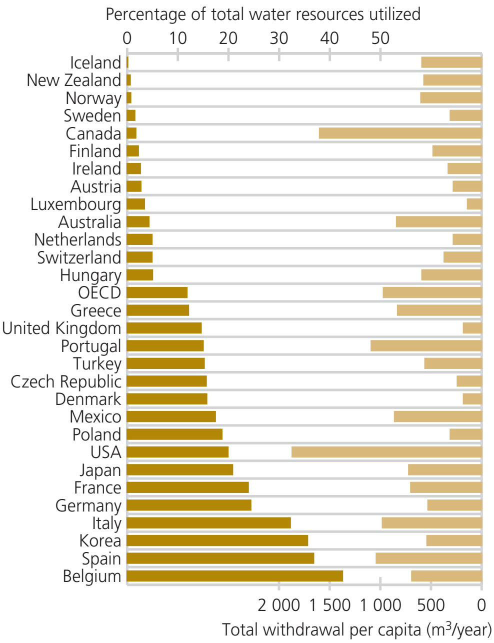


Source: Based on data from the Norwegian Institute for Water Research.

Available water resources

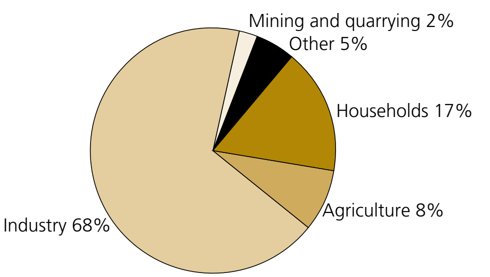
- Renewable water resources in Norway in a normal year total 369 billion m³.
- 98 per cent of the annual input of water resources is in the form of precipitation, while the remainder is in the form of incoming water flows via rivers from our three neighbouring countries.

Figure 8.2. Percentage of total water resources utilized and withdrawal per inhabitant in OECD countries at the end of the 1990s



Source: OECD 2001.

Figure 8.3. Total water consumption by sector. 1999 or latest year for which figures are available



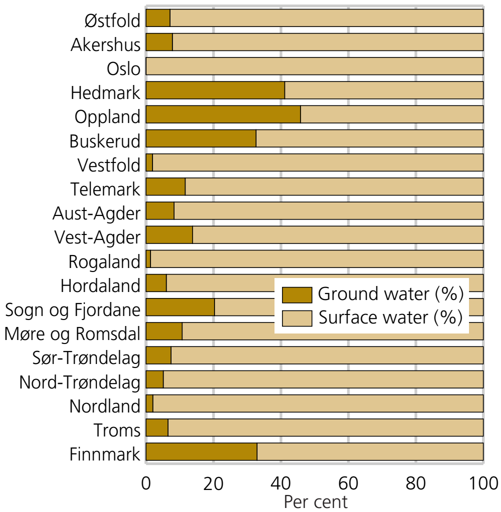
Source: Provisional figures from Statistics Norway.

Water withdrawal and consumption

- Only 0.7 per cent of the water resources available each year in Norway is utilized (water used in hydropower production is not included) before draining to the coast (98 per cent) or via rivers to neighbouring countries (2 per cent).
- The only OECD countries that utilize a smaller percentage of their total available water resources than Norway are Iceland (0.1 per cent) and New Zealand (0.6 per cent).
- About 600 m^3 of water is withdrawn annually per inhabitant in Norway. This is well below the average for the OECD countries (970 m^3). The average American uses 1 870 m^3, while an inhabitant of Denmark uses 180 m^3.
- A total of about 2 400 million m^3 of water is used annually in Norway. The largest share, just under 1 700 million m^3, is used by manufacturing industries. The sectors that utilize most are the wood processing industry, the food processing industry and the petrochemical industry.
- Over 400 million m^3 is used by households. Approximately 90 per cent of this amount is supplied by municipal water works. Industry and agriculture largely meet their water needs from their own sources.

8.2. Public water supplies

Figure 8.4. Percentage of population connected to municipal water works using various sources of drinking water[1]. 2001. By county

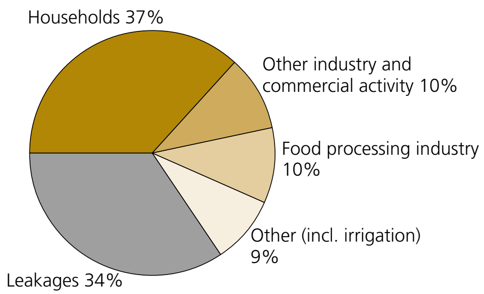


[1] The figure is based solely on municipal water works that have reported their water source for 2001 and the overall picture may therefore be distorted.
Source: National Institute of Public Health.

Water sources

- In 2001, water was supplied to about 89 per cent of Norway's population by 1 700 water works registered in the water works register of the National Institute of Public Health. The remaining 11 per cent of the population was supplied by smaller water works or from their own water sources.
- In 2001, 65 per cent of Norway's water works used surface water as their source of water, while the remainder used groundwater. Groundwater accounts for about 12 per cent of total water production in water works.

Figure 8.5. Percentage of public water supplies used by various sectors[1]. 2001

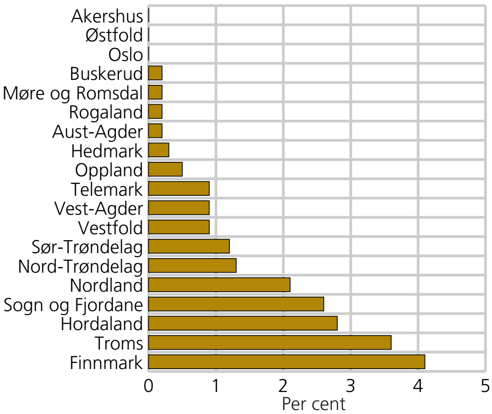


[1] The figure is based on 2001-data for 288 water works. These water works supplied 2 408 000 persons. The figures are uncertain.
Source: National Institute of Public Health.

Consumption of water

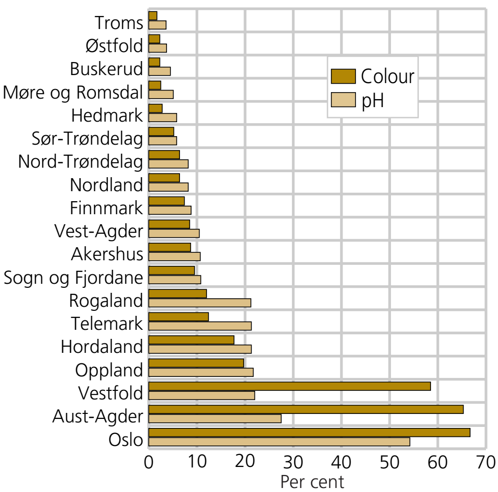
- In 2001, water production at Norwegian water works was calculated to be 750 million m^3, with households using 37 per cent of this total.
- About a third of the water produced was lost due to leakages from pipelines and joints.
- Average water consumption per person per day, including leakages, is estimated at 498 litres. Average household consumption is estimated at 184 l/p/d. There is substantial uncertainty associated with these figures as they are largely based on estimates from the water works.

Figure 8.6. Percentage of samples from municipal water works that do not satisfy the requirements with respect to content of thermo-tolerant intestinal bacteria. By county. 2001



Source: National Institute of Public Health, water works register.

Figure 8.7. Percentage of samples from municipal water works that do not satisfy the requirements with respect to pH and colour. By county. 2001



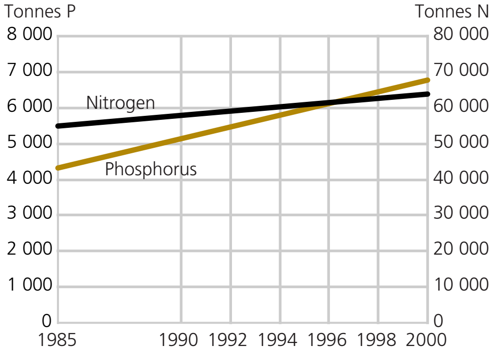
Source: National Institute of Public Health, water works register.

Water quality

- The drinking water regulations contain an absolute requirement for all water to be disinfected or treated to prevent the spread of infection. The treatment of drinking water involves adding chemicals, primarily chlorine, and the use of UV radiation.
- It is important to ensure that drinking water is not infected by intestinal bacteria. Water works in Northern and Western Norway, where a number of water works are still not equipped with disinfection facilities, are finding it hardest to satisfy the requirements with respect to thermo-tolerant intestinal bacteria.
- Acidic water corrodes pipelines and can result in high metal content levels in drinking water. High humus content colours the water brown and may cause sludge and unwanted bacterial growth in sewers. Chlorination of water containing humus may result in the formation of organic chlorine compounds, with potential effects on odour, taste and health.
- A number of water works in densely populated areas in Eastern Norway are finding it difficult to meet the acidity and colour requirements.
- The problem of brown-coloured water is mainly due to humus and organic material deposited in water sources during rainfall and minor flooding. A pH level that is too low is mainly due to acid rain and runoff from acidic rock such as granite and gneiss.

8.3. Inputs of nutrients to coastal areas

Figure 8.8. Trend in inputs of phosphorus and nitrogen to the Norwegian coast[1]. 1985-2000



[1] The curves are interpolated between the 1995 and 2000 levels because of a change in method and uncertainty as to the actual annual trend.
Source: Norwegian Institute for Water Research.

- Although total Norwegian anthropogenic inputs of phosphorus and nitrogen to the Norwegian coast have increased by 57 and 16 per cent respectively from 1985 to 2000, discharges from all sectors, with the exception of aquaculture, have declined.
- Due to the development of the aquaculture sector, phosphorus discharges by this industry have increased by 4 410 tonnes and nitrogen discharges by 21 142 tonnes. Today, this industry accounts for 70 per cent of phosphorus inputs and 36 per cent of nitrogen inputs to coastal areas.

Box 8.1. Concepts related to nutrient inputs to coastal areas and inland waters

North Sea Agreements
The North Sea Agreements and the OSPAR convention refer to the joint declarations made by the countries round the North Sea to reduce inputs of nutrients to the North Sea. One of the targets was to halve the total inputs of nitrogen and phosphorus during the period 1985 to 1995. Since Norway had not reached these targets by the end of 1995, the national time limit was extended to 2005.

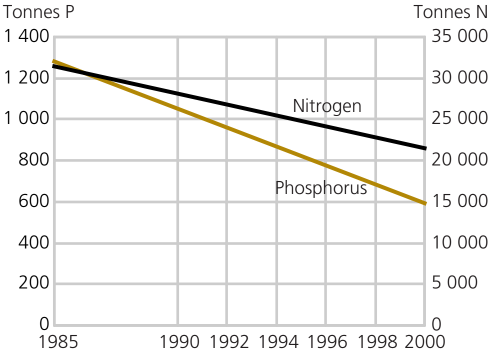
The North Sea counties or North Sea region
In principle, the North Sea Agreements apply to the areas south of 62° N. In Norway, the targets for reducing inputs of nutrients apply to the counties from the border with Sweden to Lindesnes. Thus, the North Sea counties or North Sea region means the following counties: Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark, Aust-Agder and Vest-Agder. Virtually all land in these counties drains into the Skagerrak or the North Sea.

Eutrophication
Eutrophication is a gradual process in which inputs of organic matter containing plant nutrients alter biological production conditions in water bodies. Water that is rich in nutrients and very productive biologically is called eutrophic, while water that is poor in nutrients and unproductive is termed oligotrophic. Excessive inputs of nutrients, often anthropogenic, can lead to problems such as algal blooms and oxygen depletion. In fresh water, eutrophication is usually caused primarily by phosphorus inputs, although nitrogen and other substances also play a role.

The sensitive area for phosphorus
The area that drains to the coast from the border with Sweden to Lindesnes is particularly sensitive to phosphorus inputs. As well as the North Sea counties, south-eastern parts of Trøndelag are particularly phosphorus-sensitive.

The sensitive area for nitrogen
The inner Oslofjord, the area Hvaler-Singlefjorden (around the estuary of the river Glomma) and the catchment areas of the rivers Glomma and Halden are regarded as particularly sensitive to nitrogen inputs. In these areas, the authorities have issued instructions for nitrogen removal at six waste water treatment facilities.

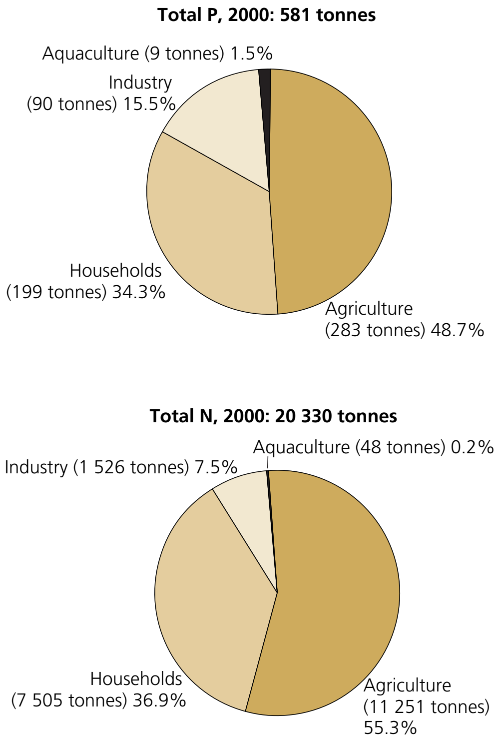
Figure 8.9. Trend in inputs of phosphorus and nitrogen to the North Sea region[1]. 1985-2000



[1] The curves are interpolated between the 1995 and 2000 levels because of a change in method and uncertainty as to the actual annual trend.
Source: Norwegian Institute for Water Research.

- In order to achieve the targets of the North Sea Agreements, substantial sums have been invested in high-grade waste water treatment facilities in the North Sea region. Measures have also been implemented in agriculture and the aquaculture sector.
- Phosphorus and nitrogen inputs to the sensitive North Sea region (from the border with Sweden to Lindesnes) have been reduced by 55 and 35 per cent respectively from 1985 to 2000.
- This means that the target set for phosphorus in the North Sea Agreements has already been achieved, but that there is some way to go before the nitrogen target is reached (see box 8.1).

Figur 8.10. Inputs of phosphorus and nitrogen to the North Sea region by sector. 2000



Source: Norwegian Institute for Water Research.

- Phosphorus inputs from municipal waste water treatment plants (households) have been reduced by 530 tonnes (73 per cent) since 1985 and nitrogen inputs by 2 400 tonnes (24 per cent).
- Phosphorus inputs from agriculture have been reduced by around 30 per cent and nitrogen inputs by 23 per cent since 1985.
- Phosphorus and nitrogen inputs from manufacturing industry have been reduced by 54 and 32 per cent respectively.
- In 1997, open aquaculture facilities were prohibited in the North Sea region, and inputs from this industry have thus been considerably reduced.

Box 8.2. Acidification of inland waters

Acidification has been one of the most serious environmental problems in Norway for a long time and is mainly caused by fossil fuel combustion outside Norway's borders. Water bodies in the southern half of Norway and eastern parts of Finnmark county are particularly vulnerable to this kind of pollution. Acidic water increases corrosion and wear on pipelines and sanitations systems. Acidification reduces animal life in general in inland waters. Surveys of fish stocks in the southern half of Norway show that 19 per cent of the stocks have been wiped out, and the salmon has disappeared from all the major salmon rivers in Southern Norway (Norwegian Pollution Control Authority/Ministry of the Environment, 2000). However, developments over the past couple of years indicate that some salmon stocks are reviving.

Southern Norway and eastern parts of Finnmark county are the areas of Norway that receive the highest concentrations of sulphur dioxide and nitrogen oxides from central and western Europe and the Russian industrial areas on the Kola peninsula respectively. About 85 per cent of sulphur and nitrogen deposition in Norway is the result of emissions in other countries. Sulphur emissions in Europe have been more than halved since 1980, and this has brought about a substantial decrease in the sulphate content of river systems in Southern Norway, and consequently an improvement in the situation caused by acidification. The situation in eastern Finnmark, however, shows little sign of improving, and an increase in sulphate concentrations was recorded in this area in 1999.

Trends in the sulphate and nitrate content of 100 lakes in 10 different regions of the country have been monitored between 1986 and 1999. The findings show that there has been a substantial reduction in sulphate content in lakes all over the country, ranging from 19 per cent in eastern Finnmark to 48 per cent in the southern part of Western Norway. Although there have also been clear changes in nitrate levels in several regions, they vary so much from year to year that it is difficult to distinguish a clear trend for this nutrient.

Despite the reduction in acidification, it may take a long time before the natural ecosystems in the fjords and river systems are restored. Measures to further reduce acidification will therefore be necessary in the future. Liming has been used for many years to reduce the damage to salmon stocks and other fauna in acidified river systems. Over the last few years, public funds for liming programmes have risen to NOK 100 million a year, and the Norwegian Institute for Water Research recommends that this level should be maintained or increased in the years ahead, despite the fact that the sulphate content of water bodies is decreasing.

In the last few years, over 60 000 tonnes of lime have been added to water bodies in Norway, most of which was used in the counties of Aust-Agder, Vest-Agder and Rogaland. The amount of lime used in Vest-Agder more than doubled between 1995 and 1999, while in Telemark the amount has been more than halved in the same period. This is partly because the sulphate content in lakes and rivers in Telemark and the mountains of the southern half of Norway has been reduced to a level closer to the critical load. Even though the sulphate content in Vest-Agder has been reduced more than in Telemark, Vest-Agder still has the highest concentrations of sulphate in the country.

A more fundamental measure to reduce acidification is the implementation of international agreements on reducing emissions to air. The latest of these is the Gothenburg Protocol, signed in 1999, which applies to emissions of ammonia and volatile organic compounds (VOCs) in addition to sulphur dioxide and nitrogen oxides.

Under this agreement, twenty-nine countries, including Norway, have undertaken to make substantial reductions in emissions in the years leading up to 2010. It is expected that this agreement will reduce the area damaged by acid rain in Norway by up to 90 per cent by 2010. The agreement will cost Norway somewhere between NOK 350 and 550 million, but the gains in the form of reduced damage to health, less material damage, higher crop yields, etc. are estimated at between NOK 1 and 3 billion (Norwegian Pollution Control Authority/Ministry of the Environment, 2000), even without including the gains from restored fish stocks and ecosystems.

Box 8.3. Eutrophication in lakes

Eutrophication is a local problem in a number of lakes, and is caused by inputs of nutrients from agriculture, industry and waste water systems. Eutrophication is most widespread in the major agricultural districts in Eastern Norway, the Jæren district in Western Norway and around the Trondheimsfjord. Typically, vegetation in eutrophicated waters grows vigorously, dominated by a relatively small number of pollution-tolerant species (but large numbers of individuals). In seriously affected waters, oxygen deficiency may reach a dangerously low level, and blooms of toxic blue-green algae may develop.

Inputs of phosphorus from agricultural activity and, to a lesser extent, untreated waste water from households are the main causes of eutrophication of fresh water sources in Norway. In comparison with the rest of Europe, eutrophication in this country cannot generally be considered a major problem. Nevertheless, it can be a considerable problem at the local level, particularly in the areas around the Oslofjord and in the lowlands of Eastern Norway, in the areas around Stavanger, in the Jæren district of Western Norway and along the Trondheimsfjord. It is also a widespread problem in areas where there is intensive milk production along the coast of Nordland county. In the 1970s, lake Mjøsa and several other large lakes in Eastern Norway were threatened by eutrophication, and substantial funds were invested in waste water treatment.

Over 90 per cent of all the lakes in Norway are considered "very good" or "good" with regard to the concentration of phosphorus in the water. Only about 2.5 per cent of all the country's lakes are considered "bad" or "very bad". This nevertheless applies to around 800 lakes and surveys show that eutrophication results in a number of user conflicts with regard to drinking water, swimming, fishing and natural assets.

The table shows changes in the degree of eutrophication in a selection of lakes in various parts of Norway in the period 1995-1999. The table does not provide the basis for any general conclusions about trends in the various regions or in the country as a whole. The lakes have been selected on the basis of the following criteria:

Change in degree of eutrophication in selected lakes. 1995-1999

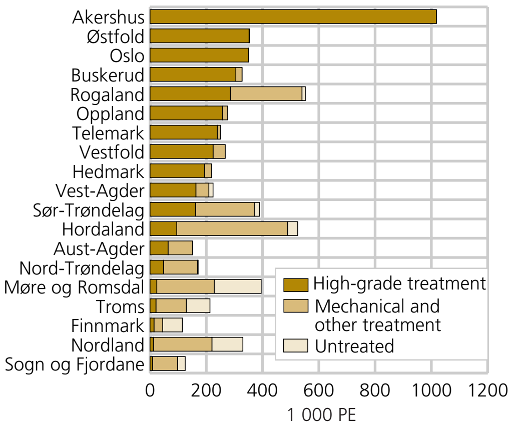
Lake	County	Change
Revovatnet	Vestfold	Definite improvement
Gjersjøen	Akershus	Improvement
Nærevatnet	Akershus	Improvement
Årungen	Akershus	Improvement
Farstadvatnet	Nordland	Improvement
Langmovatn	Nordland	Improvement
Frøylandsvatnet	Rogaland	Improvement
Liavatn	Sør-Trøndelag	Improvement
Hillestadvatnet	Vestfold	Improvement
Hellesjøvann	Akershus	Slight improvement
Stovivatnet	Akershus	Slight improvement
Stokkelandsvatnet	Rogaland	Slight improvement
Gjølsjøen	Østfold	Slight improvement
Rokkevatnet	Østfold	Slight improvement
Hersjøen	Akershus	No trend
Gjesåssjøen	Hedmark	No trend
Lyngstadvatn	Møre og Romsdal	No trend
Limavatnet	Rogaland	No trend
Frøylandsvatn	Rogaland	No trend
Laugen	Sør-Trøndelag	No trend
Akersvatn	Vestfold	No trend
Isesjø	Østfold	No trend
Hostadvatnet	Møre og Romsdal	Slight deterioration
Østensjøvatnet	Oslo	Slight deterioration
Lilandsvatnet	Nordland	Deterioration
Mæna	Oppland	Deterioration

Sources: Based on Norwegian Institute for Water Research (NIVA) (1999) and NIVA/Norwegian Centre for Soil and Environmental Research (2000).

1. They are among the most eutrophic lakes in the country,
2. Eutrophication is largely the result of human activity, primarily agriculture and waste water, and
3. All the lakes were monitored over at least 3-4 years. An improvement in water quality was recorded in 14 of these lakes, while only four showed deteriorating quality. In the remaining 9 lakes, no clear trend was recorded. The reasons for the improvement varied between the different lakes. A reduction in the quantity of phosphorus applied, spreading manure at a more suitable time of year, less autumn ploughing and a transition from the cultivation of vegetables to cereals has resulted in an improvement in the eutrophication situation in the Nærevatnet, Liavatn and Langmovatn lakes. Treating waste water from households and improving the sewerage system has had a major positive impact on the situation in lakes such as Gjersjøen. In general, the most effective ways of counteracting eutrophication are changes in agricultural methods and waste water treatment.

8.4. Municipal waste water treatment

Figure 8.11. Hydraulic capacity of waste water treatment plants[1], by treatment method. By county. 2000

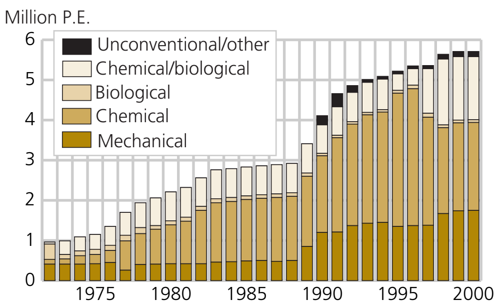


[1] Facilities with a capacity of more than 50 P.E.
Source: Waste water treatment statistics, Statistics Norway.

Treatment capacity at waste water treatment facilities

- In 2000, total waste water treatment capacity in Norway was 5.72 million population equivalents (PE), 67 per cent of which was high-grade capacity. In addition, systems with direct discharges of untreated sewage had a total capacity of 0.54 million PE.
- High-grade treatment methods account for 92.5 per cent of treatment capacity in the North Sea counties, but only 27 per cent of the total in the rest of the country.
- High-grade treatment capacity in the North Sea region totals 1.29 PE per inhabitant, while the equivalent figure for the rest of the country is 0.33 PE.

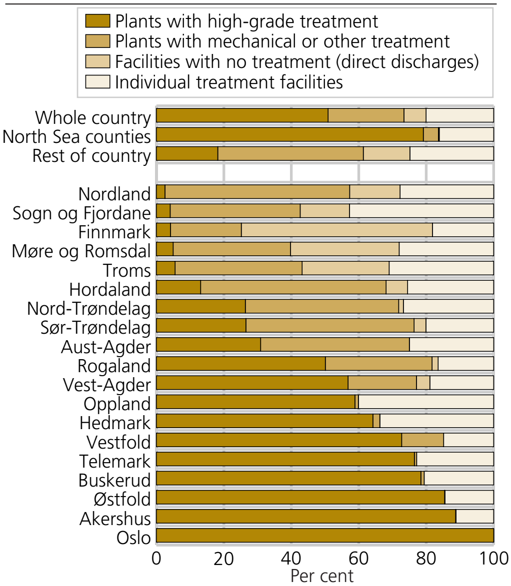
Figure 8.12. Trend in treatment capacity[1]. Whole country. 1972-2000



[1] Facilities with a capacity of more than 50 P.E.
Source: Waste water treatment statistics, Statistics Norway.

- The developments in treatment capacity reflect investments made in the 1970s in chemical treatment processes for the removal of phosphorus and the upgrading of some large treatment facilities in the inner Oslofjord to chemical-biological treatment facilities since the mid-1990s.
- The substantial increase in mechanical treatment capacity, particularly since 1988, is largely because this is when registration of strainers and sludge separators in mechanical treatment facilities was introduced.

Figure 8.13. Percentage of population connected to various types of treatment plants. By county. 2000



Source: Waste water treatment statistics, Statistics Norway.

Connection to waste water treatment plants

- In 2000, 80 per cent of the population of Norway were connected to waste water treatment plants with a capacity greater than 50 PE and to municipal sewerage systems. The remaining 20 per cent were connected to smaller, individual treatment facilities.
- Over 50 per cent of the population were connected to high-grade treatment plants in 2000. In the North Sea counties, this proportion was 83 per cent, while the figure for the rest of the country was 18 per cent.

Box 8.4. Terms, municipal waste water treatment

Waste water treatment plants are generally divided into three groups according to the type of treatment they provide: mechanical, biological or chemical. Some plants incorporate combinations of these basic types.

Mechanical waste water treatment plants include sludge separators, screens, strainers, sand traps and sedimentation plants. They remove only the largest particles from the waste water.

High-grade waste water treatment plants are those that provide a biological and/or chemical treatment phase. Biological treatment mainly removes readily degradable organic material using micro-organisms. The chemical phase involves the addition of various chemicals to remove phosphorus. High-grade plants reduce the amounts of phosphorus and other pollutants in the effluent more effectively than mechanical plants.

The number of **population equivalents (P.E.)** in an area is given by the sum of the number of permanent residents and all waste water from industry, institutions, etc. converted to the number of people who would produce the same amount of waste water. One P.E. corresponds to 1.6 g phosphorus and 12.0 g nitrogen per day.

The **hydraulic capacity** of a treatment plant is the amount of waste water it is designed to treat.

The **hydraulic load** is the amount of waste water a treatment plant actually treats.

Individual waste water treatment facilities are designed to receive waste water equivalent in amount or composition to that from up to seven residential households or holiday homes (generally private plants in areas with scattered settlements).

Discharges of plant nutrients from waste water treatment plants

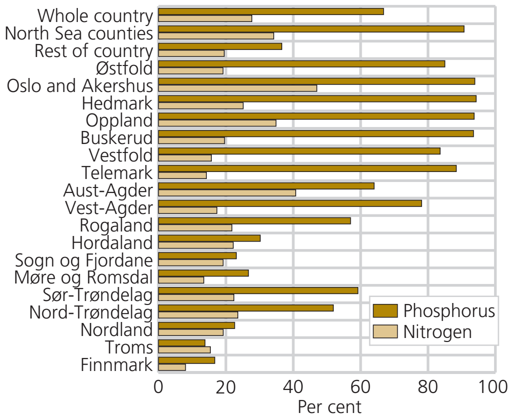
- Discharges of phosphorus and nitrogen from the waste water treatment sector in 2000 totalled 1 300 and 17 417 tonnes respectively. This includes leakages from sewers and discharges from individual treatment facilities.
- Plants in the North Sea counties accounted for 26 per cent of the phosphorus discharges and half of the nitrogen discharges. This corresponds to a discharge of 0.1 kg phosphorus and 3.5 kg nitrogen per inhabitant per year. The equivalent figures for the rest of the country were 0.5 kg phosphorus and 4.4 kg nitrogen.

Table 8.1. Total discharges of phosphorus and nitrogen from sewerage systems. By county. 2000

	Phosphorus					Nitrogen				
	Total	Discharges from municipal treatment plants	Leakages from sewer[1]	Discharges from individual treatment facilities	Discharges per inhabitant	Total	Discharges from municipal treatment plants	Leakages from sewer[1]	Discharges from individual treatment facilities	Discharges per inhabitant
	Tonnes				kg	Tonnes				kg
Total	1 300.1	825.3	124.4	350.4	0.29	17 417.0	13 191.6	912.3	3 313.1	3.89
North Sea counties	333.9	135.0	69.9	129.0	0.14	8 658.3	6 758.5	512.9	1 386.9	3.51
Other counties	966.2	690.3	54.5	221.4	0.48	8 758.7	6 433.1	399.4	1 926.2	4.35
Østfold	39.6	17.9	5.9	15.8	0.16	955.4	790.1	48.9	116.4	3.85
Akershus and Oslo	95.1	40.7	33.5	20.9	0.10	3 007.4	2 569.1	242.5	195.8	3.09
Hedmark	27.9	5.5	4.8	17.6	0.15	783.9	505.7	33.8	244.4	4.19
Oppland	22.2	5.7	4.6	11.9	0.12	684.0	468.7	36.0	179.3	3.74
Buskerud	28.6	8.4	6.5	13.7	0.12	862.5	650.0	40.4	172.1	3.64
Vestfold	39.2	15.4	4.7	19.1	0.18	809.1	617.3	36.6	155.2	3.80
Telemark	25.4	9.2	4.0	12.2	0.15	648.8	494.9	28.8	125.1	3.93
Aust-Agder	25.1	15.8	2.2	7.1	0.25	348.5	243.4	20.5	84.6	3.41
Vest-Agder	30.8	16.4	3.7	10.7	0.20	558.6	419.3	25.4	113.9	3.59
Rogaland	107.4	77.8	9.0	20.6	0.29	1 231.4	990.6	63.3	177.5	3.30
Hordaland	226.1	164.4	11.8	49.9	0.52	1 978.0	1 451.0	93.2	433.8	4.54
Sogn og Fjordane	56.9	39.7	2.6	14.6	0.53	479.6	305.4	18.9	155.3	4.46
Møre og Romsdal	150.7	109.6	7.5	33.6	0.62	1 187.5	867.9	50.1	269.5	4.88
Sør-Trøndelag	87.9	60.2	7.4	20.3	0.33	1 171.2	921.0	59.3	190.9	4.46
Nord-Trøndelag	55.4	36.4	3.8	15.2	0.44	503.4	355.2	23.2	125.0	3.96
Nordland	131.8	90.6	5.9	35.3	0.55	1 023.5	687.8	42.6	293.1	4.28
Troms	100.6	69.4	4.0	27.2	0.67	765.7	510.0	30.1	225.6	5.07
Finnmark	49.7	42.2	2.5	5.0	0.67	418.2	344.2	18.7	55.3	5.65

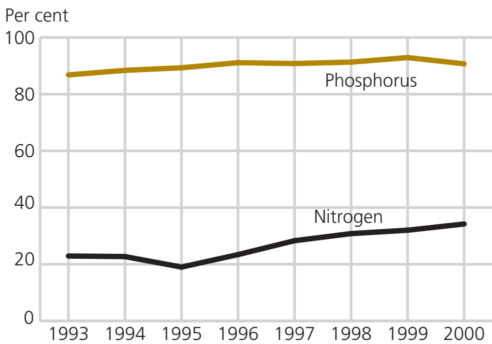
[1] Estimated at 5 per cent of the content of phosphorus and nitrogen in waste water before treatment.
Source: Waste water statistics, Statistics Norway.

Figure 8.14. Estimated treatment effect for phosphorus and nitrogen. By county. 2000



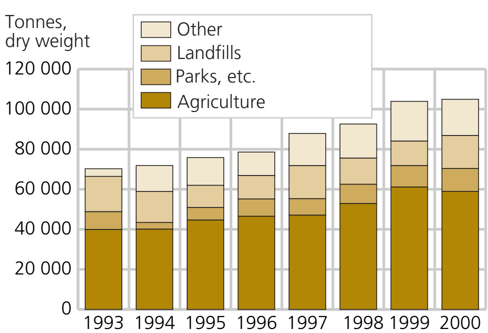
Source: Waste water treatment statistics, Statistics Norway.

Figure 8.15. Trend in treatment effect for phosphorus and nitrogen in the North Sea region. 1993-2000



Source: Waste water treatment statistics, Statistics Norway.

Figure 8.16. Quantities of sewage sludge used for different purposes. Whole country. 1993-2000



Source: Waste water treatment statistics, Statistics Norway.

Treatment efficiency

- In 2000, waste water treatment plants in the North Sea counties removed on average 91 per cent of the phosphorus and 34 per cent of the nitrogen load processed by the plants. In the rest of the country, treatment efficiency for these nutrients was 37 and 20 per cent respectively.
- Calculated treatment efficiency for both phosphorus and nitrogen outside the North Sea counties increased markedly from 1999 to 2000, by 8 and 5 per cent respectively. Some of the increase may be due to improved reporting rather than a real advance in treatment efficiency.
- In the North Sea region, a decrease of 2 per cent in treatment efficiency for phosphorus was registered from 1999 to 2000. An increase of 2 per cent was registered for nitrogen. Treatment efficiency for phosphorus has stood at over 90 per cent since 1996. Actual efficiency will vary somewhat from year to year, partly because unusual incidents (operational failure, overload, etc.) at the larger plants can have a substantial effect on the figures.
- Since 1995, treatment efficiency for nitrogen has been improved by more than 15 percentage points due to the construction of nitrogen removal plants.

Sewage sludge

- Sludge is a residual product of the waste water treatment process, but also a potential resource in integrated plant nutrient management in agricultural areas and parks and other green spaces. Nutrients and organic matter are separated from the waste water, and the sludge is stabilized and hygienized to remove odours and harmful bacteria before utilization or disposal in landfills.

- In 2000, 105 000 tonnes of sludge, expressed as dry weight, was used for various purposes, an increase of 50 per cent since 1993.
- If the content of heavy metals exceeds the limit values, the sludge cannot be used in integrated plant nutrient management.
- Lower mean values for the content of most heavy metals were registered in 2000 than in the previous year. This has been the trend for mercury, lead and copper over the past few years.
- The content of heavy metals varies, sometimes substantially, from one plant to another. This is because the composition of waste water varies (depending on, for example, the amount of waste water from households, and the proportion of industrial waste water and of rain/melt water).

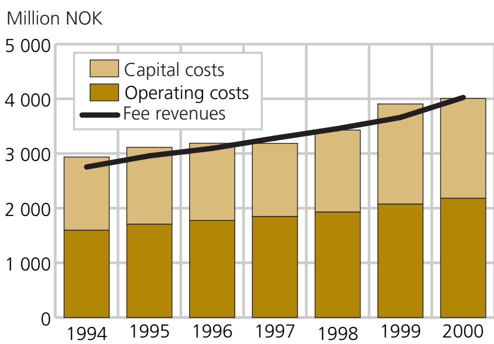
Table 8.2. Content of heavy metals in sludge. 2000

Heavy metals	Mean value	Maximum value	Limit value agriculture	Limit value parks etc.	Total amount in sewage sludge used	Change in mean value 1999-2000
	Milligrams per kg expressed as dry weight				kg	Per cent
Cadmium (Cd)	1.0	19.0	2	5	105	7.0
Chromium (Cr)	24.8	2 190.0	100	150	2 535	-16.6
Copper (Cu)	244.1	2 790.0	650	1 000	24 906	-1.7
Mercury (Hg)	0.9	23.7	3	5	94	-2.7
Nickel (Ni)	14.5	299.0	50	80	1 481	5.5
Lead (Pb)	20.6	224.0	80	200	2 099	-14.9
Zinc (Zn)	317.4	2 708.0	800	1 500	32 390	-12.1

Source: Waste water treatment statistics, Statistics Norway.

8.5. Financial situation in the municipal waste water sector

Figure 8.17. Annual costs (by type) and fee revenues. Whole country. 1994-2000

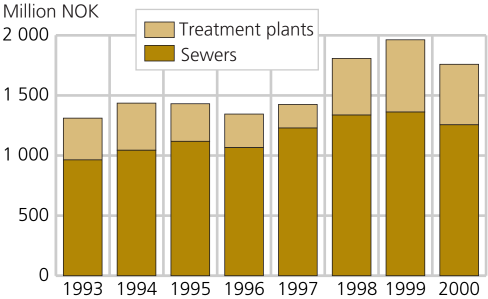


Source: Environmental protection expenditure statistics, Statistics Norway.

Costs and revenues

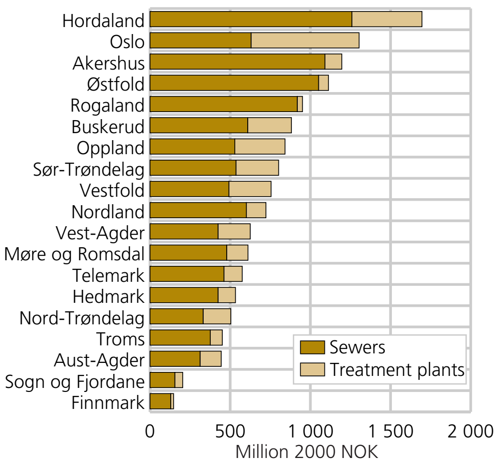
- Annual costs in the municipal waste water sector in 2000 totalled NOK 4 007 million, an increase of 3 per cent on 1999. Operating costs accounted for 54 per cent and capital costs 46 per cent of the total.
- Revenues from fees totalled NOK 4 024 million, an increase of 10 per cent.
- Annual costs and revenues from fees were the same in 2000. This has changed since 1994, when revenues from fees only accounted for 94 per cent of costs.

Figure 8.18. Investments, by type. Whole country. 1993-2000



Source: Environmental protection expenditure statistics, Statistics Norway.

Figure 8.19. Investments in municipal waste water treatment sector, by type. By county. Total for the period 1993-2000



Source: Environmental protection expenditure statistics, Statistics Norway.

Investments

- Investments in 2000 totalled NOK 1 759 million, a decrease of 10 per cent on 1999. Measured in constant prices, this is a decline of 15 per cent.
- The level of investment was highest in 1998 and 1999. High investment figures in these years are partly due to the construction of a nitrogen removal facility in Oslo, which was resumed after a lengthy delay.
- The largest share of investment was used for sewers, accounting for 71 per cent of the total in 2000.

- In Hordaland county, a total of NOK 1 696 million (constant prices) was invested in the waste water treatment sector in the period 1993-2000.
- Oslo was the only county where there was more investment in waste water treatment facilities than in sewers. NOK 674 million - 52 per cent - was invested in water treatment facilities. A large share of this amount was invested in a nitrogen removal facility that was completed at the end of this period.
- Investment in the waste water treatment sector varies widely between municipalities and counties. This is partly related to the number of inhabitants and settlement structure, and whether counties are included in the North Sea Agreements or not. A number of investments are also project-based.

More information: Svein Erik Stave and Tone Smith (financial data).

Useful websites

Statistics Norway - Water and waste water statistics:
http://www.ssb.no/english/subjects/01/04/20/
State of the Environment Norway: http://environment.no/

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9. Land use

With an area of 324 000 km^2 and 4.5 million inhabitants, Norway has the second lowest population density in Europe after Iceland. Because of Norway's climate, geology and topography, a large proportion of the country has not been developed for settlement and agriculture. The population is largely concentrated in urban settlements and the productive agricultural and forest areas surrounding them, putting these areas under considerable pressure. But land use has increased in intensity in many sparsely settled areas too, as a result of road construction, the building of holiday cabins, the construction of power lines, and so on.

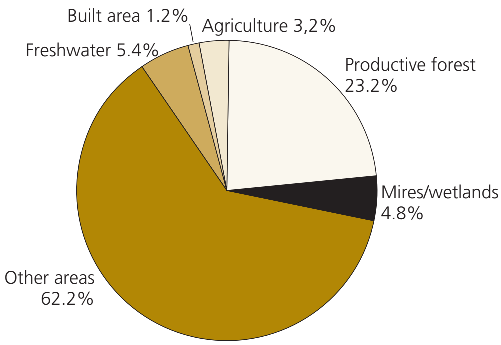
How the land is used is of great importance in terms of economics and the environment, and it affects people's lives. Changes in land use result in changes in the cultural landscape and the local environment. This has considerable impact on human health and quality of life, and on the productivity and ecological qualities of the natural environment.

Resource and environmental conflicts often result as settlements become increasingly concentrated along the coast and in the most productive agricultural areas. These can include the conversion of the most valuable agricultural areas for other purposes, pressure on recreational areas in and around urban settlements, conflicts about whether to demolish or restore old buildings, and more concentrated pollution. On the other hand, population concentrations provide opportunities for environmental gains such as reduced energy use for transport and residential areas, a greater range of play and recreational areas and more efficient water, sewage and waste disposal schemes.

Sustainable urban settlement development is one of the main issues in Report No. 29 (1996-1997) to the Storting on regional planning and land use policy. The objective of planning is to focus on strengthening economic activity and promoting settlement in urban settlement centres, reducing the need for transport, generally making more efficient use of the land and ensuring green spaces are protected for recreational purposes and to maintain biological diversity. Efforts to develop a national environmental and land use policy have been followed up in Report No. 8 (1999-2000) and Report No. 24 (2000-2001) to the Storting, which inter alia set national targets for biological diversity, outdoor recreation and the cultural heritage. National land use statistics and indicators are needed in order to monitor whether measures that have been implemented are having the desired effect and whether the environmental policy objectives mentioned above are being reached.

9.1. Land use in Norway

Figure 9.1. Proportion of different types of land cover. Mainland Norway. 2000



Source: Norwegian Mapping Authority 2000 and Statistics Norway.

The most common types of land use

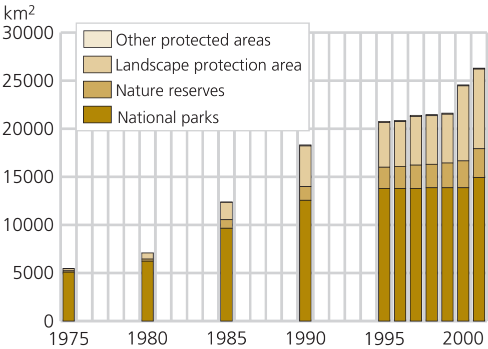
- In 2000, developed land contained a total of 3.4 million buildings, 4 000 km of rail track and 91 000 km of public roads, in addition to about 73 000 km of forestry roads and other roads. (Norwegian Mapping Authority 2002 and Norwegian State Railways 1992).
- In 2001, agricultural areas covered a total of 10 400 km^2 and productive forest about 75 000 km^2 (Norwegian Institute for Land Inventory 1999).
- The remaining land area comprises other cultivated land, scrub and heaths, marginal forest, and mountains. Of this, 2 600 km^2 is on the mainland under permanent ice and snow (Wold 1992).

Box 9.1. Norway's main geographical features

The geographical location of the country and its elongated form with variations in climate, quaternary geology and topography mean that the conditions for land use vary widely. The mainland is 323 758 km^2 in total and 1 752 km in length. It stretches from Lindesnes in the south (57° 58' N to Kinnarodden in the north (71° 7' N). 17 505 km^2 or 5.4 per cent of the mainland is made up of freshwater areas. The mainland is bounded to the south, west and north by a 2 650 km long coastline, not including fjords, bays and islands. In terms of altitude, 31.7 per cent of the land area lies 0-299 metres above sea level. As much as 20.1 per cent of the land area lies at least 900 metres above sea level and productivity (in terms of vegetation) is therefore low (see also Statistical Yearbook of Norway 2002, pp. 19-23 and 47).

9.2. Protection and development

Figure 9.2. Areas protected under the Nature Conservation Act. Whole country. 1975-2001. km²



Source: Directorate for Nature Management.

Protected area

- The area protected under the Nature Conservation Act has expanded considerably since 1975. At 31 December 2001, protected areas included 19 national parks, 1 485 nature reserves, 106 protected landscapes and 75 other types of protected area (Directorate for Nature Management 2002).
- These areas comprise an area of about 26 300 km² or 8.1 per cent of Norway's land area.
- At the end of 2001, a total of 2 203 km² of forest had been protected. This included 668 km² of productive forest, or 0.94 per cent of the total productive forest area (Directorate for Nature Management 2002).

Box 9.2. Building activity in the 100-metre belt along the coast

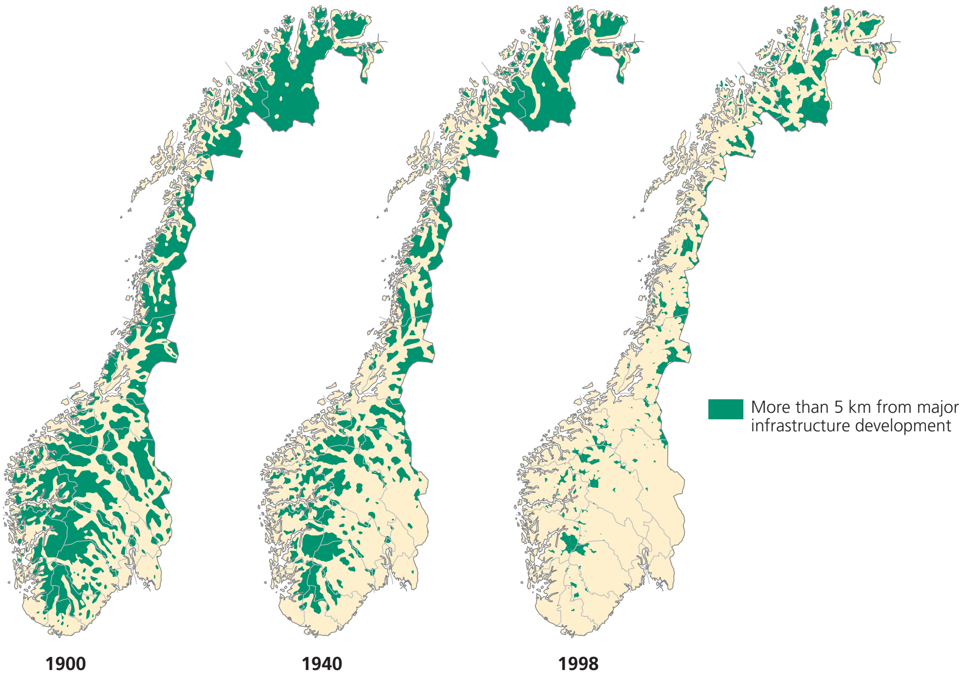
Safeguarding areas of recreational value is an express national target. Several specific key figures have been drawn up as operational tools to monitor developments in relation to the national targets set out in Report No. 24 (2000-2001) to the Storting.

Access to the 100-metre belt along the coast is one such key figure. The mainland coastline is 83 300 km long, including islands, fjords and bays. This is equivalent to twice the circumference of the earth at the equator. Most of the urban settlements and a large proportion of other built-up areas, including holiday cabins, are concentrated along the coast. As much as 23.2 per cent of the total length of the coastline is less than 100 metres from the nearest building (registered in the GAB-register (the Norwegian register for property, addresses and buildings) as of 1 January 2002). From Halden in the south-east to Hordaland in the west, a stretch of the coast specifically mentioned in the context of key figures, as much as 38.5 per cent of the coastline is less than 100 metres from a building. This indicates that public access to the 100-metre belt of the coastal zone is considerably restricted in some parts of this stretch of the coast (see Chapter 1, figure 1.2 and Appendix table H4).

Wilderness-like area

- Wilderness-like areas, defined as areas more than 5 km from major infrastructure development, have been dramatically reduced from about 48 per cent of Norway's land area in 1900 to about 12 per cent in 1998. See also figure 1.1 in Chapter 1.

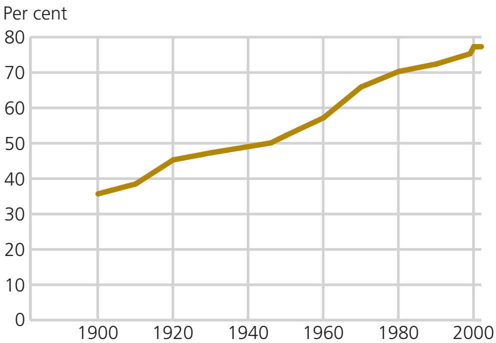
Figure 9.3. Wilderness-like areas. 1900, 1940 and 1998



Source: Directorate for Nature Management and Norwegian Mapping Authority.

9.3. Area and population in urban settlements

Figure 9.4. Percentage of population resident in urban settlements/densely populated areas. 1900-2002



Source: Population statistics, Statistics Norway.

Population trends and area of urban settlements

- The percentage of the population living in urban settlements/built-up areas has increased considerably from 1900 to 2002. A total of 77.3 per cent of the Norwegian population lived in a total of 929 urban settlements at 1 January 2002.

- From 2000 to 2002 urban settlement area for the country as a whole increased somewhat more than the number of residents in urban settlement areas, indicating that land use is becoming less effective. However, since the changes are small and the observation period relatively short, these figures must be used with caution. (See also Today's statistics for 3 September 2002 on http://www.ssb.no/english/subjects/02/01/10/beftett_en/).
- Medium-sized urban settlements of between 2 000 and 19 999 residents have expanded most from 2000 to 2002.

Table 9.1. Urban settlements, residents and area, 2002, grouped by size of urban settlement. Change from 2000 to 2002

	Number of urban settlements	Population	Residents per km²	Total area in km²	Percentage of area used for buildings	Percentage of area used for roads	Percentage change in population 2000-2002	Percentage change in area 2000-2002
Whole country	929	3 474 623	1584	2193	9.5	14.9	2.3	2.5
200 - 499	353	119 113	721	165	6.8	12.7	-2.7	-3.1
500 - 999	226	155 722	839	184	7.1	14.3	2.8	2.2
1 000 - 1 999.......	143	199 165	1000	202	7.8	14.4	-2.6	-1.3
2 000 - 19 999.......	188	981 591	1352	730	9.2	15.2	4.5	5.1
20 000 - 99 999.......	15	716 234	1716	421	10.2	15.7	2.9	3.7
100 000 -	4	1 302 798	2653	491	11.9	14.9	1.6	1.7

Source: Population statistics and land use statistics, Statistics Norway.

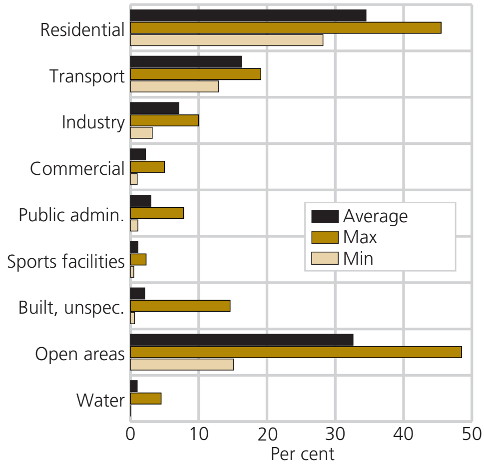
Box 9.3. Delimitation of urban settlements and background data

An urban settlement has been defined by Statistics Norway in simple terms as an area that has at least 200 residents and where the distance between buildings does not normally exceed 50 metres. Urban settlement boundaries are thus dynamic, changing in pace with building patterns and changes in the population.

In addition to the increasing expansion of the major urban settlements, general population growth has resulted in some small areas of scattered settlement developing into urban settlements. At the same time, in areas where the industrial structure is weak, a declining population has meant that some urban settlements are no longer classified as such. Changes in methods of operation in the primary industries and the evolution and concentration of the manufacturing industries and service sectors have resulted in major changes in settlement patterns over the last 100 years. Urban settlements vary widely in size, both measured by area and by population, but most of Norway's urban settlements are small.

As of 1999, urban settlement statistics are based on correlation between the National Population Register and the GAB register, the official Norwegian register for property, addresses and buildings. With the help of numerical addresses, address or building coordinates and a geographical information system (GIS), buildings and the associated population are grouped together into urban settlements. The quality of the statistics will always depend on how complete and accurate the register data are.

Figure 9.5. Land use in urban settlements. Urban settlements with more than 20 000 residents. 1999*



Source: Land use statistics, Statistics Norway.

Land use in urban settlements

- The total area that has been built on or is near buildings and that is used for housing and holiday cabins accounted for up between 28 and 46 per cent of the total land area in the urban settlements that have at least 20 000 residents.
- Transport area (roads, railways and terminal buildings) accounted for between 14 and 19 per cent of the total area.
- Areas used for commercial purposes and for public administration accounted for between 3 and 10 per cent, while areas used for industry and storage occupied between 1 and 8 per cent of the area.
- Between 15 and 49 per cent of urban settlement area is not built on or in the immediate vicinity of buildings.

Box 9.4. Land use calculation, data sources and uncertainty

Land use statistics apply to the base area of a building and its immediate area of influence. Land use for 1999 was calculated on the basis of building and property figures in the GAB register, the official Norwegian register for property, addresses and buildings, and information on commercial activity in the form of a business code from the Register of Business Enterprises. The figures are still considered to be preliminary as work is in progress to improve methods and background data in order to compile new, up-to-date land use statistics.

Open areas that have not been built on are grouped as remaining area. This area is estimated by deducting the area in the immediate vicinity of buildings, roads, railtracks and fresh water areas from the total area of the urban settlement.

Preliminary figures from the 1999 Statistics Norway land use survey show that the size of areas in the various categories corresponds closely with previous surveys based on counts made in Norway and Sweden using aerial photographs and maps (Statistics Norway 1982, Statistics Sweden 1997). This particularly applies to the residential area and transport groups and the "open areas" group. The uncertainty in land use statistics is primarily due to the varying quality of buildings and property information in the GAB register.

Urban settlement centres

- Centre zones (see box 9.5) only figured in 213 of Norway's 925 urban settlements as of 1 January 2000, and tend not to be formed in the smallest urban settlements.
- 8.8 per cent of Norway's population were resident in urban settlement centres. Residential density in these centres was about twice the level in other parts of the urban settlements.
- The total of 109 large and small centre zones recorded in the City of Oslo housed 41.7 per cent of the population and 65.4 per cent of all the enterprises in the City of Oslo (see figure 9.6 on next page).

Box 9.5. Operationalization of the concept of the centre zone

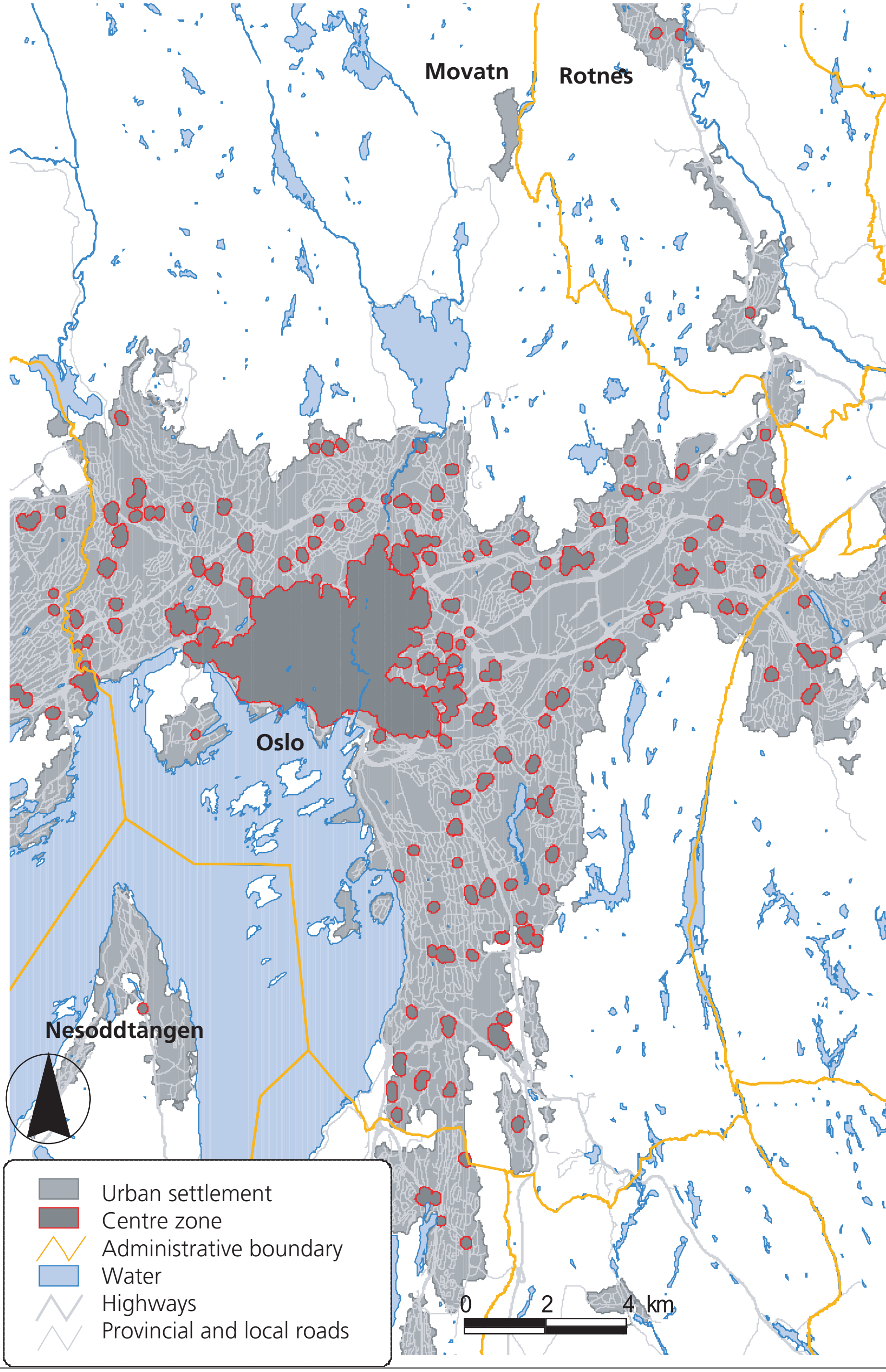
In January 1999, a national policy decision, applicable for up to five years, was adopted to call a temporary halt to the establishment of shopping centres outside central parts of towns and urban settlements (Ministry of the Environment 1999). One important reason for this decision was the desire to actively strengthen the development of urban settlement centres and to counteract the tendency towards a pattern of increased transport by private car to large shopping centres outside urban areas. As a result of this national policy decision, there was a need for a clearer definition of the concept of the centre to ensure that the decision could be uniformly practised by central and local authorities. A pilot project was therefore launched by Statistics Norway in cooperation with the Oslo and Akershus county administration to operationalize the concept of the centre core based on criteria of physical concentration and diversity of activity:

- retail trade must take place
- there must be either a public administration centre, a health and social centre or other social/personal services
- at least three main industries must be represented
- the maximum distance between the buildings where these undertakings are located must not exceed 50 metres

A 100-metre zone was added around the centre core to comprise the *centre zone*.

See map showing centre zones and urban settlements http://www.ssb.no/emner/01/01/20/tettstedskart (in Norwegian only).

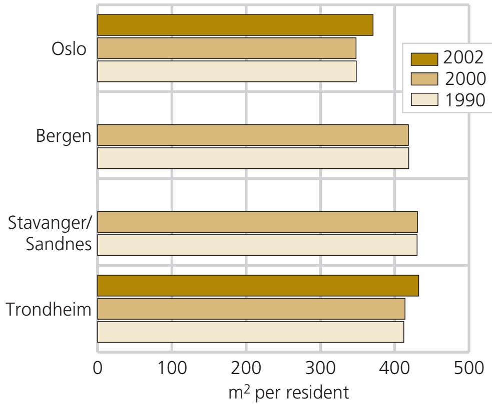
Figure 9.6. Centre zones in City of Oslo and surrounding area. 1 January 2000



Source: Land use statistics, Statistics Norway. Digital mapping data: Norwegian Mapping Authority, LKS 82003-596..

9.4. Indicators for sustainable urban development

Figure 9.7. Urban settlement area per resident. Urban settlements with more than 100 000 residents. 1990, 2000 and 2002

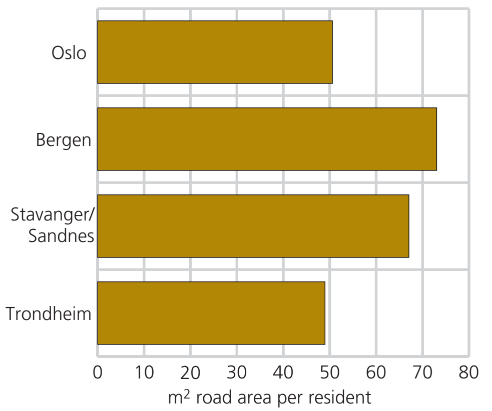


Source: Land use statistics, Statistics Norway.

Urban settlement area per resident

- The indicator shows the extent to which previously unbuilt areas have been used for buildings and other installations. Low figures (high density) should in principle be favourable, for example in the context of land resources conservation. However, high density indicates that there may be few "green lungs", and therefore limited opportunities for outdoor recreation locally, within the urban settlement boundary (Norwegian Pollution Control Authority 2000).
- Oslo is different from Norway's other large urban settlements in that population density is somewhat higher. The statistics and method are in the process of being established, and the calculated change is therefore somewhat uncertain.

Figure 9.8. Road area in urban settlements per resident in m². Urban settlements with more than 20 000 residents. 2002*



Source: Land use statistics, Statistics Norway.

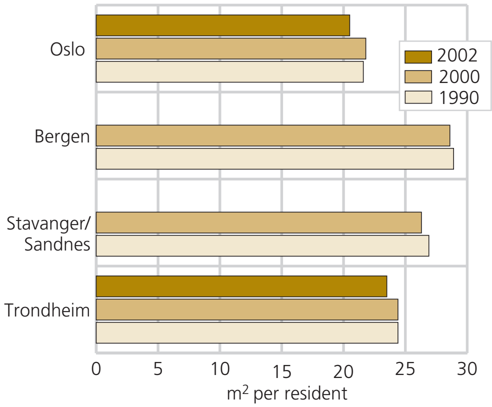
Traffic area per resident

- The indicator shows the extent to which traffic areas dominate land use in the urban settlement. The use of areas for traffic purposes can to a large extent be regarded as irreversible (Norwegian Pollution Control Authority 2000).
- A simplified calculation of road area has been made on the basis of road lengths, road types and standard road widths.

Box 9.6. Indicators for sustainable urban development

The national programme for sustainable development in five towns (Ministry of the Environment 1995) resulted in the formulation of a number of general targets for sustainable urban development. Their objective was to reduce land use for development and transport purposes and to safeguard natural surroundings and local outdoor areas to maintain biological diversity and opportunities for recreation, and to improve access to inland water bodies and the sea. In connection with these goals, a number of indicators were formulated (Norwegian Pollution Control Authority 2000) and are presented in this section.

Figure 9.9. Base area for residential buildings in urban settlements per resident. Urban settlements with more than 100 000 residents. 1990, 2000 and 2002*

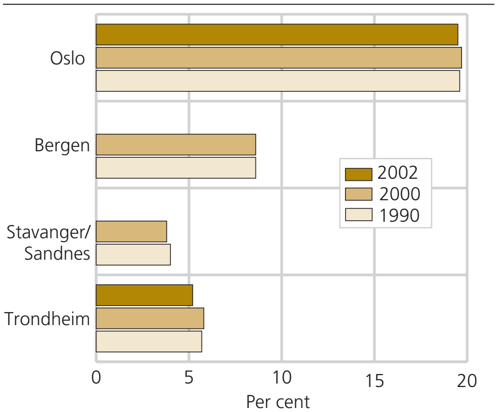


Source: Land use statistics, Statistics Norway.

Base area for residential buildings in urban settlements per resident

- The indicator describes how much area is actually used for residential buildings. Measured over time, the indicator can show whether there is a trend towards housing developments that occupy smaller areas (Norwegian Pollution Control Authority 2000).
- The differences between the four largest urban settlements are related to differences in the proportions of blocks of flats/row houses and detached houses and in the level of residential density.

Figure 9.10. Proportion of urban settlement population resident in centre. Urban settlements with more than 100 000 residents. 1990, 2000 and 2002*



Source: Land use statistics, Statistics Norway.

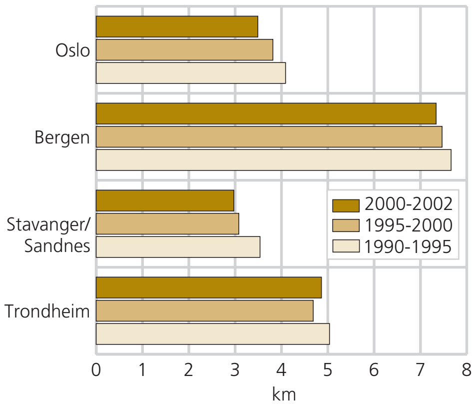
Proportion of population resident in urban settlement centre

- The indicator is based on the assumption that the function of the centre as meeting-place, for trade as well as culture, is strengthened by the fact that more people live there (Norwegian Pollution Control Authority 2000).
- Shops and other enterprises are located along several axes radiating outwards from Oslo centre. Consequently, the centre boundaries encompass a wide area, capturing large concentrations of the population in city districts such as Grünerløkka and Vålerenga that are outside the geographical centre.

Proportion of population within walking distance of various service functions

- No national figures available at present.

Figure 9.11. Average distance from centre[1] to newly-built/extended/converted residential housing. Urban settlements with more than 100 000 residents. 1990-2002



[1] Newly-built, converted and extended residential housing and distance from the main centre in Oslo, Bergen, Stavanger and Trondheim. New buildings in the centre are included.
Source: Land use statistics, Statistics Norway.

Average distance from centre to new housing

- The purpose of this indicator is to be able to compare figures from the various periods to see whether there is a trend towards a greater dependence on cars and increasing energy use or whether dependence on cars is declining (Norwegian Pollution Control Authority 2000).

9.5. Key figures for national targets for recreational areas

Box 9.7. Targets and key figures for outdoor recreation

Under the strategic objective for outdoor recreation set out in Report No. 24 (2000-2001) to the Storting, national target 4 reads as follows: "Near housing, schools and day care centres, there shall be adequate opportunities for safe access and play and other activities in a varied and continuous green structure and ready access to surrounding areas of countryside." On the basis of this target, two key figures to measure performance over time have been calculated:

- Percentage of dwellings, schools and daycare centres with safe access to play and recreational areas (at least 0.5 hectares) within a distance of 200 metres.
- Percentage of dwellings, schools and daycare centres with access to nearby outdoor recreation areas (larger than 20 hectares) within a distance of 500 metres.

Table 9.2. Percentage of day care centres, schools, residential housing and residents with access to play and recreational areas. 1999*

	Day care centres	Schools	Residen-tial –row, detached houses, etc.	Residen-tial – blocks of flats	Resi-dentials
Whole country	89	87	85	70	82
Oslo	78	80	67	67	67
Bergen	78	68	79	55	77
Stavanger/Sandnes	72	67	58	59	58
Trondheim	..	..	75	74	75

Source: Land use statistics, Statistics Norway.

Table 9.3. Percentage day care centres, schools, residential buildings and residents with access to nearby outdoor recreational areas. 1999*

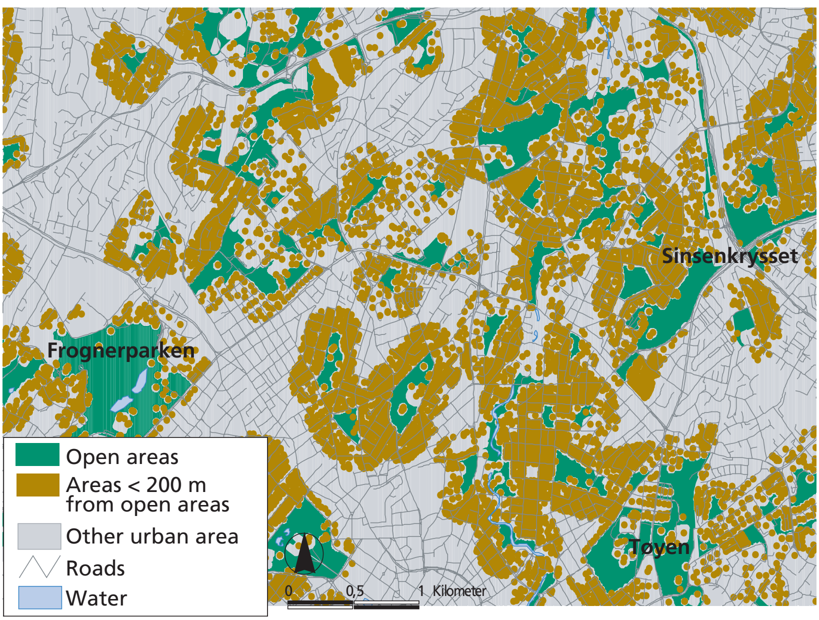
	Day care centres	Schools	Residen-tial –row, detached houses, etc.	Residen-tial – blocks of flats	Resi-dentials
Whole country	84	83	87	64	81
Oslo	58	59	65	41	71
Bergen	80	75	83	60	79
Stavanger/Sandnes	36	41	42	28	58
Trondheim	..	..	58	43	78

Source: Land use statistics, Statistics Norway.

Access to play and recreational areas and nearby areas for outdoor recreation

- There is a larger share of day-care centres and schools than of housing with access to play and recreational areas.
- There is a larger share of row houses, detached houses, etc. than blocks of flats with access to play and recreational areas.
- The population of Sandnes/Stavanger has poorer access to local outdoor recreation areas than the population of other towns. This may partly be because Sandnes/Stavanger is largely surrounded by agricultural land, which is not regarded as local outdoor recreation area
- The results also indicate that the largest housing units are more often located near local outdoor recreation areas.

Figure 9.12. Modelled "play and recreational areas" and areas with access to these. Central parts of Oslo. 1999



Source: Land use statistics, Statistics Norway. Digital mapping data: Norwegian Mapping Authority, LKS 82003-596.

9.6. Municipal land use management

Administration of plans in areas of particular environmental value

- Plans can be binding or in the form of guidelines indicating which projects can be implemented. Reports on projects in areas of particular environmental value (defined as agricultural areas, areas of natural environment and outdoor recreation areas, the 100-metre belt along the coast and special areas set aside for the preservation of the cultural heritage) show that most applications are in accordance with plans and are approved (see table 9.4).
- Applications for exemptions from adopted plans are granted more often than they are rejected. This applies to all types of area. (It should be taken into account that we do not have any information as to the type of project to which an application applies, or as to the guidelines specified in the plans for the various projects).
- The number of applications for exemption processed by a municipality has little effect on the number of exemptions granted.

Table 9.4. Building project applications in areas of particular environmental value. 2001

	Projects in agricultural areas, areas of natural environment and outdoor recreation areas	Projects in the coastal zone where building is prohibited	Projects along rivers and lakes where building is prohibited	Projects in areas set aside for preservation of the cultural heritage
No. reporting municipalities	377	377	348	345
No. of cases processed	15 853	1 636	336	799
Applications consistent with plan, percentage approved	70	.	.	79
Applications that include exemptions, percentage approved	3	67	80	12
Rejected applications, percentage	8	33	20	10

Source: Statistics Norway (2002).

The status of biological diversity, recreation and cultural heritage in municipal land-use planning

- A municipality uses the land-use part of the municipal master plan as the basis for safeguarding areas of special value. This can be done in various ways, for example by adopting plans with a special focus on environmental assets such as biological diversity, opportunities for outdoor recreation and cultural heritage.
- Of these environmental assets, the municipalities place greatest emphasis on outdoor recreation.
- Biological diversity does not seem to be high on the list of priorities. The same can be said of the cultural heritage.
- The decisive factor underlying these differences may be municipalities' perception of their areas of responsibility. Classic nature conservation and cultural heritage conservation has traditionally been regarded as a central government responsibility, while outdoor recreation has to a greater extent been delegated to local government.

Table 9.5. The status of biological diversity, outdoor recreation and preservation of the cultural heritage in municipal land-use planning as of 31 December 2001

	No. reporting municipalities	No. of these municipalities with plans	Percentage of Norway's pop. in these municipalities	Percentage of Norway's land area in these municipalities
Adopted plan with special focus on:				
Biological diversity	398	18	40	18
Outdoor recreation	401	62	73	52
Cultural heritage	399	28	54	26

Source: Statistics Norway (2002).

Land use management and municipal finances

- In 2001, the municipalities used fees and other revenues to cover about half of their planning expenses. Net expenses for this purpose accounted for 0.7 per cent of total net municipal operating expenses.
- The size of fees increases with the size of the municipality, measured by population. This may be because more interests are affected by cases involving regulation or building in larger municipalities. There may be more objections, resulting in an increase in administrative load. It is also likely that the initial processing of these cases must be conducted more thoroughly because there are more considerations to be taken into account, and in order to avoid or be better prepared for subsequent objections or other complaints.
- The low fees in relation to the level of expenses in small municipalities may be partly related to the use of low fees as an incentive to attract new businesses.

Table 9.6. Fees, operating income and operating expenses in land-use planning. Average figures for groups of municipalities[1]. 2001. NOK

	Admin. fee, proposed private regulation plan	Admin. fee for building of single family dwelling	Fee for subdivision of land proceedings including survey	Gross operating expenses, physical planning, per inhabitant	Operating income, physical planning, per inhabitant
Whole country	7 783	3 686	7 205	348	180
Above 100 000 inhabitants	35 585	10 380	10 383	410	243
50 000 - 100 000	18 250	6 628	8 629	384	184
30 000 - 50 000	15 349	6 213	8 524	330	161
20 000 - 30 000	14 815	7 866	9 505	306	164
10 000 - 20 000	12 089	6 229	8 523	302	151
5 000 - 10 000	7 440	3 552	7 183	296	135
2 000 - 5 000	5 894	2 604	6 682	798	382
Below 2 000	3 262	1 887	6 129	497	192

[1] 385 municipalities reported fees, while 406 municipalities reported income and expenses. The table only includes municipalities that submitted reports. Average fees have been calculated so that all municipalities are weighted equally, while average income and expenses per inhabitant are weighted by population.
Source: Statistics Norway (2002).

More information: Vilni Bloch, Erik Engelien and Henning Høie (municipal land use management).

Useful websites

Directorate for Nature Management: http://english.dirnat.no/
Ministry of the Environment: http://odin.dep.no/md/engelsk/
Geological Survey of Norway: http://www.ngu.no/
Norwegian Institute of Land Inventory: http://www.nijos.no/
Norwegian Institute for Air Research: http://www.nilu.no/
Norwegian Institute for Water Research: http://www.niva.no/engelsk/welcome.htm
Norwegian Water Resources and Energy Directorate: http://www.nve.no/
Statistics Norway, land use statistics: http://www.ssb.no/english/subjects/01/01/20
Norwegian Pollution Control Authority: http://www.sft.no/english/
Norwegian Mapping Authority: http://www.statkart.no/

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Report No. 17 (1998-1999) to the Storting: *Verdiskapning og miljø - muligheter i skogsektoren (Skogmeldingen)* (Wealth creation and the environment - opportunities in the forestry sector), Ministry of Agriculture.

Report No. 24 (2000-2001) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Report No. 29 (1996-97) to the Storting: (Regional planning and land use policy), *Regional planlegging og arealpolitikk*, Ministry of the Environment.

Report No. 8 (1999-2000): *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Statistics Norway (1982): *Arealbruksstatistikk for tettsteder* (Land use statistics for urban settlements), NOS B 333.

Statistics Norway (2002): Exemption from adopted plans usually given, *Today's statistics* 21 June 2002 (http://www.ssb.no/miljo_kostra/).

Statistics Sweden (1997): *Markanvänding i tätorter 1995 og förändringar 1990-1995* (Land use in urban areas 1995 and changes between 1990-1995). Statistiska meddelanden, NA 14 SM 9701.

Wold (1992): *Nasjonalatlas for Norge. Vann, is og snø* (Atlas of Norway. Water, ice and snow) Hønefoss: Norwegian Mapping Authority.

Energy

Appendix A

Table A1 Reserve accounts for crude oil. Fields already developed or where development has been approved. Million Sm³ o.e.

	1990	1995	1996	1997	1998	1999	2000	2001[1]
Reserves as of 01.01	1 189	1 477	1 654	1 795	1 858	1 810	1 692	1 770
New fields	126	131	315	84	-	36	190	106
Re-evaluations	123	212	11	166	131	24	77	94
Extraction	-98	-166	-186	-187	-179	-179	-189	-194
Reserves as of 31.12	1 340	1 654	1 795	1 858	1 810	1 692	1 770	1 776
R/P-ratio	14	10	10	10	10	9	9	9

[1]Break in homogeneity of time series between 2000 and 2001 due to changes in classification system.
Source: Norwegian Petroleum Directorate and Statistics Norway.

Table A2 Reserve accounts for natural gas. Fields already developed or where development has been approved. Million Sm³ o.e.

	1990	1995	1996	1997	1998	1999	2000	2001[1]
Reserves as of 01.01	1 261	1 346	1 352	1 479	1 173	1 172	1 247	1 259
New fields	17	32	195	12	-	45	61	229
Re-evaluations	-20	5	-27	-271	47	82	5	758
Extraction	-28	-31	-41	-47	-48	-52	-54	-57
Reserves as of 31.12	1 230	1 352	1 479	1 173	1 172	1 247	1 259	2 189
R/P-ratio	45	43	36	25	24	24	23	38

[1]Break in homogeneity of time series between 2000 and 2001 due to changes in classification system.
Source: Norwegian Petroleum Directorate and Statistics Norway.

Table A3 Norway´s hydropower potential and developed and undeveloped hydropower[1]. GWh

Year	Hydropower potential[2]	Developed as of 31 Dec.	Undeveloped						
			Under construction[3]	Licence granted	Applied for licence	Licence denied[4]	Notification submitted	Permanently protected	Remainder
1988	171 209	105 578	3 778	..	8 674	..	4 415	20 947	27 817
1989	171 475	107 816	3 055	..	7 298	..	4 557	20 947	27 802
1990	171 366	108 083	3 494	..	6 609	..	4 890	20 947	27 343
1991	171 382	108 083	3 605	..	6 631	..	5 900	20 947	26 215
1992	176 395	109 457	2 913	..	4 767	..	3 318	22 246	33 695
1993	175 387	109 635	1 232	1 430	3 223	..	4 202	34 854	20 811
1994	177 745	111 850	799	1 585	3 124	..	4 529	35 259	20 599
1995	178 116	112 348	502	1 488	3 233	..	4 559	35 259	20 728
1996	178 302	112 701	161	1 532	2 774	..	2 180	35 258	23 694
1997	178 335	112 938	292	1 471	2 912	..	2 641	35 258	22 824
1998	179 647	113 015	332	1 446	3 132	..	2 920	35 321	23 481
1999	180 199	113 442	53	1 446	2 654	..	2 893	35 321	24 389
2000	186 970	118 041	73	347	2 536	1 351	3 456	36 543	24 623
2001	186 947	118 154	349	1 036	3 765	1 344	1 576	36 543	24 179

[1]Mean annual production capability. [2]Plans for undeveloped hydropower are evaluated regularly, and this is why hydropower potential changes from year to year. [3]Includes the category 'Licence granted' for all years before 1993. [4]Included in 'Licence granted' and 'Applied for licence' before 2000.
Source: Norwegian Water Resources and Energy Directorate.

Table A4 Extraction, conversion and use[1] of energy commodities. 2000*

	Coal and coke	Wood, wood waste, black liquor, waste	Crude oil	Natural gas	Petroleum products[2]	Electricity	District heating	Total	Average annual change 1976-2000	Average annual change 1999-2000
	PJ								Per cent	
Extraction of energy commodities	18	-	6 536	2 181	[3] 269	512	-	9 515		
Energy use in extraction sectors	-	-	-	[4]-164	-16	-9	0	-188		
Imports and Norwegian purchases abroad	55	0	43	-	238	5	-	340		
Exports and foreign purchases in Norway	-17	0	-5 822	-1 960	-604	-74	-	-8 477		
Stocks (+decrease, -increase)	1	-	-35	-	5	-	-	-29		
Primary supplies	56	0	721	57	-108	435	0	1 163		
Oil refineries	7	-	-579	-	534	-2	-	-39		
Other energy sectors or supplies	-1	49	-	0	16	1	7	72		
Registered losses, statistical errors	-3	-	-142	-29	-37	-39	-1	-254		
Registered use outside energy sectors	60	49	-	27	406	395	5	942	0.6	-5.4
Domestic use	60	49	-	27	302	395	5	838	1.3	-2.5
Agriculture and fisheries	0	0	-	-	26	7	0	33	0.4	-6.3
Energy-intensive manufacturing	47	0	-	27	54	124	0	251	1.9	4.7
Other manufacturing and mining	13	25	-	0	27	57	1	122	-0.2	-5.4
Other industries	-	0	-	0	128	86	4	218	2.0	-5.7
Private households	0	24	-	0	68	121	1	214	1.4	-4.5
International maritime transport	-	-	-	-	104	-	-	104	-3.0	-24.1

[1]Includes energy commodities used as raw materials. [2]Includes liquefied petroleum gas, refinery gas, fuel gas and methane. Petrol coke is included in coke. [3]Natural gas liquids and condensate from Kårstø. [4]Includes gas terminals.
Source: Statistics Norway.

Table A5 Use of energy commodities outside the energy sectors and international maritime transport

Energy commodity	1976	1980	1985	1990	1995	1996	1997	1998	1999*	2000*	2001*	Average annual change 1976-2000	Average annual change 2000-2001
	PJ											Per cent	
Total	**608**	**677**	**735**	**752**	**786**	**809**	**822**	**854**	**859**	**838**	**864**	**1.3**	**3.0**
Electricity	241	269	329	349	374	371	374	394	393	395	407	2.1	3.1
Firm power	232	265	312	324	348	357	352	367	370	366	...	1.9	...
Spot power	9	4	17	24	26	14	22	27	24	28	...	4.9	...
Oil, total	299	294	259	246	252	275	267	271	277	250	250	-0.8	0.4
Oil other than transport	159	137	77	57	51	66	54	56	55	41	44	-5.5	6.8
Petrol	9	3	0	0	0	0	0	0	0	0	0	-23.8	0.0
Kerosene	17	16	9	7	7	8	8	7	7	5	6	-4.7	14.9
Middle distillates	66	62	43	35	30	39	31	32	33	25	25	-3.9	-1.4
Heavy fuel oil	66	56	25	14	14	18	16	17	15	11	13	-7.4	22.6
Oil for transport	141	157	183	189	202	209	212	215	222	208	206	1.7	-0.9
Petrol, aviation fuel, jet fuel	74	82	92	99	102	101	99	100	103	97	101	1.1	4.6
Middle distillates	64	71	83	86	99	108	112	115	119	111	105	2.4	-5.6
Heavy fuel oil	3	5	7	3	1	1	1	1	1	1	1	-7.0	0.0
Gas[1]	1	41	52	63	52	54	70	76	75	80	101	18.1	26.1
District heating	-	-	2	3	4	5	5	5	6	5	5	.	0.0
Solid fuel	65	73	93	92	104	104	106	108	108	109	100	2.1	-8.0
Coal and coke	47	48	57	50	58	58	58	60	58	60	51	1.0	-14.5
Wood, wood waste, black liquor, waste	19	25	35	42	46	47	49	49	51	49	49	4.1	0.0

[1]Includes liquefied petroleum gas. From 1990 also fuel gas and landfill gas, and from 1994 natural gas.
Source: Statistics Norway.

Table A6 Net use[1] of energy in the energy sectors. PJ

	1976	1980	1985	1990	1995	1996	1997	1998	1999	2000*	2001*
Total	**52**	**87**	**91**	**156**	**185**	**197**	**206**	**196**	**197**	**217**	**222**
Of this:											
Electricity	4	6	8	7	10	7	11	8	9	11	10
Natural gas	30	52	61	116	141	151	153	147	145	164	172

[1]Does not include energy use for conversion purposes.
Source: Statistics Norway.

Table A7 Use of energy commodities ouside the energy sectors and international maritime transport, by sector[1]. 1999. PJ

	Coal and coke	Wood, wood waste, black liquor, waste	Crude oil	Natural gas	Petroleum products[2]	Electricity	District heating	Total
Total	**57.6**	**50.8**	**-**	**26.6**	**325.5**	**393.4**	**5.6**	**859.5**
Manufacturing and mining	**57.5**	**26.5**	**-**	**26.5**	**82.5**	**175.7**	**0.8**	**369.6**
Oil drilling	-	-	-	-	3.5	-	-	3.5
Manufacture of pulp and paper	0.0	18.9	-	-	6.2	23.4	0.0	48.5
Manufacture of basic chemicals	11.3	0.1	-	25.5	46.9	23.2	0.3	107.1
Manufacture of minerals[3]	8.8	0.1	-	-	7.3	4.9	0.0	21.1
Manufacture of iron, steel and ferro-alloys	27.4	-	-	0.1	0.5	27.2	0.0	55.3
Manufacture of other metals	5.6	-	-	0.6	3.5	68.6	0.0	78.4
Manufacture of metal goods, boats, ships and oil platforms	4.4	0.5	-	0.0	3.7	9.9	0.1	18.6
Manufacture of wood, plastic, rubber and chemical goods, printing	-	7.0	-	-	2.6	6.8	0.1	16.5
Manufacture of consumer goods	-	0.0	-	0.3	8.3	11.7	0.3	20.6
Other industries, total	**0.1**	**24.3**	**-**	**0.1**	**243.1**	**217.6**	**4.7**	**489.9**
Construction	-	0.1	-	0.0	9.2	2.0	-	11.4
Agriculture and forestry	0.0	0.1	-	-	6.3	6.6	0.0	12.9
Fishing, whaling and sealing	-	-	-	-	21.6	0.5	-	22.1
Land transport[4]	-	-	-	0.0	46.6	2.1	-	48.7
Sea transport, domestic	-	-	-	-	22.8	0.0	-	22.9
Air transport[4]	-	-	-	-	26.3	0.3	-	26.6
Other private services	-	-	-	0.0	28.0	51.5	1.6	81.1
Public sector, municipal	-	-	-	0.0	4.0	20.2	1.2	25.4
Public sector, state	-	-	-	-	6.0	8.3	0.7	15.0
Private households	0.1	24.1	-	-	72.3	126.2	1.2	223.9

[1]Includes energy commodities used as raw materials. See also tables E3 and E4, which give emission figures for the same sectors. [2] Includes liquefied petroleum gas, fuel gas and methane. Petrol coke is included under coke. [3]Includes mining. [4]Norwegian purchases in Norway + Norwegian purchases abroad.
Source: Statistics Norway.

Table A8 Electricity balance

	1975	1980	1985	1990	1995	1997	1998	1999	2000*	2001*	Average annual change 1990-2001*	Average annual change 2000-2001*
	TWh										Per cent	
Production	77.5	84.1	103.3	121.8	123.0	111.4	116.8	122.4	143.0	121.9	0.0	-14.8
+ Imports	0.1	2.0	4.1	0.3	2.3	8.7	8.0	6.9	1.5	10.8	37.1	630.0
- Exports	5.7	2.5	4.6	16.2	9.0	4.9	4.4	8.8	20.5	7.2	-7.2	-65.1
= Gross domestic consumption	71.9	83.6	102.7	105.9	116.3	115.2	120.4	120.5	123.9	125.5	1.5	1.2
- Consumption in pumped storage power plants	0.1	0.5	0.8	0.3	1.4	1.7	0.8	0.6	0.9	0.8	7.9	-11.5
- Consumption in power plants, losses and statistical differences	7.1	8.0	10.0	7.9	10.0	8.7	9.1	9.4	10.3	9.6	1.8	-6.5
= Net domestic consumption	64.7	75.1	91.9	97.7	105.0	104.9	110.4	110.5	112.8	115.1	1.5	2.0
- Spot power	3.2	1.2	4.8	6.7	7.5	6.2	7.5	7.0	5.8	5.1	-2.4	-12.3
= Net firm power consumption	61.4	73.9	87.1	91.0	97.5	98.7	103.0	103.5	106.9	109.9	1.7	2.8
- Energy-intensive manufacturing	26.2	27.9	30.0	29.6	28.4	28.7	30.2	31.1	33.1	32.7	0.9	-1.3
= General consumption	35.2	46.0	57.1	61.5	69.1	70.0	72.8	72.4	73.8	77.2	2.1	4.7
General consumption corrected for temperature	36.3	45.1	54.6	65.4	69.6	71.6	73.5	74.9	78.3	77.9	1.6	-0.5

Source: Statistics Norway and Norwegian Water Resources and Energy Directorate.

Table A9 Average prices[1] for electricity[2] and some selected oil products. Energy supplied

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*	2001*
Heating products						Price in øre/kWh[4]							
Electricity	43.5	45.7	46.5	46.6	47.8	46.8	49.7	52.4	55.0	51.0	50.3	51.7	63.7
Heating kerosene	28.3	33.9	40.1	37.4	37.8	37.1	37.7	41.6	43.8	42.6	47.6	59.5	61.1
Fuel oil no.1/light fuel oils[3]	21.6	26.6	31.9	28.3	28.0	28.2	29.6	34.0	37.0	34.3	39.9	51.5	53.4
Fuel oil no.2	20.7	25.7	30.8	27.2	26.9	27.1	[3]..	..	..	..	..	..	..
Transport products						Price in øre/litre[4]							
Petrol, leaded, high oct.	579	643	741	795	836	851	893	.	.	.	.	.	.
Petrol, unl. 98 octane	.	622	705	747	787	791	838	880	909	904	948	1 087	976
Petrol, unl. 95 octane	541	594	677	717	757	761	807	849	888	873	919	1 052	944
Auto diesel	233	286	341	326	403	649	701	757	779	781	827	991	862

[1] Including all taxes. [2]Price for households and agriculture. The price includes energy price, grid rent and taxes. Until 1992, prices are for firm power only. From 1993, both firm power and spot power. [3]Fuel oil 1 and fuel oil 2 are so similar that they have been combined in the category light fuel oils after 1994. [4]100 øre = 1 NOK.

Source: Statistics Norway, Norwegian Competition Authority, Norwegian Water Resources and Energy Directorate and Norwegian Petroleum Institute.

Table A10 Total primary energy supply. World total and selected countries

	1971	1978	1990	1995	1998	1999	Per unit GDP (1999)	Per unit GDP (1999)	Per capita (1999)
	Million toe						toe/1000 1995-USD	toe/1000 1995-USD PPP[1]	toe per capita
World total	**5 462.2**	**6 955.8**	**8 622.2**	**9 160.7**	**9 559.2**	**9 702.8**	**0.30**	**0.24**	**1.63**
OECD	**3 385.6**	**4 075.1**	**4 512.3**	**4 880.5**	**5 135.3**	**5 229.5**	**0.20**	**0.22**	**4.68**
Norway	13.9	18.5	21.5	23.5	25.4	26.6	0.16	0.23	5.96
Denmark	19.2	20.6	17.9	20.3	20.9	20.1	0.10	0.15	3.77
Finland	18.4	22.9	28.8	29.3	33.5	33.4	0.21	0.29	6.46
Iceland	1.0	1.3	2.1	2.1	2.6	3.2	0.38	0.44	11.45
Sweden	36.5	41.1	46.7	49.8	50.8	51.1	0.19	0.26	5.77
Belgium	39.9	46.9	48.4	52.4	58.4	58.6	0.19	0.24	5.74
France	154.5	179.4	226.1	239.8	254.4	255.0	0.15	0.19	4.23
Greece	9.2	15.2	21.8	23.2	26.4	26.9	0.20	0.18	2.55
Italy	114.1	134.8	151.7	159.8	166.0	169.0	0.14	0.14	2.93
Netherlands	51.3	65.5	66.5	73.2	74.3	74.1	0.16	0.20	4.69
Poland	86.3	118.3	99.9	100.0	97.1	93.4	0.59	0.28	2.42
Portugal	6.5	9.1	16.4	19.3	21.9	23.6	0.19	0.15	2.37
Spain	43.1	65.8	90.5	103.1	112.8	118.5	0.18	0.17	3.01
United Kingdom	211.0	209.4	213.1	224.5	230.3	230.3	0.18	0.19	3.87
Switzerland	17.1	19.7	25.1	25.3	26.7	26.7	0.08	0.14	3.74
Czech Republic	45.6	45.6	47.4	41.4	41.2	38.6	0.74	0.30	3.75
Turkey	19.5	31.9	52.7	61.4	71.7	70.3	0.37	0.18	1.07
Germany	307.9	353.8	355.5	339.9	344.8	337.2	0.13	0.18	4.11
Hungary	19.2	28.9	28.4	25.5	25.3	25.3	0.49	0.24	2.51
Austria	19.0	22.1	25.2	26.4	28.3	28.4	0.11	0.15	3.51
Canada	142.7	181.8	209.1	231.8	237.4	241.8	0.36	0.31	7.93
Mexico	45.6	79.8	124.2	132.7	148.0	149.0	0.43	0.20	1.53
USA	1 593.2	1 885.2	1 925.6	2 086.2	2 205.7	2 270.0	0.26	0.26	8.32
Japan	269.6	335.5	438.8	497.7	511.0	515.5	0.10	0.17	4.07
South Korea	16.5	34.5	91.8	149.2	164.8	181.4	0.32	0.26	3.87
Australia	52.2	67.2	87.5	94.5	104.4	107.9	0.24	0.23	5.69
Non-OECD	**2 076.7**	**2 880.6**	**4 109.9**	**4 280.2**	**4 423.9**	**4 473.4**	**0.74**	**0.27**	**0.92**
Romania	42.1	64.1	62.4	46.4	40.6	36.4	1.28	0.28	1.62
Russia	..	..	..	628.4	581.4	603.0	1.87	0.60	4.12
Egypt	7.8	13.0	32.0	35.2	41.9	44.5	0.60	0.21	0.71
Ethiopia	9.0	10.5	15.2	16.5	17.8	18.2	2.59	0.48	0.29
Nigeria	36.2	48.5	70.9	79.7	85.8	87.3	2.82	0.88	0.70
South Africa	45.3	59.9	91.2	104.1	109.4	109.3	0.67	0.30	2.60
Argentina	33.7	38.9	45.0	54.9	61.7	63.2	0.21	0.15	1.73
Brazil	69.6	103.5	132.5	153.5	175.8	179.7	0.24	0.16	1.07
Guatemala	2.8	3.9	4.4	5.2	6.0	6.1	0.35	0.16	0.55
Venezuela	18.9	29.2	42.0	50.8	56.5	53.4	0.70	0.42	2.25
Bangladesh	5.7	7.6	12.9	16.2	17.5	17.9	0.39	0.10	0.14
India	183.8	228.2	359.1	438.8	471.3	480.4	1.07	0.22	0.48
Indonesia	36.3	54.9	92.8	118.8	131.6	136.1	0.68	0.25	0.66
China[2]	390.1	586.0	872.6	1 069.9	1 093.0	1 088.4	1.13	0.25	0.87
Thailand	14.1	21.5	43.2	63.2	66.5	70.4	0.43	0.20	1.17

[1] PPP (purchasing power parity): GDP adjusted for local purchasing power. [2] Hong Kong not included.
Source: OECD/IEA (2001a, b).

Table A11 Norway´s net exports of energy commodities. Selected countries and regions. 2001*. Million NOK

	Coal, coke and briquettes	Mineral oil and products	Gas, natural and manufactured	Electricity
Nordic countries	96	22 809	962	-712
EFTA	0	325	18	-
EU	-37	196 209	61 632	-712
Developing countries	-219	4 986	1 032	-
Denmark	36	4 998	-31	-203
Finland	107	4 043	135	-38
Sweden	-47	13 116	840	-471
Belgium	-7	5 606	8 820	-
France	-1	24 708	14 785	-
Ireland	-	5 979	-	-
Italy	0	3 431	1 342	-
Netherlands	-95	39 158	5 126	-
Portugal	-	1 263	5	-
Spain	-20	276	3 304	-
UK	-238	77 731	2 501	-
Czech Republic	-	1	2 941	-
Turkey	-	0	1 029	-
Germany	230	15 863	24 806	-
China	-118	3 664	182	-
Canada	-	20 485	0	-
USA	-53	26 184	638	-

Source: Statistics Norway.

Agriculture

Appendix B

Table B1 Agricultural area in use. km^2

Year	Agricultural area in use, total	Cereals and oil seeds	Other agri-cultural areas	Cultivated meadow	Other pastures
1949	10 456	1 520	1 560	5 422	1 954
1959	10 107	2 182	1 347	4 828	1 750
1969	9 553	2 525	859	4 584	1 585
1979	9 535	3 252	856	4 195	1 232
1989	9 911	3 530	850	4 438	1 093
1999	10 382	3 345	651	4 875	1 511
2000	10 436	3 370	622	4 861	1 583
2001*	10 415	3 353	605	4 855	1 603

Source: Agricultural statistics from Statistics Norway.

Table B2 Sales of commercial fertilizer expressed as content of nitrogen and phosphorus.

Year	Total, tonnes		Mean quantity (kg) applied per decare agricultural land in use	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus
1980/81	102 513	26 980	10.9	2.9
1981/82	107 546	28 291	11.4	3.0
1982/83	109 120	27 638	11.5	2.9
1983/84	110 648	27 382	11.6	2.9
1984/85	110 803	24 828	11.6	2.6
1985/86	106 011	22 752	11.1	2.4
1986/87	109 807	21 935	11.5	2.3
1987/88	111 208	19 699	11.6	2.0
1988/89	110 138	17 376	11.1	1.8
1989/90	110 418	16 002	11.1	1.6
1990/91	110 790	15 190	11.0	1.5
1991/92	110 123	14 818	11.0	1.5
1992/93	109 299	13 722	10.8	1.4
1993/94	108 287	13 688	10.6	1.3
1994/95	110 851	13 291	10.8	1.3
1995/96	111 976	13 836	10.8	1.3
1996/97	112 879	13 522	10.9	1.3
1997/98	112 327	13 408	10.7	1.3
1998/99	106 017	13 092	10.2	1.3
1999/2000	107 410	13 325	10.3	1.3
2000/2001	100 592	12 399	9.7	1.2

Source: Agricultural statistics from Statistics Norway and Norwegian Agricultural Inspection Service.

Table B3 Sales of pesticides. Environmental taxes on pesticides

Year	Sales of pesticides/Tonnes active substances					Taxes as per cent of purchase price[1]		Taxes		
	Total	Fungi-cides	Insecti-cides	Herbi-cides	Other sub-stances including additives	Environ-mental tax	Control fee	Total	Environ-mental tax	Control fee
	Tonnes					Per cent		Million NOK		
1985.	1 529.3	138.4	38.7	1 236.2	116.1	-	-	-	-	-
1988.	1 193.6	107.8	37.9	919.2	128.7	2.0	5.5	..	1.5	..
1989.	1 033.8	119.5	27.3	856.9	30.1	8.0	6.0	30.3	17.3	..
1990.	1 183.5	153.0	19.0	965.1	46.4	11.0	6.0	28.5	20.2	8.3
1991.	760.0	133.1	18.5	563.7	44.7	13.0	6.0	26.7	18.8	7.9
1992.	781.1	148.6	26.9	561.3	44.3	13.0	6.0	31.6	22.5	9.1
1993.	764.6	179.7	16.9	510.1	57.9	13.0	6.0	32.0	21.9	10.1
1994.	861.5	156.7	20.5	626.0	58.3	13.0	6.0	30.7	21.0	9.7
1995.	931.3	167.3	20.4	688.9	54.7	13.0	6.0	27.6	18.9	8.7
1996.	706.2	139.7	15.8	503.2	47.4	15.5	7.0	32.3	21.8	10.5
1997.	754.2	175.4	19.5	503.8	55.5	15.5	7.0	30.4	21.0	9.5
1998.	954.6	263.3	22.8	544.3	124.3	15.5	9.0	41.3	26.1	15.2
1999.	796.3	219.0	24.7	448.7	103.9	.	.	52.6	35.4	17.2
2000.	380.2	53.1	10.7	283.4	33.0	.	.	68.7	52.9	15.8
2001.	518.7	118.6	9.8	377.2	13.1	.	.	44.6	34.9	9.7

[1]From 1999 no longer a fixed rate (percentage of purchase price) but differentiated rates according to the health- and environmental risk of the substances.
Source: Norwegian Agricultural Inspection Service and Norwegian Agricultural Economics Research Institute.

Table B4 Number of holdings and areas managed ecologically. Number of livestock on holdings managed ecologically and grants paid. 1986-2001

Year	Total grants to ecological farming	Conversion and acreage support	No. of holdings managed ecologically[1]	Area of agri-cultural land managed ecologically	Agricultural area under conversion to ecological farming	No. of milk cows	No. of sheep
	Million NOK			Decares			
1986.	-	-	19	..	..	..	..
1987.	-	-	41	..	..	..	..
1988.	-	-	52	..	..	..	..
1989.	5	-	89	..	..	..	..
1990.	13	4	263	..	..	..	..
1991.	20	7	410	18 145	6 288	237	3 007
1992.	23	8	473	26 430	582	193	6 524
1993.	22	6	501	32 343	5 444	294	7 102
1994.	22	6	542	38 278	6 916	437	10 064
1995.	23	6	670	44 596	13 082	572	10 628
1996.	35	14	911	46 573	32 401	766	13 291
1997.	35	21	1 278	73 921	43 143	1 816	18 895
1998.	33	13	1 573	105 200	50 615	2 705	29 812
1999.	54	37	1 707	149 510	37 824	2 998	18 393
2000.	59	35	1 823	180 841	24 387	3 531	20 776
2001.	76	54	2 086	197 900	68 831	3 729	22 911

[1]Includes all holdings approved for grants and/or to sell products labelled as ecologorganically produced.
Source: Debio and Ministry of Agriculture.

Table B5 Number of holdings and area managed ecologically. County. 2001

	Number of holdings	Area of agricultural land managed ecologically	Agricultural land under conversion to ecological farming	Percentage of agricultural area
		Decares		
Whole country	**2 086**	**197 900**	**68 831**	**2.6**
Østfold	91	6 895	4 922	1.6
Akershus and Oslo	136	17 305	3 958	2.7
Hedmark	194	22 711	5 473	2.6
Oppland	241	22 184	9 281	3.1
Buskerud	158	13 037	3 496	3.2
Vestfold	80	9 390	1 759	2.6
Telemark	93	8 345	2 730	4.3
Aust-Agder	42	2 973	377	2.9
Vest-Agder	50	5 672	1 228	3.5
Rogaland	42	5 418	569	0.6
Hordaland	109	7 009	1 927	2.0
Sogn og Fjordane	190	17 711	2 423	4.2
Møre og Romsdal	112	9 036	2 790	1.9
Sør-Trøndelag	226	18 385	15 061	4.4
Nord-Trøndelag	156	13 340	6 845	2.3
Nordland	113	12 343	2 951	2.6
Troms	50	6 169	2 441	3.2
Finnmark	6	578	601	1.1

Source: Debio.

Forest and uncultivated land

Appendix C

Table C1 Forest balance 2000. 1000 m³ without bark

	Total	Spruce	Pine	Broad-leaved trees
Growing stock as of 01.01	685 682	304 081	229 874	151 727
Total losses	11 171	7 324	2 198	1 649
Of which total roundwood cut	8 969	6 238	1 719	1 012
Sales, excl. fuelwood	7 478	5 811	1 606	61
Fuelwood, sales and private	1 289	268	73	948
Own use	202	159	40	3
Other losses	2 202	1 086	479	637
Logging waste	579	374	103	101
Natural losses	1 624	711	376	536
Total increments	23 488	11 858	6 273	5 357
Volume as of 31.12	697 998	308 614	233 949	155 436

Source: Statistics Norway and Norwegian Institute for Land Inventory.

Table C2 Growing stock under bark and annual increment. 1000 m³

	Growing stock				Annual increment			
	Total	Spruce	Pine	Broad-leaved	Total	Spruce	Pine	Broad-leaved
Whole country								
1933	322 635	170 960	90 002	61 673	10 447	5 835	2 535	2 077
1967	435 121	226 168	133 972	74 981	13 200	7 131	3 364	2 706
1990	578 317	270 543	188 279	119 495	20 058	10 528	5 200	4 330
1996/2000[1]	665 783	297 547	223 682	144 553	22 418	11 597	5 932	4 889
Region, 1996/2000								
Østfold, Akershus/Oslo, Hedmark	187 216	96 371	70 271	20 575	6 879	3 852	2 165	862
Oppland, Buskerud, Vestfold	145 567	84 111	39 477	21 979	4 713	2 903	962	849
Telemark, Aust-Agder, Vest-Agder	116 602	37 780	52 757	26 065	3 599	1 436	1 300	863
Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal	83 923	19 361	34 887	29 674	3 190	1 350	901	940
Sør-Trøndelag, Nord-Trøndelag	82 028	48 637	18 449	14 942	2 441	1 536	396	510
Nordland, Troms	47 377	11 286	5 507	30 582	1 514	522	143	849
Finnmark	3 071	1	2 333	736	81	0	66	16

[1]Volume and average annual increment for all types of land use classes for 1996-2000 in counties inventoried and Finnmark.
Source: Norwegian Institute for Land Inventory. (Figures from inventories supplemented by calculations by Statistics Norway for Finnmark, where no inventory has been carried out.).

Table C3 Registered non-harvest mortality of cervids

Hunting year	Total				Killed by motor car or train				Felled as pests, felled illegally or killed by other causes			
	Moose	Red deer	Wild rein-deer	Roe deer	Moose	Red deer	Wild rein-deer	Roe deer	Moose	Red deer	Wild rein-deer	Roe deer
1987/1988	2 167	365	279	2 044	1 200	157	6	1 396	967	208	273	648
1988/1989	2 036	444	122	2 140	1 016	200	4	1 632	1 020	244	118	508
1989/1990	2 152	411	137	1 955	962	171	4	1 537	1 190	240	133	418
1990/1991	2 466	485	124	2 684	1 210	201	4	2 065	1 256	284	120	619
1991/1992	2 554	544	132	3 034	1 324	284	5	2 427	1 230	260	127	607
1992/1993	3 748	715	233	4 195	2 048	376	5	3 327	1 700	339	228	868
1993/1994	4 155	1 061	125	6 621	2 481	461	5	4 007	1 674	600	120	2 614
1994/1995	3 405	915	72	4 601	1 757	374	-	3 057	1 648	541	72	1 544
1995/1996	2 915	874	88	4 233	1 650	383	1	3 045	1 265	491	87	1 188
1996/1997	3 378	985	89	4 587	2 010	515	4	3 513	1 368	470	85	1 074
1997/1998	2 962	995	133	3 895	1 582	443	6	3 091	1 380	552	127	804
1998/1999	3 215	958	123	4 097	1 886	488	7	3 259	1 329	470	116	838
1999/2000	3 186	1 183	104	3 893	1 921	543	5	3 118	1 265	640	99	775
2000/2001	3 338	1 082	65	4 132	1 968	461	5	3 313	1 370	621	60	819

Source: Statistics Norway.

Table C4 Registered mortality of large carnivores and eagles

Hunting year	Total				
	Bear	Wolf	Wolverine	Lynx	Eagle
1993/1994	3	-	13	48	56
1994/1995	1	-	17	64	51
1995/1996	1	-	16	103	47
1996/1997	3	-	17	113	58
1997/1998	3	-	19	127	51
1998/1999	5	1	22	105	59
1999/2000	5	2	31	101	54
2000/2001	6	17	40	98	32
Cause of death 2000/2001					
Killed by vechicle or train	-	2	2	13	3
Felled by permit[1]	3	13	9	1	-
Licenced hunting of wolverine	.	.	27	.	.
Quota hunting of lynx	.	.	.	80	.
Other causes[1]	3	2	2	4	29

[1]Including animals felled in self-defence or illegally, unknown reasons, etc.
Source: Statistics Norway.

Fisheries, sealing, whaling and fish farming

Appendix D

Table D1 Stock trends for some important fish stocks. 1 000 tonnes

Year	North-East Arctic cod[1]	North-East Arctic haddock[1]	North-East Arctic saithe[2]	Greenland halibut[7]	Barents Sea capelin[3,5]	Norwegian spring-spawning herring[3]	North Sea herring[4]	North Sea cod[3]
1977	2 130	240	480	100	6 250	280	50	820
1978	1 800	260	460	90	6 120	350	70	810
1979	1 490	320	430	110	6 580	390	110	810
1980	1 200	260	550	90	8 220	470	130	1 020
1981	1 190	200	530	90	4 490	500	200	860
1982	750	120	480	90	4 210	500	280	840
1983	740	70	480	100	4 770	570	440	650
1984	820	50	410	90	3 300	600	680	720
1985	960	150	370	90	1 090	500	700	500
1986	1 260	290	350	90	160	410	680	680
1987	1 120	230	360	90	110	990	910	570
1988	910	170	360	80	360	3 170	1 200	430
1989	890	120	330	90	770	3 970	1 250	420
1990	960	120	400	80	4 900	4 500	1 170	330
1991	1 560	150	530	70	6 650	4 730	960	300
1992	1 900	230	690	50	5 370	4 580	680	400
1993	2 280	460	750	50	990	4 320	450	340
1994	2 010	550	730	50	260	4 790	500	420
1995	1 680	490	770	60	190	5 680	480	420
1996	1 590	410	770	70	470	7 330	480	380
1997	1 460	310	700	70	870	8 580	580	500
1998	1 140	200	770	70	1 860	7 800	780	310
1999	1 040	200	740	80	2 580	7 140	940	260
2000	1 020	170	840	80	3 840	5 990	940	280
2001	1 250	240	800	80	3 480	5 220	1 430	270
2002	1 340	290	820	80	..	5 290	1 700	..

Year	North Sea haddock[3]	North Sea saithe[3],[6]	North Sea whiting[3]	North Sea plaice[3]	North Sea sole[3]	Blue whiting (northern and southern stock[4]	Mackerel (North Sea, western and southern)[4]
1977	570	630	1 080	480	60	..	..
1978	670	570	750	470	60	..	..
1979	670	580	890	470	50	..	..
1980	1 250	540	840	490	40	..	..
1981	670	640	630	490	50	2 520	..
1982	840	680	480	560	60	2 080	..
1983	760	810	480	540	70	1 700	..
1984	1 490	840	480	550	70	1 420	2 650
1985	860	710	440	540	60	1 540	2 620
1986	720	690	650	640	50	1 730	2 630
1987	1 070	490	540	620	60	1 550	2 610
1988	430	480	410	610	70	1 370	2 690
1989	400	460	550	570	100	1 290	2 720
1990	340	420	460	540	110	1 180	2 580
1991	740	460	460	450	100	1 510	2 900
1992	600	500	390	420	110	2 030	2 940
1993	850	550	370	370	100	1 990	2 770
1994	500	560	370	310	90	1 960	2 610
1995	930	710	360	280	70	1 820	2 850
1996	590	610	300	260	50	1 700	2 930
1997	640	600	250	300	50	1 870	3 170
1998	490	590	260	330	70	2 650	3 300
1999	370	550	320	320	70	3 040	3 720
2000	1 540	630	380	310	60	2 780	3 820
2001	970	660	440	340	60	2 560	4 020
2002	..	..	..	..	..	2 240	..

[1] Fish aged 3 years and older. [2]Fish aged 2 years and older. [3] Fish aged 1 year and older. [4]Spawning stock. [5] As of 1 August. [6] Including saithe west of Scotland. [7]Fish aged 5 years and older.
Source: ICES working group reports and Institute of Marine Research.

Table D2 Norwegian catches by species and groups of species. 1 000 tonnes

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998*	1999*	2000*	2001*
Total	**1 971**	**1 789**	**2 198**	**2 619**	**2 584**	**2 526**	**2 702**	**2 820**	**3 055**	**3 040**	**2 809**	**2 895**	**2 852**
Cod	186	125	164	219	275	374	365	358	401	321	257	220	209
Haddock	39	23	25	40	44	74	80	97	106	79	53	46	52
Saithe	145	112	140	168	188	189	219	222	184	194	198	170	169
Tusk	32	28	27	26	27	20	19	19	14	21	23	22	19
Ling/Blue ling	29	24	23	22	20	19	19	19	16	23	20	18	15
Greenland halibut	11	24	33	11	15	13	14	17	12	12	20	13	15
Redfish	27	41	56	38	33	29	22	30	23	29	31	26	29
Others and unspecified	29	30	44	43	57	31	27	32	40	43	29	29	41
Capelin	108	92	576	811	530	113	28	208	158	88	92	375	483
Mackerel	143	150	179	207	224	260	202	137	137	158	161	174	180
Herring	275	208	201	227	352	539	687	763	923	832	829	800	578
Sprat	5	6	34	33	47	44	41	59	7	35	22	6	11
Other industrial fisheries[1]	696	655	447	527	541	587	745	642	798	964	828	734	810
Crustaceans and molluscs	64	73	58	57	61	48	49	44	45	61	67	71	67
Seaweed	183	197	191	189	170	185	185	173	192	180	179	192	175

[1]Includes lesser and greater silver smelt, Norway pout, sandeel, blue whiting and horse mackerel.
Source: Directorate of Fisheries.

Table D3 Consumption of antibacterial agents in fish farming. kg of active ingredients

Year	Total	Oxytetra-cyclin-chloride	Nifura-zolidone	Oxolinic acid	Trimetoprim + sulphadiazine (Tribrissen)	Sulpha-merazine	Flume-quin	Flor-fenicol
1981	3 640	3 000	-	-	540	100	-	-
1982	6 650	4 390	1 600	-	590	70	-	-
1983	10 130	6 060	3 060	-	910	100	-	-
1984	17 770	8 260	5 500	-	4 000	10	-	-
1985	18 700	12 020	4 000	-	2 600	80	-	-
1986	18 030	15 410	1 610	-	1 000	10	-	-
1987	48 570	27 130	15 840	3 700	1 900	-	-	-
1988	32 470	18 220	4 190	9 390	670	-	-	-
1989	19 350	5 014	1 345	12 630	32	-	329	-
1990	37 432	6 257	118	27 659	1 439	-	1 959	-
1991	26 798	5 751	131	11 400	5 679	-	3 837	-
1992	27 485	4 113	-	7 687	5 852	-	9 833	-
1993	6 144	583	78	2 554	696	-	2 177	56
1994	1 396	341	-	811	3	-	227	14
1995	3 116	70	-	2 800	-	-	182	64
1996	1 037	27	-	841	-	-	105	64
1997	746	42	-	507	-	-	74	123
1998	679	55	-	436	-	-	53	135
1999	591	25	-	494	-	-	7	65
2000	685	15	-	470	-	-	52	148
2001	645	12	-	517	-	-	7	109

Source: Norwegian Institute of Public Health.

Table D4 Exports of some main groups of fish products. 1 000 tonnes

Year	Fresh	Frozen whole	Fillets	Salted or smoked	Dried	Canned, etc.	Meal	Oil
1981	24.6	58.7	74.0	13.6	86.2	15.0	266.5	107.3
1982	46.2	100.2	76.3	14.9	68.8	11.2	228.6	101.1
1983	91.5	62.6	91.6	24.9	59.4	22.4	283.9	128.0
1984	72.9	78.7	98.5	24.6	69.5	22.7	248.9	76.9
1985	74.5	79.5	95.9	20.3	64.6	23.4	173.9	114.3
1986	139.4	98.8	95.2	22.7	62.9	24.4	92.6	38.8
1987	189.6	114.2	105.0	38.0	40.6	24.3	88.3	71.3
1988	212.5	126.7	105.1	36.9	47.0	22.9	68.9	45.6
1989	215.1	159.8	95.2	46.2	48.0	23.2	45.4	39.1
1990	238.8	263.4	71.0	34.6	50.6	23.9	45.3	42.7
1991	249.6	366.9	68.7	48.6	50.3	23.0	110.8	58.5
1992	258.8	351.6	103.2	48.0	57.4	23.9	140.1	53.7
1993	309.1	412.4	141.3	66.4	62.6	23.9	139.6	62.0
1994	307.4	518.2	195.2	100.1	66.5	26.4	72.0	63.5
1995	341.1	579.7	210.8	94.4	70.5	20.6	66.1	85.6
1996	369.5	682.7	234.3	91.5	76.1	19.3	87.1	68.1
1997	427.2	801.5	241.4	82.3	75.7	18.0	64.0	55.1
1998	486.0	637.5	238.7	79.0	84.9	19.1	154.4	38.2
1999	490.5	791.0	247.6	65.6	65.7	17.7	153.6	48.5
2000	461.1	904.0	248.1	54.4	75.0	15.8	88.0	50.9
2001*	417.0	908.8	208.1	53.6	76.4	12.9	85.8	39.0

Source: External Trade Statistics from Statistics Norway.

Table D5 Exports of fish and fish products by important recipient countries. Million NOK

Year	Total	EU-countries, total	Of this				Other countries, total	Of this	
			France	Denmark	United Kingdom	Germany		Japan	USA
1982	5 931.4	2 494.0	419.9	211.4	880.9	338.3	3 437.5	229.5	421.2
1983	7 367.7	3 186.2	568.8	337.2	1 022.1	515.0	4 181.3	334.5	747.6
1984	7 675.2	3 233.3	530.3	350.3	1 026.7	545.8	4 442.1	408.2	920.1
1985	8 172.3	3 605.0	605.1	377.1	1 202.0	632.8	4 567.8	463.8	1 129.2
1986	8 749.4	4 293.9	781.0	626.9	1 014.2	705.5	4 455.5	408.8	1 194.7
1987	9 992.3	5 597.0	1 114.1	926.7	1 059.1	754.2	4 395.3	501.0	1 397.9
1988	10 693.1	6 107.2	1 318.6	1 115.1	987.2	932.3	4 585.9	808.0	1 059.6
1989	10 999.2	6 416.1	1 305.5	1 196.0	1 019.5	892.9	4 583.1	755.7	996.1
1990	13 002.4	8 119.2	1 617.1	2 046.3	868.8	1 046.5	4 883.3	1 067.5	754.7
1991	14 940.4	9 114.8	1 534.8	2 021.9	991.0	1 196.1	5 825.6	1 797.7	436.4
1992	15 385.2	10 180.2	1 850.7	1 794.1	1 388.9	1 309.3	5 205.0	1 366.3	400.0
1993	16 619.1	10 365.3	1 835.9	1 690.1	1 542.3	1 369.2	6 253.8	1 810.3	565.7
1994	19 536.9	11 709.4	2 250.3	1 767.8	1 484.5	1 698.3	7 827.5	1 999.2	723.1
1995	20 095.0	13 176.4	2 138.0	2 192.2	1 591.4	1 605.4	6 918.6	1 987.5	800.1
1996	22 444.5	13 839.2	2 167.5	2 431.0	1 765.1	1 529.5	8 605.2	2 503.8	762.7
1997	24 632.3	14 531.5	2 274.3	2 640.9	2 022.2	1 532.0	10 100.8	2 752.2	962.9
1998	28 164.5	17 845.6	2 540.3	3 112.5	2 819.2	1 948.1	10 319.0	2 797.8	999.8
1999	29 740.4	18 105.4	2 669.1	3 020.8	2 710.0	1 722.2	11 634.9	4 408.2	1 351.4
2000	31 456.7	18 295.5	2 702.4	3 654.9	2 683.1	1 655.7	13 161.4	4 218.9	1 390.3
2001*	30 645.5	16 930.5	2 340.2	3 032.6	2 204.0	1 460.7	13 715.0	4 105.5	1 121.2

Source: External Trade Statistics from Statistics Norway.

Table D6 Exports of salmon

Year	Total		Farmed salmon. Fresh, chilled and frozen		Fresh and frozen fillets, smoked, gravlax, other salmon, etc.[1]	
	Amount 1000 tonnes	Value Million NOK	Amount 1000 tonnes	Value Million NOK	Amount 1000 tonnes	Value Million NOK
1981	7.9	317.7	7.5	292.9	0.4	24.9
1982	9.6	422.7	9.2	395.3	0.4	27.4
1983	15.9	743.8	15.4	709.1	0.5	34.6
1984	20.4	998.5	19.6	944.8	0.7	53.7
1985	24.9	1 385.4	24.0	1 308.8	0.9	77.1
1986	40.1	1 773.4	38.9	1 663.7	1.2	109.7
1987	44.6	2 308.8	43.2	2 174.4	1.4	134.3
1988	66.9	3 175.7	66.0	3 079.7	1.0	96.0
1989	98.2	3 681.4	95.5	3 486.1	2.7	195.3
1990	132.9	5 043.3	130.7	4 834.9	2.2	208.4
1991	134.7	4 998.9	126.6	4 449.6	8.1	549.3
1992	133.3	5 117.8	122.1	4 399.9	11.1	717.9
1993	143.1	5 365.0	131.0	4 553.2	12.1	811.8
1994	170.3	6 476.4	153.8	5 425.3	16.4	1 051.1
1995	207.3	6 790.3	189.1	5 660.8	18.2	1 129.5
1996	238.1	6 991.6	214.1	5 692.9	24.0	1 298.7
1997	261.4	7 657.0	233.1	6 191.0	28.3	1 466.0
1998	282.0	8 761.9	252.3	7 135.9	29.7	1 626.0
1999	336.8	10 726.3	295.6	8 385.2	41.2	2 341.1
2000	343.1	12 271.9	304.0	9 797.7	39.1	2 474.2
2001*	338.4	9 999.9	299.6	7 770.0	38.8	2 229.9

[1] Mainly farmed salmon, but other categories are also included.
Source: External Trade Statistics from Statistics Norway.

Table D7 Catch quantities[1] and export value[2] of fish and fish products. Selected countries

Country[3]	1995		1996		1997		1998		1999	
	Catch quantity	Export-value	Catch quantity	Export-value	Catch quantity	Export-value	Catch quantity	Export-value	Catch quantity	Export-value
	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD
World, total	**91 871**	**51 802**	**93 531**	**52 828**	**93 766**	**53 285**	**86 933**	**51 272**	**92 867**	**52 883**
China	12 563	2 835	14 182	2 857	15 722	2 937	17 230	2 656	17 240	2 960
Peru	8 937	870	9 515	1 120	7 870	1 342	4 338	639	8 430	788
Japan	5 967	713	5 933	709	5 926	889	5 263	718	5 176	720
Chile	7 434	1 704	6 691	1 697	5 811	1 782	3 265	1 597	5 051	1 697
USA	5 225	3 384	5 001	3 148	4 983	2 850	4 709	2 400	4 750	2 945
Indonesia	3 504	1 667	3 558	1 678	3 791	1 621	3 965	1 628	4 149	1 527
Russia	4 312	1 635	4 677	1 686	4 662	1 356	4 455	1 168	4 141	1 248
India	3 220	1 041	3 474	1 116	3 517	1 227	3 215	1 049	3 317	1 020
Thailand	3 013	4 449	3 005	4 118	2 878	4 330	2 900	4 031	3 005	4 110
Norway	2 524	3 123	2 648	3 416	2 857	3 399	2 851	3 661	2 620	3 765
South Korea	2 320	1 565	2 414	1 509	2 204	1 376	2 027	1 246	2 120	1 393
Philippines	1 860	502	1 784	437	1 806	435	1 833	445	1 870	372
Iceland	1 613	1 343	2 060	1 426	2 206	1 360	1 682	1 434	1 736	1 379
Denmark	1 999	2 460	1 682	2 699	1 827	2 649	1 557	2 898	1 405	2 884
Malaysia	1 112	335	1130	327	1 173	337	1 154	310	1 252	299

[1]'Catch quantities include marine and inland waters fisheries, but not aquaculture production. Whales, seals and other marine mammals and marine plants are not included. [2] Aquaculture production is included in the export figures. [3]The countries are ranked according to catch quantities in 1999.
Source: FAO (2001b and c).

Table D8 Total catches[1] in world fisheries. 1999

	1000 tonnes	Per cent
Total catches	**92 867**	**100**
By area:		
Inland waters	8 260	8.9
Marine areas	84 606	91.1
By animal group:		
Fishes	78 631	84.7
Crustaceans	6 286	6.8
Molluscs	7 348	7.9
Others	602	0.6
Catches in marine areas by various distributions		
Marine catches, total	**84 606**	**100**
By marine fishing areas:		
North Atlantic	12 521	14.8
Central Atlantic	5 369	6.3
Mediterranean and Black Sea	1 536	1.8
South Atlantic	3 855	4.6
Indian Ocean	8 464	10.0
North Pacific	26 712	31.6
Central Pacific	11 198	13.2
South Pacific	14 952	17.7
By continents:		
Africa	4 034	4.8
North America	7 354	8.7
South America	16 111	19.0
Asia	40 135	47.4
Europe	15 576	18.4
Oceania	1 149	1.4
Other, not elsewhere specified	247	0.3
By species:		
Anchoveta - *Engraulis ringens*	8 723	10.3
Alaska pollock - *Theragra chalcogramma*	3 363	4.0
Atlantic herring - *Clupea harengus*	2 404	2.8
Skipjack tuna - *Katsuwonus pelamis*	1 976	2.3
Chub mackerel - *Scomber japonicus*	1 955	2.3
Japanese anchovy - *Engraulis japonicus*	1 820	2.2
Chilean jack mackerel - *Trachurus murphyi*	1 423	1.7
Largehead hairtail - *Trichiurus lepturus*	1 419	1.7
Blue whiting - *Micromesistius poutassou*	1 323	1.6
Yellowfin tuna - *Thunnus albacares*	1 258	1.5
Atlantic cod - *Gadus morhua*	1 093	1.3
Argentine shortfin squid - *Illex argentinus*	1 091	1.3
Capelin - *Mallotus villosus*	905	1.1
European pilchard - *Sardina pilchardus*	901	1.1
Araucanian herring - *Strangomera bentincki*	782	0.9
Gulf menhaden - *Brevoortia patronus*	694	0.8
European sprat - *Sprattus sprattus*	684	0.8
Atlantic mackerel - *Scomber scombrus*	611	0.7
Akiami paste shrimp - *Acetes japonicus*	599	0.7
European anchovy - *Engraulis encrasicolus*	598	0.7
Japanese Spanish mackerel - *Scomberomorus niphonius*	595	0.7
Japanese pilchard - *Sardinops melanostictus*	515	0.6
Japanese flying squid - *Todarodes pacificus*	498	0.6
Round sardinella - *Sardinella aurita*	481	0.6
Pacific herring - *Clupea pallasii*	472	0.6
Patagonian grenadier - *Macruronus magellanicus*	447	0.5

[1]Not including farmed fisk. Not including whales, seals and other sea mammals and aquatic plants.
Source: FAO (2001b).

Air pollution and climate

Appendix E

Table E1 Emissions of greenhouse gases to air

	CO_2	CH_4	N_2O	HFC 23	HFC 32	HFC 125	HFC 134	HFC 143	HFC 152	HFC 227	C_3F_8	CF_4	C_2F_6	SF_6	CO_2 equiva-lents
	Mill. tonnes	1000 tonnes		Tonnes											Mill. tonnes
GWP[1]	1	21	310	11 700	650	2 800	1 300	3 800	140	2 900	7 000	6 500	9 200	23 900	
1950	..	131	7	-	-	-	-	-	-	-	..	..	..	..	..
1960	..	175	10	-	-	-	-	-	-	-	..	..	..	..	..
1970	..	216	12	-	-	-	-	-	-	-	..	..	..	..	..
1973	30.4	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1974	27.6	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1975	30.5	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1976	33.2	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1977	33.2	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1978	32.5	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1979	34.5	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1980	32.3	258	13	-	-	-	-	-	-	-	..	..	..	0	..
1981	31.7	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1982	30.8	..	..	-	-	-	-	-	-	-	..	..	..	91	..
1983	31.8	..	..	-	-	-	-	-	-	-	..	..	..	100	..
1984	33.7	..	..	-	-	-	-	-	-	-	..	..	..	185	..
1985	32.1	..	..	-	-	-	-	-	-	-	..	489	20	199	..
1986	34.6	..	..	-	-	-	-	-	-	-	..	479	20	240	..
1987	33.3	292	14	-	-	-	-	-	-	-	..	464	19	240	53
1988	35.4	292	15	-	-	-	-	-	-	-	..	443	18	223	55
1989	34.3	305	16	-	-	-	-	-	-	-	..	430	18	107	51
1990	35.2	307	17	-	-	-	-	-	0	-	..	441	18	91	52
1991	33.5	309	16	-	-	-	0	-	0	-	..	369	14	86	50
1992	34.3	314	14	-	-	-	0	-	1	-	..	294	11	29	48
1993	35.8	320	15	-	-	-	2	-	1	-	..	290	10	30	50
1994	37.7	326	15	0	0	0	5	0	1	-	..	251	9	36	52
1995	37.8	328	16	0	0	2	10	2	1	-	0	229	8	24	52
1996	40.9	332	16	0	0	5	17	4	1	0	0	214	5	23	55
1997	41.2	334	15	0	0	10	26	7	2	0	0	201	8	23	55
1998	41.3	329	16	0	0	15	38	10	5	0	0	185	7	29	55
1999	41.7	326	17	0	1	20	50	15	6	0	0	164	6	35	56
2000*	41.3	324	17	0	1	25	61	18	6	0	0	131	5	37	55
2001*	42.4	323	17	0	1	30	74	21	8	0	0	145	6	32	56

[1]Impact on greenhouse effect of emission of 1 tonne of the gas compared with that of 1 tonne CO_2.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E2 Emissions to air

	SO_2	NO_X	NH_3	Acid equivalents[1]	NMVOC	CO	Particulates[2]
				1000 tonnes			
1973	156	184	..	..	187	721	38
1974	149	181	..	..	178	681	36
1975	138	185	..	..	200	734	36
1976	147	184	..	..	201	778	35
1977	146	197	..	..	207	824	37
1978	142	190	..	..	166	850	37
1979	144	201	..	..	182	888	42
1980	137	194	23	9.8	175	881	41
1981	128	183	..	..	181	873	44
1982	111	187	..	..	188	882	42
1983	104	192	..	..	201	874	42
1984	96	207	..	..	212	901	44
1985	98	218	..	..	231	904	45
1986	91	234	..	..	249	928	47
1987	73	234	23	8.7	255	889	47
1988	67	231	21	8.4	248	918	46
1989	58	229	23	8.1	275	872	46
1990	53	226	23	7.9	300	875	52
1991	44	215	23	7.4	294	806	47
1992	36	214	25	7.3	322	788	48
1993	35	223	25	7.4	338	790	52
1994	35	222	25	7.4	353	782	56
1995	34	223	26	7.4	368	747	54
1996	33	232	26	7.6	372	719	57
1997	30	235	26	7.6	367	684	58
1998	30	236	26	7.6	349	642	54
1999	28	240	25	7.6	349	606	53
2000*	26	223	25	7.2	363	570	51
2001*	25	225	25	7.2	357	550	51

[1]Total acidifying effect of SO_2, NO_x and NH_3. [2]Process emissions calculated for road dust only.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E3 Emissions of greenhouse gases to air by sector. 1999

	CO_2	CH_4	N_2O	HFC[1]	PFC[2]	SF_6	CO_2-equivalents
	Mill. tonnes	1000 tonnes		Tonnes			Mill. tonnes
Total	**41.7**	**326.2**	**17.0**	**179.5**	**1 121.8**	**34.9**	**56.0**
Energy sectors	**12.8**	**26.4**	**0.1**	**2.3**	**0,0**	**2.6**	**13.4**
Extraction of oil and gas[3]	10.3	26.0	0.1	2.1	0.0	-	10.9
Extraction of coal	0.0	0.2	0.0	0.0	-	-	0.0
Oil refining	2.1	0.1	0.0	0.0	-	-	2.1
Electricity supplies[4]	0.4	0.1	0.0	0.0	-	2.6	0.4
Manufacturing and mining	**11.7**	**29.5**	**6.3**	**32.5**	**1 121.4**	**30.4**	**16.2**
Oil drilling	0.3	0.2	0.0	0.0	-	-	0.3
Manufacture of pulp and paper	0.5	12.0	0.1	0.0	-	-	0.8
Manufacture of basic chemicals	2.8	0.9	6.1	0.1	-	-	4.7
Manufacture of minerals[5]	2.0	0.0	0.0	0.0	-	-	2.0
Manufacture of iron, steel and ferro-alloys	2.8	0.0	0.0	0.6	-	-	2.8
Manufacture of other metals	2.3	0.0	0.0	0.6	1 121.4	30.4	4.2
Manufacture of metal goods, boats, ships and oil platforms	0.3	0.0	0.0	17.1	-	0.1	0.3
Manufacture of wood, plastic, rubber, and chemical goods, printing	0.2	16.3	0.0	0.3	-	-	0.5
Manufacture of consumer goods	0.6	0.0	0.0	13.8	0.0	-	0.7
Other	**12.0**	**261.3**	**9.6**	**131.6**	**0.3**	**1.9**	**20.7**
Construction	0.7	0.1	0.1	1.6	-	-	0.7
Agriculture and forestry	0.6	100.7	8.3	1.2	-	-	5.3
Fishing, whaling and sealing	1.6	0.1	0.0	8.4	0.0	-	1.6
Land transport, domestic	3.4	0.2	0.2	8.6	0.0	-	3.5
Sea transport, domestic	1.7	0.1	0.0	4.1	0.0	-	1.7
Air transport[6]	1.2	0.0	0.0	0.5	-	-	1.2
Other private services	2.1	0.5	0.3	100.3	0.3	1.9	2.3
Public sector, municipal	0.3	159.6	0.5	4.3	0.0	-	3.8
Public sector, state	0.4	0.0	0.0	2.6	0.0	-	0.4
Private households	**5.2**	**8.9**	**1.0**	**13.1**	**-**	**0.3**	**5.8**

[1]The distribution by sectors is uncertain. [2]Includes C_3F_8, CF_4 and C_2F_6. [3]Includes gas terminal, transport and supply ships. [4]Includes emissions from waste incineration plants. [5] Including mining. [6]Domestic air transport only, including emissions above 1000 m.

Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E4 Emissions to air by sector. 1999

	SO_2	NO_X	NH_3	Acid equivalents[1]	NMVOC	CO	Particulates[2]
				1000 tonnes			
Total	**28.5**	**239.5**	**25.5**	**7.6**	**348.7**	**605.9**	**52.8**
Energy sectors	**3.5**	**64.2**	**0.0**	**1.5**	**218.4**	**8.0**	**0.6**
Extraction of oil and gas[3]	0.6	60.3	-	1.3	207.0	7.0	0.4
Extraction of coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil refining	2.1	2.6	0.0	0.1	10.9	0.0	0.1
Electricity supplies[4]	0.7	1.3	0.0	0.1	0.5	1.0	0.2
Manufacturing and mining	**20.0**	**29.4**	**0.3**	**1.3**	**23.5**	**47.2**	**0.9**
Oil drilling	0.1	5.9	-	0.1	0.5	0.6	0.0
Manufacture of pulp and paper	2.0	1.9	0.0	0.1	0.3	3.4	0.2
Manufacture of basic chemicals	6.1	4.7	0.3	0.3	2.2	32.3	0.1
Manufacture of minerals[5]	1.6	5.9	0.0	0.2	2.1	0.7	0.2
Manufacture of iron, steel and ferro-alloys	6.4	6.9	0.0	0.4	1.5	0.1	0.0
Manufacture of other metals	2.4	1.3	0.0	0.1	0.0	1.1	0.0
Manufacture of metal goods, boats, ships and oil platforms	0.1	0.7	0.0	0.0	2.7	1.2	0.0
Manufacture of wood, plastic, rubber, and chemical goods, printing	0.3	0.8	0.0	0.0	12.7	6.8	0.1
Manufacture of consumer goods	0.9	1.3	0.0	0.1	1.5	1.0	0.1
Other	**4.1**	**124.8**	**24.0**	**4.2**	**46.6**	**114.5**	**5.4**
Construction	0.1	6.2	0.0	0.1	11.6	5.2	0.7
Agriculture and forestry	0.2	5.6	23.6	1.5	2.8	13.3	0.7
Fishing, whaling and sealing	0.9	35.0	0.0	0.8	0.8	7.1	0.3
Land transport, domestic	0.6	25.6	0.1	0.6	5.4	22.8	2.7
Sea transport, domestic	1.4	36.0	-	0.8	1.8	1.5	0.4
Air transport[6]	0.1	4.0	-	0.1	2.3	5.3	0.0
Other private services	0.5	9.1	0.3	0.2	18.7	56.9	0.6
Public sector, municipal[7]	0.2	0.3	0.0	0.0	1.3	0.3	0.0
Public sector, state	0.1	3.0	0.0	0.1	1.9	2.0	0.0
Private households	**1.0**	**21.2**	**1.2**	**0.6**	**60.1**	**436.2**	**46.0**

[1]Total acidifying effect of SO_2, NO_X and NH_3. [2] Process emissions calculated for road dust only. [3] Includes gas terminal, transport and supply ships. [4]Includes emissions from waste incineration. [5]Including mining. [6]Includes only domestic air transport. [7]Includes water supplies.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E5 Emissions to air by source[1]. 1999

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particu-lates
	Mill. tonnes	1000 tonnes							
Total	**41.7**	**326.2**	**17.0**	**28.5**	**239.5**	**25.5**	**348.7**	**605.9**	**52.8**
Stationary combustion	17.7	11.6	0.3	6.3	56.5	0.1	12.3	199.3	45.4
Process emissions	7.9	311.6	14.7	17.8	11.8	23.9	272.1	33.0	1.5
Mobile combustion	16.2	3.1	2.0	4.3	171.3	1.5	64.2	373.5	5.9
Stationary combustion									
Total	**17.7**	**11.6**	**0.3**	**6.3**	**56.5**	**0.1**	**12.3**	**199.3**	**45.4**
Oil and gas extraction	8.9	3.2	0.1	0.3	41.4	-	1.6	6.6	0.1
Natural gas	6.2	2.4	0.1	-	24.1	-	0.6	4.5	-
Flaring	1.6	0.2	0.0	-	8.1	-	0.1	1.0	-
Diesel combustion	0.5	0.0	0.0	0.2	8.6	-	0.6	0.6	0.1
Gas terminals	0.6	0.6	0.0	0.0	0.7	-	0.3	0.5	-
Manufacturing and mining	6.5	0.7	0.2	4.5	11.0	-	2.1	11.4	0.8
Refining	2.1	0.1	0.0	0.0	1.4	-	0.9	0.0	0.1
Manufacture of pulp and paper	0.5	0.3	0.1	1.4	1.9	-	0.3	3.4	0.2
Manufacture of mineral products	0.9	0.0	0.0	0.4	4.1	-	0.0	0.2	0.0
Manufacture of chemicals	1.5	0.1	0.0	0.7	1.5	-	0.0	0.2	0.1
Manufacture of metals	0.5	0.0	0.0	0.2	0.5	-	0.0	0.1	0.0
Other manufacturing	1.1	0.2	0.0	1.8	1.6	-	0.7	7.5	0.3
Other industries	1.2	0.6	0.0	0.7	1.3	-	0.2	10.1	0.1
Dwellings	0.9	7.0	0.0	0.7	1.9	0.1	8.2	171.0	44.3
Incineration of waste and landfill gas	0.1	0.1	0.0	0.2	0.9	-	0.4	0.2	0.1
Process emissions									
Total	**7.9**	**311.6**	**14.7**	**17.8**	**11.8**	**23.9**	**272.1**	**33.0**	**1.5**
Oil and gas extraction	0.7	22.9	-	-	-	-	205.0	-	-
Venting, leaks, etc.	0.0	7.6	-	-	-	-	4.0	-	-
Oil loading at sea	0.6	14.1	-	-	-	-	186.4	-	-
Oil loading, on shore	0.0	0.1	-	-	-	-	12.5	-	-
Gas terminals	0.0	1.2	-	-	-	-	2.2	-	-
Manufacturing and mining	6.8	1.1	6.1	17.8	11.8	0.3	13.6	33.0	-
Refining	0.0	-	-	2.1	1.1	-	10.0	-	-
Manufacture of pulp and paper	-	-	-	0.6	-	-	-	-	-
Manufacture of chemicals	0.6	0.8	6.1	2.8	1.2	0.3	0.9	32.0	-
Manufacture of mineral products	0.9	-	-	0.7	-	-	-	-	-
Manufacture of metals	5.3	-	-	11.7	9.6	-	1.8	1.0	-
Iron, steel and ferro-alloys	3.3	-	-	9.1	8.7	-	1.8	-	-
Aluminium	1.8	-	-	1.7	0.8	-	-	-	-
Other metals	0.3	-	-	1.0	0.0	-	-	1.0	-
Other manufacturing	0.0	0.2	-	-	-	-	0.9	-	-
Petrol distribution	0.0	-	-	-	-	-	9.0	-	-
Agriculture	0.2	100.2	8.1	-	-	23.6	-	-	-
Landfill gas	0.0	187.0	-	-	-	-	-	-	-
Solvents	0.1	-	-	-	-	-	44.6	-	-
Road dust	-	-	-	-	-	-	-	-	1.5
Other process emissions	0.0	0.4	0.5	-	-	-	-	-	-

Tabell E5 (cont.). Emissions to air by source[1]. 1999

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particu-lates
	Mill. tonnes	1000 tonnes							
Mobile combustion									
Total	**16.2**	**3.1**	**2.0**	**4.3**	**171.3**	**1.5**	**64.2**	**373.5**	**5.9**
Road traffic	9.4	2.3	1.5	1.2	54.6	1.5	45.4	309.0	3.2
Petrol engines	4.9	2.0	1.3	0.3	23.2	1.5	36.6	276.1	0.4
Passenger cars	4.3	1.8	1.2	0.3	20.2	1.4	32.7	245.0	0.3
Other light vehicles	0.6	0.2	0.1	0.0	2.4	0.1	3.4	28.3	0.0
Heavy vehicles	0.0	0.0	0.0	0.0	0.6	0.0	0.5	2.8	0.0
Diesel engines	4.3	0.2	0.2	0.8	31.2	0.0	4.2	15.4	2.9
Passenger cars	0.5	0.0	0.0	0.1	1.2	0.0	0.4	1.6	0.4
Other light vehicles	1.1	0.0	0.1	0.2	2.6	0.0	1.0	4.4	0.8
Heavy vehicles	2.7	0.1	0.1	0.5	27.4	0.0	2.8	9.5	1.6
Motorcycles, mopeds	0.1	0.1	0.0	0.0	0.1	0.0	4.7	17.5	0.0
Motorcycles	0.1	0.1	0.0	0.0	0.1	0.0	2.2	12.6	0.0
Mopeds	0.0	0.0	0.0	0.0	0.0	0.0	2.5	4.8	0.0
Snow scooters	0.0	0.0	0.0	0.0	0.0	0.0	1.6	3.0	0.0
Small boats	0.2	0.2	0.0	0.0	1.0	-	8.8	19.7	0.3
Motorized equipment	0.8	0.1	0.3	0.1	11.3	0.0	3.8	25.3	1.3
Railways	0.1	0.0	0.0	0.0	0.8	-	0.1	0.2	0.1
Air traffic	1.4	0.0	0.0	0.1	4.8	-	1.5	6.8	0.0
Domestic < 1000 m	0.4	0.0	0.0	0.0	1.3	-	0.3	2.2	0.0
Domestic > 1000 m	1.0	-	0.0	0.1	3.5	-	1.1	4.6	0.0
Shipping	4.4	0.4	0.1	2.8	98.7	-	3.2	9.5	0.9
Coastal traffic, etc.	2.6	0.2	0.1	1.8	58.1	-	1.9	2.0	0.6
Fishing vessels	1.6	0.1	0.0	0.9	34.8	-	0.8	6.9	0.3
Mobile oil rigs, etc.	0.3	0.1	0.0	0.1	5.7	-	0.4	0.6	0.0

[1] Does not include international sea traffic.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E6 Emissions to air by source[1]. 2000*

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particu-lates
	Mill. tonnes	1000 tonnes							
Total	**41.3**	**324.5**	**16.6**	**26.2**	**223.2**	**25.3**	**363.0**	**569.5**	**51.1**
Stationary combustion	17.9	11.5	0.3	4.9	57.5	0.1	12.0	195.7	44.3
Process emissions	8.3	310.0	14.2	17.1	12.2	23.6	291.7	33.6	1.5
Mobile combustion	15.1	2.9	2.1	4.2	153.6	1.6	59.3	340.2	5.3
Stationary combustion									
Total	**17.9**	**11.5**	**0.3**	**4.9**	**57.5**	**0.1**	**12.0**	**195.7**	**44.3**
Oil and gas extraction	9.9	3.2	0.1	0.3	43.8	-	1.4	7.3	0.1
Natural gas	7.2	2.8	0.1	-	26.7	-	0.7	5.2	-
Flaring	1.7	0.2	0.0	-	8.4	-	0.1	1.1	-
Diesel combustion	0.5	0.0	0.0	0.3	8.1	-	0.5	0.6	0.1
Gas terminals	0.6	0.3	0.0	0.0	0.7	-	0.1	0.5	-
Manufacturing and mining	6.2	0.7	0.2	3.3	9.9	-	2.0	11.2	0.7
Refining	2.1	0.1	0.0	0.1	1.3	-	0.9	0.0	0.1
Manufacture of pulp and paper	0.3	0.3	0.1	0.9	1.5	-	0.3	3.2	0.2
Manufacture of mineral products	0.8	0.0	0.0	0.4	3.9	-	0.0	0.2	0.0
Manufacture of chemicals	1.6	0.1	0.0	0.4	1.3	-	0.0	0.4	0.1
Manufacture of metals	0.6	0.0	0.0	0.2	0.6	-	0.0	0.1	0.0
Other manufacturing	0.8	0.1	0.0	1.3	1.2	-	0.7	7.3	0.3
Other industries	0.9	0.6	0.0	0.5	1.0	-	0.1	9.9	0.0
Dwellings	0.7	6.9	0.0	0.6	1.7	0.1	8.0	167.1	43.4
Incineration of waste and landfill gas	0.1	0.1	0.0	0.2	1.0	-	0.4	0.2	0.1
Process emissions									
Total	**8.3**	**310.0**	**14.2**	**17.1**	**12.2**	**23.6**	**291.7**	**33.6**	**1.5**
Oil and gas extraction	0.8	24.3	-	-	-	-	228.8	-	-
Venting, leaks, etc.	0.0	6.6	-	-	-	-	3.8	-	-
Oil loading at sea	0.7	16.2	-	-	-	-	209.0	-	-
Oil loading, on shore	0.0	0.1	-	-	-	-	14.0	-	-
Gas terminals	0.0	1.4	-	-	-	-	2.1	-	-
Manufacturing and mining	7.2	1.2	5.6	17.1	12.2	0.5	12.4	33.6	-
Refining	0.0	-	-	1.9	1.3	-	9.0	-	-
Manufacture of pulp and paper	-	-	-	0.5	-	-	-	-	-
Manufacture of chemicals	1.0	0.9	5.6	2.4	1.3	0.5	0.7	32.6	-
Manufacture of mineral products	0.9	-	-	0.7	-	-	-	-	-
Manufacture of metals	5.3	-	-	11.6	9.6	-	1.8	1.0	-
Iron, steel and ferro-alloys	3.2	-	-	9.3	8.7	-	1.8	-	-
Aluminium	1.8	-	-	1.4	0.9	-	-	-	-
Other metals	0.3	-	-	0.9	0.0	-	-	1.0	-
Other manufacturing	0.0	0.3	-	-	-	-	0.8	-	-
Petrol distribution	0.0	-	-	-	-	-	8.3	-	-
Agriculture	0.1	97.6	8.2	-	-	23.1	-	-	-
Landfill gas	0.0	186.5	-	-	-	-	-	-	-
Solvents	0.1	-	-	-	-	-	42.3	-	-
Road dust	-	-	-	-	-	-	-	-	1.5
Other process emissions	0.0	0.4	0.5	-	-	-	-	-	-

Tabell E6 (cont.). Emissions to air by source[1]. 2000*

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particulates
	Mill. tonnes	1000 tonnes							
Mobile combustion									
Total	**15.1**	**2.9**	**2.1**	**4.2**	**153.6**	**1.6**	**59.3**	**340.2**	**5.3**
Road traffic	9.0	2.2	1.7	0.7	49.1	1.6	41.2	277.7	2.8
Petrol engines	4.8	1.9	1.5	0.3	20.4	1.6	32.4	245.0	0.3
Passenger cars	4.2	1.7	1.4	0.2	17.8	1.5	29.0	218.1	0.3
Other light vehicles	0.6	0.1	0.1	0.0	2.1	0.1	2.9	24.4	0.0
Heavy vehicles	0.0	0.0	0.0	0.0	0.6	0.0	0.5	2.6	0.0
Diesel engines	4.2	0.1	0.2	0.4	28.5	0.0	3.8	13.9	2.5
Passenger cars	0.5	0.0	0.0	0.0	1.2	0.0	0.3	1.6	0.4
Other light vehicles	1.1	0.0	0.1	0.1	2.5	0.0	0.9	4.3	0.8
Heavy vehicles	2.6	0.1	0.1	0.3	24.8	0.0	2.6	8.1	1.3
Motorcycles, mopeds	0.1	0.1	0.0	0.0	0.2	0.0	5.0	18.8	0.0
Motorcycles	0.1	0.1	0.0	0.0	0.1	0.0	2.4	13.9	0.0
Mopeds	0.0	0.0	0.0	0.0	0.0	0.0	2.6	4.9	0.0
Snow scooters	0.0	0.0	0.0	0.0	0.0	0.0	1.6	3.0	0.0
Small boats	0.2	0.2	0.0	0.0	1.0	-	8.8	19.7	0.3
Motorized equipment	0.8	0.1	0.3	0.3	11.2	0.0	3.7	25.3	1.3
Railways	0.0	0.0	0.0	0.0	0.7	-	0.1	0.2	0.1
Air traffic	1.1	0.0	0.0	0.1	3.8	-	1.1	5.3	0.0
Domestic < 1000 m	0.4	0.0	0.0	0.0	1.1	-	0.3	1.9	0.0
Domestic > 1000 m	0.7	-	0.0	0.1	2.7	-	0.8	3.4	0.0
Shipping	3.9	0.4	0.1	3.0	87.8	-	2.9	9.1	0.8
Coastal traffic, etc.	2.1	0.2	0.1	1.9	47.7	-	1.6	1.7	0.5
Fishing vessels	1.5	0.1	0.0	0.9	32.5	-	0.8	6.7	0.2
Mobile oil rigs, etc.	0.3	0.1	0.0	0.2	7.5	-	0.5	0.7	0.1

[1] Does not include international sea traffic.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E7 Emissions to air by county. 1999

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particulates[1]
	Mill. tonnes	1000 tonnes							
Total	**41.9**	**326.2**	**17.0**	**28.9**	**241.8**	**25.5**	**348.8**	**606.6**	**52.9**
Of this, national emission figures	41.8	326.2	17.0	28.9	241.6	25.5	348.7	606.0	52.9
Of this, international sea and air traffic[2]	0.1	0.0	0.0	0.0	0.2	0.0	0.1	0.6	0.0
Østfold	1.5	14.7	0.7	2.7	6.2	1.5	8.1	31.7	2.7
Akershus	1.8	17.8	0.9	0.5	8.7	1.5	14.3	64.5	4.6
Oslo	1.3	7.8	0.2	0.5	5.6	0.1	12.2	30.5	1.0
Hedmark	0.8	19.2	1.0	0.3	4.9	2.2	5.9	35.0	3.8
Oppland	0.7	22.1	0.9	0.2	4.3	2.5	5.6	34.3	4.4
Buskerud	1.1	17.9	0.6	1.0	6.0	1.0	7.0	39.8	4.6
Vestfold	1.2	12.0	0.4	1.0	5.2	0.9	8.6	28.9	2.3
Telemark	3.0	11.0	4.4	1.1	7.3	0.8	5.9	27.9	3.3
Aust-Agder	0.5	6.8	0.2	2.3	2.1	0.3	3.2	41.5	1.4
Vest-Agder	1.1	12.0	0.3	1.8	3.6	0.6	4.7	19.8	1.6
Rogaland	2.9	35.8	1.2	1.4	8.4	3.5	13.4	37.3	2.5
Hordaland	3.6	27.2	0.6	2.6	9.7	1.3	32.0	38.4	2.6
Sogn og Fjordane	1.3	11.7	0.4	1.5	4.1	1.3	2.8	13.1	1.3
Møre og Romsdal	1.5	17.2	0.7	0.5	5.7	1.8	6.7	28.9	3.2
Sør-Trøndelag	1.3	17.1	0.7	2.4	5.6	1.8	6.6	34.5	2.9
Nord-Trøndelag	0.7	15.7	0.8	0.9	3.5	2.1	4.1	27.4	4.0
Nordland	2.4	20.0	2.5	3.4	9.2	1.5	6.0	28.3	3.4
Troms	0.8	8.8	0.3	1.4	4.2	0.6	3.6	15.2	1.3
Finnmark	0.3	6.5	0.2	0.1	2.0	0.2	2.1	9.0	0.7
Svalbard and Jan Mayen	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Continental shelf	12.6	24.5	0.2	2.6	122.2	0.0	194.3	14.2	0.9
Airspace[3]	1.1	0.0	0.0	0.1	4.3	0.0	1.3	5.3	0.0
Open sea[4]	0.4	0.0	0.0	0.2	8.8	0.0	0.2	1.0	0.1

[1]Process emissions calculated for road dust only. [2] Emissions from international sea traffic in Norwegian ports and international air traffic below 100 metres. [3]Domestic air transport. [4] Emissions from Norwegian fishing vessels outside the Norwegian Economic Zone.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E8 International emissions of CO_2 from energy use[1]. Million tonnes CO_2. Emissions per unit GDP and per capita

	1980	1985	1990	1995	1997	Per unit GDP 1997[2]	Per capita 1997
	Mill. tonnes					kg/1000 USD	tonnes per capita
Whole world	18 307	19 090	20 870	21 668	22 561	..	3.9
OECD	10 956	10 628	11 176	11 725	12 235	629	11.1
Norway	30	28	30	32	34	336	7.7
Denmark	63	62	53	59	62	560	11.8
Finland	60	52	54	56	64	712	12.5
Sweden	73	62	53	56	53	341	6.0
France	485	385	378	361	363	320	6.2
Italy	374	361	408	424	424	409	7.4
Netherlands	157	150	161	179	184	639	11.8
Portugal	26	27	41	51	52	443	5.2
United Kingdom	593	569	585	567	555	518	9.4
Switzerland	42	42	44	42	45	294	6.3
Germany	1 083	1 032	981	884	884	597	10.8
Canada	430	401	428	455	477	771	15.7
USA	4 785	4 634	4 873	5 199	5 470	773	20.4
Japan	917	907	1 062	1 149	1 173	448	9.3

[1]The figures for Norway according to these data from the OECD differ somewhat from more recent Norwegian calculations of emissions.
[2]GDP 1997 expressed in 1991 prices.
Source: OECD (1999).

Table E9 International emissions of SO_X[1]. Emissions per unit GDP and per capita

	1980	1985	1990	1995	1997	Per unit GDP 1997[2]	Per capita 1997
	1000 tonnes					kg/1000 USD	kg per capita
Norway	137	98	53	34	30	0.3	6.8
Denmark	454	363	217	150	109	1.0	20.7
Finland	584	382	260	96	100	1.1	19.5
Sweden	508	266	136	94	91	0.6	10.3
France	3 348	1 451	1 252	959	[3] 947	0.8	16.2
Italy	3 757	1 901	1 651	1 322	..	..	..
Netherlands	495	254	202	145	125	0.4	8.0
Portugal	266	199	344	359	..	..	..
United Kingdom	4 894	3 759	3 764	2 351	[3]2 028	1.9	34.5
Switzerland	116	76	43	34	33	0.2	4.6
Germany	..	..	5 321	2 118	1 468	1.0	17.9
Canada	4 643	3 178	3 305	2 805	2 691	4.4	88.9
USA	23 501	21 072	21 482	17 408	18 481	2.6	69.0
Japan	1 277	..	..	[4] 903	..	..	..

[1]The figures for Norway according to these data from the OECD differ somewhat from more recent Norwegian calculations of emissions.
[2]GDP 1997 expressed in 1991 prices. [3]GDP 1997 expressed in 1991 prices. [4]GDP 1997 expressed in 1991 prices.
Source: OECD (1999).

Table E10 International emissions of NO_X[1]. Emissions per unit GDP and per capita

	1980	1985	1990	1995	1997	Per unit GDP 1997[2]	Per capita 1997
	1000 tonnes					kg/1000 USD	kg per capita
Norway	188	210	218	212	222	2.2	50.4
Denmark	273	298	282	252	248	2.2	47.0
Finland	295	275	300	258	260	2.9	50.6
Sweden	448	..	388	354	337	2.2	38.1
France	1 646	1 400	1 886	1 729	[3]1 698	1.5	29.0
Italy	1 638	1 614	1 938	1 768	..	..	..
Netherlands	584	581	579	498	445	1.5	28.5
Portugal	165	..	309	373	..	..	..
United Kingdom	2 460	2 398	2 752	2 145	[3]2 060	1.9	35.0
Switzerland	170	179	166	136	129	0.8	18.0
Germany	..	..	2 709	2 007	1 803	1.2	22.0
Canada	1 959	2 044	2 106	1 999	[3]2 011	3.3	66.4
USA	22 558	21 302	21 258	21 561	21 394	3.0	79.9
Japan	1 622	1 322	1 476	[4]1 409	..	..	..

[1]The figures for Norway according to these data from the OECD differ somewhat from more recent Norwegian calculations of emissions.
[2]GDP 1997 expressed in 1991 prices. [3]1996 values. [4]1992 values.
Source: OECD (1999).

Table E11 Emissions to air of hazardous substances

	Pb	Cd	Hg	PAHs	Dioxins
	Tonnes	kg		Tonnes	Grammes
1990	186	1 690	1 671	158	130
1991	143	1 625	1 563	133	98
1992	126	1 615	1 412	134	96
1993	86	1 682	1 103	146	96
1994	23	1 225	1 165	145	94
1995	21	1 053	1 076	144	71
1996	9	1 093	1 104	149	50
1997	9	1 120	1 121	157	43
1998	9	1 176	1 086	147	35
1999	8	1 014	1 144	139	40
2000*	6	746	960	137	34

Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table E12 Emissions to air of hazardous substances[1] by source. 2000*

	Pb	Cd	Hg	PAH-total	Dioxins
	Tonnes	kg	kg	Tonnes	Grammes
Total	**6.5**	**745.7**	**960.1**	**137.3**	**34.1**
Stationary combustion	1.1	384.8	457.9	53.0	21.0
Process emissions	3.4	311.9	349.4	74.5	7.8
Mobile combustion	2.0	49.1	152.7	9.7	5.3
Stationary combustion					
Total	**1.1**	**384.8**	**457.9**	**53.0**	**21.0**
Oil and gas extraction	0.0	9.5	12.1	0.4	0.9
Natural gas	0.0	6.1	3.6	0.1	0.2
Flaring	0.0	1.4	0.8	0.2	0.2
Diesel combustion	0.0	1.5	7.4	0.2	0.6
Gas terminals	0.0	0.5	0.3	0.0	0.0
Manufacturing and mining	0.6	198.6	215.6	0.4	5.1
Refining	0.0	0.8	1.6	0.0	0.0
Manufacture of pulp and paper	0.3	130.2	136.4	0.2	4.6
Manufacture of mineral products	0.1	6.9	4.8	0.0	0.1
Manufacture of chemicals	0.1	5.8	10.6	0.0	0.1
Manufacture of metals	0.0	2.5	0.8	0.0	0.0
Other manufacturing	0.1	52.5	61.4	0.1	0.5
Other industries	0.0	22.8	14.5	5.5	3.2
Dwellings	0.1	121.1	128.5	45.8	9.3
Incineration of waste and landfill gas	0.4	32.8	87.2	0.8	2.4
Process emissions					
Total	**3.4**	**311.9**	**349.4**	**74.5**	**7.8**
Oil and gas extraction	-	-	-	-	-
Venting, leaks, etc.	-	-	-	-	-
Oil loading at sea	-	-	-	-	-
Oil loading, on shore	-	-	-	-	-
Gas terminals	-	-	-	-	-
Manufacturing and mining	3.3	270.6	305.1	61.4	7.8
Refining	-	-	-	-	-
Manufacture of pulp and paper	-	-	-	-	-
Manufacture of chemicals	0.4	63.9	3.9	2.0	0.0
Manufacture of mineral products	0.3	14.7	35.9	-	0.1
Manufacture of metals	2.6	191.8	265.2	59.3	7.6
Iron, steel and ferro-alloys	2.0	84.2	253.4	1.4	5.2
Aluminium	0.6	42.6	4.2	56.0	1.1
Other metals	0.0	65.0	7.6	1.9	1.3
Other manufacturing	-	-	-	0.0	0.1
Petrol distribution	-	-	-	-	-
Agriculture	-	-	-	-	-
Landfill gas	-	-	-	-	-
Solvents	-	-	-	12.8	-
Road dust	0.1	41.2	2.3	0.4	-
Use of products	-	-	42.0	-	-
Other process emissions	0.0	0.0	0.1	-	0.0

Tabell E12 (cont.). Emissions to air of hazardous substances[1] by source. 2000*

	Pb	Cd	Hg	PAH-total	Dioxins
	Tonnes	kg	kg	Tonnes	Grammes
Mobile combustion					
Total	**2.0**	**49.1**	**152.7**	**9.7**	**5.3**
Road traffic	0.2	28.7	65.5	6.7	0.3
Petrol engines	0.0	15.3	-	1.5	0.2
Passenger cars	0.0	13.4	-	1.3	0.1
Other light vehicles	0.0	1.8	-	0.2	0.0
Heavy vehicles	0.0	0.1	-	0.0	0.0
Diesel engines	0.1	13.1	65.5	5.1	0.1
Passenger cars	0.0	1.5	7.5	0.7	0.0
Other light vehicles	0.0	3.6	17.8	1.6	0.0
Heavy vehicles	0.1	8.1	40.3	2.9	0.1
Motorcycles, mopeds	0.0	0.3	-	0.1	0.0
Motorcycles	0.0	0.2	-	0.0	0.0
Mopeds	0.0	0.1	-	0.0	0.0
Snow scooters	0.0	0.0	-	0.0	0.0
Small boats	0.0	0.5	0.7	0.1	0.0
Motorized equipment	0.0	2.4	11.1	0.8	0.0
Railways	0.0	0.2	0.8	0.1	0.0
Air traffic	1.6	3.5	10.4	0.1	0.0
Domestic < 1000 m	0.3	1.2	3.5	0.1	0.0
Domestic > 1000 m	1.3	2.3	6.9	0.1	0.0
Shipping	0.1	13.8	64.2	2.0	5.0
Coastal traffic, etc.	0.1	8.1	35.8	1.1	2.7
Fishing vessels	0.0	4.7	23.1	0.7	1.9
Mobile oil rigs, etc.	0.0	1.1	5.3	0.2	0.4

[1]Does not include international sea and air traffic.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Waste

Appendix F

Table F1 Waste in Norway. 1993-2000. 1000 tonnes

	Total	Paper, cardboard and pasteboard	Metals	Plastic	Glass	Wood waste	Textiles	Biodegradable waste	Concrete	Other	Hazardous
1990	..	..	..	271	..	1 263	82	..	..	..	610
1991	..	..	..	295	..	1 160	83	..	..	..	613
1992	..	1 049	1 223	285	..	1 092	83	..	..	..	617
1993	7 386	1 055	1 301	324	158	1 105	87	878	610	1 247	621
1994	7 407	1 040	1 348	339	157	1 095	90	906	638	1 156	640
1995	7 451	1 011	1 370	351	159	1 103	94	964	661	1 109	628
1996	7 529	1 032	1 498	366	155	1 068	99	1 005	665	1 032	608
1997	7 887	1 120	1 523	367	148	1 037	103	1 057	726	1 211	596
1998	8 265	1 131	1 541	380	145	1 038	108	1 076	751	1 386	709
1999	8 291	1 102	1 554	381	146	990	109	1 091	735	1 553	631
2000	8 517	1 334	1 563	376	146	1 000	110	1 102	715	1 540	631
By product type, 2000											
Buildings and building products	940	2	18	51	51	143	..	.	618	58	..
Electrical and electronic equipment	169	.	113	40	10	2	..	.	3	..	..
Packaging	709	379	35	132	46	110	6	.	..	..	..
Clothing, footwear and other textile products	45	.	..	.	.	..	45	.	.	..	..
Food	566	.	.	.	.	.	.	566	.	.	.
Furniture and household products	343	91	49	82	15	81	26	.	..	..	..
Park and garden waste	94	.	.	.	.	.	.	94	.	.	.
Ships and large constructions	..	..	..	..	..	..	..	.	..	..	..
Means of transport excl. ships	267	..	218	14	4	2	2	.	..	28	..
Printed matter	642	642	..	..	..	..	..	.	..	..	..
Other	2 174	84	1 002	46	7	11	29	.	21	343	631
Residues from manufacturing	2 569	135	128	11	13	651	3	443	73	1 111	..
By industry, 2000											
Households	1 560	466	152	178	54	29	88	471	3	112	6
Agriculture, forestry and fishing	97	4	..	..	..	..	5	86	..	..	1
Mining and quarrying	126	3	..	..	..	..	..	..	..	37	86
Manufacturing	3 339	169	193	46	13	690	6	445	178	1 193	406
Electricity, gas and water supply	21	2	..	..	..	..	..	..	..	15	3
Construction	752	22	49	7	46	129	..	1	494	..	4
Service industries	897	319	96	128	19	47	11	78	..	155	44
Other or unspecified	1 725	348	1 073	17	13	106	..	20	40	28	80
By treatment/disposal, 2000											
Material recovery	2 276	514	693	21	39	226	10	502	150	120	..
Composting	352	..	.	..	.	80	..	189	.	82	.
Energy recovery	842	114	..	56	.	378	18	132	.	143	..
Incineration without energy recovery	121	51	..	6	.	8	7	50	.	..	..
Landfill	1 627	613	..	280	107	202	76	219	..	131	..
Other or unspecified	3 299	42	869	12	-	106	-	10	565	1 065	631

Source: Waste statistics from Statistics Norway.

Table F2 Hazardous waste generation in Norway. By type and sector of origin. Tonnes. 1999

Material	Total	By sector: Agriculture and forestry	Fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Construction	Service industries	Waste management	Households	Unknown sector	Unknown[2]
Total	**630 960**	**345**	**683**	**85 987**	**406 032**	**3 432**	**3 640**	**44 370**	**16 404**	**6 357**	**63 710**	**50 310**
Waste containing oil	162 576	331	675	55 653	27 473	874	2 538	35 072	3 403	3 157	33 400	33 400
Waste containing solvents	18 485	7	3	1 376	6 376	63	168	2 049	30	2 612	5 800	5 800
Waste containing heavy metals	155 324	0	1	1 123	122 856	2 438	673	1 208	12 558	65	14 400	1 100
Corrosive waste	240 853	1	1	74	239 822	4	6	270	9	327	340	340
Photochemicals	5 156	1	-	3	1 384	0	3	2 070	50	44	1 600	1 600
Contaminated waste water	29 963	-	-	26 753	310	-	-	2 829	71	-	-	-
Other organic hazardous waste[1]	14 945	4	2	407	6 872	47	38	445	121	109	6 900	6 800
Other inorganic hazardous waste	1 871	-	0	34	156	2	203	186	89	-	1 200	1 200
Unclassified hazardous waste	1 787	0	-	563	782	2	11	242	73	44	70	70

[1]Uncontaminated concrete attached to concrete containing PCBs is defined as hazardous waste if the two cannot be separated. Uncontaminated concrete is not included in the figures. Frames from insulating windows containing PCBs are treated as hazardous waste, but not defined as such, and are not included in the figures. [2] Of total dealt with outside proper channels.
Source: Waste statistics from Statistics Norway.

Table F3 Quantities of household waste. Total and separated for recovery[1]

	Total (kg per capita)	For recovery (kg per capita)	Total (1000 tonnes)	For recovery (1000 tonnes)	Percentage for recovery
1974	174	..	693	..	..
1985	200	..	831	..	..
1992	235	20	1 012	86	9
1995	269	49	1 174	213	18
1996	272	60	1 195	260	22
1997	287	83	1 259	366	29
1998	308	102	1 365	453	33
1999	314	118	1 397	524	38
2000	324	130	1 452	581	40
2001	334	149	1 507	668	44
2001 by material					
Paper and cardboard	117	53	529	237	
Glass	11	7	49	33	
Plastic	25	1	114	4	
Metals	20	7	91	33	
EEE waste	..	5	..	23	
Wet organic waste	84	29	378	131	
Wood waste	27	18	121	79	
Textiles	16	2	73	8	
Hazardous waste	..	2	..	9	
Other	34	25	153	112	

[1]The figures have been adjusted downwards to correct for the intermixture of waste from industrial sectors.
Source: Waste statistics from Statistics Norway and Heie (1998).

Table F4 Household waste, by recovery or disposal. 1992-2001. 1000 tonnes

	Total	Separated for recovery	Landfilled	Incinerated	Other	Per cent final disposal[1]
1992	1 012	86	657	269	0	74
1995	1 174	213	648	314	0	62
1998	1 365	453	592	320	0	50
2000	1 454	581	467	406	0	40
2001	1 507	668	382	445	11	33

[1] Final disposal means landfilling or incineration without energy recovery. Calculated from an average energy recovery rate of 73 per cent at Norwegian waste incineration plants.
Source: Waste statistics from Statistics Norway.

Table F5 Manufacturing waste by material. 1000 tonnes

	1993	1996	1999
Total	**3 288**	**3 132**	**3 547**
Hazardous waste	320	401	432
Production and consumer waste	2 967	2 731	3 115
Waste category			
Paper and board	207	173	173
Plastic	34	53	45
EPS-products	.	1	2
Glass	55	19	15
Iron and other metals	180	253	200
Textiles	16	5	6
Food and organic waste	447	426	451
Tyres	0	4	2
Other rubber	1	2	3
Wood waste	879	839	671
Park and garden waste	.	6	1
Soil, gravel, etc.	.	.	169
Concrete and bricks	143	224	166
Asphalt	.	4	4
Ash	18	25	36
Dust	74	34	61
Sludge; dry matter	250	170	237
Slag	272	331	653
Chemicals	19	5	17
Other	214	70	77
Mixed and unknown waste	158	88	124

Source: Waste statistics from Statistics Norway.

Table F6 Waste from service industries in Norway. By NACE group and material. 1999. Tonnes

NACE group	Total[1]	Mixed waste	EEE waste	Glass	Plastic	Soil, gravel etc.	Paper	Metals	Wood	Biodegradables	Hazardous
Total	766 902	332 979	5 599	21 043	1 247	520	281 155	11 223	31 287	77 168	4 681
50	53 778	29 597	34	28	1	5	17 821	2 734	1 334	250	1 976
51	82 812	33 508	58	4 317	396	63	28 388	5 908	9 230	705	240
52	245 162	107 808	98	1 562	244	196	66 254	285	3 060	65 546	108
Of which 52.11	119 076	45 380	0	209	101	0	34 779	50	145	38 384	29
55	29 091	10 697	0	3 409	1	166	5 849	17	4	8 934	13
61-63	68 427	30 000	2	10 721	234	0	19 154	470	7 031	0	815
64-74	101 596	46 624	122	748	372	90	45 235	1 436	6 567	254	148
75-93	186 037	74 745	5 285	258	0	0	98 453	373	4 061	1 480	1 381

[1]The figures differ from table F1 mainly because end-of-life vehicles are omitted from table F6 and waste is better distributed by material in table F1.
Source: Waste statistics from Statistics Norway.

Water resources and water pollution

Appendix G

Table G1 Water sources, number of water works and number of people supplied. By county. 2001

	Total		Lake[1]		River/stream		Ground water	
	Number of water works[3]	Number of people	Number of water works	Number of people	Number of water works	Number of people	Number of water works	Number of people
Whole country[3]	**1 569**	**3 988 034**	**630**	**3 218 929**	**391**	**370 668**	**550**	**399 937**
01 Østfold	24	241 152	13	164 367	4	56 023	7	20 762
02 Akershus	32	410 395	19	285 533	3	116 581	10	8 281
03 Oslo	1	514 000	1	514 000	-	-	-	-
04 Hedmark	98	145 277	11	67 333	8	1 545	79	76 399
05 Oppland	77	122 591	20	65 363	7	3 180	50	54 048
06 Buskerud	67	223 202	17	147 743	2	2 620	48	72 839
07 Vestfold	39	194 064	13	187 332	-	-	26	6 732
08 Telemark	63	141 858	24	110 666	3	12 693	36	18 499
09 Aust-Agder	34	82 190	18	73 158	7	3 669	9	5 363
10 Vest-Agder	40	133 294	15	113 285	5	1 086	20	18 923
11 Rogaland	50	346 371	35	338 520	5	2 630	10	5 221
12 Hordaland	164	367 002	91	319 028	35	28 535	38	19 439
14 Sogn og Fjordane	106	78 590	43	51 787	37	15 042	26	11 761
15 Møre og Romsdal	158	220 938	57	167 855	58	31 735	43	21 348
16 Sør-Trøndelag	117	248 097	55	222 840	16	3 737	46	21 520
17 Nord-Trøndelag	76	105 971	41	96 889	6	1 225	29	7 857
18 Nordland	214	212 629	90	164 564	88	42 028	36	6 037
19 Troms	124	132 469	30	97 432	78	29 295	16	5 742
20 Finnmark	85	67 944	36	30 034	28	18 744	21	19 166
21 Svalbard[2]			1	1 200	1	300	-	-

[1]Including 3 waterworks supplying 250 persons from sea water in Nordland county. [2]One waterworks in Svalbard has two main water sources of different types. [3]The table contains information from 1557 water works. As some water works use several sources of water of different types, the total figure given in the table is higher than 1557.
Source: Norwegian Institute of Public Health.

Table G2 Number of municipal waste water treatment plants. By county. 2000

County/region	Total[1]	Direct discharges	Mechanical	Chemical	Biological	Chemical/ biological	Other treatment	Individual treatment plants
Total 1997	**2 811**	**551**	**1 169**	**233**	**125**	**320**	**413**	**331 820**
Total 1998	**3 269**	**507**	**1 534**	**254**	**117**	**333**	**507**	**346 365**
Total 1999	**3 415**	**544**	**1 634**	**251**	**125**	**323**	**538**	**351 750**
Total 2000	**3 452**	**570**	**1 653**	**252**	**124**	**323**	**530**	**317 946**
North Sea counties (1-10)	916	3	69	202	28	246	368	138 749
Rest of country (11-20)	2 536	567	1 584	50	96	77	162	179 197
01 Østfold	57	1	8	12	3	24	9	13 731
02 Akershus	52	-	-	29	2	19	2	20 412
03 Oslo	9	-	-	-	1	2	6	631
04 Hedmark	130	-	-	26	2	39	63	30 329
05 Oppland	218	-	6	21	-	76	115	12 828
06 Buskerud	188	-	6	46	1	23	112	20 064
07 Vestfold	34	-	2	10	-	20	2	14 647
08 Telemark	108	-	9	30	12	18	39	11 055
09 Aust-Agder	50	-	12	16	2	11	9	6 447
10 Vest-Agder	70	2	26	12	5	14	11	8 605
11 Rogaland	291	5	237	15	10	3	21	14 219
12 Hordaland	361	25	293	5	9	16	13	40 132
14 Sogn og Fjordane	244	49	143	3	11	7	31	16 100
15 Møre og Romsdal	571	261	287	1	4	2	16	24 955
16 Sør-Trøndelag	124	8	56	6	18	15	21	20 104
17 Nord-Trøndelag	158	3	89	9	22	21	14	12 135
18 Nordland	452	46	354	6	15	3	28	27 088
19 Troms	171	64	87	2	6	5	7	19 834
20 Finnmark	164	106	38	3	1	5	11	4 630

[1]Individual treatment plants are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table G3 Hydraulic capacity of waste water treatment plants. 1000 PE. By county. 2000

County/region	Total	Direct discharges	Mechanical	Chemical	Biological	Chemical/ biological	Other treatment
Total 1993	**[1]4 837**	**..**	**1 282**	**2 685**	**61**	**752**	**49**
Total 1995	**[1]5 219**	**..**	**1 318**	**3 326**	**70**	**411**	**68**
Total 1997	**5 801**	**576**	**1 358**	**2 568**	**95**	**1 115**	**89**
Total 1999	**6 250**	**541**	**1 744**	**2 189**	**72**	**1 575**	**129**
Total 2000	**6 256**	**541**	**1 750**	**2 194**	**71**	**1 574**	**127**
North Sea counties (1-10)	3 439	15	181	1 654	38	1 476	76
Rest of country (11-20)	2 817	526	1 569	540	34	97	51
01 Østfold	354	-	1	329	1	23	1
02 Akershus	1 019	-	-	270	0	748	0
03 Oslo	351	-	-	-	0	350	1
04 Hedmark	220	-	-	85	1	108	25
05 Oppland	276	-	1	85	-	173	17
06 Buskerud	327	-	1	275	0	30	21
07 Vestfold	267	-	43	210	-	14	0
08 Telemark	251	-	6	214	12	13	6
09 Aust-Agder	152	-	85	34	22	8	3
10 Vest-Agder	224	15	44	153	2	8	2
11 Rogaland	553	12	233	283	2	1	21
12 Hordaland	525	36	393	67	3	25	1
14 Sogn og Fjordane	126	27	87	0	4	5	3
15 Møre og Romsdal	395	167	201	20	1	3	3
16 Sør-Trøndelag	390	17	207	138	4	20	3
17 Nord-Trøndelag	171	2	117	22	11	14	4
18 Nordland	331	110	206	3	7	2	3
19 Troms	214	84	99	5	1	16	10
20 Finnmark	115	70	28	2	0	11	3

[1]Direct discharges are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table G4 Number of people connected to different types of treatment plants. By county. 2000[1]

County/region	Total[2]	Direct discharges	Mecha- nical	Chemical	Biological	Chemical/ biological	Other treatment	Individual treatment plants	Proportion connected to the sewage system[2]
Total 1997	**3 302 338**	..	..	..	..	..	..	**881 691**	**79**
Total 1998	**3 514 590**	..	..	..	..	..	..	**912 966**	**79**
Total 1999	**3 561 353**	..	..	..	..	..	..	**895 272**	**80**
Total 2000	**3 580 550**	**262 520**	**964 285**	**1 331 811**	**40 049**	**957 686**	**24 200**	**892 796**	**80**
North Sea counties (1-10)	2 067 270	6 199	101 919	1 018 176	19 667	910 466	10 843	403 152	84
Rest of country (11-20)	1 513 280	256 321	862 366	313 636	20 382	47 219	13 357	489 644	75
01 Østfold	212 290	-	20	199 723	111	12 258	177	35 050	86
02 Akershus	414 761	-	-	212 946	92	201 353	370	51 326	89
03 Oslo	507 467	-	-	-	-	507 467	-	1 578	100
04 Hedmark	123 954	-	-	51 598	488	68 023	3 844	75 145	66
05 Oppland	109 396	-	143	26 990	-	80 548	1 715	53 532	60
06 Buskerud	188 005	-	142	164 815	255	20 641	2 152	50 761	79
07 Vestfold	181 202	-	26 303	145 649	-	9 080	170	41 793	85
08 Telemark	127 333	-	783	117 717	4 891	3 628	314	34 133	77
09 Aust-Agder	76 628	-	44 086	14 037	13 269	4 262	973	23 419	75
10 Vest-Agder	126 234	6 199	30 442	84 700	559	3 205	1 128	36 415	81
11 Rogaland	311 740	6 741	116 244	185 124	1 381	441	1 808	45 594	84
12 Hordaland	324 136	27 762	238 610	44 133	1 495	11 429	708	110 555	74
14 Sogn og Fjordane	61 602	15 735	41 011	126	2 786	1 482	462	40 792	57
15 Møre og Romsdal	175 023	78 366	82 807	10 877	346	849	1 778	66 307	72
16 Sør-Trøndelag	210 051	9 237	129 293	53 940	2 406	13 389	1 786	51 180	80
17 Nord-Trøndelag	93 077	1 777	57 090	16 325	7 152	10 040	693	32 878	73
18 Nordland	172 707	35 711	130 284	847	4 318	880	667	72 617	72
19 Troms	104 324	39 015	53 874	2 206	498	5 678	3 054	55 365	69
20 Finnmark	60 620	41 977	13 153	57	-	3 032	2 401	14 358	82

[1]The reported number of people connected to the sewage system may differ slightly from the official population statistics. [2] People connected to individual treatment plants are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table G5 Discharges of phosphorus by county and treatment method. 2000. Tonnes

County/region	Total	Direct dis-charges	Mecha-nical	Chemi-cal	Biolo-gical	Chemical/ biological	Other treat-ment	Individual treatment plants	Discharges per inhabitant, kg	Average treatment efficiency[1] Per cent
Total 1993	[1,2] **534**	..	..	..	..	..	..	..	..	..
Total 1995	[1,2] **601**	..	..	..	..	..	..	..	..	..
Total 1997	[1,2] **570**	..	..	..	..	..	..	..	..	..
Total 1999	[1] **836**	..	..	..	..	..	..	..	..	..
Total 2000	**1 175.8**	**197.8**	**481.6**	**86.7**	**9.7**	**45.1**	**4.6**	**350.4**	**0.26**	**66.8**
North Sea counties (1-10)	264.1	5.7	27.8	54.9	3.6	40.5	2.5	129.0	0.11	90.7
Rest of country (11-20)	911.7	192.1	453.8	31.8	6.1	4.5	2.1	221.4	0.45	36.6
01 Østfold	33.7	-	0.0	17.1	0.1	0.5	0.1	15.8	0.14	85.0
02 Akershus	40.9	-	-	6.1	0.1	14.3	0.1	20.4	0.09	96.1
03 Oslo	20.7	-	-	-	0.0	20.0	0.2	0.6	0.04	85.7
04 Hedmark	23.1	-	-	3.2	0.2	2.0	0.1	17.6	0.12	94.3
05 Oppland	17.7	-	0.1	2.4	-	2.4	0.8	11.9	0.09	93.7
06 Buskerud	22.1	-	0.2	6.7	0.1	0.5	0.9	13.7	0.09	93.5
07 Vestfold	34.5	-	7.5	7.5	-	0.4	0.0	19.1	0.16	83.6
08 Telemark	21.4	-	0.4	7.2	1.4	0.2	0.1	12.2	0.13	88.4
09 Aust-Agder	23.0	-	13.7	0.4	1.6	0.1	0.1	7.1	0.22	64.0
10 Vest-Agder	27.1	5.7	5.9	4.3	0.2	0.1	0.2	10.7	0.17	78.1
11 Rogaland	98.4	3.9	56.2	16.9	0.5	0.0	0.3	20.6	0.26	57.0
12 Hordaland	214.2	20.8	137.3	5.3	0.6	0.3	0.1	49.9	0.49	30.2
14 Sogn og Fjordane	54.3	11.2	27.4	0.0	0.9	0.1	0.2	14.6	0.50	23.1
15 Møre og Romsdal	143.2	60.1	48.1	1.0	0.2	0.0	0.3	33.6	0.59	26.7
16 Sør-Trøndelag	80.5	6.8	46.7	3.9	0.9	1.7	0.3	20.3	0.31	59.2
17 Nord-Trøndelag	51.5	1.0	29.1	3.7	1.0	1.3	0.2	15.2	0.41	51.9
18 Nordland	125.9	25.9	61.7	1.0	1.7	0.1	0.3	35.3	0.53	22.6
19 Troms	96.5	30.0	38.6	0.0	0.1	0.5	0.1	27.2	0.64	13.8
20 Finnmark	47.2	32.5	8.6	0.0	0.0	0.5	0.5	5.0	0.64	16.7

[1]Discharges from individual treatment plants are not included. [2]Direct discharges are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table G6 Discharges of nitrogen by county and treatment method. 2000. Tonnes

County/region	Total	Direct dis-charges	Mecha-nical	Chemical	Biolo-gical	Chemical/ biological	Other treat-ment	Individual treatment plants	Dis-charges per in-habitant, kg	Average treat-ment effi-ciency[1] Per cent
Total 1998	[1]**13 554**	..	..	..	..	..	..	..	..	..
Total 1999	[1]**13 492**	..	..	..	..	..	..	..	..	..
Total 2000	**16 504.5**	**1 478.0**	**3 823.8**	**4 921.3**	**126.2**	**2 685.8**	**156.2**	**3 313.1**	**3.68**	**27.7**
North Sea counties (1-10)	8 145.2	37.6	291.7	3 785.5	53.3	2 495.3	95.0	1 386.9	3.30	34.2
Rest of country (11-20)	8 359.3	1 440.4	3 532.2	1 135.8	73.0	190.6	61.2	1 926.2	4.15	19.5
01 Østfold	906.5	0.2	0.1	727.0	0.9	60.1	1.9	116.4	3.65	19.2
02 Akershus	1 849.4	-	-	828.4	0.5	829.5	1.3	189.7	3.96	53.8
03 Oslo	915.4	-	-	-	0.1	905.3	4.0	6.1	1.80	27.6
04 Hedmark	750.1	-	-	187.5	1.7	285.5	30.9	244.4	4.01	25.1
05 Oppland	648.0	-	0.8	165.9	-	282.0	20.0	179.3	3.55	34.9
06 Buskerud	822.1	-	1.6	563.6	0.9	59.6	24.3	172.1	3.47	19.6
07 Vestfold	772.4	-	86.8	498.5	0.1	31.2	0.6	155.2	3.63	15.7
08 Telemark	620.0	-	2.9	449.8	23.1	16.6	2.4	125.1	3.76	14.2
09 Aust-Agder	328.0	-	139.1	60.2	24.5	14.5	5.1	84.6	3.21	40.7
10 Vest-Agder	533.2	37.4	60.3	304.5	1.5	11.0	4.6	113.9	3.42	17.3
11 Rogaland	1 168.1	29.1	421.6	526.0	5.2	2.1	6.6	177.5	3.13	21.8
12 Hordaland	1 884.8	156.0	1 029.9	210.7	5.5	47.1	1.8	433.8	4.33	22.2
14 Sogn og Fjordane	460.7	83.8	198.4	0.7	11.8	6.3	4.4	155.3	4.28	19.2
15 Møre og Romsdal	1 137.4	450.4	360.7	45.6	1.4	3.3	6.5	269.5	4.68	13.4
16 Sør-Trøndelag	1 111.9	51.1	523.6	276.3	9.7	53.5	6.8	190.9	4.23	22.4
17 Nord-Trøndelag	480.3	7.8	230.1	59.2	23.5	30.7	4.0	125.0	3.78	23.5
18 Nordland	980.9	194.0	468.5	2.9	13.1	3.3	6.0	293.1	4.10	19.2
19 Troms	735.6	224.8	233.1	10.2	2.3	25.4	14.3	225.6	4.87	15.4
20 Finnmark	399.6	243.5	66.4	4.3	0.4	18.9	10.8	55.3	5.40	8.0

[1]Discharges from individual treatment plants are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table G7 Disposal of sewage sludge. By county. 2000. Tonnes dry weight.

County/region	Total	Cover on landfills	Agriculture	Parks and green spaces	Other use
Total 1993	**70 250**	**..**	**39 900**	**8 880**	**..**
Total 1995	**75 810**	**..**	**44 630**	**6 270**	**..**
Total 1997	**87 900**	**..**	**48 100**	**8 730**	**..**
Total 1999	**103 900**	**..**	**61 301**	**10 390**	**..**
Total 2000	**104 923**	**16 456**	**58 948**	**11 430**	**18 089**
01 Østfold	12 364	4 536	5 650	2 105	73
02 Akershus	26 720	229	20 075	833	5 583
03 Oslo	18 550	-	16 640	1 910	-
04 Hedmark	2 916	1 283	1 336	187	110
05 Oppland	4 825	2 522	36	32	2 235
06 Buskerud	8 259	1 064	4 186	2 829	180
07 Vestfold	8 707	-	7 539	291	877
08 Telemark	3 533	247	2 075	736	475
09 Aust-Agder	1 969	1 762	-	-	207
10 Vest-Agder	3 933	-	-	500	3 433
11 Rogaland	2 999	1 782	-	20	1 197
12 Hordaland	350	9	-	-	341
14 Sogn og Fjordane	709	588	106	15	-
15 Møre og Romsdal	1 577	780	-	350	447
16 Sør-Trøndelag	3 785	531	692	1 353	1 209
17 Nord-Trøndelag	1 537	805	476	256	-
18 Nordland	1 875	121	106	-	1 648
19 Troms	92	38	31	13	10
20 Finnmark	223	159	-	-	64

Source: Waste water treatment statistics from Statistics Norway.

Table G8 Principal economic figures for the municipal wastewater sector. County. 2000

	Invest-ments	Annual costs	Fees collected	Income-to-cost ratio[1]	Number of subscribers	Invest-ment per subscriber[1]	Annual cost per subscriber[1]	Fees collec-ted per subscriber[1]
	Mill. NOK			Per cent	Number	NOK per subscriber		
Whole country (01-20)	**1 760**	**4 007**	**4 024**	**100**	**1 621 859**	**1 085**	**2 471**	**2 481**
North Sea counties (01-10)	1 046	2 570	2 587	101	914 184	1 144	2 811	2 830
Rest of country (11-20)	714	1 437	1 437	100	707 674	1 009	2 031	2 031
01 Østfold	150	281	287	102	93 273	1 606	3 013	3 074
02 Akershus	162	477	476	100	167 274	971	2 851	2 843
03 Oslo	181	498	574	115	262 489	689	1 898	2 185
04 Hedmark	57	185	177	96	59 600	950	3 104	2 977
05 Oppland	88	212	197	93	57 412	1 528	3 693	3 428
06 Buskerud	113	252	240	95	70 505	1 606	3 580	3 408
07 Vestfold	124	228	214	94	73 681	1 682	3 092	2 905
08 Telemark	50	171	163	96	51 325	971	3 324	3 185
09 Aust-Agder	71	107	116	108	31 374	2 257	3 395	3 683
10 Vest-Agder	51	159	144	90	47 252	1 075	3 371	3 039
11 Rogaland	142	297	295	99	152 510	928	1 946	1 933
12 Hordaland	126	343	347	101	157 214	801	2 181	2 207
14 Sogn og Fjordane	24	63	56	88	26 568	898	2 377	2 094
15 Møre og Romsdal	87	142	145	102	76 022	1 144	1 873	1 908
16 Sør-Trøndelag	107	174	184	106	106 982	999	1 622	1 722
17 Nord-Trøndelag	68	116	107	93	42 941	1 582	2 694	2 497
18 Nordland	76	150	137	91	66 068	1 157	2 265	2 069
19 Troms	55	105	124	118	52 175	1 057	2 015	2 374
20 Finnmark	29	48	43	89	27 195	1 065	1 759	1 571

[1]In calculating mean value for the county as a whole, municipalities are weighted according to their fee income and annual costs.
Source: Environmental protection expenditure statistics from Statistics Norway.

Table G9 Investments in the municipal waste water sector, by type. County. 1993-2000

	2000			Total 1993-2000		
		Type of investment			Type of investment	
	Total	Sewage system (pipes)	Treatment plants	Total	Sewage system (pipes)	Treatment plants
	Million NOK			Million 2000-NOK		
Whole country (01-20)	**1 760**	**1 266**	**494**	**14 358**	**10 807**	**3 551**
North Sea counties (01-10)	1 046	718	328	8 269	6 024	2 245
Rest of country (11-20)	714	548	166	6 089	4 783	1 306
01 Østfold	103 299	144	6	1 113	1 051	62
02 Akershus	189 164	151	12	1 196	1 091	105
03 Oslo	255 904	77	104	1 304	630	674
04 Hedmark	55 466	52	5	533	424	109
05 Oppland	69 193	60	28	843	529	313
06 Buskerud	58 800	65	49	882	609	273
07 Vestfold	134 551	55	69	755	492	263
08 Telemark	67 011	43	6	575	461	114
09 Aust-Agder	60 140	31	40	444	312	132
10 Vest-Agder	92 424	41	10	625	424	201
11 Rogaland	126 095	133	9	951	918	33
12 Hordaland	191 928	101	25	1 696	1 259	437
14 Sogn og Fjordane	29 983	15	9	203	155	49
15 Møre og Romsdal	77 694	64	23	611	478	133
16 Sør-Trøndelag	99 917	46	60	802	536	266
17 Nord-Trøndelag	107 185	49	19	504	331	173
18 Nordland	111 598	69	8	723	601	122
19 Troms	71 912	46	9	452	376	75
20 Finnmark	21 437	25	4	147	129	18

Source: Environmental protection expenditure statistics from Statistics Norway.

Table G10 Average fees[1] for a standard dwelling[2]. County. 1995, 1998 and 2001. NOK

	Connection fee			Annual fee for a standard dwelling			Fee per m^3		
	1995	1998	2001	1995	1998	2001	1995	1998	2001
Whole country (01-20)	**10 661**	**11 668**	**13 046**	**1463**	**1765**	**2 176**	**5.92**	**7.63**	**9.58**
North Sea counties (01-10)	13 550	14 776	16 862	2 021	2 343	2 873	8.44	10.58	13.32
Rest of country (11-20)	8 730	9 781	10 526	1 116	1 389	1 744	4.16	5.42	6.86
01 Østfold	7 450	8 248	9 953	1 979	2 576	3 138	11.10	13.88	16.99
02 Akershus	17 192	25 809	26 670	2 195	2 410	2 928	9.62	11.06	14.34
03 Oslo	3 570	26 117	32 893	1 080	1 877	2 065	6.05	9.64	10.61
04 Hedmark	13 315	19 147	18 256	2 485	2 449	3 096	9.96	13.65	16.77
05 Oppland	18 151	22 853	22 744	2 085	2 447	2 932	8.48	10.66	13.24
06 Buskerud	11 780	9 642	12 475	2 462	2 316	2 968	8.43	10.16	13.78
07 Vestfold	16 618	20 286	21 634	1 496	2 023	2 548	6.83	8.08	9.69
08 Telemark	8 058	6 146	6 951	2 002	2 567	2 706	7.99	9.99	11.65
09 Aust-Agder	12 372	12 204	14 082	1 692	2 041	2 789	6.39	8.23	10.07
10 Vest-Agder	15 512	12 371	13 498	1 596	2 094	2 646	5.60	7.46	10.50
11 Rogaland	10 951	11 024	13 206	944	1 281	1 550	3.27	4.67	6.13
12 Hordaland	8 495	11 132	12 224	990	1 284	1 671	3.29	4.84	5.94
14 Sogn og Fjordane	11 556	11 954	12 073	1 179	1 460	1 881	4.08	5.38	7.60
15 Møre og Romsdal	8 926	9 247	10 893	1 025	1 299	1 529	3.93	5.08	6.37
16 Sør-Trøndelag	11 810	13 074	13 617	1 390	1 664	2 048	4.91	6.91	7.39
17 Nord-Trøndelag	7 588	10 734	12 193	1 690	1 953	2 542	5.52	7.36	10.41
18 Nordland	5 898	7 837	7 650	951	1 324	1 619	6.03	6.14	6.92
19 Troms	4 198	4 573	4 852	848	1 101	1 475	2.95	3.98	5.44
20 Finnmark	12 588	9 239	9 070	1 309	1 261	1 620	2.86	4.22	5.93

[1]In calculating mean value for the county as a whole, municipalities are weighted according to their fee income and annual costs. [2]The fees for the years 1995 and 1998 are reported for a standard dwelling of 140 m^2. For 2001 the fees are reported for a stand and dwelling of 120 m^2.
Source: Environmental protection expenditure statistics from Statistics Norway.

Land use

Appendix H

Table H1 Urban settlements with more than 20 000 inhabitants. 1 January 2002

	Population	Inhabitants per km²	Total urban settlement area km²	Percentage urban settle-ment area built on	Percentage urban settle-ment area covered by roads	Percentage change urban settlement population 2000-2002	Percentage change urban settlement area 2000-2002
All urban settlements in Norway	3 474 623	1 584	2 193.2	9.5	14.9	2.3	2.5
Oslo	783 829	2 871	273.0	11.8	14.5	1.3	1.5
Bergen	209 375	2 387	87.7	10.6	17.4	1.8	1.9
Stavanger/Sandnes	166 703	2 324	71.7	14.0	15.6	2.9	2.8
Trondheim	142 891	2 427	58.9	12.0	11.9	1.6	1.2
Fredrikstad/Sarpsborg	95 077	1 508	63.1	10.0	14.8	1.9	0.9
Drammen	88 481	1 881	47.0	11.0	16.1	2.0	1.1
Porsgrunn/Skien	84 049	1 561	53.9	9.3	15.9	0.8	0.9
Kristiansand	62 546	2 111	29.6	14.5	16.2	1.9	1.1
Tromsø	50 754	2 334	21.8	11.1	16.5	2.8	2.6
Tønsberg	43 991	1 482	29.7	9.7	15.1	1.5	1.0
Ålesund[1]	43 302	1 492	29.0	8.6	15.0	20.8	36.9
Haugesund	39 729	1 777	22.4	11.4	18.1	1.6	2.6
Sandefjord	38 366	1 519	25.3	9.1	14.7	3.1	2.7
Moss	33 960	1 952	17.4	10.7	13.5	2.7	6.1
Bodø	32 700	2 433	13.4	12.1	17.4	1.1	1.1
Arendal	30 916	1 255	24.6	7.6	15.2	2.5	2.6
Hamar	28 045	1 616	17.4	12.2	16.8	1.9	4.5
Larvik	22 650	1 675	13.5	11.9	16.2	2.1	3.2
Halden	21 668	1 706	12.7	10.7	16.1	1.8	1.6

[1] As of 1 January 2002, urban settlement 6025 Ålesund/Spjelkavik was combined with Langevåg urban settlement to form 6025 Ålesund urban settlement.
Source: Land use and population statistics, Statistics Norway.

Table H2 Urban settlement area (km²) and main categories land use in urban settlements. Grouped by size of population. 1 January 2000. Per cent

Grouped by size of population	Total urban settlement area km²	Total area built on or near buildings	Housing, holiday homes and associated buildings	Business activity	Transport and commu-nications	Other built on area	Unbuilt
All urban settlements	2 138.7	60.6	32.4	9.7	15.7	2.7	39.4
200 - 499	169.9	49.7	23.2	10.4	14.7	1.3	50.3
500 - 999	180.0	53.5	26.6	9.8	15.6	1.7	46.5
1 000 - 1 999	204.7	56.8	29.5	10.0	15.5	1.7	43.2
2 000 - 19 999	695.3	60.4	32.4	10.0	16.0	1.9	39.6
20 000 - 99 999	405.6	65.1	36.8	9.5	16.4	2.4	34.9
100000 -	483.1	65.5	35.4	9.1	15.4	5.5	34.5

Source: Land use statistics, Statistics Norway.

Table H3 Percentage day care centres, schools, residential housing and residents with safe access to recreational areas. 1999*

	Day care centres	Schools	Blocks of flats	Row, detached, etc. houses	Residents
Whole country	**89**	**87**	**70**	**85**	**82**
Østfold	90	87	69	80	78
Akershus	85	89	77	77	78
Oslo	76	79	65	65	69
Hedmark	92	89	71	87	84
Oppland	94	91	74	91	89
Buskerud	87	90	76	85	83
Vestfold	84	86	58	76	74
Telemark	90	94	77	88	87
Aust-Agder	93	83	69	88	87
Vest-Agder	96	78	65	89	87
Rogaland	83	79	63	75	73
Hordaland	92	85	63	89	86
Sogn og Fjordane	91	96	72	94	92
Møre og Romsdal	90	88	68	90	87
Sør-Trøndelag	95	96	78	88	86
Nord-Trøndelag	90	93	82	90	88
Nordland	94	96	81	93	91
Troms	96	95	79	93	91
Finnmark	96	91	79	91	90

Source: Land use statistics, Statistics Norway.

Table H4 Percentage of coastline within 100 m from buildings

	1985	1990	2000	2002
Whole country	**21.8**	**22.2**	**23.0**	**23.2**
County nos. 01-12	36.1	36.7	38.3	38.5
01 Østfold	40.7	41.0	42.2	42.3
02 Akershus	70.7	71.0	71.8	71.9
03 Oslo	75.1	75.7	76.9	77.4
06 Buskerud	65.7	66.3	67.3	67.5
07 Vestfold	41.4	42.0	43.4	43.7
08 Telemark	55.1	56.1	59.1	59.4
09 Aust-Agder	48.4	49.0	50.4	50.7
10 Vest-Agder	34.1	35.0	36.9	37.2
11 Rogaland	29.2	29.8	31.5	31.7
12 Hordaland	31.6	32.2	33.5	33.8
14 Sogn og Fjordane	21.7	22.2	23.0	23.1
15 Møre og Romsdal	27.5	28.0	29.0	29.2
16 Sør-Trøndelag	14.4	14.7	15.2	15.3
17 Nord-Trøndelag	13.4	13.6	14.2	14.4
18 Nordland	12.9	13.2	13.8	13.9
19 Troms	26.9	27.2	28.0	28.2
20 Finnmark	12.3	12.4	12.8	12.8

Source: Land use statistics, Statistics Norway.

Publications by Statistics Norway concerning natural resources and the environment. 2000-2002

Official Statistics of Norway (NOS)

C 557 Transport and Communication Statistics 1998.

C 560 Agricultural Statistics 1998.

C 580 Oil and gas activity, 3rd quarter 1999. Statistics and analysis.

C 582 Maritime Statistics 1998.

C 584 Forestry Statistics 1997.

C 592 Oil and gas activity, 4th quarter 1999. Statistics and analysis.

C 595 Energy Statistics 1998.

C 600 Statistical Yearbook of Norway 2000.

C 601 Electricity statistics 1997.

C 605 Oil and gas activity, 1st quarter 2000. Statistics and analysis.

C 608 Salmon and Sea Trout Fisheries 1999.

C 609 Fish Farming 1998.

C 612 Forestry Statistics 1998.

C 615 Oil and gas activity, 2nd quarter 2000. Statistics and analysis.

C 618 Hunting Statistics 1999.

C 619 Electricity Statistics 1998.

C 623 Fishery Statistics 1996-1997.

C 625 Waste Statistics. Municipal Waste 1998.

C 628 Transport and Communication Statistics 1999.

C 633 Maritime Statistics 1999.

C 642 Agricultural Statistics 1999.

C 647 Oil and gas activity, 3rd quarter 2000. Statistics and analysis.

C 648 Forestry Statistics 1999.

C 651 Oil and gas activity, 4th quarter 2000. Statistics and analysis.

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