Environment Switzerland 2007

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Office for the Environment FOEN

Federal Statistical Office FSO

Data sources

SI A statistical institution

IF An official institution within the field in question

RI A research institute

IO An interested organisation

☐ Several data sources involved which cannot be defined or whose definition is not useful

Method used for collecting data

FS Random sampling, systematic measuring network or full survey which includes the entire state or canton

R+ Pragmatically selected measuring network in the sense of "typical circumstances" which includes all regions and situations

R Pragmatically selected measuring network in the sense of "typical circumstances" which excludes certain regions and situations

M Model computation

E Estimation or expert opinion

■ Several collection methods involved which cannot be defined or whose definition is not useful

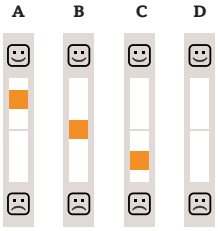
Links

Links to charts (» G6.1 ...
Links to maps (» M6.1 ...
Links to figures (» F6.1 ...
Links to tables (» T6.1 ...

Links to a boxes (» Heading, page 11 ...
Links to a chapter (» Chapter 18 ...
Links to a page (» Page 30 ...
Links to bibliography (» FSO 2004 ...
Links to glossary sectors

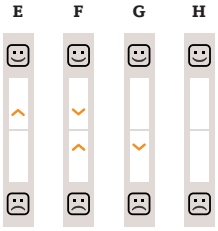
Chart assessments

The pictograms show a combination of state assessments:



A Good
B Adequate
C Poor
D Impossible to evaluate

and trend assessments:



E Positive
F Stable
G Negative
H Impossible to evaluate

Environment Switzerland 2007

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Table of contents

Foreword

The quality of the environment makes an important contribution to our welfare. The way in which we use natural resources has an effect on our health and safety and also on the beauty of our immediate surroundings and of Switzerland as a whole.

In addition, the way in which we use our natural resources has economic effects. Any form of production requires not only work and capital but also various natural resources, so they are a factor in our economy.

Therefore, it is good that we spare no effort to check exactly how we protect and use natural resources, and whether the need to use them, the amount used and the type of protection or use are justified. In order to evaluate the quantity and quality of the available resources and to prepare and assess regulations, it is essential to have information on the state of the environment.

The present "Environment Switzerland 2007" report gives a succinct, systematic overview of the state of the environment in Switzerland. It also describes the overall results of protection measures introduced in recent years and the relationships between human activities and the environment. It is the result of close collaboration between the Federal Office for the Environment (FOEN) and the Federal Statistical Office (FSO), who pooled their competences to provide pertinent, up-to-date information and analyses.

The overall situation as regards Swiss policy on the environment and resources is in many ways encouraging. In certain areas that presented problems in the recent past – water quality, waste management, air pollution involving certain pollutants – a new trend has begun or the goals have already been reached.

However, the overview reveals a general pattern: the reductions in emissions per unit of productivity are again made up for by population growth and an increase in per capita consumption. In the overall picture, this is like running a race with an open exit.

This race can only be won by pushing forward innovation in our processes of production and consumption. The challenge is targeting the same productivity using fewer resources. This seems to be the only way to maintain the quality of our environment in the long term. In view of the world-wide decrease in natural resources, it is also the best way to maintain the competitiveness of the economy. Seen in this way, the economic and ecological interests of Switzerland are largely in agreement. This allows us to look upon the future of resource policy with confidence.

Bruno Oberle, Director
Federal Office for the Environment (FOEN)

Adelheid Bürgi-Schmelz, Director
Federal Statistical Office (FSO)

Overview

The "Swiss Environmental Report 2007" was prepared by the Federal Office for the Environment (FOEN) and the Federal Statistical Office (FSO). It is designed to provide systematic information about the state of the environment and its development according to the latest knowledge and the data available. It takes an approach that combines environmental issues and related concerns in sectoral policies such as transport, energy and agriculture. It outlines the position in Switzerland compared with that of several other European countries. This report is the fifth published in Switzerland and differs from previous ones in that it includes an assessment of environmental policy and is shorter and more structured. It is primarily directed at decision-makers and the general public.

The 2007 edition shows mixed results. Compared with the last assessment in "Environment Switzerland 2002", the state of the environment as a whole has not improved noticeably; the situation is good in some areas but poor in others. The major concerns include climate change, signs of which are now plainly visible in our country, together with the imponderables associated with it; and the use of resources. The main challenge over the next few years will be to manage the resources sustainably, because our way of life and our consumption habits cancel out the progress made in environmental protection. Other causes of concern relate to biodiversity, air pollution, chemical products and the links between pollution and health.

Mixed results…

For the first time, the report presents the results of implementation of environmental policy based on objectives set by law. In general, this policy has produced good results as regards combating pollution (air, water and soil), protection of the ozone layer, and waste processing. However, although the objectives in certain areas were attained, others require further effort to ensure compliance with national legislation and international obligations.

For instance, atmospheric emissions of ozone precursors or fine particles are still too high, as are greenhouse gas emissions. Air quality needs to be improved further because of excessive immissions of nitric oxide, ozone and suspended dust. In the case of water, new micropollutants such as hormonal substances and pesticide residues have emerged, and the instream flows of certain watercourses are proving to be inadequate. When it comes to noise, the general public is still exposed to excessive immissions.

We have not succeeded in curbing the loss of biodiversity in the natural environment, and 30 to 50 % of native species are currently endangered. In addition, certain biotopes are experiencing the problem of invasive species. While Switzerland has a wealth of remarkable scenery, more should be made of some of its landscapes.

Waste production continues to climb, but treatment methods have been optimised. Remediation of contaminated sites has begun for urgent cases, and surveys of polluted sites are continuing. As regards chemical products, there are a great number of substances in the environment about whose origins, impact and behaviour little is known. Our society is aware of the threats posed by natural hazards and major accidents. Hazard maps have been prepared for better prevention management of natural disasters; these will be completed by 2011. The potential risk of major accidents remains the same in Switzerland, and owners of installations at risk are subject to permanent supervision.

…due to pressure on the environment caused by our activities

Population density and human activity put the environment in Switzerland under considerable pressure, which is linked to our transport and mobility needs, industrial and farming activities, and our consumption of resources and energy. Development towards an increasingly urban Switzerland and the regional imbalances this concentration triggers are aggravating this pressure further.

Every year, we consume around 12 tonnes of resources per capita (construction minerals, metals, biomass, fossil fuels etc.). Over the past ten years, consumption has remained stable. However, many of these resources are non-renewable. The tertiary sector occupies an increasingly important place in our economy, but services do not produce tangible commodities. Anything not manufactured in Switzerland has to be imported. Imports are indeed growing steadily, and the resultant environmental burden on other countries, as well as from the transport of these goods, are therefore also increasing.

Switzerland also depends on other countries to satisfy its energy needs, which are mainly covered by fossil fuels. We are using more and more energy because, although per capita consumption has remained the same, population growth has caused a rise in overall consumption. Meanwhile, the increase in electricity consumption continues unchecked, and roughly one quarter of CO_2 emissions are produced by household heating systems.

In Switzerland, each inhabitant uses an average of 233 liters of water a day and produces 660 kilogrammes of waste a year. Wastewater drainage and purification and waste processing cost money. The polluter-pays principle has not yet been applied systematically, so some of these costs are still borne by the community at large.

Only 18 % of passenger journeys are undertaken by public transport, while rail traffic accounts for 40 % of freight transport. The impact of traffic is still considerable, particularly in the form of emissions of atmospheric pollutants and noise. Between 2000 and 2004, transport-related CO_2 emissions were stabilised at 34 % of all CO_2 emissions in Switzerland. Among other things, external costs linked to health and damage to climate and the environment were estimated at CHF 6.5 billion in 2003.

Thanks to technological progress and development of Switzerland's industry, greenhouse gas emissions caused by industry have remained stable since 1990, even though the gross domestic product (GDP) has risen. In 2004, 21 % of all CO_2 emissions were produced by industry. In 2003, Switzerland's industry spent CHF 1.28 billion on environmental protection, i.e. nearly 0.3 % of GDP. This percentage is in line with the European average – so Swiss industry is not being penalised. Preference is given to investments, which account for 56 % of expenditure. Environmental technologies designed primarily to solve environmental problems at source generate 61,000 jobs and a turnover of CHF 6.7 billion per year.

By occupying land, agriculture plays a key role in preserving biological and landscape diversity. Considerable progress has been made at ecological level since 1993, but farming is still diffusing pollution, with the main culprits being ammonia and – to a greater or lesser degree, depending on the region – phosphorus.

Urban sprawl and more intensive land use exert considerable pressure on the environment. This expansion primarily affects farming land, causing the disappearance of arable land, and fragmentation of ecosystems and the landscape.

The major challenges

In Switzerland, the average temperature rose 1.5 °C between 1970 and 2005, i.e. 1.5 times faster than that recorded for emerged land in the northern hemisphere. The most obvious sign of climate change is glacier shrinkage. If the ice continues to melt at the same rate, three quarters of glaciers in the Alps will have disappeared by 2050. Thawing of the permafrost layer, changes to vegetation and variations in rain- and snowfall are other tangible pointers. As an alpine country, Switzerland is particularly vulnerable to climate change. Although these developments are due to natural fluctuations in climate, greenhouse gas emissions generated by human activity also play their part. To attain the goals set in the CO_2 Act and the Kyoto Protocol, Switzerland will have to implement new measures to reduce these gases.

Efforts to preserve biodiversity must be intensified by monitoring species protection to detect fauna and flora development trends in good time and take appropriate action.

Air quality needs to be improved still further; hence the need to reduce atmospheric emissions. Although they are difficult to express clearly, the links between pollution and health are now recognised. The public is chronically exposed to low concentrations of pollutants. Air pollution, noise, chemical products, extreme weather conditions and radiation constitute serious health threats.

Among other concerns, new technologies offer numerous fields of application and considerable opportunities, and have the potential to do good as well as harm. Little is known about some of their repercussions on human beings and the environment, and a public debate on these threats and their appraisal is needed.

Efforts to reduce pressure on the environment are achieving uneven results, so the challenge of the coming years will be to build the environment into sectoral policies and to put a resources policy in place.

Introduction

The Swiss Environmental Report provides a clear, simple update on the state of the environment and its development, as required under Swiss legislation (Federal Constitution, Environmental Protection Law, Federal Law on Statistics). Each report is based on appropriate, reliable and relevant information, as well as on validated, official data. The information provided can be used as a basis for debate on environmental policy and sectoral policies.

Structure of the report

The "Swiss Environmental Report 2007" consists of four parts: a stocktaking of environmental policy implementation (part I), the state of the environment (part II), trends and outlook (part III), and a comparison with some European countries (part IV). This is the fifth report published in Switzerland and differs from the "Swiss Environmental Report 2002" in that it includes an assessment of environmental policy and is shorter and more structured. It is primarily directed towards decision-makers and the general public. More specific information, such as details of the indicators used, can be found on the Internet.

Conceptual framework and methodological principles

The report adopts an approach that covers environmental issues and the related sectoral-policy concerns. It was based on the standardised Europe-wide DPSIR[1] model, a causal framework that permits analysis of links between factors that affect the environment. Links have been established between human activity and the environment (» F1).

This systematic evaluation provided a foundation for preparing the report in line with the following principles:

- The main environmental problems were identified using environmental legislation, the latest assessment in the "Swiss Environmental Report 2002" and problems that have arisen in the meantime. As exhaustive a list as possible was drawn up and compared with work done at international level.
- A DPSIR analysis was performed for each of the problems identified, to ascertain the links between the socio-economic and environmental themes and hence to establish the report structure.
- The most appropriate indicators were selected for the issues analysed. Where possible, they present chronological series derived from systems or sets of existing indicators.
- Experts from the Swiss administration participated in this process and in drafting the report.

1 DPSIR: **D**riving forces, **P**ressures, **S**tate, **I**mpact, **R**esponses

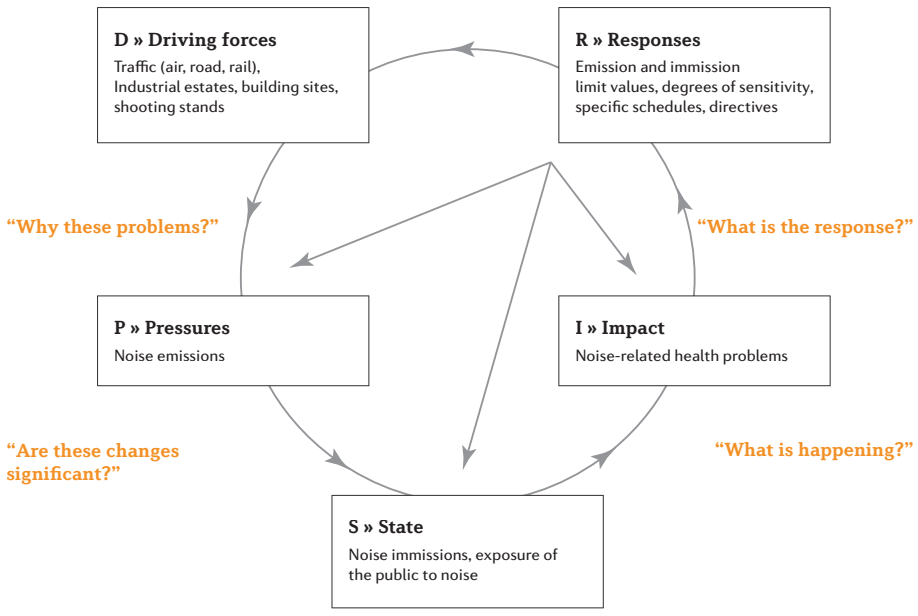
Diagram evaluation
Diagram evaluation took the form of pictograms. Each pictogram provided information about the state of the environment and how it had changed for a given theme, and highlighted the key message. The evaluation was conducted in terms of an objective set either in legislation or in a strategy. Evaluation criteria were defined for systematic, transparent evaluation of each diagram.

The state of the environment in the various areas under study was evaluated on the basis of the average of available data for the last three years concerning this objective. The evaluation distinguishes four possible scenarios:
- Good state: set objective attained
- Adequate state: close to the set objective
- Poor state: set objective not attained
- Impossible to evaluate: no objective or insufficient data

The trend applies for the period covering the last ten years since the latest year available. Development is analysed in terms of the objective and distinguishes four possible scenarios:
- Positive trend: marked development toward the objective
- Stable trend: little or no development
- Negative trend: marked development away from the objective
- Impossible to evaluate: no objective or insufficient data

In general, the indicators presented are based on data available up to October 2006. Figures are rounded up or down, which may mean that their sum differs from the total given.

F1 DPSIR model
DPSIR analysis applied to noise



I. Stocktaking of environmental policy implementation

This part takes stock of environmental policy implementation. The effects of environmental policy are investigated in terms of the objectives laid down in legislation, action plans or strategies, so as to provide a brief response to the following issues for each topic:

– How do matters stand?
– What are the shortcomings?
– What causes them?
– What measures are being taken, and what impact are they having?

The key messages are backed by relevant indicators for evaluating whether the objectives set have been reached. Some themes are presented without indicators because no data are available as present knowledge stands.

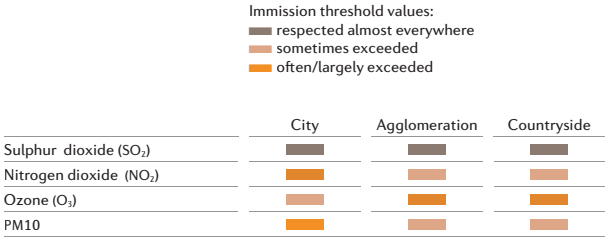
This rapid overview provides a generally accessible picture of environmental status and of the effectiveness of measures taken to date.

The topics addressed are: air, climate, the ozone layer, chemical products, waste, contaminated sites, risk of major accidents, hazardous organisms, noise and vibrations, biodiversity, nature and the landscape, forests, soils, water, international cooperation, natural hazards and non-ionising radiation.

Air

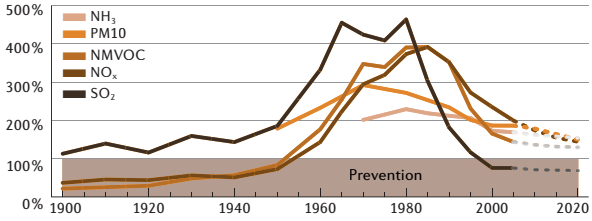
Air quality has improved. However, NH_3, PM10, NO_x and NMVOC emissions generated by transport, industry, households and agriculture still cause excessive immissions of ozone, fine particulates and nitrogen deposits. Implementing measures that are efficient in the long term – such as vehicles and equipment fitted with state-of-the-art technology, incentive taxes such as the Mileage-Related Heavy Vehicle Tax (MRHVT), or that on VOCs – must continue. It is also important to continue the international efforts to combat transboundary pollution.

G1 Exceedences of immission threshold values of Ordinance on Air Pollution control in 2006



Source: FOEN

G2 Emissions of air pollutants

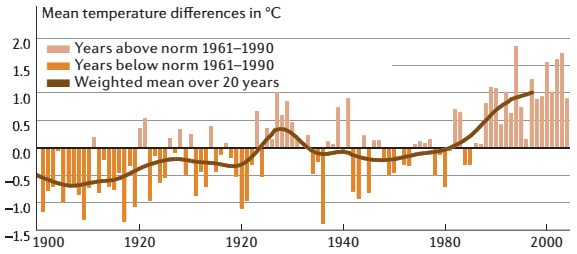


Source: FOEN

Climate

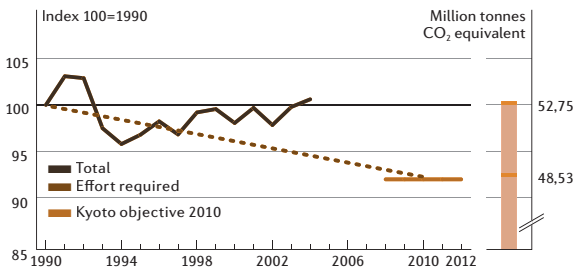
The increase in the average temperatures in Switzerland over the last 30 years is 1.5 times greater than on the emerged lands of the northern hemisphere. There are visible signs of climatic variation (for example glacier recession, permafrost melt, and changes in vegetation). Between 1990 and 2005, there was a 0.5 % reduction in greenhouse gas emissions. According to the Kyoto Protocol, by 2010 they need to be reduced by 8 % compared with the 1990 values. In order to reach this goal, the Swiss federal Law on CO_2 emissions commits to the reduction by 10 % of CO_2 emissions caused by the consumption of fossil energy, which represents almost 80 % of greenhouse gas emissions. To achieve this, the "climate centime" applicable to fuel was introduced in 2005, and a tax on CO_2 for combustibles will be introduced in 2008.

G3 Temperature differences in Switzerland compared to the 1961–1990 mean



Source: MeteoSuisse

G4 Evolution of greenhouse gas emissions

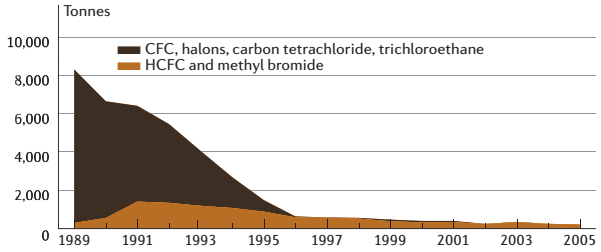


Source: FOEN

Ozone layer

In Switzerland, the concentration of stratospheric ozone has decreased by 4 % since 1989, resulting in an increase in UVB radiation. During cold winters, the concentration of ozone can drop by 15 % in the Arctic; mini-holes can form and sometimes travel over Switzerland. Substances depleting the ozone layer include those used in synthetic foams, solvents and refrigeration. The objectives of the Montreal Protocol to reduce the use of these products have been achieved in Switzerland. Consumption of these substances has been almost zero since 1996, except for HCFCs, which will be totally banned from 2015.

G5 Imports of ozone-depleting substances



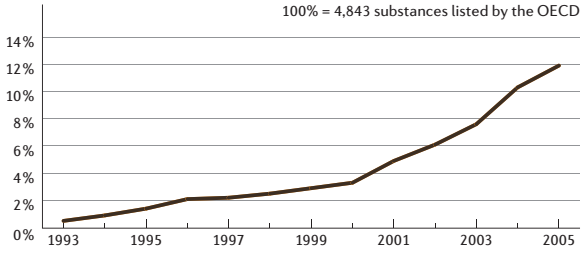
Source: FOEN

IF E

Chemical products

The amount of pollutants (heavy metals, polychlorinated dioxins, PCBs or nonylphenol) has decreased significantly. With a share of 4.3 %, Switzerland is the world's ninth-largest exporter of chemical and pharmaceutical products. In 2005, the Chemicals Ordinance came into force, bringing with it new provisions to increase the level of protection. However, there are still many chemical products in the environment, the origin, effects and behaviour of which are not well understood. There should be more analysis and assessment of chemical products. Similarly, it is essential to improve the necessary evaluation base for chemical products with specific properties or mechanisms of action, in particular the substances with endocrine effects and nanomaterials.

G6 Share of assessed substances compared with total of substances on the OECD list



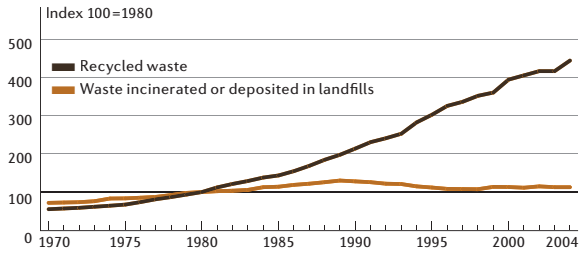
Source: OECD 2005

E

Waste

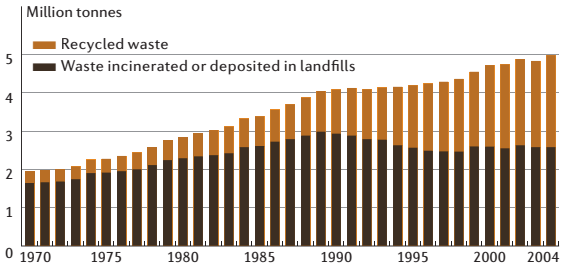
About 5 million tonnes of municipal waste have been produced every year since 2000. They are either disposed of or recycled. Nearly half the waste is sorted and recycled, while the rest is incinerated in an environmentally safe way in line with existing waste policy. The 1.1 million tonnes of hazardous waste produced every year is recycled, disposed of within Switzerland or exported in accordance with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Financing of the appropriate methods for treating waste tends to respect the polluter-pays principle. However, the waste policy is not in a position to lower the consumption of raw-materials in Switzerland. Sustainable resource management would imply a coherent management policy of resources and products.

G8 Treatment of municipal waste



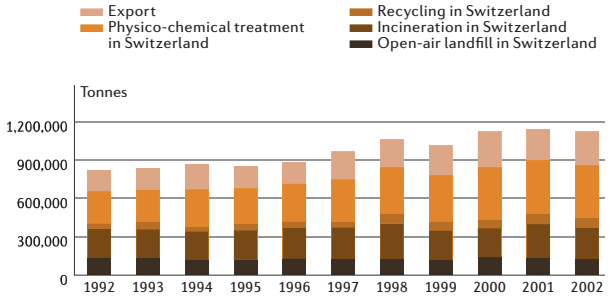
Source: FOEN

G7 Municipal waste production



Source: FOEN

G9 Hazardous waste quantity and treatment processes

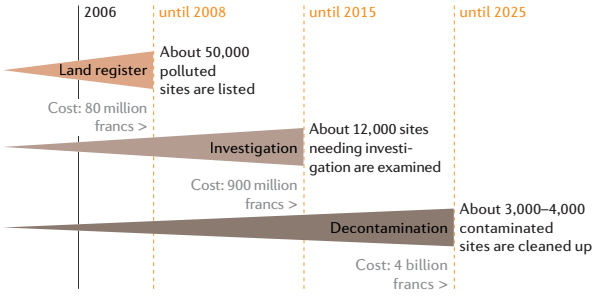


Source: FOEN

Contaminated sites

There are approximately 50,000 polluted sites in Switzerland, 12,000 of which must be investigated. 3,000 to 4,000 of these sites are contaminated and must be remediated. 40 % of polluted sites are listed in cantonal land registers accessible to the public. Investigation and decontamination of the most urgent cases are underway. 25 % of the necessary investigations have already been completed and more than 200 sites decontaminated. The global cost of decontamination is in the order of CHF 5 billion. Completion of the cantonal land registers and investigation of polluted sites will make it possible to expedite the decontamination of sites, especially with the possible financial support of the Confederation (approximately CHF 25 million per year).

G10 Steps in the treatment of contaminated sites

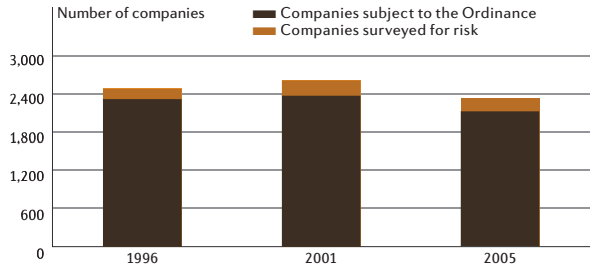


Source: FOEN

Risks of major accidents

2,327 companies, 4,000 km of railways and 7,850 km of roads are subject to the Ordinance on Protection against Major Accidents (MAO). Owners of these infrastructures are obliged to take adequate safety measures, and are subject to continuous monitoring. A risk survey is performed for installations that could cause serious damage to human beings or the environment, and is assessed by the authorities. Because of economic and technological progress, prevention of major accidents is a continuous task. Density of land occupation necessitates more and more preventive measures within the framework of national planning.

G11 Companies subject to the Ordinance on Protection against Major Accidents



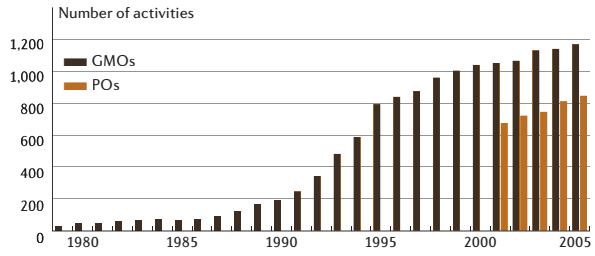
Source: FOEN

IF R+

Hazardous organisms

The contained use of hazardous and pathogenic organisms has increased in the fields of research and in manufacturing of pharmaceutical and industrial products. Three experiments involving the release of genetically modified organisms (GMOs) have been authorised up to the end of 2006. Heightened safety measures have been taken in this sector, following the provisions that came into force in 2004. Activities deemed to present a high potential hazard are subject to authorisation. The moratorium on genetically modified organisms bans their direct use in the environment until 2010 – particularly seeds, except for research purposes.

G12 Activities involving use of genetically modified organisms (GMOs) or pathogenic organisms (POs) in containment facilities



Source: FOEN

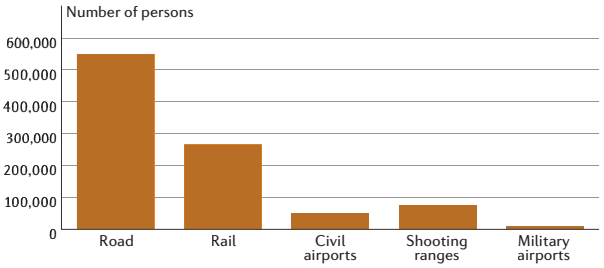
IF R

Noise and vibrations

One million people are exposed to excessive noise immissions mainly generated by transport (road, rail, air). About 25,000 people are subject to vibration levels close to threshold values. Despite the preventive principle and improvements already made, measures are often complex to implement and are no longer sufficient to compensate for the consequences of increased traffic. Protection of the population is not guaranteed. The strategy of combating noise must also concentrate on maintaining the peacefulness of the environment. A national, integrated network of noise monitoring is currently being established.

G13 Number of persons exposed to noise pollution

Status 1985, revised 2002



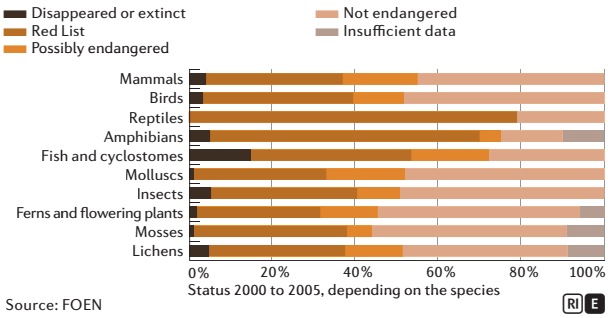
Source: SAEFL 2002d

IF M

Biodiversity

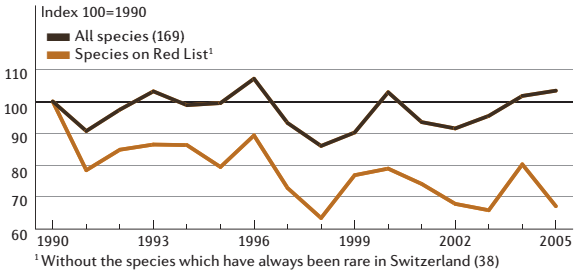
Around 50,000 plant and animal species exist in Switzerland. Many of them that used to be present in great number are today endangered, and some have considerably declined in number. Biodiversity decline has not slowed down in Switzerland. Expansion of urban sprawl, development of activities linked with tourism and transport infrastructures exert great pressure on biodiversity. Intrusive species (the American crayfish or Canada goldenrod, for example) have become problematic in some biotopes. There is no guarantee that we will be able to halt the decline in biodiversity, one of the objectives of the Convention on Biological Diversity, which Switzerland ratified in 1995.

G15 Species disappeared, possibly endangered or not endangered



Source: FOEN

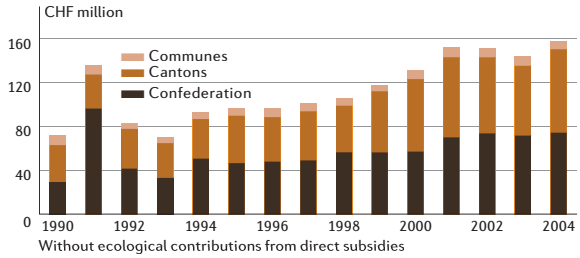
G14 Population of breeding birds in Switzerland



¹ Without the species which have always been rare in Switzerland (38)

Source: Swiss ornithological monitoring station, Swiss Bird Index®

G16 Net public expenditure for nature protection (constant francs)



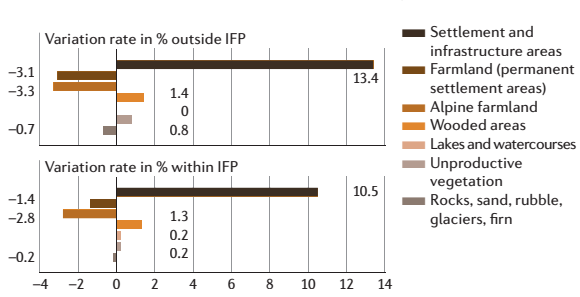
Without ecological contributions from direct subsidies

Sources: FFA, FSO

Nature and landscape

Switzerland is a country rich in outstanding natural and rural landscapes. Some of them are of international value. These resources are essential for our quality of life and for tourism. The intensification in land use exerts a significant pressure on the landscape and on protected areas. Conservation of natural landscapes and habitats and improvement of sites with natural interest are not ensured. Enforcement of the "LANDSCAPE 2020" concept will ultimately contribute to improving the situation, as will the creation of new national, regional and periurban natural parks.

G17 Changes in land use between 1983 and 1995, outside and within the limits of the IFP objectives

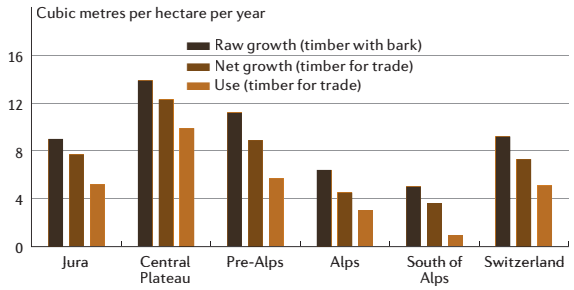


Source: FOS GEOSTAT, land use statistics; FOEN

Forests

The surface occupied by forests – currently 1.25 million hectares – is increasing. About a third of the 7.4 million cubic metres of annual growth of usable timber is not exploited. The Swiss forestry programme takes into account the economic, social and ecological aspect of forests. It would be necessary to increase the production of domestically grown timber and wood products, and make the forest industry more competitive. Mountain forests are supposed to protect the population and infrastructures and, according to this programme, 10 % of the forests should be classified biological reserves in order to sustain biodiversity. The partial revision of the current Law on Forests should ensure the sustainable management of forests.

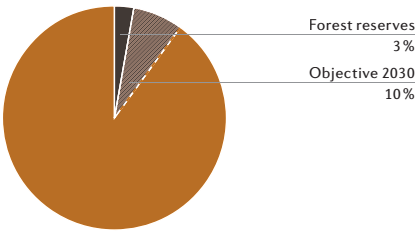
G18 Timber supply and growth in 2004



Source: WSL 1999, SAEFL 2005g

FS

G19 Forest reserves in Switzerland compared with total forest area in 2004



Source: FOEN, WSL 2005

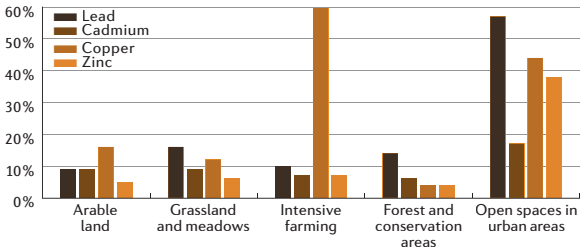
FS

Soils

Everyday, 11 ha of farmland are lost for good. Intensive use of the soil has not been stopped. As far as chemicals are concerned, the threshold values are considerably exceeded for 1 % of the soils and slightly for 90 %. Widespread infrastructures, streamlined farming and polluting activities are responsible for the current state of the soils. Measures such as atmospheric emission limitations from installations, measures regulating the use of substances and organisms or requirements about water infiltration have proved to be efficient. However, physical damage (compaction or erosion) is not always mastered and may result in a non-reversible loss of soils. More rigorous enforcement of the preventive principle is therefore necessary.

G20 Exceedences according to land use, 1990–1996

About 14,000 cantonal and national sites surveyed



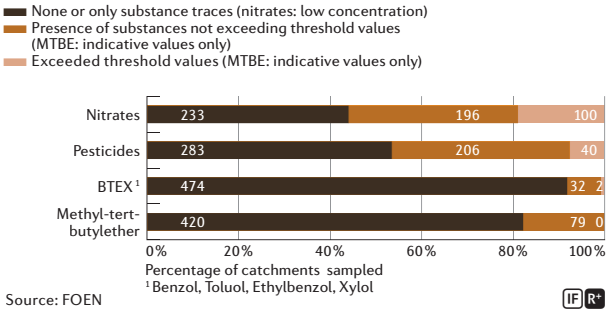
Source: SAEFL 2000

IF M

Water

The quality of the water in the lakes and rivers has improved significantly in the last few years. However, micropollutants from hospitals, households, industry and small businesses pose a problem. Groundwater quality is good, in spite of an excess of nitrates and the presence of traces of pesticides, especially in farming areas. An important challenge remains concerning the construction, maintenance and adaptation of infrastructures, especially with regard to water treatment. Quantitative – insufficient residual discharge rate – and structural damages are still extensive. Almost 1,500 billion cubic metres of wastewater are produced annually and adequately treated. Global water management relies on guaranteed funding for the restoration of streams, in particular against floods, to fight against micropollutants (substances with endocrine effects, such as pesticides) and to reduce general pollution further.

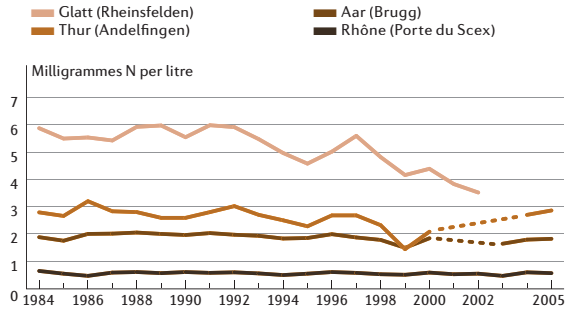
G21 Concentrations of substances in ground water



Source: FOEN

IF R+

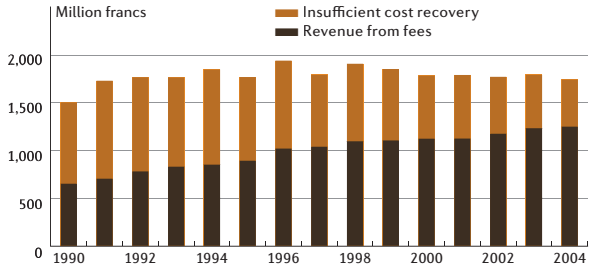
G22 Nitrate levels in watercourses



Source: FOEN

IF R

G23 Cost recovery of public expenditure for wastewater management



Source: FSO

SI FS

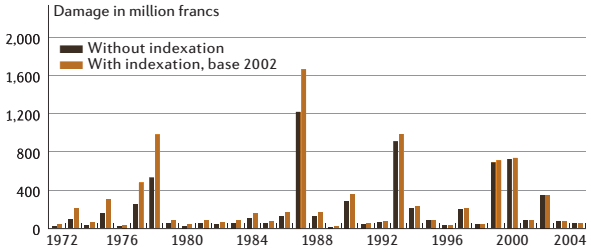
International cooperation

Switzerland is active at international level in the management of global ecological problems: depletion of the ozone layer, climate change, impoverishment of biodiversity, deforestation, reduction in freshwater supplies, soil deterioration, and dispersal of persistent organic pollutants. These problems demand the continuation and extension of global environmental policy. The Aarhus and Espoo Conventions, the UNECE Protocol on the register of pollutant releases and transfers, and the Protocols of the Alpine Convention have not yet been ratified by Switzerland.

Natural hazards

Natural hazards have always existed in Switzerland. Natural disasters cause an average of 6 fatalities per year. The extent of the damage is continually increasing, reaching a yearly average of over CHF 330 million. As a result of increasing urbanisation, assets and properties have proliferated in risk-prone areas. Infrastructures have therefore become more vulnerable. 41 % of expenditure linked to risk management is devoted to prevention. Maps showing hazard-prone zones will be completed by 2011. More integrated strategies, taking into account other sectoral policies (spatial planning, transport, tourism, forests), would contribute to improving risk management.

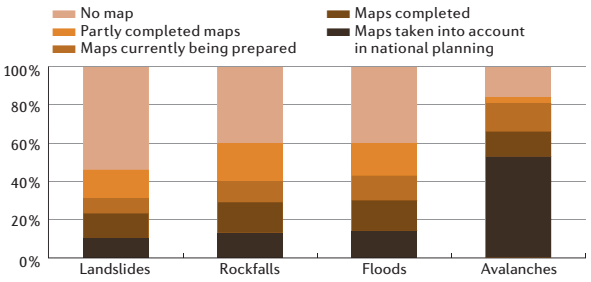
G24 Damage from floods, mud slides and landslides



Source: WSL/ENA

RI E

G25 Readiness status of maps showing natural dangers in 2006 (% of surface area)

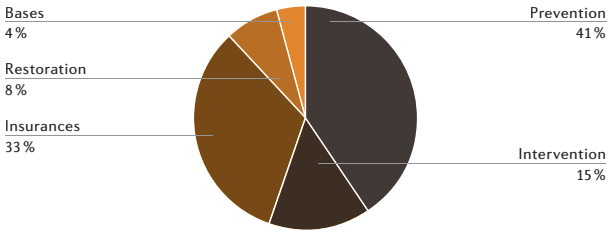


Source: FOEN

IF FS

G26 Expenditure for protection against natural dangers by measure type in 2004

(total cost = 2.5 billion francs)



Source: PLANAT 2005

RI FS

Non-ionising radiation

Radiation exposure limits are generally respected in Switzerland. Stricter limits are applied in the case of long-term exposure to mobile-telephony and radio transmitters, as well as to power lines and electrified railway lines. The ever-increasing use of electricity, the increase in the number and use of electrical appliances and mobile telephones, results in a build-up of non-ionising radiation. The development of technologies with lower-level radiation makes it possible to reduce exposure as a precautionary measure. The long-term effects on health of this non-ionising radiation are still unclear. A national research programme is currently underway, and should enable some of these uncertainties to be resolved by 2009.

II. State of the environment

Human activity has a considerable impact on the environment, and controlling it will certainly be one of the major challenges over the next few years. These relationships are studied using detailed indicator-based analyses, and the explanations provided will help the reader to gain a better grasp of the sometimes complex links between human activity and the environment, as well as of the measures taken.

Environmental themes are considered in a way that supplements the information given in part I. The analyses and explanations provide an overview of the present situation, developments in the state of the environment and of the measures taken.

The topics dealt with are: Resources and material flows – Energy and electromagnetic radiation – Transport and mobility – Industry, production and commerce – Households and consumption – Agriculture – Air quality – Climate change – Ozone layer – Water quality – Soils – Landscape and biodiversity – Forests – Natural risks – Risk of major accidents – Noise and vibrations – Environment and health.

1. Resources and material flows

Each year, the Swiss economy uses approximately 100 million tonnes of materials: 14 t per inhabitant. Only a quarter of these materials are renewable.

Over the last 20 years, domestic growth has increased more rapidly than resource consumption. This change has been achieved partly at the expense of the rest of the world. Imports increase regularly, resulting in environmental pressures abroad.

In the future, a global resources policy should enable their conservation: the entire life cycle of a given product must be managed from the moment of production, in cooperation with economic organisations and intermediary countries.

Material flows

The quantity of resources consumed by our economy depends greatly on our lifestyles, as well as production and consumption habits (» Chapters 2, 3, 4, 5, 6). These resources come from raw materials, extracted in Switzerland or imported, as well as from processed substances and manufactured products from abroad. Once processed and manufactured, some of them are exported, and the rest either used or stored in Switzerland for a shorter or longer period (buildings, vehicles, furniture etc.). However, whether they are abroad or in Switzerland, one day all return to the en-vironment, as air, soil or water emissions, or as waste (» F1.1). There is therefore a connection between input and output flows and the resulting pressures. Several surveys show that the greater the quantity of material, energy and area used, the greater the environmental pressures (» Van der Voet et al. 2004 for example).

In 2004, Direct Material Input to the Swiss economy (DMI) was approximately 103 million tonnes, or about 14 t per inhabitant. The quantity of water pumped out for public consumption and electricity production was in the order of 2,500 million tonnes (» Chapter 10).

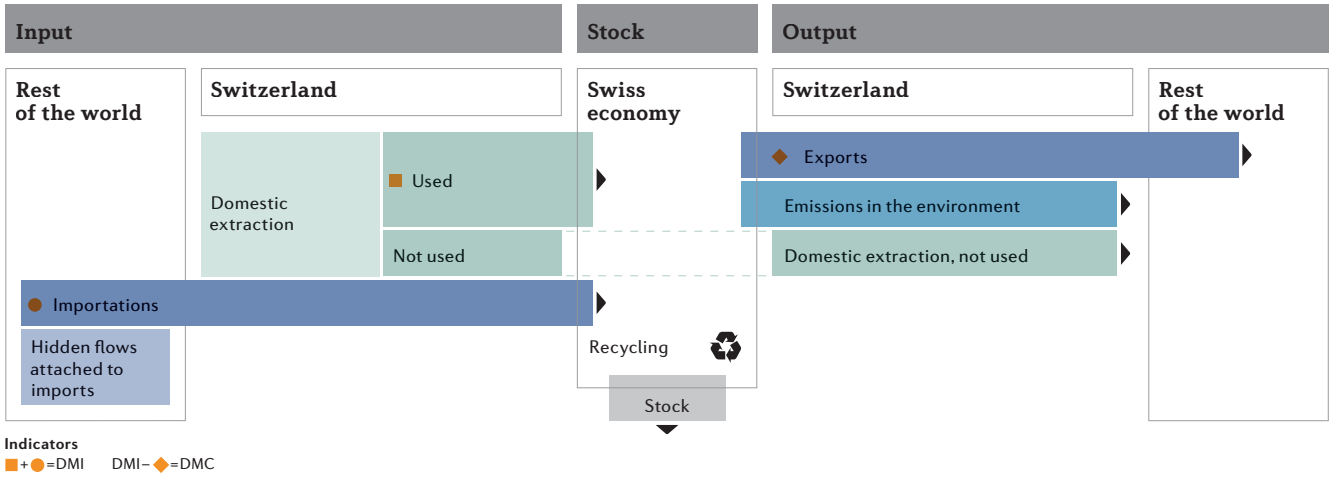
In the same year, almost half the DMI (not including water) consisted of construction minerals (sand, gravel etc.), 23 % of biomass elements (products from agriculture, timber etc.), 15 % of fossil fuels (fuels and combustibles), 6 % of industrial minerals (metals etc.), and 7 % of "other" products (» G1.1). For the period in question, fluctuations in DMI (±10 %) were observed, but no significant trend towards an increase or decrease in DMI was noticeable.

Renewable material (mainly products from the biomass category) accounts for only a quarter of total DMI. Renewable resources distinguish themselves by their capacity to regenerate over a short timespan, measured on the human scale. They can be considered inexhaustible only if the extraction rate respects the system's reproductive capacity.

Variations in the different material categories can be linked to economic, structural, meteorological or even technological factors. The evolution in the quantity of construction minerals is thus heavily dependent on the economic climate in the building industry (» G1.2), whereas the continual increase in the quantity of "other" imported products illustrates a more structural phenomenon. Meteorological factors have a prevailing influence on biomass. For example, the occurrence of hurricane Lothar at the end of 1999 caused wood supplies to be considerably more abundant in 2000 than in the previous years.

In spite of some fluctuations due to the factors mentioned, supplies of biomass, fossil fuels and construction

F1.1 **Material flows in Switzerland**



Source: FSO, modified from Eurostat 2001

minerals remain relatively stable. Conversely, quantities of industrial minerals and other products increase regularly and significantly (annual averages of 2.3 and 2.8 %, respectively). The former probably progress according to technological and industrial factors, and the latter more because of the way our service sector is developing.

As well as monitoring total flows transiting through our economy, it is also essential to keep a close watch on the most hazardous substances, in order to prevent their eventual release into the environment (» Substance flows, page 25).

Materials used in Switzerland

Between 1981 and 2004, DMC decreased by 7 %, while GDP (measured at constant prices) increased by 40 %. The result was a 49 % increase in material efficiency (» G1.3). Consequently, for the whole of the period in question, total decoupling was observed, which represents dematerialisation of our economy. However, this observation was qualified by a more thorough analysis, which identified three periods. During the first period (1981–1989), GDP and »

Material flows

The total of material flows entering a country's economic system – without regard for their toxicity – is accounted for annually in tonnes using a method designed by » EUROSTAT (2001). Water and airflows are not taken into account. Direct Material Input (DMI) measures the quantity of material directly entering the economy during the year. Domestic Material Consumption (DMC) relates to flows consumed in a year, i.e. DMI minus exports (» FSO 2005a, 2005b). Flows are divided into five categories: biomass, fossil fuels, construction minerals, industrial minerals, and others. Each of the first four categories covers materials extracted in Switzerland, those imported, and associated imported manufactured goods. For example, imported canned goods are classified as biomass by virtue of their content, and metal pipes as in-dustrial minerals. Imported manufactured products made of various materials are classified under "other". This category includes, in particular, furniture, electronic appliances and cameras, as well as some chemical products, including flame-retardants.

Indirect flows that do not enter the economic system must be added to the direct ones. They include both hidden flows associated with imports of material and energy needed for extraction, transforming potential and transporting substances and products in Switzerland; and material extracted in Switzerland but not used. Calculating these flows encounters many methodological problems. The first estimates of hidden flows associated with imports have been performed by the FSO on the basis of methods similar to those used at international level (» FSO 2007a).

Material flow indicators can be compared to macroeconomic indicators such as GDP. Material efficiency is expressed in value-added units (GDP in CHF) per kilo of consumed material (DMC in tonnes). The growth in material efficiency illustrates a decoupling of economic performance and quantity of consumed material.

› DMC increased, but GDP increased faster than DMC. The result was a small increase in material efficiency and a proportional decoupling of the economy. During the second period (1990–1999) stagnation followed by increase in GDP (7 %) were registered, whereas DMC decreased markedly (–21 %). Material efficiency improved considerably, at an annual rate of 3 %, so that for the same economic result, a smaller amount of material was directly used in Switzerland each year. This period corresponds to a total dematerialisation of the economy. However, it has to be mentioned that the decrease in DMC was mostly due to the reduction in the consumption of construction minerals (–29 %), as this category contributes half the DMC on average. During the third period (2000–2004), material efficiency remained globally stable; there was no dematerialisation. Furthermore, in 2004, DMC was still 88 million tonnes, or 12 t per inhabitant, of which less than a quarter are renewable materials.

The improvements in efficiency noted were the result of a number of factors. Over about the last 15 years, some industrial and technological processes have become more efficient, which is beneficial for the environment. But at the same time, our society has undergone a structural reorganisation highlighted by a decrease in activity in the industrial sector and an increase in service activities that require fewer materials (development of the service sector), as well as the transfer of industrial production abroad (delocalisation). The increasing proportion of transformed materials and manufactured products in total imports says a lot: it effectively rose from 55 % in 1988 to 62 % in 2004. This structural evolution plays an important part in material efficiency improvement and dematerialisation of the Swiss economy, but in parallel it creates an increase in environmental pressures abroad.

This analysis must therefore be completed with an account of the hidden flows generated by intermediary countries, in connection with our imports, and thus indisputably a product of our lifestyle.

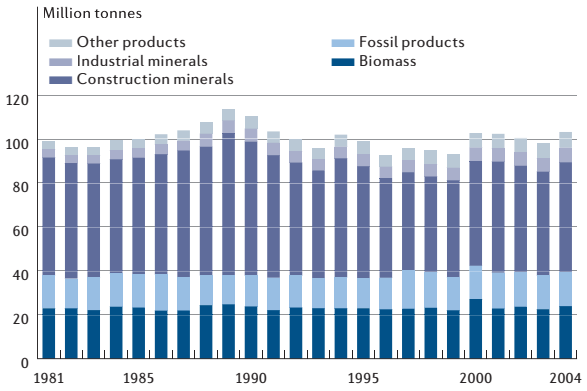
A far-reaching vision would need also to include indirect flows, accounting for material extracted in Switzerland but not used by our economy (» F1.1), because they have a local impact, sometimes polluting water or modifying the landscape (extraction of construction minerals, for example).

Export of environmental pressures

The flows of imported material increased from 36 to 47 million tonnes in Switzerland between 1981 and 2004. The DMI import share increased continuously, rising from 36 % in 1981 (40 % in 1988) to 45 % in 2004. Thus, our economy is still increasingly dependent on imported materials.

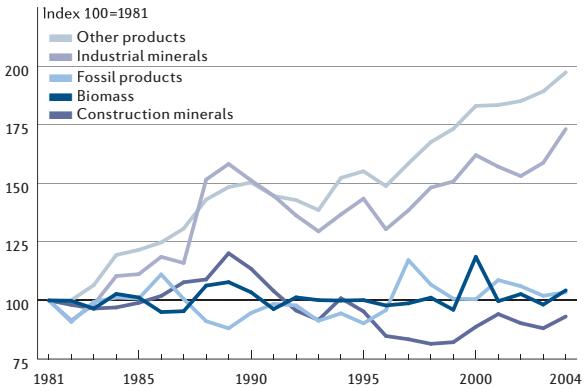
In 2004, these imports consisted of 17 % biomass, 33 % fossil fuels, 22 % construction minerals, 12 % industrial minerals, and 16 % other products. While construction mineral imports decreased (–16 %) between 1988 and 2004, those of material from all the other categories tended to increase

G1.1 DMI – Direct Material Input



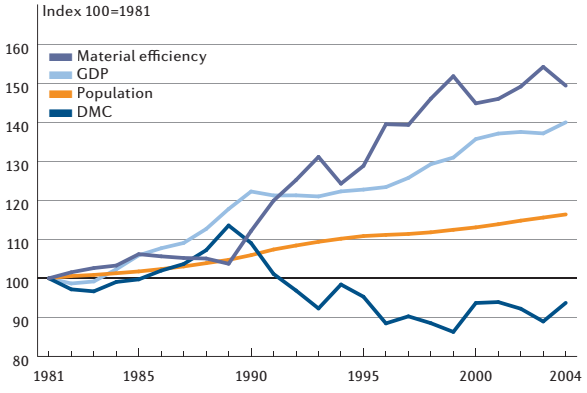
Source: FSO SI FS

G1.2 Evolution of Direct Material Input (DMI)



Source: FSO SI FS

G1.3 Evolution of DMC, material efficiency, GDP (real) and population



Source: FSO SI FS

Substance flows: the case of brominated flame-retardant agents

Some brominated flame-retardants are considered to be highly non-degradable compounds that can build up in the food chain. Furthermore, when items containing such substances are inadequately incinerated, brominated dioxins and furans may form. These are also highly non-degradable and their toxicity is problematic.

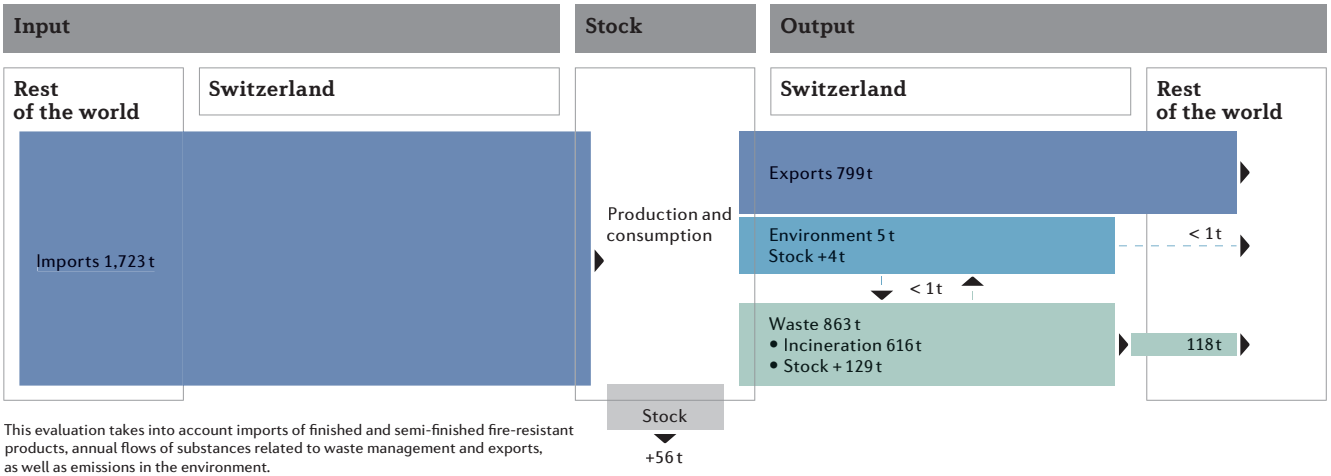
World consumption of brominated flame-retardants has doubled over the last ten years, with the annual increase currently between 5 and 7 %. They can be used for a wide variety of applications and are found in many components of consumer electronics, telecommunication systems and digital equipment (computers, screens and accessories), as well as in cables, construction materials (insulating foams), fabrics and household electrical goods.

Switzerland imports large quantities of brominated flame-retardants and the stock therefore increases significantly and continuously in households, industry and transport. At the same time, a sizeable proportion of the compounds in question becomes waste, which is generally incinerated, thus removing this material from the system. Finally, some of this waste is dumped in landfills, where another stock of brominated flame-retardants is created; this stock is increasing by about 130 t a year.

Every year, emissions from industry and trade produce about 5 t of brominated flame-retardant agents that find their way into the environment. Released into the air, these substances settle in the soil, at a rate of some 4 t a year. It is currently estimated that approximately 120 t of these substances are present in soils.

Market globalisation, particularly of electrical and electronic devices, makes an analysis of the overall spread of brominated flame-retardants difficult. The necessary measures must therefore be debated at international level (and especially within the context of the OECD): in the long term, only measures supported by a majority of countries will bear fruit.

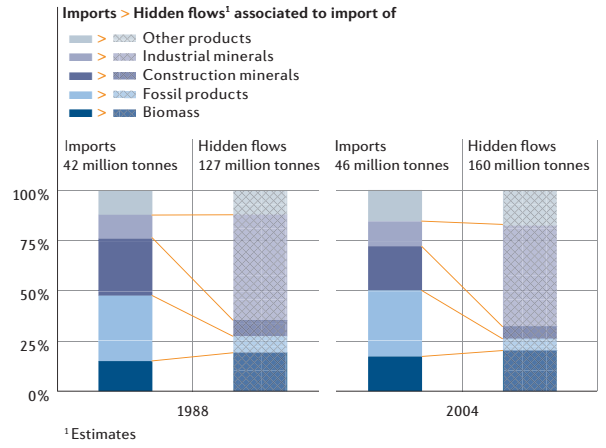
F1.2 Brominated fire-retardant agents in 2001
pentaBDPE, octaBDPE, decaBDPE, TBBPA (in tonnes)



This evaluation takes into account imports of finished and semi-finished fire-resistant products, annual flows of substances related to waste management and exports, as well as emissions in the environment.

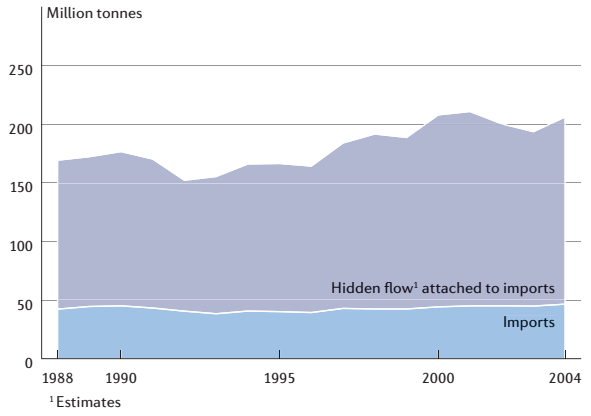
Source: SAEFL 2002a

G1.4 Imports structure and associated hidden flows



Source: FSO

G1.5 Imports and hidden flows



Source: FSO

(» G1.4). The increase was 14 % for fossil fuels, 28 % for biomass, 15 % for industrial minerals, and 38 % for other products.

Hidden flows associated with the environment vary for each material type and product. Thus, they were not very high for construction materials, higher for materials in the "other" category, and considerable for industrial minerals (» G1.4). An illustration: hidden flows connected with copper imports correspond to 180 t per tonne of imported material. These hidden flows remained in exporting countries where they put pressure on the environment. They relate particularly to material that has had to be extracted to reach the copper vein in the mine, an operation that is likely to change the landscape and pollute water.

It is important to note that the general increase of imports in the input flows to our economy, and the gradual change in the type of these imports, produce more and more hidden flows (» G1.5). Thus, the latter increased from 127 million tonnes in 1988 to 160 million tonnes in 2004 – an increase of 26 % – whereas imports increased by only 10 %. They are three times higher than the imports themselves, and even higher than the total of direct input flows to the economy (DMI).

The dematerialisation observed above, which is essential for our economy to grow sustainably, is thus partially explained by the increase in environmental pressures that Switzerland generates abroad.

Measures in place and their impact

Although there are some sector-based strategies that are aimed at sustainable management of some resources, Switzerland has no global policy on this topic. In fact, Switzerland has to date mainly been concerned with output flows. Conversely, half the European Union member countries have already set objectives of a global nature that aim to

improve material **efficiency** and dematerialise or reduce DMC.

However, in spheres such as waste management, bans and limitations on the use of a whole series of environmentally damaging substances have enabled more considerate management of some resources, and in particular have encouraged the production of more ecological consumer goods.

Asbestos, mercury, cadmium and polychlorinated biphenyls (PCB) are some examples of these regulated substances. At the other end of the chain, waste can be used as a resource, thanks to sorted collection and efficient reprocessing schemes (» Chapter 5). Waste from used electrical and electronic appliances contain large amounts of metals (iron and copper in particular), which can be reprocessed and reused as secondary materials. These resources are lost if waste is incinerated in household waste incineration plants (HWIP). Small appliances contain around 4 % copper, rising to 14 % in some special equipment. In Switzerland the disposal of electrical and electronic appliances thus produces copper in quantities of between 3,100 and 3,800 t a year. In addition to 58 % of metal, this waste also contains nearly 9 % cathode ray tubes, 14 % plastic, 6 % metal and plastic composites and 13 % residual materials. These include large concentrations of substances that are harmful to human health and the environment, such as antimony, lead, cadmium, mercury, PCBs and brominated organic compounds (flame-retardants in particular). It is therefore paramount to collect used appliances separately.

Processes for recovering metals from incineration residues have become increasingly efficient. Current techniques enable non-ferrous metals to be easily recovered from **clinker**, from a 4-mm minimum size (» Chapter 5).

Effective waste processing cannot therefore be ignored in terms of conserving resources; it is important today and will remain so in the future. •

2. Energy and electromagnetic radiation

Switzerland covers 80 % of its energy needs by imports. Most of the energy used comes from fossil fuels. Energy consumption is increasing, with electricity consumption growing even more rapidly than the gross domestic product.

Increased electricity consumption and use of electrical appliances and mobile telecommunication devices is causing an increase in non-ionising radiation.

According to the CO_2 Law, by 2010, CO_2 emissions from the consumption of fossil energy carriers must be reduced by 10 % compared with 1990 levels. The SWISS ENERGY programme plans a 5 % maximum increase in electricity from 2000 to 2010, and a growth in the proportion of renewable energies, in particular for the production of electricity and heat.

Production, supply and consumption

Switzerland has only limited supplies of raw materials. This is one of the reasons why a large part of its energy needs are covered by imports (» G2.1), which make up nearly 80 % of its needs in primary energy. Petroleum and gas, two fossil energy carriers, cover over half, and nuclear fuels approximately one quarter. Hydroelectric power is of primary importance in domestic energy production. Other sources of energy are electricity and heat generated by household waste incineration plants (HWIP, 4 %), biomass exploitation (2 %), and other sources of renewable energy (atmospheric heat, wind or photovoltaic energy).

Conversion of energy within Switzerland includes the production of electricity and district heating from hydropower, nuclear fuels, oil products, gas, waste and renewable energy sources (» G2.1). The resulting losses (mainly waste heat) correspond to about 20 % of the consumption of primary energy. Within final consumption, the 8 % "other" is mainly composed of heat from renewable energy carriers (such as biomass, HWIP waste heat, and atmospheric and solar heat).

If we take economic sectors into account, private and public transport create the largest demand for energy in the country (32 %).

In 2005, the total proportion of renewable energies in Swiss consumption of final energy amounted to 16.2 % (» G2.2). This proportion was 12 % for heat production, but close to 47 % for electricity. We consider as renewable any form of energy that can be used in a natural way to prepare final energy or is directly available as final energy. Hydropower makes up the largest proportion of renewable energy, well ahead of wood and biogas. Biomass (organic materials produced more or less directly through photosynthesis) is an important source and is the simplest way of using its energy. However, its calorific yield is relatively low.

Electricity production varies from month to month (» G2.3). The nature of hydroelectric power stations means that more electricity is produced in summer than in winter, creating excesses that have to be exported. The situation is reversed in winter: without imports, the supply could not be guaranteed. But even during this season, during daytime peak hours, electricity is exported and a greater amount is

Primary and secondary energy

Energy is defined as the capacity to produce work. Contrary to what is often believed, it can neither be produced nor consumed, but only converted.

By energy vehicles, we mean all the substances that enable energy to be generated, whether directly or after conversion. Primary energy is contained in energy carriers found in nature that have not yet undergone conversion. They can either be used directly or indirectly in this form. Wood, coal, crude oil, natural gas, nuclear fuels and hydropower are examples of primary energy carriers. Secondary energy carriers are derived from the conversion of primary energy carriers. This process always involves energy loss. Electricity, petrol and district heating are secondary energy carriers.

Final energy is the one found at the end of the commercial chain. This is the energy that the consumer buys or produces him- or herself for a specific use. For example, petrol for a car or power for electric lights.

imported during the night. Pumped-storage plants enable Switzerland to exploit hydropower to the full, compensating for the daily variations in consumption within Europe.

In 2005, 32,759 GWh of electricity were produced by hydropower, 6.3 % less than the previous year. The share of hydropower for the entire national production was thus 56.6 % (average for the last ten years: 57.1 %). Since the first nuclear power plant was commissioned in 1969, this type of energy has grown rapidly. In 2005, the proportion of nuclear energy was 38 % (average of the last ten years 38.8 %). The proportion of fossil fuel energy and other types of electricity production was 5.4 %.

In Switzerland, consumption of energy has increased more than eight-fold since 1945 (» G2.4). In parallel, the dominance of coal has given way to that of petrol.

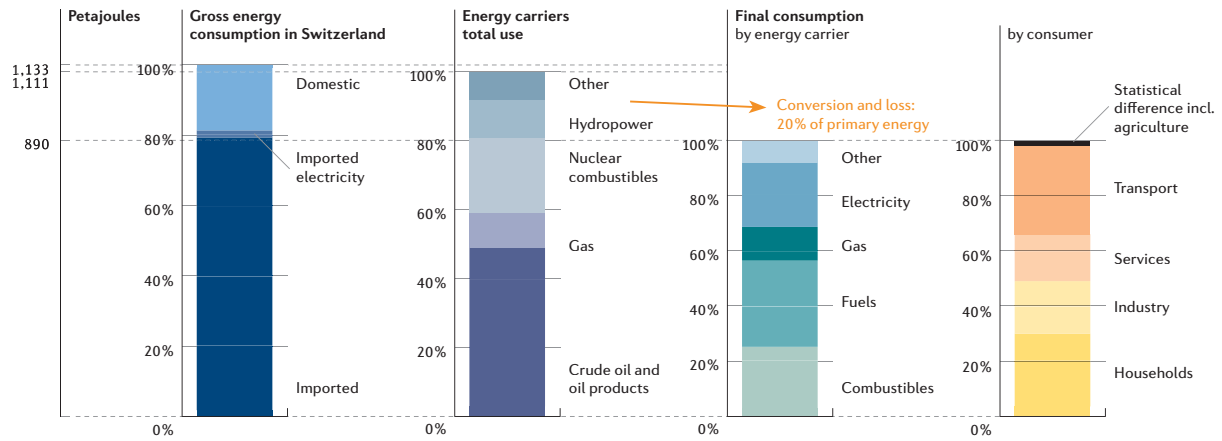
Between 1945 and 1973, the demand for oil products progressed more rapidly than total consumption. The average increase reached 12.5 % between 1950 and 1970 for this type of energy carrier. Although the proportion of oil products in final consumption has declined continuously since the first oil crisis (1973), it remains very high. It is noted that the proportion of fossil combustibles in total energy consumption has been halved since 1973, whereas the proportion of fossil fuels has increased from 25 to 29 %.

Since the early 1970s, Switzerland has been connected to the international gas network. This energy source has shown the most notable growth rate of all the traditional energy carriers. Its proportion is currently 12 %.

Electricity consumption has progressed regularly from the middle of the 1940s. Since the late 1980s, its proportion in final energy consumption has stabilised at about 22 %.

Wood energy and charcoal, which still provided 18 % of final energy after the Second World War, only produced 1.6 % in the 1980s. Since then, the use of domestic wood as a fuel has been on the increase. The same applies to the use of other renewable energy sources, such as solar power, wind, biogas and ambient heat – although at a very low level at present. »

G2.1 Energy use and final energy consumption in 2005



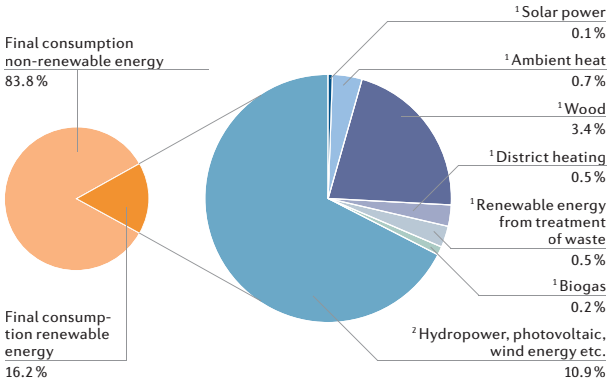
Source: FOE, overall energy statistics

Energy intensity

The importance of the variations of winter temperatures is visible if we observe the evolution of energy consumption against the main macroeconomic indicators. Heating degree-days are in particular an indicator. In the long term, however, it is variables such as GDP, population growth, industrial production and housing and motor vehicles that determine how consumption develops (» G2.6).

The 28 % increase in energy consumption since 1980 is lower than economic growth, which is approximately 46 %. Over the last few years, electricity consumption has however increased twice as rapidly as GDP. Energy intensity in the economy as a whole (energy consumption per unit of GDP) has decreased only slightly (by about 12 %). This can be explained partly by an increase in the per capita living space, and by increased mobility (» Chapters 3 and 5).

G2.2 Share of renewable energy in final energy consumption in 2005



[1] Final consumption for renewable heat production
[2] Total consumption of renewable electricity

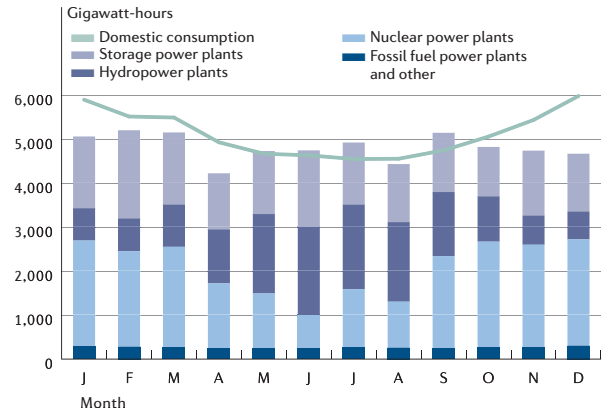
Source: FOE, Swiss renewable energy statistics

Pressures on the environment

Energy production as a whole

Any form of energy production or consumption affects the environment. Production impacts soils and landscapes (» Chapters 11 and 12), the air and climate (» Chapters 7 and 8), and material flows (» Chapter 1). It also, for example, has an effect on the hydrological regime; below the water catchment systems, residual discharge rates can be insufficient. Additionally, downstream from the hydraulic stations, many streams suffer rapid flow variations (ebb and flow effect). Natural silting can also be affected, which is harmful to the habitat of many aquatic life forms (» Chapter 10).

G2.3 Monthly quota and domestic consumption during 2005



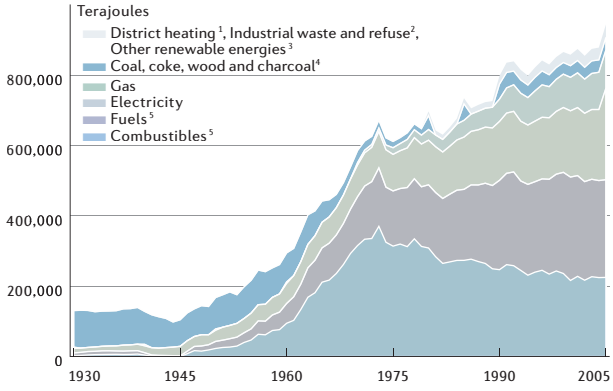
Source: FOE

Emission

The combustion and consumption of fossil or biogenous energy carriers pollute the atmosphere through emissions of nitrogen oxides (NO_x), fine particulates (PM10) and sulphur dioxide (SO_2); and also releases carbon dioxide (CO_2), methane (CH_4) or nitrous oxide (N_2O), which are greenhouse gases (» G2.5).

Heavy air pollution has adverse effects on our health and on ecosystems (» Chapters 7, 10, 13 and 17). As far as NO_x are concerned, over 90 % of emissions are energy-related. Transport is the main source (» Chapter 3). Of the greenhouse gases covered in the Kyoto Protocol, CO_2 is by far the most prevalent (» Chapter 8). Whereas this gas is mainly produced as a result of the consumption of fossil combustibles and fuels, the proportion of energy-linked emissions is secondary in the case of CH_4 and N_2O.

G2.4 Final energy consumption by energy carrier



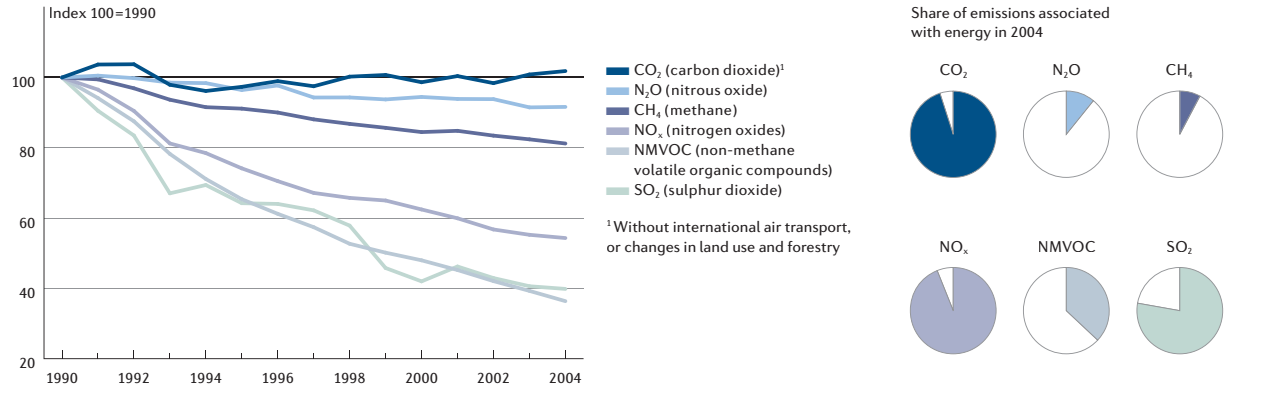
[1] Readings from 1978, [2] Readings from 1978 and including HWIP consumption from 1990, [3] Solar power, biogas, ambient heat: readings from 1990, [4] From 1990, new survey, [5] From 1990, new calorific values

Source: FOE, overall energy statistics for Switzerland

Impact on the landscape

Energy production, transport and consumption, and in particular the infrastructures that these activities necessitate, can be harmful to nature and the landscape. The infrastructures used for energy transport and production transform the landscape. In Switzerland, power lines and poles, dams, hydroelectric power stations and windmills are the most

G2.5 Changes in greenhouse gases and air pollutants emissions, and proportion of emissions associated with energy consumption



Source: FOEN, Swiss greenhouse gas inventory

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visible elements. Gas pipes and wind turbines[1] are much less noticeable. In order to limit the effects, it is important to include demands relating to the respect of nature and landscape at the beginning of the planning phase for energy infrastructures (» SAEFL 2002b).

The impact of power lines on the landscape is obvious in Switzerland. For low and medium voltages, placing the lines in cables and avoiding protected biotopes or those in need of protection, and their surroundings, considerably reduces the effects on the landscape. From 2000 to 2005, 150 km of power lines were taken down in protected sites to compensate for the construction of new ones. The length of cables was 20 % greater in 2005 than in 2000. Some 97 % of the lines that were taken down have evidently been replaced by new underground cables.

Non-ionising radiation

Everywhere that electricity is produced, transported or used, secondary effects are present in the form of low-frequency magnetic or electrical fields. Similarly to high-frequency radiation from mobile telephony, broadcast transmitting stations and other radio equipment, these fields produce non-ionising radiation (NIR). The NIR generated by technical installations is often referred to as "electrosmog".

Low-frequency radiation includes electrical and magnetic fields from overhead railway contact lines, high-voltage lines and household appliances. During the last few decades, environmental or human exposure to low-frequency NIR has increased as a result of the growth in electricity consumption and the increased use of electrical appliances. As far as electricity supply is concerned, the more powerful fields develop in the immediate vicinity of high-voltage lines and transformer substations. Overhead lines of 380 kV can increase magnetic fields in houses up to 150 to 200 m away (» SAEFL 2005a). Beyond that distance, a normal base load, ranging between 0.02 and 0.04 microtesla (μT) is measured in dwellings connected to the electricity supply (» Stratmann et al. 1995). Near electrical appliances, however, the magnetic field may be much stronger.

Over the last few years, high-frequency radiation has also increased greatly in the environment as a result of the growth in mobile telephony (» G2.7). This type of radiation also occurs with broadcasting, radio transmission systems, cordless telephones and digital wireless networks (WLAN). Whereas immissions associated with broadcasting as a whole are usually prominent in rural areas, the contribution from mobile telephony to this type of radiation is greater in towns and conurbations. However, individual exposure often depends on low-intensity transmitters used very close to the body. Thus, mobile telephones, because they transmit close to the head, irradiate their user much more than all the nearby base stations (» Measures against non-ionising radiation, page 34). The effects of this type of radiation on humans vary according to frequency range and intensity (» Chapter 17).

Ionising radiation

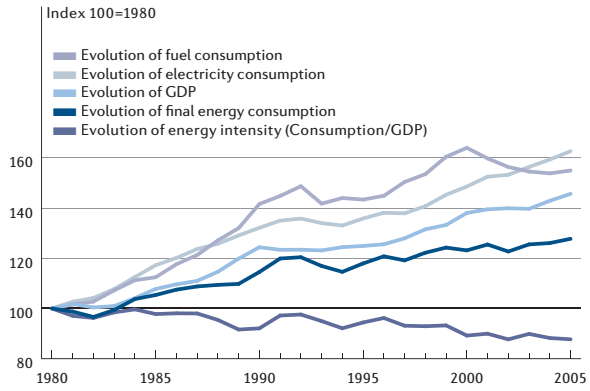
Ionising radiation is often mentioned in connection with nuclear power stations. However, radiation doses connected to other sources are much greater. The average dose to which the Swiss population is exposed is about 4 millisieverts (mSv[2]) per year. It is made up of natural and artificial radiation sources. Radon gas and its derivatives, and medical devices are the main sources (» G2.8).

The average radiation dose from natural sources to which the population is exposed is about 3 mSv per year (» T2.1). Natural radionuclide elements found in soils together »

[1] Underground installations to transport the energy produced by wind farms.

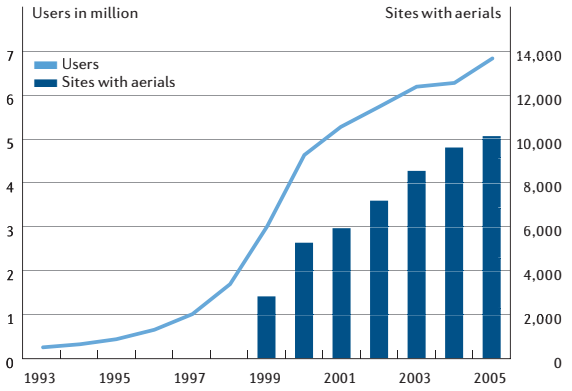
[2] The millisievert (mSv) is a unit of radiation dose. The level of dose is directly proportional to the biological effect of the radiation. An identical number of mSv implies the same risk associated with the radiation, whether it is of natural or artificial origin.

G2.6 Evolution of final energy consumption, GDP (real), energy intensity, fuel and electricity consumption



Source: FSO, FOE: overall energy statistics for Switzerland

G2.7 Evolution of mobile telephony in Switzerland



Source: OFCOM, telecommunication statistics

› with cosmic radiation account for about 0.8 mSv per year, on average. In dwellings, cosmic radiation is weakened by the building's structure. On the other hand, the ground element is intensified by the radionuclides present in the walls. On the whole, the dose inside dwellings is about 10 % greater than the dose outside.

Radionuclides also enter the body via the food we eat and the air we breathe. Radon-222 and its derivatives, present in dwelling and working premises, are the greatest generators of radiation. This rare radioactive gas forms naturally when radium, present everywhere in the ground, disintegrates. It is then released into the atmosphere. Once in the open air it dilutes at altitude, but much higher concentrations can be present in buildings (» Chapter 17).

There are also internal and external components of doses emanating from artificial radiation sources. The external component is mostly generated by medical diagnostics using X-rays, which create an average load of 1 mSv per year. Lower doses are associated with professional exposure to radiation in nuclear power stations, industry, trade, public services, research and medicine, as well as consumer goods and commonplace items containing radionuclides. Watches with luminous radioactive displays are thus responsible for about 0.2 mSv per year. In Switzerland, the effects of the Chernobyl nuclear accident of April 1986 remain only as traces, with doses of a few hundredths of mSv. This also applies to radiation from tests of atomic weapons at ground level performed in 1950–1970.

The internal component of artificial radiation sources comes from the radionuclides that enter the body through the air we breathe, the water we drink and the food we consume. Caesium-137 and Strontium-90 together form the largest intake through food. They stem from the testing of atomic weapons between 1950 and 1970, and, primarily, from the accident in the reactor at Chernobyl. The dose applicable to Switzerland is currently below one thousandth of a mSv per year. Overall, the radiation dose represented by artificial radioactivity or commonplace items containing radioactive substances (medical applications excluded) is between 0.01 and 0.05 mSv for the majority of the population in Switzerland.

Nuclear power stations are the main producers of radioactive waste, although it also comes from medicine, industry and research. In the course of the waste disposal process, radioactive substances are often transported. The carrier is mainly responsible for radiological safety and for complying with the provisions relating to transport. In the case of transport of nuclear fuels and other highly radioactive substances, the carrier must obtain an authorisation from the main division of the Swiss Nuclear Safety Inspectorate (HSK). In 2005, 13 authorisations were issued.

Waste treatment is the first step towards disposal of radioactive waste. It consists in the transformation of raw waste into an intermediary or definitive form, enabling it to be stored (» G2.9). A reduction in the quantity of waste is often achieved during treatment. This is performed in nuclear power stations, at the Paul Scherrer Institute (PSI), and at the intermediary storage depot at Würenlingen.

Reprocessing of waste to separate uranium (96 %) and plutonium (1 %) from non-usable products is performed

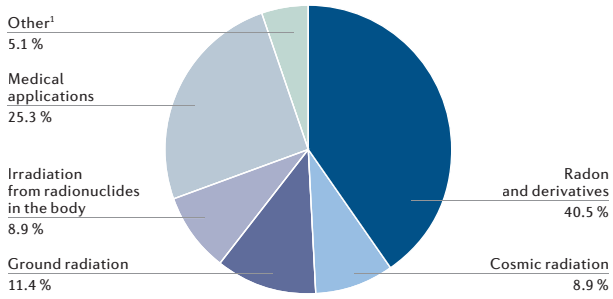
T2.1 Exposure of the Swiss population to natural radiation by sources

Source	Average in mSv	Maximum in mSv
Ground radionuclides	0.45	1.0
Cosmic radiation	0.35	0.6
Radionuclides in the body	0.35	0.5
Radon in dwellings	1.60	100.0

Source: FOPH

G2.8 Average dose of ionised radiation

Dose of radiation to which the population is exposed



[1] Fallout from nuclear bombs, Chernobyl accident, nuclear power installations, industries and hospitals, weak sources etc.

Source: FOPH

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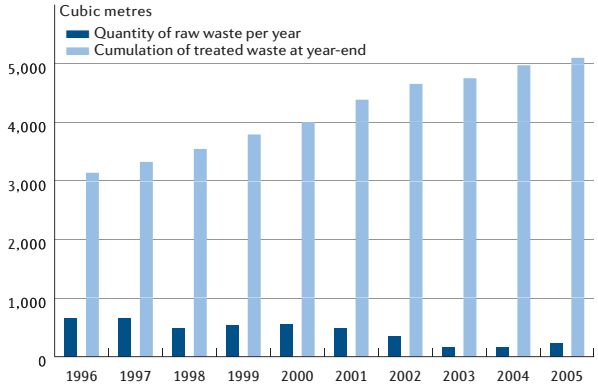
G2.9 Radioactive waste produced in Switzerland



Source: FOE, HSK

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abroad. Uranium and plutonium are recycled, but non-usable products are sent back to their country of origin. In Switzerland, this waste is stored in the intermediary storage depot at Würenlingen.

Sustainable waste storage must take place in the form of an underground repository over a period of several thousand years. Intermediary storage is necessary as long as a definitive solution is not available. Each nuclear power plant has its own intermediary storage depot for its own waste. The federal intermediary storage depot at the PSI is intended for the storage of nuclear waste from medicine, industry and research. The overall volume of radioactive waste stored in intermediary storage depots in Switzerland in 2005 was equivalent to 5,000 m^3 (» G2.9).

Measures in place and their impact

Measures during energy production and consumption

The Energy Law[3] and its associated application ordinances form the legal basis of the Confederation's energy policy. This law, which plans a broad cooperation with the private sector, is based on the principle of subsidiarity of State interventions, and puts the emphasis on voluntary measures. It also defines the division of tasks between the Confederation and the cantons, especially concerning energy standards in the construction sector, as well as the development of incentive programmes for the cantons.

The principal measures to improve energy efficiency have been implemented in the SWISS ENERGY programme for 2001 to 2010, which followed the ENERGY 2000 programme (1991–2000). SWISS ENERGY's core quantitative objectives support those laid down in the CO_2 Law, as well as Switzerland's commitments in the Framework Convention on Climate Change (» Chapters 8 and 18). CO_2 emissions from the consumption of fossil fuels must decrease by 2010 by 10 % compared with their 1990 level. Consumption of electricity must not exceed 2000 levels by more than 5 %. Furthermore, the proportion of renewable energies must increase by 0.5 terawatt hours (TWh = 10^9 kilowatt-hours) for electricity production and by 3 TWh for heat.

Within this context, SWISS ENERGY has put the emphasis on various supplementary measures. One of the main measures consisted in agreeing a contract for services with the Energy Agency for Industry (EAI). Set up as a private entity, the EAI helps companies to define internal measures to reduce energy consumption and CO_2 emissions. Private energy agencies have been put in charge of coordinating, assessing and supervising the activities linked to the sectoral conventions concluded on a voluntary basis, as well as writing the corresponding reports. Another measure is the introduction of "Energy" labels for household appliances and vehicles. With regard to vehicles, it is planned to also include pollutant emissions and noise. These labels must guarantee greater transparency for the consumer when purchasing goods.

The introduction of a new quality assurance system to improve certification according to the Minergy standard is also part of the measures adopted. This label is for buildings whose energy consumption does not exceed a three quarter of that of typical buildings. Switzerland has also introduced energy consumption reduction and follow-up services for big consumers in the public sector. The "Energy city" label is also encouraged (over a quarter of the population of Switzerland already lives in an "Energy city"). Finally, a network of private agencies and competence centres has been created to promote renewable energies and energy efficiency.

Measures taken in the area of energy and air pollution control must always be evaluated in terms of their possible interactions. Thus, measures aimed at changing behaviour to promote the efficient use of resources often result in »

[3] Swiss Federal Law on Energy of 26 June 1998 (ENG), RS 730.0.

reduced energy consumption and reduced emissions of greenhouse gases and pollutants. At the same time, measures taken, for example, to optimise engine performance and consumption may produce increased air pollution. These aspects must therefore be taken into account within the context of engine technology and the processing of exhaust gas (using catalytic converters or particle filters in particular » Chapters 3, 7 and 8).

In the area of energy production and transport, other measures relate to soils (» Chapter 11), air (» Chapter 7), climate (» Chapter 8) and water (Chapter 10).

Energy production, transport and storage in their different forms can be very harmful to the environment, nature and the landscape. The installations concerned must therefore be the subject of an environmental impact assessment (EIA). This ensures a precise analysis of the environmental effects and their global evaluation. Construction and renovation of hydroelectric power stations have recently been at the forefront. Soon, the development of a few gas power stations will be subjected to an assessment. A substantial extension of the transport network for high-voltage electricity is also underway. Power line routes will need to comply with all the environmental demands, sparing the landscape while guaranteeing the protection of the population from non-ionising radiation.

To minimise the impact of energy infrastructure installations on the landscape, power lines must be grouped where possible, avoid built-up areas and locations where they would be highly visible, and circumvent landscapes of national importance and protected sites or pass under them in underground cables (» Chapter 12). The goal is to integrate the power lines into the landscape in the best possible way (» FDHA 1980). Any new transalpine power lines must use existing routes.

Measures against non-ionising radiation

The Federal Council has issued the Protection against Non-ionising Radiation (ONIR)[4] to protect the population from the effects of electrosmog. The text sets threshold values for the radiation of stationary installations such as high-voltage lines and broadcasting and mobile telephony transmitters. Electrical devices such as mobile telephones, cordless telephones or microwave ovens are however not covered by the ONIR. These devices irradiate their users in the first instance, and not the environment, so their radiation is not covered by environmental protection legislation.

Radiation exposure limits protect the population – with a sufficient degree of assurance – from scientifically recognised effects on health: thermal effects of high-frequency radiation and the undesirable triggering of nervous stimulation and muscular contractions by low-frequency fields (» Chapter 17). The values refer to the overall amounts of low-frequency and high-frequency radiation measured in one place. They must be adhered to wherever human beings are likely to reside, even for a short period. In Switzerland this is not usually a problem.

[4] Ordinance of 23 December 1999 on Protection against Non-ionising Radiation (ONIR), RS 814.710.

Some indicators give us the impression that biological effects appear even at exposures lower than the radiation exposure limits. Current knowledge does not enable us to state whether these effects are a health hazard, or under which conditions [5] (» FNS 2005). When the ONIR was adopted, the Federal Council did not want to wait until science had supplied all the answers. Taking the precautionary principle of environmental legislation as a basis, this ordinance has established even more stringent exposure limits, primarily to maintain long-term exposure at a low level. For mobile telephony installations, the threshold values are about 10 times inferior to the radiation exposure limits, and even 100 times lower than for high-voltage lines. The installation exposure limit applies to radiation from a single installation and must be adhered to in all places where people reside on a regular basis (for example: dwellings, schools, hospitals, offices or playgrounds). Thus, Swiss legislation for these places is one of the most restrictive in the world.

Measures against ionising radiation

The Radiological Protection Ordinance[6] limits the dose of radiation from artificial sources to which the population can be exposed to 1 mSv per annum. Radon and medical applications are not included. A limit of 20 mSv per annum applies to individuals whose professional activity may expose them. For this group, exposure to radiation is calculated by recognised dosimetry services and recorded in a central registry at the Federal Office for Public Health. The Ordinance on Protection against Radiation also defines the exposure limits for air and water, and for direct radiation. It indicates threshold and directive values for radon in dwellings and workplaces. Threshold and tolerance values for radionuclides occurring in food are given in the Ordinance on Contaminants and Ingredients of Foodstuffs[7].

The FOEN is the supervisory authority for nuclear energy and the FOPH deals with the other areas, in particular medicine, industry and research.

Ambient dose rates are constantly monitored in 58 stations, using an automatic network fitted with Geiger counters (NADAM network). Other, denser automatic monitoring networks operate in the vicinity of nuclear power plants. An automatic network of 10 stations also monitors atmospheric radioactivity, with an additional station in the Principality of Liechtenstein (RADAIR). The FOPH coordinates the data from the numerous laboratories of the Confederation, cantons, polytechnics and research institutes. It collects, assesses and regularly publishes data and the resulting radiation doses for the population's information. •

[5] National research programme 57 (NRP 57), "Non-ionising Radiation – Health and Environment", which receives a credit line of CHF 5 million, will continue until the end of 2009 » www.snf.ch » Research programmes » National programmes » Current programmes » NRP 57.

[6] Ordinance of 22 June 1994 on Protection against Radiation (Radiological Protection Ordinance, RPO), RS 814.501.

[7] FDHA Ordinance of 26 June 1995 on Contaminants and Ingredients of Foodstuffs, RS 817.021.23.

3. Transport and mobility

Individual motorised transport has doubled since 1970 and road freight transport has tripled.

Public transport accounts for 18 % of passenger transport and rail accounts for 40 % of freight transport.

Since the year 2000, CO_2 emissions from transport have been stable. In 2004 they made up 34 % of the overall CO_2 emissions in Switzerland.

Hydrocarbons, NO_x and PM10 emissions have decreased since 1985, but they must be further reduced, mainly by the application of new technologies.

Transport, particularly road traffic, is the primary source of noise.

External transport costs were estimated at CHF 6.5 billion in 2003.

Mobility in Switzerland

Passenger transport

In the year 2005, each person residing in Switzerland travelled an average of 15,700 km on land. The total covered distances in Switzerland in one year by residents or visitors ("transport services") amounted to 112 billion person-kilometres in 2004 (» G3.1).

The private car is by far the most common means of transport. In 2004, 82 % of the overall covered distances were by motorised private transport, with the share of public transport at under 18 %. This ratio, called "modal distribution", has essentially remained stable since the 1990s. If we add non-motorised traffic (bicycle, walking), the cumulative modal distribution of non-motorised and public transport traffic was 28 % in 2005 (» FSO/ARE 2007).

The increase in transport is mainly due to the use of private cars. The number of kilometres travelled has almost doubled since 1970. Population growth only accounts for one fifth of this increase. The main reasons for this concern the increasing distance between place of residence and workplace, centralisation of shops and services, and above all, leisure travel. In 2005, 45 % of the average daily distance covered related to leisure activities (not including long-distance holiday travel) (» G3.2). Work-related travel amounted to less than a quarter of personal transport.

The choice of transport plays a decisive role in the impact of traffic on the environment. It is motivated by the purpose of the travel (» G3.3). Thus, the proportion of distances covered on foot or by public transport is substantially greater within the category "personal development" than in the other categories, because of the high percentage of under–18-year-olds who cannot yet drive.

Surveys have shown that the mere fact of having a car determines the choice of transport means to a great extent (» Franzen 1997). Currently, 81 % of households own at least one and 31 % have two or more cars (» G3.4).

Freight transport on land

As our economy is based on work division, the transport of goods plays an important part. The total distance covered by freight currently exceeds 26 billion tonne-kilometres per year (» G3.5). Whereas in 1970, 60 % of freight (in tonne-kilometres) was still being transported by rail, this propor-

tion (modal distribution) was only 40 % in 2004. This change is explained by the fact that freight transport by road tripled during this period, recording an even more significant increase than that of private passenger transport. In comparison with gross domestic product (GDP), freight traffic as a whole also increased in greater than average proportions (» G3.6): between 1980 and 2004, freight transport per GDP unit – called "transport intensity" – progressed by 23 %. Again, there are many reasons for this: concentration of the manufacturing on a limited number of sites in order to increase the production volume, and thus productivity; the trend for just-in-time deliveries; and growing consumption.

In the debate on transport and the environment, transalpine freight transport is of particular importance. Here, the traffic flow is concentrated on a few roads where the residents are particularly affected by various forms of pollution. Again, the volume of traffic has more than doubled since 1980, whereas the share of transport by rail dropped from 93 to 65 % (» ARE 2005a) (» G3.7).

Air transport

The increase in mobility is also exemplified by air travel, but it is important to remember that passengers and freight are usually transported aboard the same aircraft. Aircraft take-off and landing cause a considerable amount of noise and other nuisance for people living close to airports. They also consume a large amount of energy and generate a high level of pollution as a consequence. The traffic recorded at the three main national airports (Zurich, Geneva and Basel-Mulhouse) shows that the number of scheduled and charter flights nearly tripled between 1970 and 2000 (+184 %). However, following the perturbation in the Swiss air travel sector, this figure has since decreased by over 20 % (» G3.8).

Consumption in the transport sector

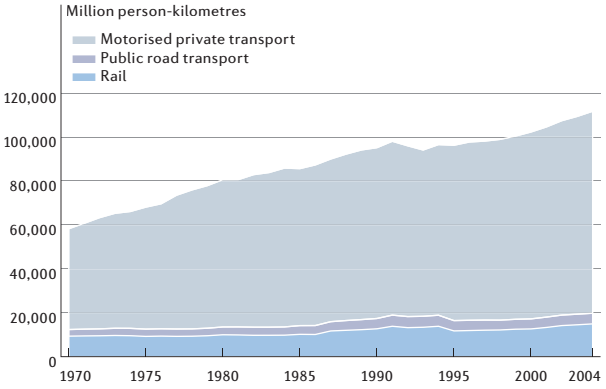
In spite of the improvement in energy efficiency, annual energy consumption in the transport sector doubled in Switzerland between 1970 and 2000 (» G3.9). However, a slight decrease has been observed since 2000. In 2005, transport consumed 32.3 % of overall final energy in Switzerland (» Chapter 2). The greatest proportion was used for road traffic. Since 1970, 95 to 97 % of the energy used by transport has been derived from oil products. The decrease in energy consumption in this sector since 2000 is due to the decrease in air traffic (» G3.8).

Pressures on the environment

Air pollution

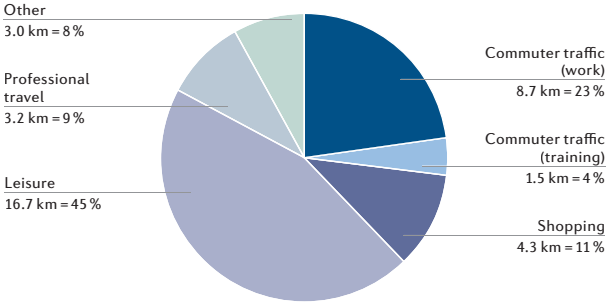
In 2004, CO_2 emissions from traffic were 15.4 million tonnes, which corresponds to 34 % of total CO_2 emissions and 29 % of the overall greenhouse gas emissions in Switzerland. Having increased by over 8 % between 1990 and 2000, they have generally stabilised since then (» G3.10). Nearly three

G3.1 Passenger transport services



Source: FSO

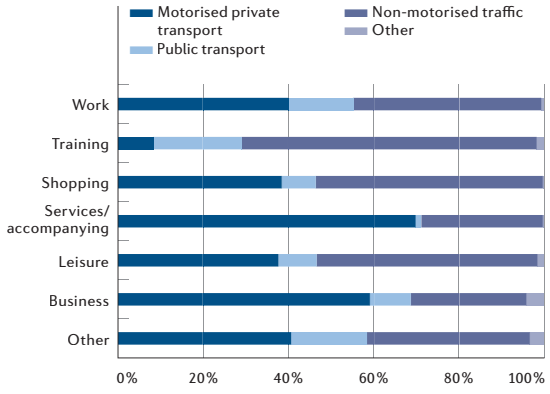
G3.2 Average daily distance travelled according to purpose in 2005



kilometres per day: 37.3 km

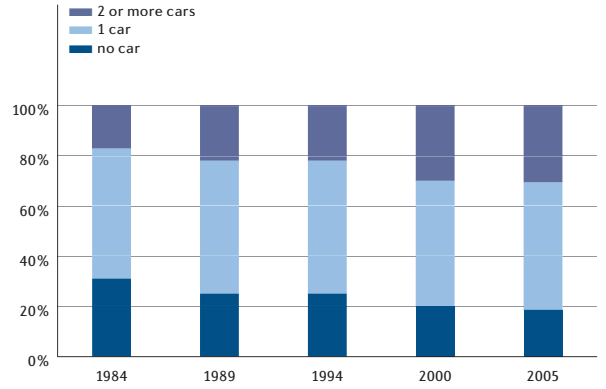
Source: FSO, ARE: Microcensus transport habits

G3.3 Journeys according to type of transport and purpose of travel in 2005



Source: FSO, ARE: Microcensus transport habits

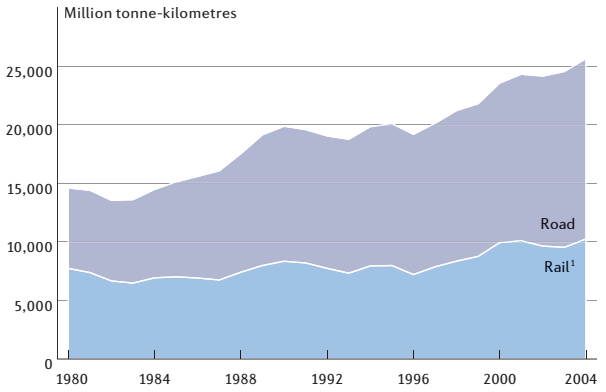
G3.4 Number of vehicles per household



Source: FSO, ARE: Microcensus transport habits

FS

G3.5 Freight transport services: rail and road

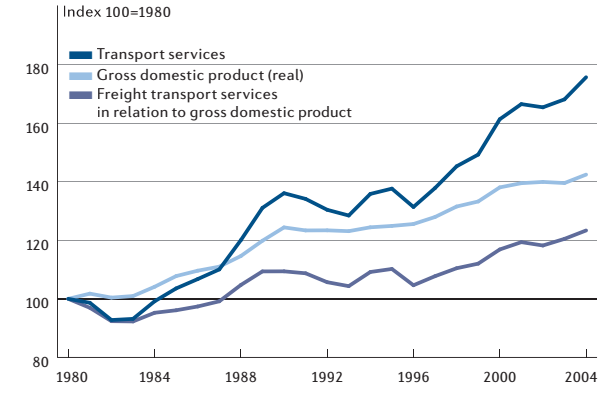


¹ Net tonne-kilometres: not including weight of freight transport vehicles (and trailers), containers and mobile bodies in combined transport.

Source: FSO

SI FS

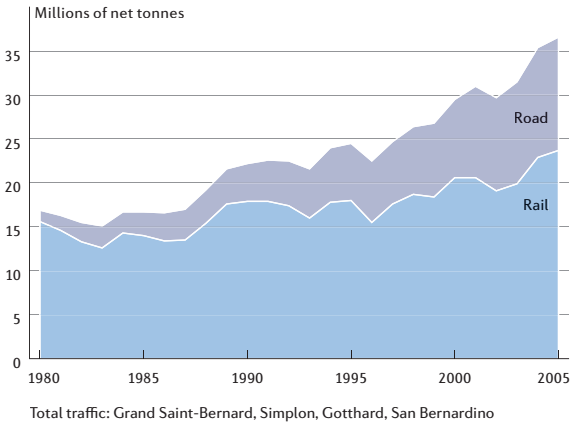
G3.6 Freight transport services in relation to gross domestic product



Source: FSO

SI FS

G3.7 Transalpine freight traffic in Switzerland

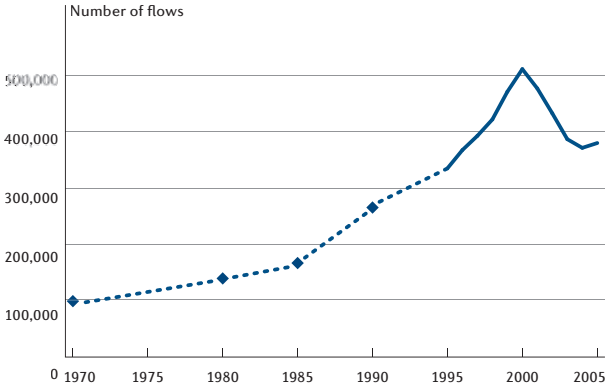


Total traffic: Grand Saint-Bernard, Simplon, Gotthard, San Bernardino

Source: FOT 2005

IF FS

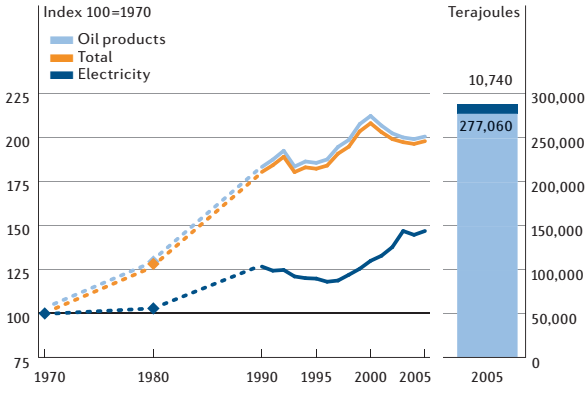
G3.8 Flows in scheduled and charter traffic at domestic airports



Source: FOCA

IF FS

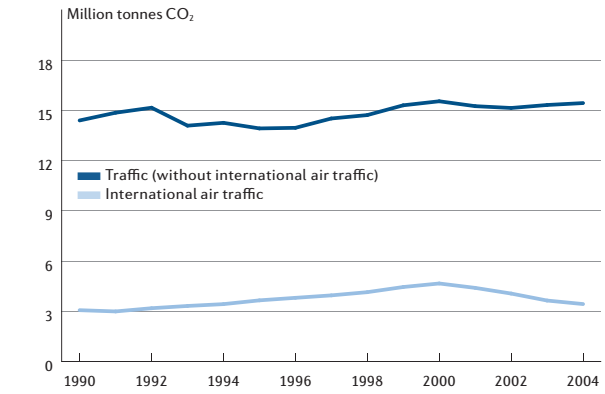
G3.9 Transport final energy consumption

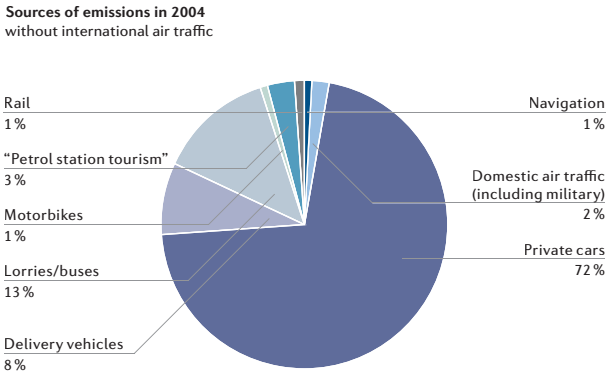


Source: FOE, Overall energy statistics of Switzerland

IF

G3.10–G3.11 CO_2 emissions from traffic





Source: FOEN, Swiss inventory of greenhouse gas emissions

IF M

quarters of CO_2 emissions from traffic in Switzerland are generated by private cars. The Kyoto Protocol (» Chapter 8) stipulates that fuel bought in Switzerland but used on foreign roads must also be accounted for when calculating emissions. This "petrol station tourism" accounts for 3 % of CO_2 emissions. On the other hand, CO_2 emissions from international air traffic are not covered by the objectives set in this Protocol. These are therefore mentioned separately; they increased by 48 % between 1990 and 2000, rising from 3.1 to 4.7 million tonnes. However, since then they have almost returned to their 1990 level, at 3.4 million tonnes in 2004, owing to the crisis in Swiss air transport (» Air transport, page 37).

In the private motorised transport sector, technological improvements to vehicles (low-consumption engines) have produced a continuous decrease in CO_2 emissions per person-kilometre, which dropped by 12 % between 1990 and 2004. This performance improvement in terms of CO_2 has however been undermined by the increase in transport volumes. CO_2 emissions across the whole of the transport sector have followed the evolution in the economy: they remained steady during the phase of economic stagnation in the first half of the 1990s, and increased slightly with the economic recovery between 1995 and 2000. Since then, economic growth has slowed down again, and as a result, so has the increase in emissions.

For several years we have observed a decrease in the emissions of most air pollutants from road traffic (» G3.12). Thus, emissions of nitrogen oxides (NO_x) and hydrocarbons (HC) have decreased. It is a different story for particulate matter (» Chapters 7 and 17). Although the emissions of particles present in exhaust gas (diesel soot) have significantly decreased during the last few years – a deceleration of this decrease has however been noted – global emissions remain constant. This is due to the increase in other PM10 emissions generated by traffic, and especially from mechanical friction between vehicles and roads, and vortexes caused by vehicles (» SAEFL 2004a).

NO_x and particulate matter emissions in particular must be reduced further to reach the objectives with regard to air pollution control.

The correlation between emissions from traffic and measured immissions is not constant, as shown by the pollution and noise measurements taken along the A2 (Gotthard) and A13 (San Bernardino) motorways. Pollution rates recorded in the Alpine valleys are striking. Although the traffic (all traffic and not just lorries) is considerably less heavy, NO_x and particulate matter deposits are as high as along the A2 and A1 motorways (in the Basel agglomeration and on the Central Plateau, respectively, » FOEN 2007). Because of the topographical and meteorological characteristics of the Alpine valleys, measurements of traffic emissions are higher than the average. As air pollutants cannot be released sideways, they are kept close to the ground by air masses during thermal inversion.

Fluctuations throughout the week are also observed. NO_x immissions decrease considerably at weekends because of the Sunday ban on heavy goods transport. In addition, noise pollution varies greatly with time of day. On working days, the noise level increases rapidly when the ban on night driving for heavy goods vehicles is lifted and commuter traffic starts, then it remains constant until about 6 p. m. and decreases until 2 a. m. It is the opposite for rail: at night the noise level caused by goods trains predominates. As a yearly average, it decreases only very slightly compared with daytime noise, whereas that of road traffic is significantly lower at night (» Chapter 16).

Impact of infrastructures

According to land use statistics, transport areas account for 32 % of the habitat and infrastructure surfaces (» G11.1). They increased by 10 % within the last 12 years of last century. »

› As a result of the development of the domestic road network, the increase in motorway areas has been higher than the 33 % average (» G3.14). With an increase of nearly 38 %, parking spaces register the highest progression among transport surfaces (in parallel, the number of private cars has approximately doubled. Railway surfaces occupy 10 % of transport surfaces and have only slightly increased (+1 %), although the number of railway users increased by 55 % between 1980 and 1990. Land parcelling by roads and railway lines is one of the major causes of the decrease in many animal populations (» Chapter 12). The mortality rate due to collisions of vehicles with wildlife is also rising.

Noise pollution

Transport is the primary source of noise in Switzerland (» G13). Within this category, road traffic generates over half the cases where threshold limits are exceeded (» Chapter 16).

External costs

Companies and private individuals choose their means of transport primarily in relation to the variable costs they would incur (fuel, travel or consignment costs; maintenance of the vehicle). They often do not consider fixed costs (insurance, provision for depreciation of vehicles, season tickets) or external costs sufficiently. The latter are borne by third parties, often the community and future generations. They relate principally to the costs incurred in the areas of the environment, climate and health, as well as those associated with damage to buildings. The total of these costs was estimated to be CHF 6.5 billion in 2003: CHF 6.1 billion for road traffic and CHF 0.4 billion for railway traffic (» FSO 2006a). Railway traffic generates the lowest external costs per passenger-kilometre, followed by public road transport and private motorised traffic (» G3.15). In the case of freight traffic, external costs are significantly lower for railway transport than for heavy goods vehicles. On the other hand, the latter cover 20 % of their external costs through the MRHVT[1]. There is therefore a need for environmentally harmful transport infrastructures, which are very expensive for the community and not economically optimal.

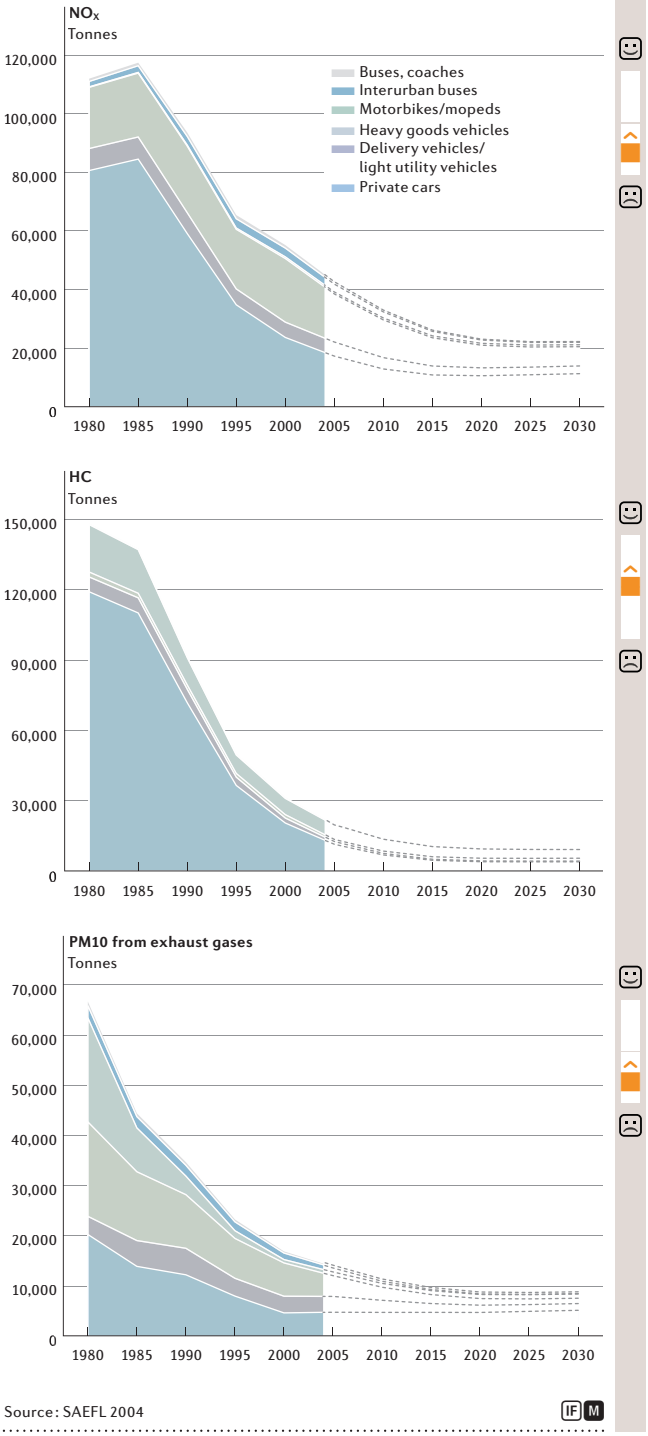
Measures in place and their impact

Transport policy

Switzerland's transport policy is based on the principle of sustainable development, by designing infrastructures to respond to mobility needs while respecting criteria relating to cost, efficiency and demands associated with the public services, and without harming the natural environment in the process. The reorganisation of the railways, the tax on heavy goods vehicles (MRHVT) and the modernisation of rail infrastructures are some of the measures put in place. The goal is to combine the advantages of various means of transport, by promoting public transport, increasing non-polluting mobility, and transferring freight traffic from road to rail (» DETEC 2005a).

From an ecological point of view, transport policy aims long-term to reduce the damage to the environment attributable to transport, such as air pollution and climate change, noise, land use, landscape and environment degradation; as well as to reduce energy consumption, especially that of non-renewable energy carriers. Efforts are also being made

G3.12 Evolution of emissions by vehicle category

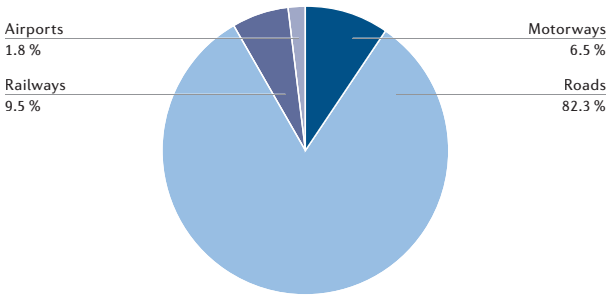


Source: SAEFL 2004

IF M

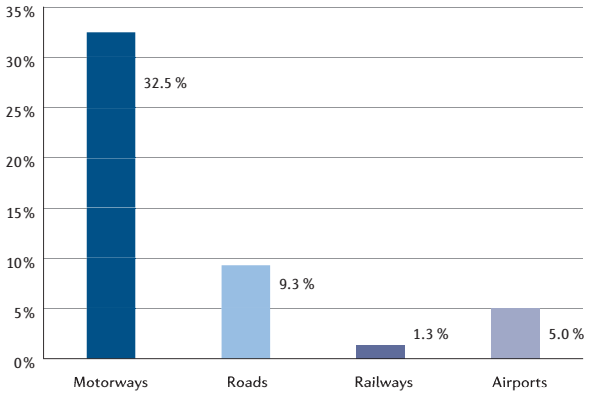
[1] MRHVT: Mileage-Related Heavy Vehicle Tax on road usage of heavy good vehicles; Swiss Federal Law on MRHVT, RS 641.81.

G3.13 Transport surfaces
Structure for 1992/1997 – total: 89,331 ha



Source: FSO, land use statistics

G3.14 Transport surfaces
Evolution 1979/1985–1992/1997



Source: FSO, land use statistics

for the various means of transport to cover their running costs as well as the external costs that they occasion. Furthermore, all technological solutions are being put in place to optimise the infrastructures, vehicles and fuels for the most efficient use of existing installations.

Transfer from road to rail and internalisation of external costs
The MRHVT introduced in 2001 applies to lorries whose actual weight exceeds 3.5 t. It is calculated on the basis of the number of kilometres travelled on Swiss territory, the authorised total weight and the emission values of pollutants. The level of the tax will increase progressively, the maximum being reached in 2008. Together with the accompanying measures introduced from 2000, the MRHVT resulted in a considerable decrease in HGV traffic across the Alps and the preservation of a high level of rail traffic. Thus, 1.2 million HGV movements across the Alps were recorded in 2005, as opposed to 1.4 million in 2000; the volume of freight transported by rail increased in parallel by 15 % (» DETEC 2006).

Reduction of traffic pollutant emissions
The continuous enforcement of the provisions on exhaust gases (NO_x, HC, CO, PM10) and fuel quality (sulphur, lead) has proved by far the most efficient measure in reducing pollutant emissions. This could nevertheless decrease much more significantly if the best available technologies were rigorously applied to new vehicles (particle filters for diesel-powered vehicles, new propulsion technologies or alternative technologies).

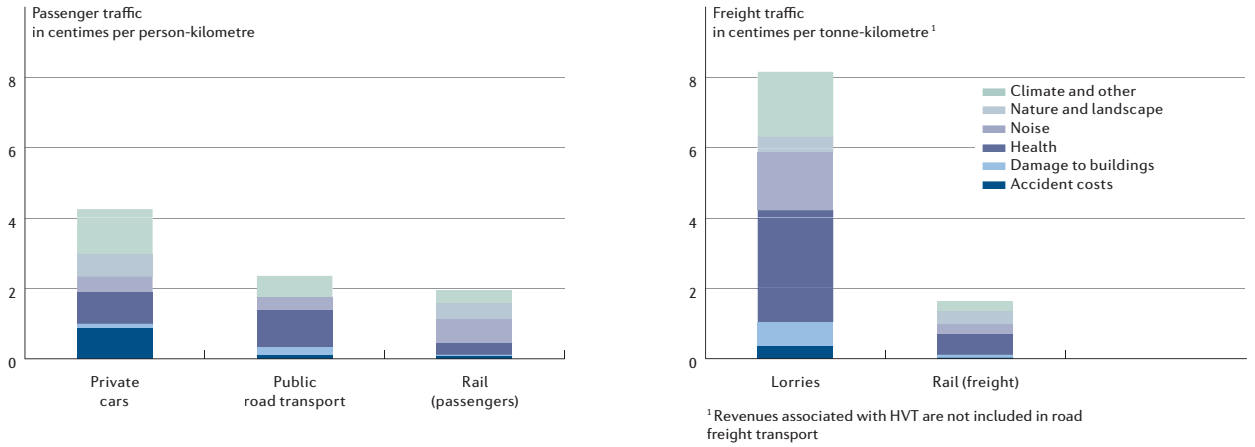
Climate protection
By ratifying the Kyoto Protocol, Switzerland committed to reducing its greenhouse gas emissions by 8 % (» Chapter 8) until 2012 at the latest. The volume of CO_2 emissions from road traffic depends not only on the number of kilometres travelled but also on the vehicles' specific fuel consumption. The Swiss association of automobile importers and the DETEC have agreed an annual decrease of 3 % between 2000 and 2008 for this type of consumption. Although consumption has dropped for new vehicles for several years, the decrease remains below this value. Reasons for this include the fact that consumers are purchasing ever heavier and more powerful vehicles. Cantonal tax on motor vehicles is calculated on the basis of criteria determined, in principle, by fuel consumption. Thus, vehicles with good energy efficiency tend to be charged lower cantonal taxes. Several cantons grant a reduction or even exemption on the tax for motor vehicles to owners of "clean" vehicles with particularly good energy efficiency.

Noise pollution control
Various measures are being taken to reduce noise from traffic, at source, where it is emitted, and on buildings; as well as spatial planning measures. Measures for reducing noise emissions are already in place (» Chapter 16). However, a large potential for reduction still subsists, through the technical development of quieter vehicles, noise-dampening tyres and muffling road surfaces.

Nature and landscape protection
Transport infrastructures and their use are the main cause of habitat fragmentation. These effects can be diminished by planning compensation measures when new installations are built, and when sectorial plans are established within the framework of spatial planning (» Chapters 11 and 12).

Fuel consumption reduction
In the passenger transport sector, fuel consumption reduction should be achieved through public information to encourage the use of less polluting vehicles (» Reduction of »

G3.15 External costs of accidents and environmental damage in 2003



Source: FSO 2006

traffic pollutant emissions) and adopt more environmentally friendly driving techniques (such as Eco-drive), and through the promotion of public transport.

An increasing number of private cars run on diesel fuel: 40 % of new vehicles registered in Switzerland in 2005 already use this fuel. With identical use, diesel engines consume 20 to 30 % less fuel than cars equipped with petrol engines. Therefore they release 10 to 15 % less CO_2. However, diesel engines not equipped with particle filters are harmful to human health because they emit about 1,000 times more carcinogenic particulate matter than petrol engines. Moreover, diesel engine cars release on average eight times more nitrogen oxide than cars with petrol engines. As a result, only diesel engine cars equipped with a particulate filter (Euro–5) should be used.

One possibility of reducing consumption of fossil fuels lies in technologies that enable biomass to be converted into fuel. To this effect, a reduction in the price of gas (used as fuel) and biofuels will probably be introduced in 2007 by means of a tax on mineral oils. However, production of these biofuels will need to present a globally positive ecological assessment to gain the right to be promoted (technological development, zero-rating) by the public authorities. In addition, the Swiss government would like to introduce tax incentives in order to increase the number of motor vehicles fitted with propulsion systems enabling the economical use of resources to 400,000 between now and 2012.

Taxes on fuels affect the quantities of petrol and diesel consumed because of the price rise they cause. The price of unleaded petrol – in constant francs – increased continuously by 16 % between 1990 and 2005, and that of diesel by 19 % between 1993 and 2005. Taxes on unleaded petrol and diesel have not changed since 1999 and 1997, respectively. They represented 48 % and 46 % of the pump price in 2005. The quantity of fuel consumed increased between 1990 and 2000 but has since stabilised. However, the taxa-

tion rate and average fuel prices are still too low to encourage people to choose more ecological behaviour as well as technologies likely to lower total fuel consumption.

Environmental Impact Assessment

When planning construction or transformation projects for large transport infrastructures, an environment impact assessment (EIA) must be performed to ensure that the environmental protection demands are met. The decision-making authority expresses an opinion on the project and, if necessary, imposes new conditions so that such projects can be performed in an environmentally respectful manner. Roads, large car parks, railways and airports are subject to EIAs. Between 1990 and 2005, the FOEN studied 548 reports connected with transport infrastructures.

In the last few years, monitoring of transport infrastructure construction sites has become a very useful tool for ensuring that the measures on environment protection are applied adequately and in conformity with current legislation. To streamline the preparation of reports concerned with environmental impact, and to ensure the implementation of the protection measures anticipated, the FOEN has substantiated its demands relative to the monitoring of construction sites and acceptance of environmental measures. The file prepared for this purpose shows how to integrate monitoring into the management of the sites, and how best to achieve the distribution of tasks and cooperation between the client, the persons in charge of environmental monitoring, and the authorities. •

4. Industry, production and commerce

Although gross domestic product (GDP) has increased since 1990, greenhouse gas emissions resulting from economic growth have remained stable.

In 2003, Swiss industry spent CHF 1.28 billion to protect the environment; about 0.3 % of GDP. The same proportion applies in European industry.

Switzerland has achieved a high level of autonomy in disposing of hazardous wastes, most of which are produced by the remediation of contaminated sites.

Switzerland's 3,000 to 4,000 contaminated sites will be cleaned up in a sustainable way over the next 25 years. Some 17 km^2 of industrial zones with contaminated sites will be reassigned.

About 100,000 chemical substances are used for economic purposes worldwide. About 70 of the 4,800 substances listed by the OECD are produced in Switzerland – nearly three quarters of these are intended for use in the life sciences.

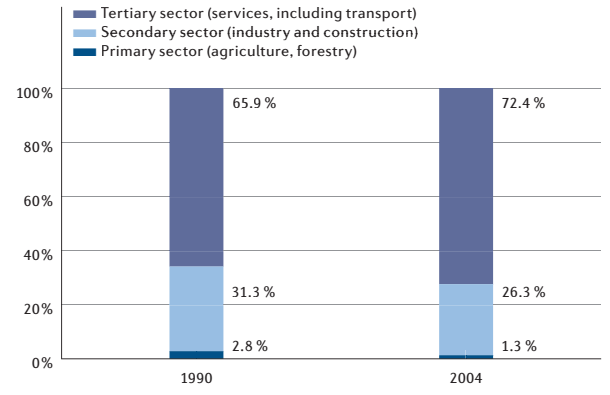
Environmental technologies create 61,000 jobs a year and a turnover of CHF 6.7 billion. Their primary goal is to solve environmental problems at source, and they offer a strong potential for innovation.

Industry and services

The Swiss economy is characterised by significant and growing activity in the service sector, and by an industrial sector that is retreating globally but still dynamic. It has international status in certain high-technology and skill-intensive sectors, such as chemicals, pharmaceuticals, watchmaking and machine equipment, and a shrinking primary sector (» Chapter 6). The service sector continued to develop in Switzerland between 1990 and 2004. Indeed, the share of the service sector in gross domestic product (GDP) increased from 65.9 to 72.4 %, whereas that of industry dropped from 31.3to 26.3 % (» G4.1).

This variation can also be observed in terms of the number of companies. While the number of companies has increased by 66,100 in the industry and service sectors since 1991 (+24 %), to reach 339,300 in 2004, the increase has been greater in the service sector, where the share went up from 73 to 76 % over the same period. The dominance of the service sector is also noticeable, although slightly less marked, in terms of jobs (64 %).

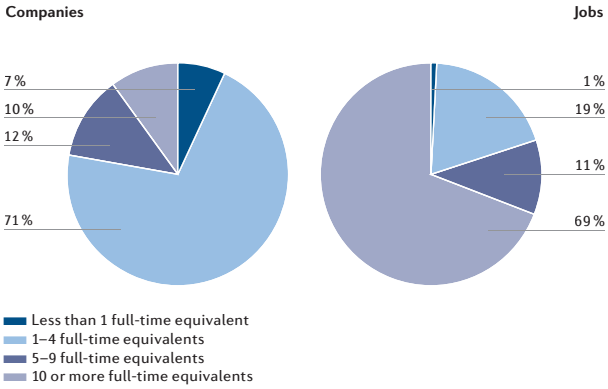
G4.1 Evolution of economy sectors contribution to GDP



Source: FSO

G4.2 Number of companies and jobs by size class in 2004

Secondary and tertiary sectors



Source: FSO

Another way in which the Swiss economy distinguishes itself is through the high number of small production units (» G4.2). In 2003, 99.7 % of companies in the industry and service sectors were in the category of small and medium-sized enterprises (SME). About 89 % of them were made up of microcompanies employing fewer than ten people. The reverse is true with regard to the number of jobs, since they are concentrated at 69 % in units with more than ten positions.

Pressures on the environment

Energy consumption

In 2005, final industrial energy consumption amounted to 19 % of the total final energy consumption in Switzerland, while that of the service sector was 17 % (» Chapter 2).

Emissions

Any kind of economic activity has an impact on the environment. Industry and industrial arts and crafts are therefore among the largest producers of cadmium and mercury in Switzerland and are primarily responsible for producing volatile organic compounds. They are also responsible for some of the emissions of particulate matter and volatile organic compounds (» Chapter 7). Industry and services produce over 30 % of greenhouse gases (» Chapter 8). Together with hospitals and laboratories, they also contribute to wastewater pollution (» Chapter 10).

Production and use of chemicals

The usefulness of chemicals for society is undisputed. However, because of their high number, diversity and the quantities consumed, it is not always entirely possible to control the risks linked to their use.

A "chemicalisation" of the Earth has taken place: to date, over 20 billion chemical substances have been mentioned in scientific publications, 100,000 of which are used for economic purposes. Although substances with a related structure can manifest similar properties, each is unique and implies its own particular ecotoxicological risk.

When a member state of the Organisation for Economic Cooperation and Development (OECD) manufactures or imports more than 1,000 t of a substance per year, this substance is defined as a high production volume chemical (HPVC). There are currently over 4,800 of these on the OECD's list. With a 4.3 % share in world exports of chemical and pharmaceutical products, Switzerland ranks ninth on the list of exporting countries. Over the last 25 years, chemical and pharmaceutical exports have increased by 21 % on average, to stabilise at about CHF 50 billion a year, making this the second export sector in Switzerland. Within this context, the production of basic chemical products for industry is of secondary importance: only about 70 substances are produced in quantities in excess of 1,000 t. The distribution of sales by sector attests to the Swiss chemical industry's vocation: specialities. Indeed, products intended for life sciences, in other words, those that act on the metabolic processes of living organisms, account for over three quarters of production. They include active pharmaceutical ingredients (pharmaceutical products), vitamins, advanced chemical compounds, products used for diagnostics, and pesticides (» Chapter 6).

A proportion of chemical products are distributed in the environment. Permanent measurement networks (» Chapters 7, 10 and 11) provide data on the pollution of streams, groundwater, air and soil by particular substances, thus revealing the evolution of environmental impact over time.

Selective measurements enable a current analysis of the situation, and depending on the methods, a retrospective one as well. For example, it was observed that, following the ban on nonylphenol in detergents and on the brominated flame-retardant pentaBDE (» Substance flows, »

Greenhouse gas emissions closely monitored

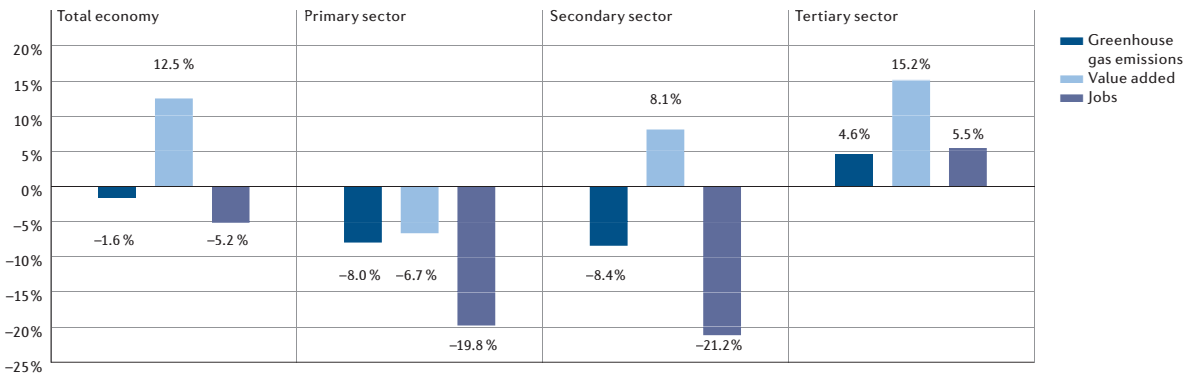
The evolution of the service sector seems favourable to decoupling economic growth and environmental pressures. Where greenhouse gas emissions are concerned, services account for nearly three quarters of GDP and are responsible for half the emissions produced by the economy (not including households). In contrast, the industry sector accounts for just over a quarter of GDP but generates a third of the emissions, according to the NAMEA pilot survey (» FSO/SAEFL 2005). Additionally, decoupling effectively occurred between 1990 and 2002, with GDP progressing in real terms by 12.5 %, while the overall emissions produced by the economy decreased by about 1.6 % (» G4.3). As a result, the intensity of emissions per value added unit decreased by 13 % during this period, dropping from 93 to 81 g CO_2 equivalent per franc, which shows an increase in the performance of the economy with regard to greenhouse gases. This should however be investigated within a more global perspective. Monitoring of the production system's emissions actually remains incomplete if emissions associated with the production of imported and exported goods are not taken into account. Relocation of industry and the growing share of imported manufactured goods, whose production and transport generate emissions abroad, cannot be completely ignored in an overall assessment of the Swiss economy's development in the service sector. However, the data required to perform this kind of analysis are not available (» Chapter 1).

An analysis of the evolution of the Swiss economy's efficiency by economic sector shows significant variations resulting, in particular, from the structural changes and technological progress accomplished. Thus, in the service sector – which generated 49 % of the emissions produced by the economy in 2002 – only a relative decoupling occurred between 1990 and 2002, as emissions did not decrease in absolute value but only increased less rapidly (+4.6 %) than the value added (+15 %). The increase in emissions from the service sector is a direct result of transport[1], where emissions have increased by some 16 % since 1990 – practically at the same pace as economic growth in that sector. On the other hand, the industry sector – which generated 32 % of the emissions caused by the economy in 2002 – can be regarded as having an absolute decoupling, as emissions decreased (–8.4 %) while added value increased (+8 %). This decrease is the result of technological progress and structural changes this sector underwent to the benefit of more dynamic and less emission-producing sectors such as chemicals, pharmaceuticals, watchmaking and machinery.

It is also important to note that the decoupling observed between economic growth and emissions did not occur in relation to employment, which decreased by 5.2 %, expressed in full-time equivalent. The intensity of emissions resuling from employment thus progressed by nearly 4 %, rising from 10.1 to 10.5 t of CO_2 equivalent per full-time job equivalent.

[1] This concerns transport activities in the service sector, in other words transport for individual purposes as well as transport for third parties performed by the "transport and communications" sector (» sections 60–64 of NOGA – General Classification of Economic Activities). Transport for individual purposes in the other two sectors and household transport are not included here.

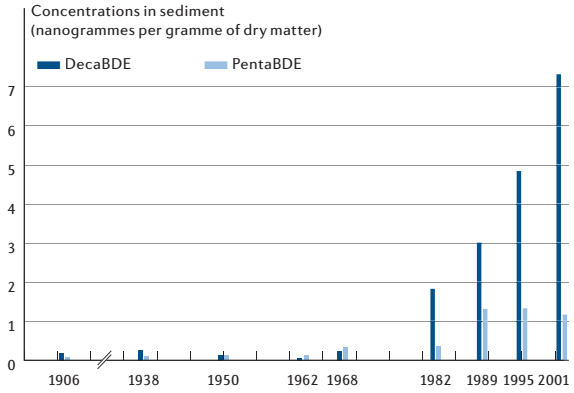
G4.3 Evolution of greenhouse gas emissions, value added[1] and jobs[2]



[1] Between 1990 and 2002, [2] Between 1991 and 2002

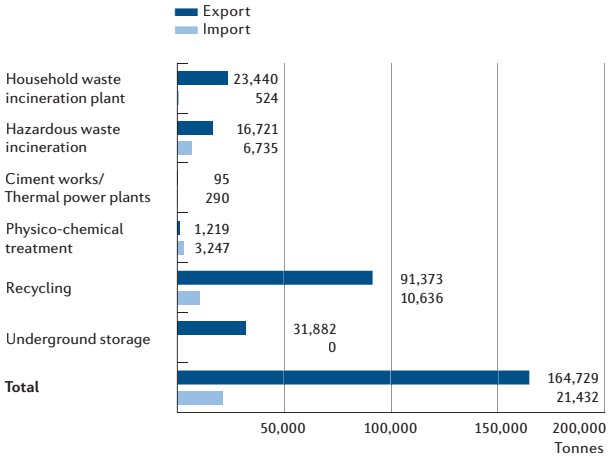
Source: FSO/SAEFL 2005

G4.4 Brominated flame-retardant agents in sediments in Greifensee ZH



Source: M. Kohler et al., 2005

G4.5 Import and export of hazardous waste in 2005



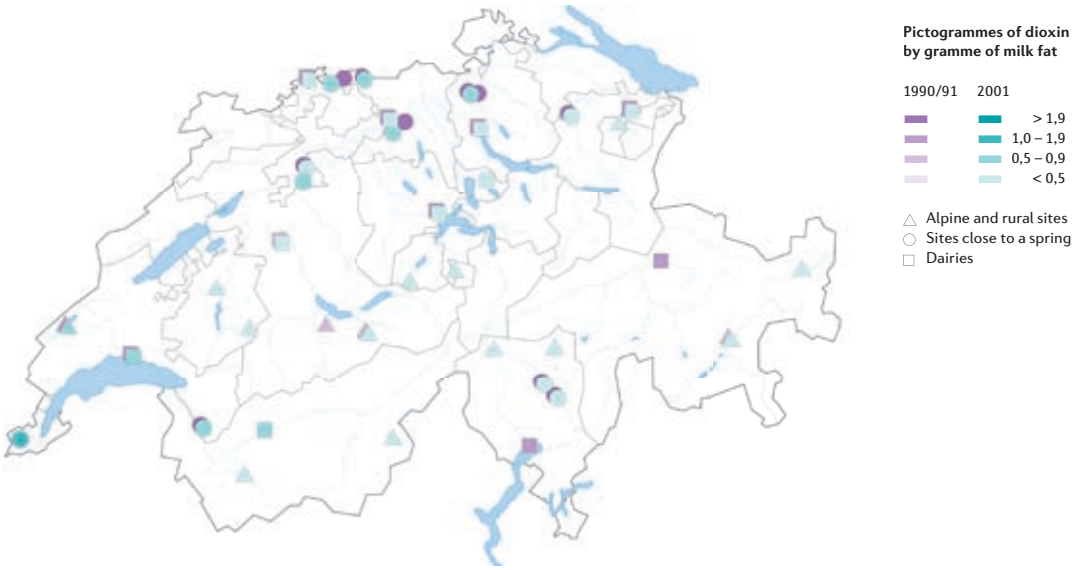
Source: FOEN

page 25), the quantities measured in sediments had considerably decreased; conversely, pollution of sediments by decaBDE – the use of which is still permitted – continues to increase (» G4.4).

Periodic measurement campaigns enable us to draw conclusions about these trends. For dioxins unintentionally generated during various processes, these measurement campaigns have shown that the concentrations present in cow's milk have decreased since stricter emission reduction measures have been implemented (» M4.1; Chapter 11).

Little is known about the origin, effect and behaviour of the large number of chemical substances existing in the environment in low concentrations, which are called micropollutants (» Chapter 10). This category includes natural and synthetic oestrogens that are responsible for the feminisation of fish downstream from wastewater treatment plants. Chemical products are also thought to cause the decrease in fish populations, but it is currently impossible to authenticate or invalidate this hypothesis. It is also possible that certain new technologies, such as nanotechnologies (» Chapter 19), conceal as yet unknown dangers. Similarly, it is possible to make only incomplete evaluations and predictions for those substances exhibiting specific properties or mechanisms of action. The same applies to the simultaneous impact of several products on the environment or even the combined effects of chemical substances and environmental parameters such as temperature, foods or illnesses. »

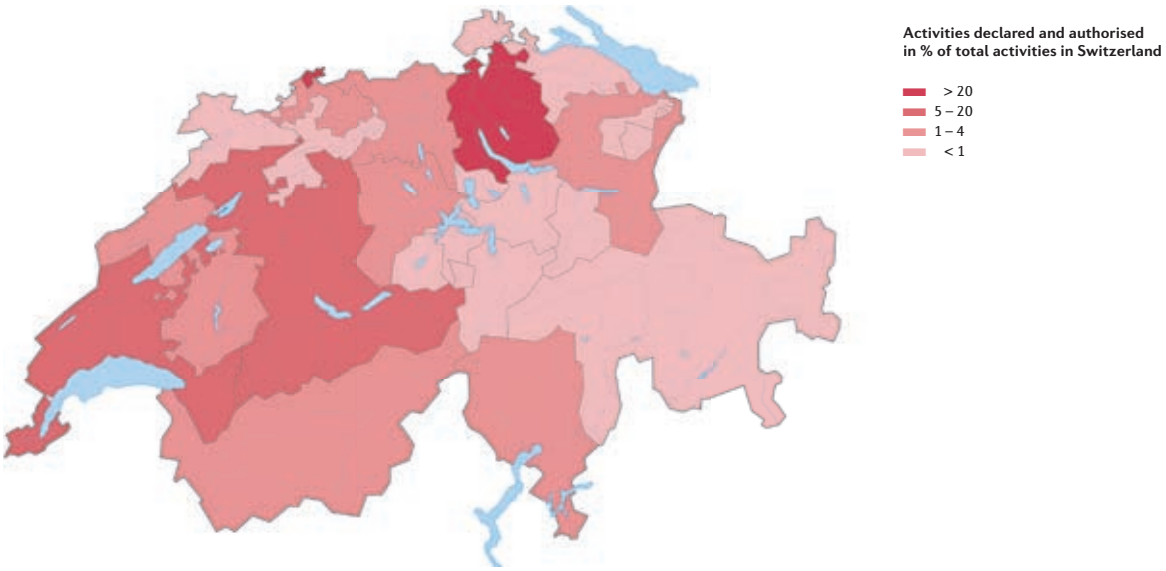
M4.1 Dioxin content of cow's milk in 1990/1991 and 2001



Source: P. Schmid and Ch. Schlatter, 1992 and P. Schmid et al. 2003

Map: ThemaKart, FSO

M4.2 Genetically modified or pathogenic organisms: activities declared and authorised in 2005



Source: FOEN Map: ThemaKart, FSO IF R

› ***Hazardous waste***

Since the year 2000, Switzerland's total volume of hazardous waste has stabilised at 1.1 million tonnes per annum (» G9), which is equivalent to about 6 % of the overall quantity of waste. In general, economic growth is accompanied by an increase in industrial production, consumption and construction activities, and consequently hazardous waste. Construction sites developed on polluted ground (» Contaminated sites, page 50) generate large quantities of polluted soil, which currently make up the largest share of hazardous waste (25 %).

In 2002, about 40 % of hazardous waste was incinerated, 27 % was deposited in landfill sites after appropriate treatment, 22 % underwent physico-chemical treatment, and 11 % was directly recycled (» SAEFL 2004b). Cement manufacturing plants incinerate approximately 30 % of hazardous waste, particularly sump oil and solvents, which enables them to conserve raw materials and energy (» Chapter 2). Physico-chemical treatment is mainly performed in Switzerland, in particular for polluted wastewater, soil from the treatment of contaminated sites and mixed liquids (emulsions).

About 10 % of hazardous waste is exported to be upgraded, treated, incinerated and deposited in landfills (» G9), of which three quarters are taken to Germany and the balance almost exclusively to EU member countries: France, Belgium, Italy, the Netherlands and Finland. Apart from the storage of particulate matter from the electrofilters of household waste incineration plants (HWIP) in underground facilities in Germany, and the incineration of waste from grinding of non-metallic compounds in foreign plants, the Confederation authorises the export of hazardous waste mainly for recycling purposes. As Switzerland has no facilities for metallurgic recycling of non-ferrous metals, the exports are primarily industrial waste containing copper, nickel, zinc, lead, chromium and tin; in acids, stripping baths, sewage sludge containing metallic hydroxides, fine particles from industry (e.g. sheet metal works), refractory coatings, or even soil from contaminated sites. Materials resulting from the treatment of the hazardous waste landfills at Bonfol and Kölliken will also need to be exported, as the capacity of Swiss hazardous waste incineration facilities is insufficient to treat them.

If handled improperly, hazardous waste presents a danger for the environment. Since the middle of the 1980s it has been established that even if state-of-the-art protection measures are applied, depositing this waste in landfills can pollute the groundwater for hundreds of years (» Chapter 10). This finding led to the compulsory incineration of hazardous wastes. Remediating former hazardous waste landfills will cost the Swiss economy over one billion francs.

Disposal of hazardous wastes on domestic territory and its export are subject to strict controls: the Basel Convention[1] (» Chapter 18) regulates crossborder movements of hazardous waste at international level. The authorities will permit export and import only if the wastes are disposed of in an environmentally acceptable way, and if the other countries involved have given their agreement. Moreover, the Basel Convention forbids export to countries that are not members of the OECD. This legislation corresponds to the policy that Switzerland has pursued for several years. The new Ordinance of 22 June 2005 on the Handling of Wastes (VEVA)[2] came into force in 2006. The objectives concerning the disposal of hazardous waste are as follows: avoid their production, recycle them wherever possible,

[1] Basel Convention of 22 March 1989 on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (with appendices), RS 0.814.05.
[2] Ordinance of 22 June 2005 on the Handling of Wastes (VEVA), RS 814.610.

treat those that are not recyclable so that they can be deposited in landfills in an eco-compatible manner, dispose of them mainly in Switzerland. The accomplishment of these objectives resulted in the creation of an efficient disposal infrastructure in Switzerland, and the establishment of an infallible legislation on hazardous waste flows. Industry in particular has improved its management of hazardous waste by taking measures to prevent it and to recycle unavoidable waste more efficiently.

Genetically modified organisms (GMOs)

In Switzerland, the use of genetically modified or pathogenic organisms within contained facilities increased sixfold in the 1990s (» G12), to settle at a high level. They are used in research, diagnostics and the manufacture of pharmaceutical and industrial products. At the end of 2005, slightly less than 60 % of the 1,800 activities recorded related, entirely or partly, to the production or use of GMOs (» Chapters 6 and 15). The other activities (about 40 %) concern exclusively pathogenic organisms. 80 % of all the activities concern projects relating to microorganisms, 16 % focus on animals and about 4 % on plants.

The Ordinance on the Contained Use of Organisms (Containment Ordinance, CO[3]) divides the activities involving genetically modified or pathogenic organisms into four categories (1 to 4) according to the risk they present: Categories 3 and 4 include activities with a moderate or high risk; Category 2 activities with a low risk; and Category 1 activities with a zero or negligible risk.

Category 1 activities are by far the most common. Given that the CO has not yet made it compulsory to disclose them, their exact number is not known, but it is estimated that they make up 55 % of the activities involving genetically modified or pathogenic organisms, whereas 40 % fall within Category 2, and 5 % within Categories 3 and 4 (» M4.2).

According to the CO, activities involving Categories 1 and 2 genetically modified or pathogenic organisms must be notified, while those of Categories 3 and 4 only require authorisation. As part of the relevant procedures, the federal authorities, supported by federal commissions and the competent cantonal services, check that the risk assessment has been properly performed, that the classification of activities is correct, and that the safety measures envisaged to protect humans, animals and the environment are sufficient. The decisions are taken by the federal authorities (FOPH, FOEN), and their application at local level is monitored by the competent cantonal services.

Measures in place and their impact

Environmental management

The legislation and measures put in place over the last decades to protect the environment have been positive in several respects. They have enabled the restriction of a range of pollution types and protected both the environment and people's health while avoiding the costs that a high level of pollution incurs, and contributing to economic growth and technical progress.

However, these provisions sometimes generate expenses for companies, which committed CHF 2.5 billion for environmental protection in 2003, about 0.6 % of gross domestic product (GDP) (» FSO 2005c). Compared to 1993, this expenditure has decreased by about 7 % in real terms. Given the economic growth recorded during this period, the financial burden that companies have borne for environmental protection has also decreased. This statement does not, however, imply either a disengagement of the economy or an increase in pollution, or a degradation of the environment in Switzerland. The decrease may in fact also be explained by structural changes (» Chapter 1), the adoption of cleaner production processes that produce additional expenses for environmental protection, or even by the recourse to more efficient purification and processing technologies.

40 % of this expenditure was devoted to waste management, 29 % to wastewater management and 19 % to air pollution control and climate protection. About nine francs out of ten are spent in these three areas. The remaining 12 %, included under "other", was allocated to noise protection, biodiversity, soils, groundwater and landscape protection, as well as to research and development.

Of the CHF 2.5 billion spent in 2003 for environmental protection, 68 % represented current expenditure and 32 % investments. Investment was at 45 % for pollution treatment (e.g. wastewater purification plants), and 55 % for pollution prevention (e.g. cleaner production processes). In 1993, both types still made up two thirds and one third, respectively, of the investments in environmental protection. The transition from a curative to a preventive approach, which »

[3] Ordinance of 15 August 1999 on the Contained Use of Organisms (Containment Ordinance, CO), RS 814.912.

› seems to emerge from these figures, indicates a growing interest in "clean" technologies.

The analysis of expenditure by sector shows considerable variations, not only in absolute values, but also in francs per job (» G4.6). For example, the CHF 452 billion spent by the chemicals industry and transport and communications sectors shows great differences in terms of financial burden, respectively CHF 5,314 and CHF 2,085 per job position. Similarly, the CHF 8 million spent by the extractive industry corresponds to CHF 3,448 per job position, whereas the CHF 256 million spent by the manufacturing industries corresponds to CHF 821 per job position.

Swiss industry is however not being penalised when compared at international level. It devoted about CHF 1.28 billion to environmental protection in 2003, which is nearly 1.4 % of its added value (AV) and 0.3 % of GDP (» G4.7), a financial burden identical to that supported by European industry in 2002 (EU-15). This amount fluctuated in the previous years, particularly because of the irregular and cyclic aspect of investments.

Companies can, on a voluntary basis, have their environmental engagement certified: international standard ISO 14001, established in 1996, establishes criteria for environmental management that were revised for the first time in 2004. Any company satisfying these criteria vouches that, as a result of its own initiative and commitment, it has included more environmentally friendly and efficient approaches in its processes. Thus, 7 companies were certified in 1995 and 48 more in 1996; subsequently there have been about 160 per year. At 31 December 2005, 1,562 companies in Switzerland were ISO 14001-certified. There are other options available to companies willing to make their management and production more environmentally friendly, such as the Responsible Care initiative in the chemical sector, and the EcoEnterprise label of French-speaking cantons.

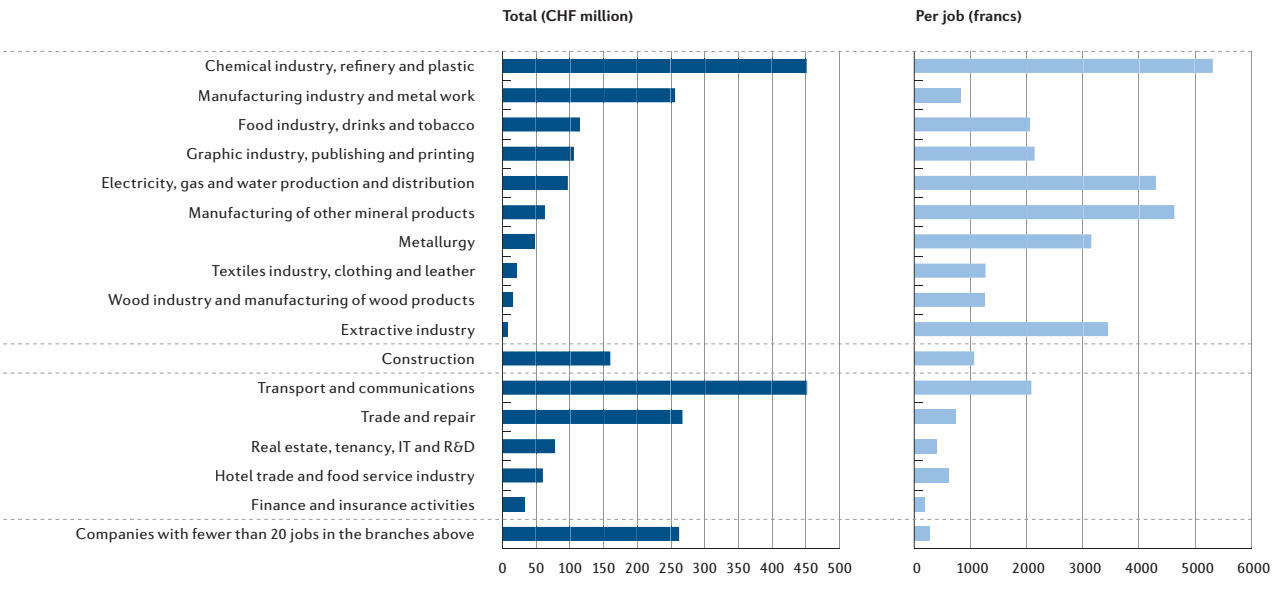
Contaminated sites

There are approximately 50,000 polluted sites in Switzerland, 12,000 of which are considered as needing investigation (» G10). Between 3,000 and 4,000 of them are likely to be contaminated and 200 have already been treated. The inventory of polluted sites, which will be used as a basis for planning, will be drawn up by 2011. The necessary investigations will be completed by 2015 and will be used as a basis for decision-making (» SAEFL 2001a). For urgent cases and to prevent hazards, the required treatment will have to be completed or started by 2017; for other contaminated sites this will have to be done by 2025. This step-by-step approach complies with the provisions on treatment of contaminated sites in the Ordinance on the Remediation of Contaminated sites (OSITES)[4].

The compilation of the registers for the 50,000 polluted sites falls under the jurisdiction of the competent cantonal and federal authorities, which should have completed them by 2011. After this date, the authorities will then be able to assign their resources to investigating the sites in question and designate the sites that need to be rehabilitated (contaminated sites). The remediation activities will increase during the investigation phases and even further subsequently.

[4] Ordinance of 26 August 1998 on the Remediation of Contaminated sites (OSITES), RS 814.680.

G4.6 Companies environmental protection expenditure in 2003, total and per job



Source: FSO

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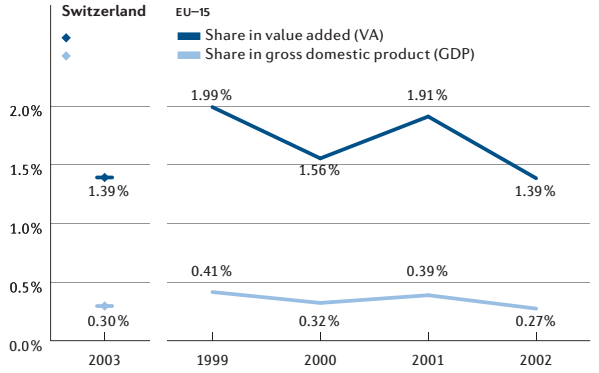
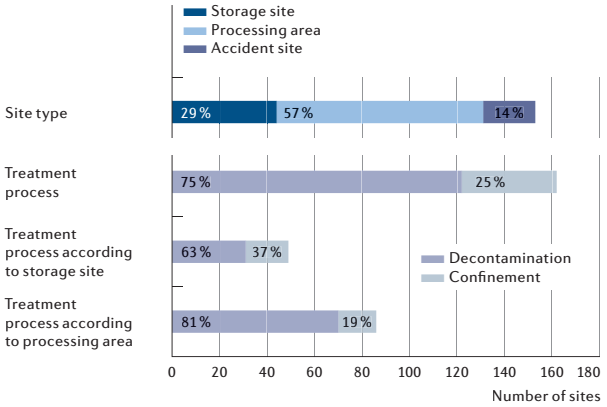
G4.7 Environmental protection expenditure of Swiss industry and in EU–15

Share of these expenses in GDP and VA



Source: FSO, Eurostat

G4.8 Treatment of contaminated sites: sites and treatment processes in 2005



Source: FOEN

The Confederation is able to pay large allowances at all stages of treating contaminated sites[5], and in particular to support the cantons in their implementation of such treatment. The means are thus available for enforcing treatment measures more quickly in an environmentally acceptable and cost-effective way, in accordance with the state of technology. The FOEN has at its disposal the OTAS[6] fund, which receives about CHF 26 million per year from a tax on the final storage of waste.

Polluted sites and contaminated sites
Polluted sites are either storage sites (landfills), processing areas or places where an accident has occurred or where waste has been deposited or seeped through.
Contaminated sites are polluted sites that generate harmful and inconvenient health hazards, or where there is a tangible risk of such hazards occurring. These sites need to be remediated.

The risk of pollution and its financial consequences encourage many investors to prefer vacant sites to obsolete industrial zones that are often more accessible. Obsolete industrial and urban zones currently make up an area of 17 km^2, larger than 2,300 football fields put together or even Geneva (» SAEFL/ARE 2004). In the majority of cases, pollution is not a significant obstacle in itself. If access is easy, the cost of cleaning up the area is considerably lower than its average commercial value. The current delays in reassigning these zones result in shortfalls amounting to several billion francs, which particularly affect the communes' tax revenues and the incomes of owners.

By 2017, zones containing contaminated sites should have become usable again. The FOEN, in cooperation with the ARE, is currently developing a blueprint of measures for the revival of these zones, including the following main goals: making the assessments of contaminated sites transparent; adapting the demands of configuration of the area (e.g. in case of zone assignment changes) that guarantee the initial funding; eliminating administrative obstacles; and publicising the existence of usable zones in the whole of Switzerland (by means of a "zone mart").

Chemicals

In 2005, taking the Chemicals Act[7] and the Environmental Protection Act as a legal basis, the Federal Council enforced new euro-compatible ordinances on chemicals whose effect will have a beneficial effect on the environment. These ordinances subject biocidal products to authorisation, consolidate the demands regarding degradability of detergents and cleaning products, and introduce a whole series of new bans. Certain heavy metals such as lead, cadmium, mercury and chromium are banned from use in electrical appliances and vehicles; lead is totally banned from use in paints, as are some brominated diphenylethers and some paraffins. These substances, used as additives in many consumer durable goods, have in fact proved highly non-degradable (persistent), bioaccumulative and toxic (» Persistent organic pollutants [POPs], page 52).

At international level, Switzerland has ratified the Convention on persistent organic pollutants (Stockholm Convention)[8], which aims to eliminate the most dangerous pollutants (» Chapter 18); and the Rotterdam PIC Convention[9], »

[5] Made possible thanks to the Ordinance of 5 April 2000 on Charges for the Remediation of Contaminated Sites (OTAS), RS 814.68, and modification of 16 December 2005 of the Swiss Federal Law of 7 October 1983 relating to Protection of the Environment (LPE), RS 814.01.
[6] This reference comes from the Ordinance of 5 April 2000 on Charges for the Remediation of Contaminated Sites (OTAS), RS 814.681.
[7] Swiss Federal Law of 15 December 2000 concerning Protection against Dangerous Substances and Preparations (Chemicals Law, LCHEM), RS 813.1.
[8] Stockholm Convention of 22 May 2001 on Persistent Organic Pollutants (POP Convention, with appendices), RS 0.814.03.
[9] Rotterdam Convention of 10 September 1998 on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC Convention, with appendices), RS 0.916.21.

Persistent organic pollutants (POPs)

POPs are toxic chemical substances that decompose only with great difficulty. Once released, they spread over the surface of the Earth, carried by air or water, and through the food chain. They are thus a danger to human beings and the environment, even far away from the place where they were released. In particular, they are likely to cause cancers, to interfere with the endocrine system and to be detrimental to reproduction.

At present, 12 such substances are listed in the Stockholm Convention[8] (» Chapter 18).

- *Pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, toxaphene and hexachlorobenzene (HCB)*
- *Chemical products stemming from the production of other chemical substances or waste incineration: dioxins and furans*
- *Polychlorinated biphenyls (PCB): a group of chlorinated hydrocarbons used in various industrial applications such as insulation of transformers and capacitors, heat exchange and paint and plastic additives*

which makes it compulsory to divulge the export of hazardous or strictly regulated chemical products. This measure enables developing countries to become aware of the risks that these substances represent and to apply protective measures themselves.

A lot still remains to be accomplished in the control and assessment of commercialised chemical products before the introduction of efficient provisions on chemical products (old substances). To date, only 600 HPVC substances (high production volume chemical substances) out of the 4,800 mentioned on the OECD list have been assessed (» Production and use of chemicals, page 45, and G6). Data are also lacking on a large number of the 30,000 substances whose volume on the European market exceeds 1 t. This situation has encouraged the European Commission to propose a large-scale revision of its regulations on chemical substances. Thus, the REACH (Registration, Evaluation, Authorisation of Chemicals) Convention should greatly speed up the analysis of old substances. Its integration into Swiss legislation is currently being debated. •

Promotion of environmental technologies

The tradition of developing and using environmental technologies has existed in Switzerland for a long time. As early as the 1960s the country became a pioneer in this domain by rigorously installing treatment and incineration plants with stringent emission standards. The recycling principle was also applied very swiftly everywhere and Swiss recycling rates are among the highest in the world (» Chapter 5). These activities led to numerous innovations and the development of a whole economic sector that currently achieves, on the Swiss market, a turnover of about CHF 6.7 billion per year and maintains 61,000 jobs; for exports these figures are CHF 1.4 billion and 12,500 jobs (» SAEFL 2005i).

The implementation of environmental technologies within the sector of goods production and services is known under the names "Eco-efficiency" and "Cleaner production". When the initiative extends to product design and purpose, it is called "Ecodesign". All these technological approaches aim to solve environmental problems at source and consist of a myriad of innovations, ranging from more resistant production tools to substituting solvent-based products with recyclable biological detergents. The sum invested by private companies for such preventive measures is significant: in 2003 it amounted to CHF 450 million (» FSO 2005c).

In order to remain competitive, this expanding sector of the economy must encourage innovation. Since 1997, the Confederation has been awarding grants to support the development of innovations in environmental technologies. The FOEN is responsible for implementing this programme, with approximately CHF 4 million a year at its disposal[1]. Projects supported aim to introduce these innovations onto the market. Recent projects include the following environmental topics:

- *Air pollution control (» Chapter 7): particulate matter filters for diesel engines currently achieve 99.9 % efficiency. Measurement instruments quantifying the amount of particulate matter emitted rather than their mass have enabled these filters to be perfected. Additionally, systems enabling the subsequent fitting of vehicles have been designed. There are also catalytic systems running on ammonia or even based on exhaust gas recirculation and intended to reduce NO_x emissions. To treat fine particle emissions from small wood-burning installations, a simple and low-price electric filter will be available from 2007.*
- *Water pollution control (» Chapter 10): the greatest innovation of the last few years is without doubt the development of filters that are both increasingly efficient and suited for a wide range of different needs. The combination of chemical and biological techniques enables the efficiency of wastewater treatment to be increased. Since the recent introduction of the ban on land disposal of sewage sludge, a number of technologies for drying it while saving energy (by air vacuum process, for example), and reclaiming phosphates to turn them into fertilisers, are being elaborated. Moreover, the production of natural flocculants[2] from oleaginous plants seems to open up possibilities. With regard to the production of drinking water, the rigorous use of probes transmitting data in real time has become more widespread and enables remote and increasingly reliable digital management.*
- *Soil pollution control (» Chapter 11): protection against soil erosion, compaction and degradation relate primarily to agronomic processes associated with sustainable management of farmland. Mobile and simple measuring instruments ensure better monitoring of soil degradation and recovery processes.*
- *Waste management (» Chapter 5): production of renewable energy connected with waste treatment is the essential preoccupation in this sector. Whether it be diesel fuel production from plastic waste or used edible oils, that of biogas from organic waste or sewage sludge fermentation, the search for all possible technological solutions has attracted more attention since the increase in energy prices. The reclaiming of metallic elements (copper, zinc, nickel) in slag or ashes from electrofilters also benefits from the price escalation on the minerals market.*
- *Noise pollution control (» Chapter 16): the emphasis is currently on activities that aim to reduce the noise generated by railway equipment: brake-blocks made of synthetic materials, vibration dampers for the wheels, and revolutionary bogie concept for goods wagons. A better understanding of sound wave deviation phenomena associated with the geometrical shape of ridges on anti-noise walls should improve their efficiency and costs.*

[1] Information on obtaining federal support for the development of new environmental technologies can be found at www.environnement-suisse.ch » English » Topics » Technology promotion.

[2] Substances enabling the precipitation of solid pollutants.

5. Households and consumption

In Switzerland, each inhabitant consumes an average of 233 litres of water a day and produces 660 kg of waste a year. Final energy con-sumption has remained stable although more living space is occupied. Population growth results in an overall increase of the pressures on the environment caused by households.

Approximately one quarter of CO_2 emissions are attributable to households, primarily due to heating, and not including emissions associated with transport.

Today, 49 % of municipal waste is sorted and recycled. The remainder is incinerated in an environmentally friendly manner.

The polluter-pays principle in the area of waste is not yet being rigorously enforced.

Our environment is affected by our consumption habits, and our use of goods and services, as well as our choices concerning place of residence and work, and our leisure and travel habits. These choices can be influenced by historic developments, relating for example to national planning or transport infrastructures, our available financial resources and prices, or even our standards and lifestyles.

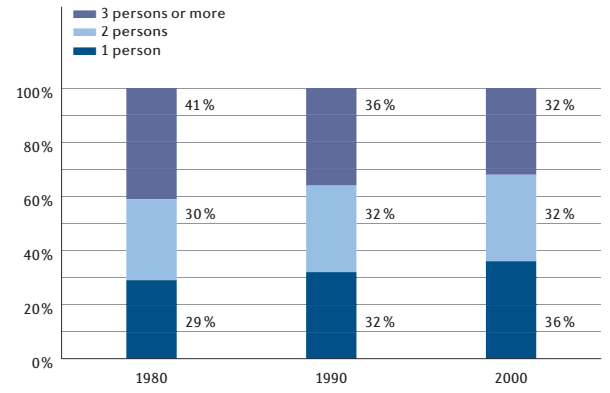
Households and population

Between 1980 and 2000, the number of private households[1] increased considerably more than the resident population. This number of households rose to 3.12 million, a progression of 27 % compared to the population increase of only 14 % during the same period. Over the whole of Switzerland, the average size of households continues to decrease. The proportion of one-person households thus increased from 29 % in 1980 to 36 % in 2000 (» G5.1), which corresponds to a progression of 57 %; in 2000, however, they accounted for only one sixth of the resident population.

In the 1990s, the change in family structures was particularly marked by the increase in the number of persons living on their own, couples without children and single-parent households. Having fewer children and living longer were also noted as trends. But as in 1990, in 2000 four fifths of the resident population were still living in a family context, and about half of them were couples with one child or more (» FSO 2005d). The increase in the number of small households was greatest in urban communes and cantons. The greatest proportion of one-person households was found in the cantons of Basel-Stadt (one in two households), Geneva and Zurich (two in five households). The number of two-person households also increased slightly from 1990 to account for nearly one third of all households in 2000. The average size of households thus fell from 2.5 persons in 1980 to 2.2 in 2000.

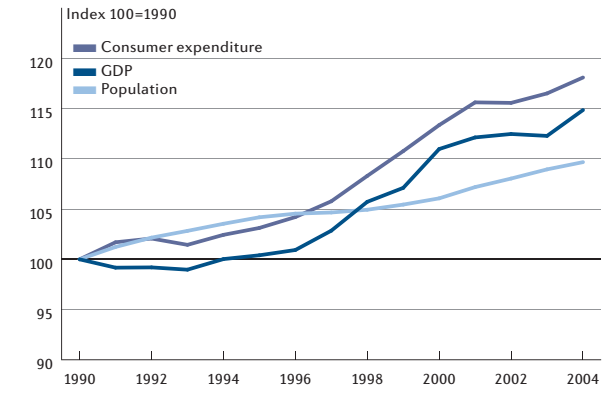
[1] Private households do not include collective households (homes, hospitals, prisons, boarding schools etc.).

G5.1 Evolution in household size



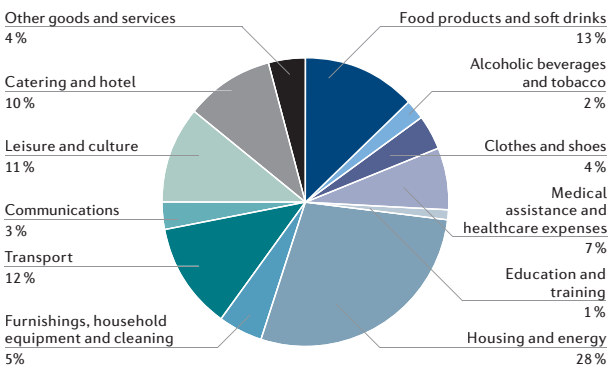
Source: FSO

G5.2 Evolution in GDP, population and consumer expenditure



Source: FSO

G5.3 Distribution of consumer expenditure in 2004



Source: FSO 2006b

Household consumption habits

Households decide on the goods and services that they consume. They are therefore an essential element of the production-consumption cycle. Their choices more or less directly affect the pressures exerted on the environment. Even if each individual exerts a low pressure, the cumulative effect for the country's population as a whole is substantial.

The population increased by 10 % between 1990 and 2004. In the same period, GDP (effective) increased by 15 % (» G5.2). Household consumer spending increased by almost 17 % during the same period, peaking at CHF 260 billion in 2004 – a share of between 59 and 61 % of GDP during that period. Per capita, it increased from CHF 32,350 in 1990 to CHF 34,835 in 2004 (still in real terms), which is equivalent to a growth of nearly 8 %.

The overall increase in consumer spending is mainly the result of growth in expenditure for healthcare, housing, communications and various goods and services. Graph » G5.3 provides an illustration of the structure of consumer spending in 2004, which did not change much between 1980 and 2004.

Over the last 20 years, per capita living space has increased by 10 m^2. In 2000, it amounted to 44 m^2 per person (» G5.4). The development varies according to household size. It was low in households with five or more people (from 24 to 25 m^2), but greater in those with one person (from 68 to 75 m^2). The latter's share continues to grow and thus the propensity to use an ever bigger living area. This evolution is taking place to the detriment of farmland and causes an increased consumption of resources, among other effects (» Chapters 1, 6 and 11).

Final energy consumption for households as a whole – not including transport energy needs (» Chapter 3) – fluctuated between 1990 and 2004, showing a slight upward trend (» G5.5). This was due to the increase in the number and size of dwellings, as well as the growing use of various electrical household appliances, televisions, computers, mobile telephones etc., although these devices are becoming increasingly energy-efficient. In fact, the energy gain achieved thanks to more economical appliances is partly cancelled out by their increased number. Final energy consumption per capita seems stable. In 2004, households consumed almost 29 % of the total final energy (» Chapter 2).

The consumption of drinking water by households and small businesses[2] amounted to 631 million cubic metres in 2004. Considering that these are projections, the shifts observed are small (» G5.5). In 2004, water consumption per capita and per day stood at 233 l, or 60 % of all the drinking water. It stood at 257 l in 1990, and has therefore decreased by 10 % (» Chapter 10).

Household mobility habits also create substantial pressures on the environment (» Chapter 3).

Many leisure infrastructures have been created to respond to demand. In 2003, about three quarters of the population devoted time to outdoor activities such as walking »

[2] It is not possible to separate household consumption from that of small businesses (which use the same supply network).

› or meeting friends at least once a week, and over 60 % of the population practised an individual or group sport with the same frequency (» FSO 2005e). Practising leisure activities away outside the home tends to exacerbate pressures on the environment, in particular by the increased mobility it generates, the facilities required and, in the case of outdoor sports, the disruption to fauna and flora.

Our public spaces are strewn with more and more waste. This phenomenon referred to as "littering" is a public problem with adverse effects on the image of towns, the quality of the landscape and the environment. Moreover, it increases the costs of cleaning up. The analysis recommends the combination of targeted measures to remedy the situation: awareness campaigns, commitment from businesses (code of conduct), information on packaging and fines.

Pressures on the environment

Emissions in the atmosphere

Most household emissions are the result of private motorised traffic (» Chapters 3 and 7) and heat production (heating, hot water).

Households are responsible for about one quarter of total CO_2 emissions (» G5.6), not including those produced by private traffic. In particular, these emissions come from the combustion of domestic heating oil. Since 1990, household CO_2 emissions have been stable and the deviations between years are due primarily to the differences in winter temperatures, which greatly affect heating energy consumption.

Households' share in total sulphur dioxide emissions also amounts to 28 %. However, today this type of pressure on the environment is far below the threshold values imposed by the Ordinance on Air Pollution Control[3]. As for most other polluting substances, households' share in the total emissions is well under 10 % (» G5.7).

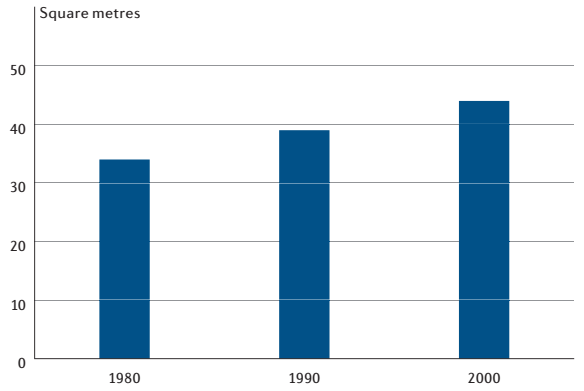
Other types of emission largely attributable to households are those associated with waste disposal. Today, smoke from household waste incineration plants (HWIP) only contains tiny quantities of particles, sulphur dioxide, nitrogen oxide, chlorine, dioxin and heavy metals, compared to the 1970s (» G5.8 and Measures in place and their impact, page 57). In comparison with other emission sources, such as traffic or heating installations, emissions from household waste incineration plants (HWIP) are therefore insignificant, although each year they dispose of 3 million tonnes of combustible waste – of which some 2.6 million tonnes are municipal waste.

Municipal waste

In Switzerland, about 4.9 million tonnes of municipal waste were produced in 2004, compared with one third less in 1984 with 3.3 million tonnes (» G7). This is equivalent to 660 kg per capita. These figures include sorted (» G8) and unsorted waste.

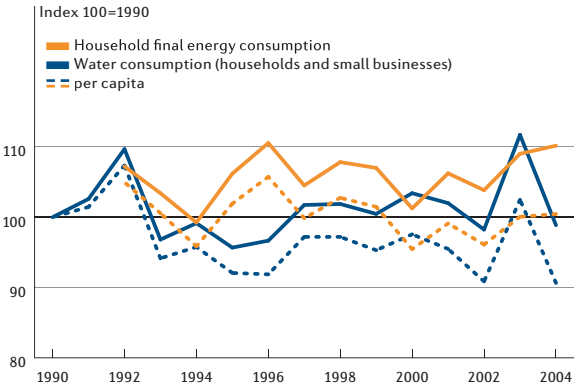
[3] Ordinance on Air Pollution Control (OAPC) of 16 December 1985, RS 814. 318.142.1.

G5.4 Average per capita living space



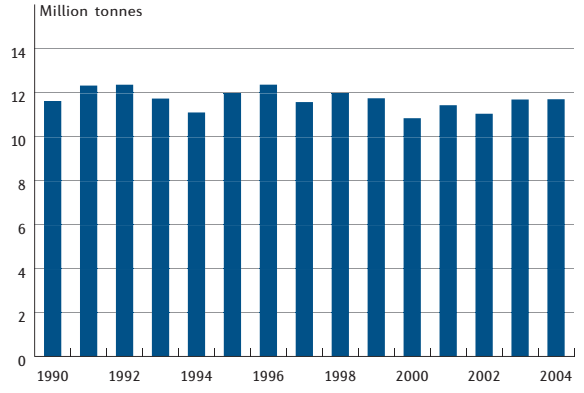
Source: FSO

G5.5 Evolution of household water and final energy consumption



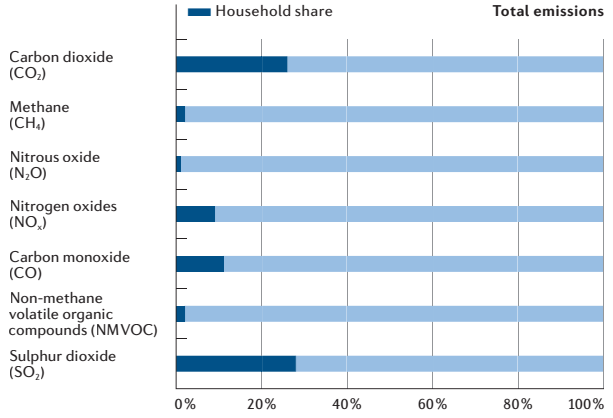
Source: SSIGE, SFOE

G5.6 Evolution of household CO_2 emissions (traffic not included)



Source: FOEN, Swiss Greenhouse Gas Inventory

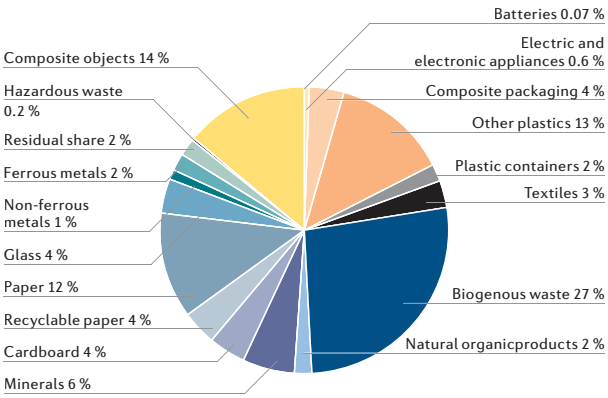
G5.7 Household share in total greenhouse gas and air pollutant emissions in 2004



Source: FOEN

IF M

G5.9 Composition of household waste 2001/2002



Source: FOEN

IF E

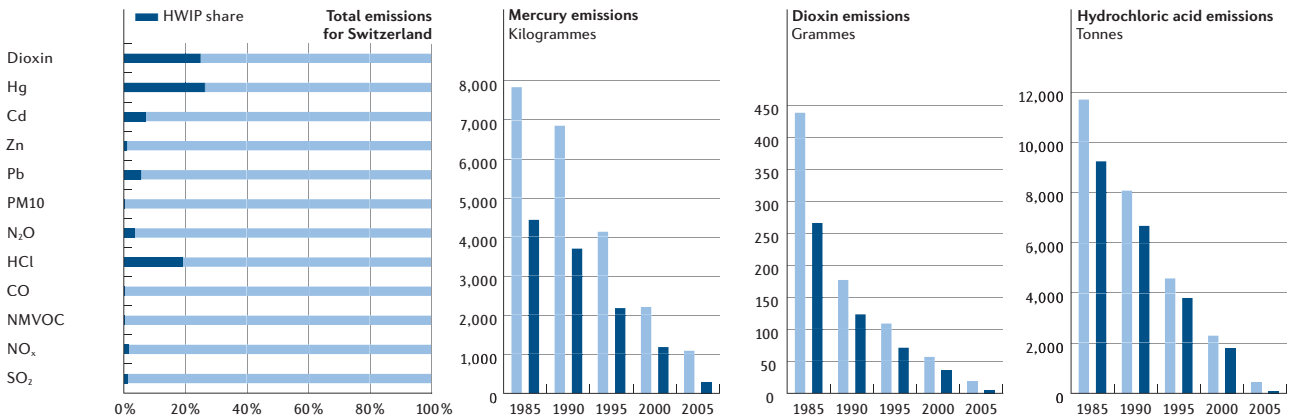
Today, the share of sorted waste in total waste volume represents 49 % of total municipal waste (2.4 million tonnes), against 22 % (0.8 million tonnes) in 1984. In the last 20 years, sorted waste has thus gone up from 115 to 322 kg per capita and per year. It is mainly thanks to this increase that the volume of waste to be incinerated has been maintained at 2.6 million tonnes per year in spite of population growth, and the volume of waste disposed of per capita decreased from 397 to 337 kg. This result is probably due, in part at least, to the funding of waste disposal by means of the "pay per bag" principle.

The composition of unsorted household waste collected by the refuse collection services (» G5.9) varies from year to year. Compared to the beginning of the 1990s, the volume of waste per capita not only decreased but the share of paper in household waste has fallen from 21 to 16 %, that of cardboard from 7 to 4 % and natural organic products such as wood and leather from 5 to 2 %. On the other hand, biogenic waste – cooking and garden waste, leftover foods – has increased from 22 to 27 % and that of composite materials (appliances and products) from 8 to 14 %, which is significant. The share of pure plastics has remained almost unchanged. These figures reflect both how successful sorted collection has been, and the change in consumption habits, particularly the shift from items made out of natural products such as wood, leather and metals to products made out of composite materials, which cannot decompose and which contain plastic.

Other pressures

Apart from emissions and waste production, households also exert pressure on the soil through the existence of built-up areas (» Chapter 11 and 12) and water pollution (» Chapter 10). »

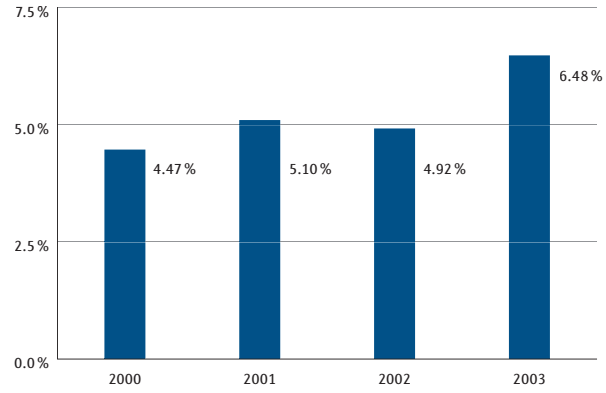
G5.8 Household waste incineration plants share in total emissions in Switzerland in 2005



Source: FOEN

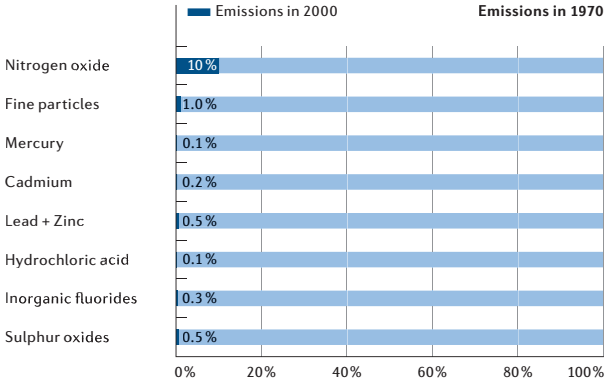
IF

G5.10 Share of household expenditure for organic food products in total expenses for food and drink



Source: FSO

G5.11 Household waste incineration plants emissions in 2000 compared with 1970



Source: FOEN

Measures in place and their impact

Changes in household habits

Graph » G5.10 shows the trend of changes in household habits and gives an idea of the level of consumers' awareness of ecological problems associated with the production of foodstuffs. It shows to what extent people are prepared to spend more for organic food products. This indicator does not however give an indication of the exact market share of this type of commodity. Turnover for organic products stagnated in 2005 (» BIO SUISSE 2006). There is still a paucity of information showing changes in household habits towards more sustainable behaviour.

Reduction of pressures from households

Since the 1980s, Switzerland has put in place numerous measures to reduce pollution from households, including:

- Bringing laws and regulations into force, such as the ban on mercury and PCBs
- Setting up financial schemes such as incentive taxes on air pollution prevention (» Chapter 7) and the "pay per bag" principle
- Consultancy, communication and public information
- Promoting new technologies (heat pump, solar energy)
- Energy-saving campaigns for households such as SWISSENERGY (advice, grants » Chapter 2)
- Private initiatives such as the creation of standards (MINERGY and MINERGY+) and ecological labels (FSC for wood, Bourgeon for farm products)
- Partnership with the economy
- National planning measures and
- Mobility measures (» Chapter 3) »

The causality principle

The causality principle implies that anyone harming the environment must bear the costs. Strictly, these are associated with the necessary protective measures. From a wider perspective, they include external costs.

For example, in 2001 the private sector – i.e. companies, households and farmers – committed CHF 530 million to waste management, to which CHF 1.5 billion were added from public expenditure. Out of this, a little less than CHF 1.1 billion was passed on to responsible parties through taxes. The remaining CHF 418 million, funded through tax receipts, represent a shortfall: it is the amount still to be charged to responsible parties for the causality principle to be fully enforced in Switzerland (» SAEFL 2005c).

State expenditure for the total of the environmental sectors, the shortfall in the causality principle was over CHF 2 billion in 2001. External costs are higher still, since they also include indirect – i.e. not localised and therefore impossible to attribute directly – environmental costs – resulting from utility loss and repairs. This category includes the cost of healthcare as a result of air pollution and noise (» Chapter 17), and the risks generated by climate change (» Chapters 8 and 14). In 2001, external pollution costs were estimated to be at least CHF 8.9 billion. The main responsible parties are traffic, energy and agriculture, but consumers also contribute, in particular through mobility, housing and food consumption.

Out of this amount, only CHF 1.3 billion were "internalised", i.e., charged to the responsible parties – for example, by means of the heavy goods vehicle tax (HVT) (» Chapter 3) – and the tax on VOCs (» Chapter 7).

If public expenditure not covered by the responsible parties and non-internalised costs are added, the total for the environmental sector is a shortfall in the polluter-pays principle of between CHF 9.7 and 20.9 billion (» T5.1).

T5.1 Recovery costs related to environmental protection and external environmental costs in 2001 in million francs

	Private expenditure[1] (without taxes)	Public expenditure	Taxes	Funded through tax	External costs		Internalisation	Under recovery	
	A	B	C	D=B–C	Min. E	Max. F	G	Min. H=D+E–G	Max. I=D+E–G
Water pollution control	681	1,782	1,130	652	391	475	9	1,034	1,119
Soil pollution control	24	27	2	25	386	454	9	402	469
Waste	530	1,500	1,081	418	0	0	0	418	418
Climate	460	117	9	107	2,495	6,769	413	2,189	6,463
Air pollution control	1,361	117	14	103	3,260	7,230	519	2,844	6,814
Noise pollution control	41	536	23	512	998	1,568	138	1,372	1,942
Environment and landscape	335	443	128	315	1,323	3,526	221	1,417	3,620
Environmental research	0	63	11	52	0	0	0	52	52
Total	**3,432**	**4,583**	**2,400**	**2,184**	**8,853**	**20,022**	**1,308**	**9,729**	**20,898**

[1] Expenditure of companies, households and agriculture

Source: SAEFL 2005c

› ***Waste management***

The Confederation's policy on waste has also contributed to a marked reduction in environmental pressures, in spite of the continuous increase in total municipal waste volume. This progress is mainly due to the strengthening of standards for landfills; the ban on depositing untreated municipal waste in landfills; the availability of sufficient treatment capacity in particular for HWIPs; the improvement in sorted collections and the reprocessing of urban waste; the recovery and recycling obligation for various products; and finally, the introduction of the polluter-pays principle to fund waste disposal (» FOEN 2006a).

The environmental pressure attributable to waste incineration has been significantly reduced through an optimisation of the combustion process and smoke purification. In the space of ten years, "end of pipe" technologies (which permits pollutants to be eliminated at the end of the fabrication process) such as the purification and filtering of smoke have produced a reduction in the level of pollution attributable to waste incineration in HWIPs to about 1 % of previous values (» G5.11).

In Switzerland, excellent results have been achieved in the sorted collection and reprocessing of various categories of municipal waste, such as glass, aluminium cans, PET bottles, paper, and plant waste, as well as used electrical and electronic appliances (» G8). The total cost of sorted collection, reprocessing of matching waste and incineration in HWIPs of remaining waste comes to about CHF 114 per year per capita, or 30 centimes per day.

The greatest proportion of this cost is funded according to the polluter-pays principle: whoever generates waste must pay for its disposal (» SAEFL 2005c) (» The causality principle, page 59). In 2002, approximately 70 % of the population funded all or part of their waste disposal through contributions commensurate to the quantities, and a further 27 % through taxes or a basic fee. •

6. Agriculture

Agriculture is in the process of being restructured. Farms are growing in size while their number is decreasing, herds are becoming larger, and mechanisation and automation are increasing.

Because of its considerable land use, agriculture plays a central role in maintaining biological and landscape diversity.

Since 1993, major ecological progress has been accomplished by agriculture. However, it still remains a source of distributed pollution, especially of ammonia, pesticides and fertillisers and, – in a more or less serious way according to the regions – phosphorus.

Under its constitutional mandate, agriculture contributes considerably, through sustainable and market-oriented production, to ensuring the availability of food supplies to the population, decentralised settlement of the land, conservation of natural resources and maintenance of the rural landscape. Indeed, the Swiss landscape has for centuries been shaped by human beings, and in particular by farming activities.

Organisation of Swiss agriculture

There was a decrease of more than 30 % in the number of farms between 1990 and 2005, which dropped from 92,800 to 63,600 units (» G6.1). During this period their number decreased by 32 % in mountain areas, 29 % in hilly areas and 32 % in the plains. This reduction took place in a similar way in the three regions, but from 2000 to 2005 the development was much more significant in mountain areas (» FSO 2006c).

At the same time, average farm size increased in all the regions between 1990 and 2005, rising from 11.5 to 16.7 ha, which corresponds to an increase of 45 % per farm (» G6.1). Medium-sized farms in the mountain areas show a higher-than-average increase of over 52 % (from 10.3 to 15.9 ha per farm).

Total agricultural area used, which was 1.1 million hectares in 1996, decreased by 1.6 % during the 1996–2005 period. This reduction is distributed unequally throughout the regions. Settlement, installation and industrial areas have for the most part taken over farmlands, and only a small proportion has been turned into forest, brush or leisure areas (parkland) (» Chapter 11).

Fewer and fewer farmers raise livestock. This results in an increase in herd sizes for most categories of animals and in nearly all the cantons. In Switzerland, the average size of cattle herds increased from 30 to 34 heads between 1996 and 2005. The cattle population is declining in number: during the same period, it decreased by 11 to 1.5 million heads (940,200 livestock units – LU).

An average-sized pig herd totalled only 77 heads in 1996, against 137 in 2005 (» M6.1). Between 1996 and 2005, the pig population increased from 1.3 to 1.6 million heads (206,100 LU).

There were more than 418,000 sheep in Switzerland in 1996, and about 446,000 (43,000 LU) in 2005. The average size of the herd increased from 30 heads in 1996 to 40 in 2004.

Poultry – laying hens, chickens, and fattened birds – increased from 6.2 million in 1996 to 8.1 million in 2004 (47,700 LU in 2004). During the same period the number of poultry farms decreased from 25,400 to 17,100, with stock sizes increasing on average from 245 to 475 birds per breeder.

To be able to respond to market demands and increase their productivity, farms have to be mechanised (farm machinery) and automated for most activities (for example, machine milking). This results in an increase in usable land for each farm and the replacement of the workforce by machines (» G6.2). Although the number of tractors has »

› decreased slightly since 1990, the number of powerful machines (more than 75 HP[1]) increased by 173 % between 1990 and 2003. At the same time, the number of tractors under 74 HP decreased by 21 %.

Since the introduction of the census on fruit trees in 1951, approximately 80 % of the 14 million standard trees have been uprooted. The reasons for this dramatic decline can be explained in particular by streamlining and the market orientation that farmers have chosen. In the last fruit tree census in 2001, there were 2.9 million standard trees (» Chapter 12).

Impact of farming patterns on the environment

In spite of the more limited use of pesticides and fertilisers, distributed losses from farming generate water pollution by nitrates, phosphorus and pesticides (» Chapter 10) and air pollution by ammonia. Diesel-engined vehicles and farm machinery release particulate matter (PM10) (» Chapter 7) and greenhouse gases (» Chapter 8). Livestock is the main source of methane emissions, while mineral fertilisers and manure are responsible for that of nitrous oxide; both are greenhouse gases. Agriculture can also harm soils, compacting and damaging it by erosion, polluting it with heavy metals (» Chapter 11). Finally, intensive farming leads to degradation of the landscape and the loss of many living organisms (» Chapter 12). Most of the impact farming exerts on the environment is not concentrated in one specific location but is distributed.

Nitrogen

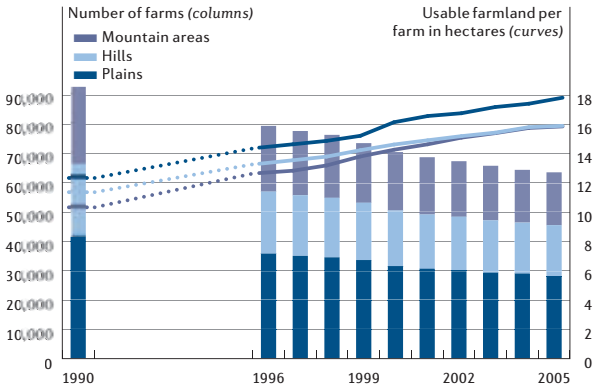
Nitrogen (N) is essential for plant growth. It is found in nature in highly diverse chemical forms. Losses from nitrogen are found in the environment as ammonia, (NH_3), nitrate (NO_3) and nitrous oxide (N_2O). NH_3, which evaporates and is deposited over the whole of the country (» Chapter 7), causes soil acidification and eutrophication, thus affecting particularly vulnerable ecosystems such as forests, peatlands or rough pastures. NO_3 pollutes drinking water, while N_2O is a greenhouse gas.

Animal manure contributes 50 % of the total nitrogen in agriculture. The other 50 % comes in equal part from mineral fertilisers and recycling (e.g. compost), and other sources. The evolution in the quantity of excess nitrogen has stabilised (» G6.3).

When urine and faeces come into contact with air, they decompose and produce ammonia. This gas evaporates and is spread through the circulation of air away from farmland. 93 % of ammonia emissions comes from farming. They amount to 43,000 t of nitrogen a year, which is significantly above the 25,000 t set as the maximum environmentally compatible value (critical loads). Today, one fifth of liquid manure is still stored in open tanks and only 11 % is spread using techniques that reduce emissions. Ammonia causes

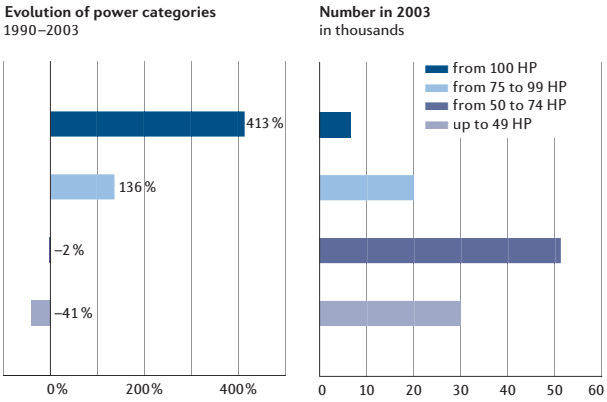
[1] 1 horsepower (HP) = 0.735 kilowatt.

G6.1 Evolution of farms per region and size



Source: FSO OS EE

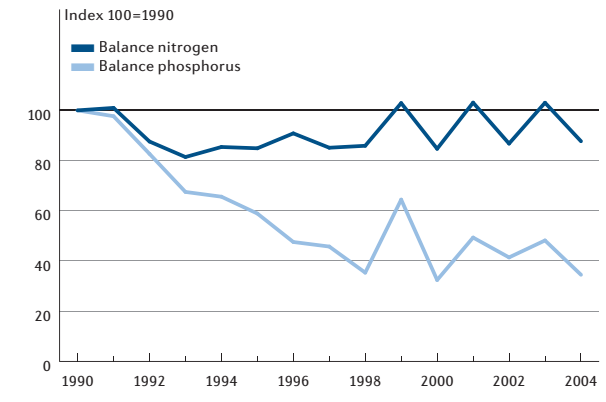
G6.2 Mechanisation of agriculture: tractors



1 horsepower (HP) = 0.735 kilowatt

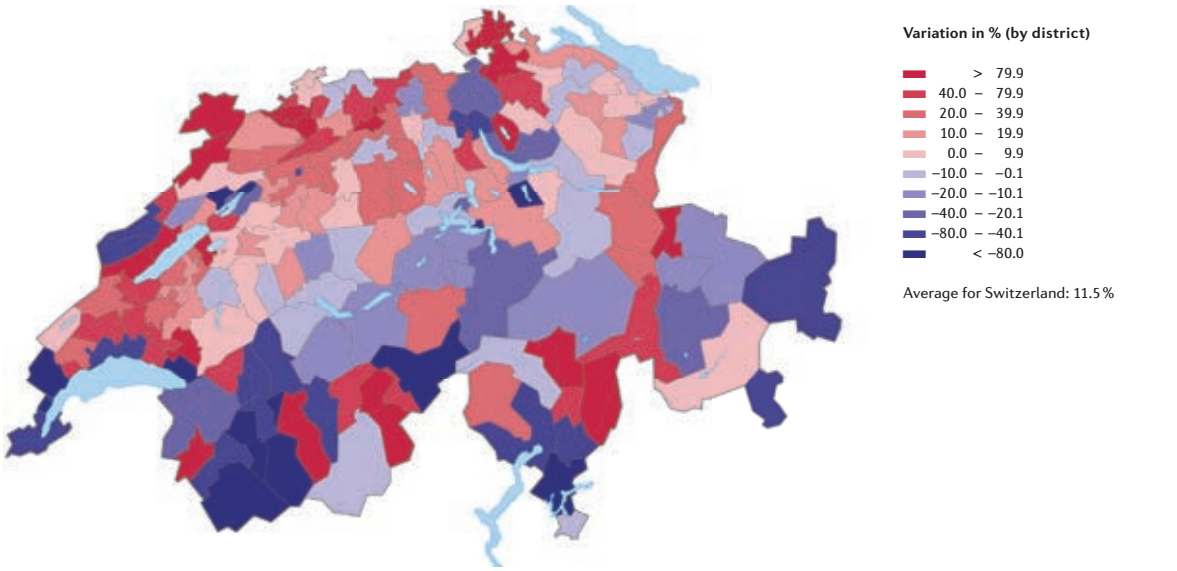
Source: FSO SI FS

G6.3 Evolution of nitrogen and phosphorus surpluses



Source: FSO SI M

M6.1 Pig population: variation 1996/2004



Source: Farming census, FSO Map: ThemaKart, FSO SI FS

visible damage to forests (soil acidification). It also results in the loss of plants growing on lean soils (oligotrophic) in rough pastures or peatland.

Leaching of NO_3 into groundwater can be observed, mainly on arable lands but also in intensively farmed meadows and pastures. In the majority of measurement stations surveyed, NO_3 concentrations decreased in groundwater for the period 1990–2003 (» NAQUA 2004). Large-scale enforcement of the environmental management system (EMS: restrictions on use of fertilisers, organic fertilisers in winter), and targeted complementary measures taken in water-catchment basins high in nitrates can, in part, explain this result. However, trends for 2004 and 2005 show a significant increase in nitrate values.

Phosphorus

Phosphorus (P) is one of the main plant nutrient, together with nitrogen and potassium. A good supply of phosphorus in soils is essential to obtain good crop yields. For decades, soils have been supplied with phosphate-enriched mineral fertilisers and are therefore well stocked.

Excess phosphorus can find its way into water, when phosphorus runs off grasslands, or when there is leaching and erosion on arable lands. This results in excessive growth of algae and aquatic plants. Oxygen-consuming bacteria and fungi decompose the dead plants lying at the bottom of lakes, thus depleting oxygen, which causes the environment of more evolved life forms to shrink. »

Wooded grazing land of the Jura Mountains bolster biodiversity and landscape

The wooded grazing land of the Jura forms a distinctive landscape, with which a whole region, extending from the Franches-Montagnes to the Jura vaudois, identifies. This pasture land is made up of a mosaic of trees of various ages, isolated or in coppices, with grasslands stretching between them, scattered with bushes. A subtle and fragile balance between humans, animals and plants permits this multipurpose landscape to be maintained. It combines three roles: production (agriculture and forestry), protection of biodiversity and tourism. The wide diversity of ecological habitats in these wooded pastures extending from grazing woods to open meadows enables over one sixth of Swiss flora (approximately 500 species out of 3,000) to benefit from suitable conditions. The current trend is to abandon less productive areas, which naturally turn into forests, and to use the more productive areas more intensively, which results in the disappearance of trees. In both cases these changes are detrimental to biodiversity and landscape. A return of the forest causes the withdrawal of species from the open areas and a dominance of forest species, which are already too prevalent in the forests that occupy nearly one third of Swiss territory (» Chapters 11 and 13). Intensive farming causes the disappearance of species specific to lean areas and which already are no longer found on most other farm areas. The landscape thus loses its character and its socio-cultural, ecological and tourist value (» Gallandat et al. 1995).

Use of and regulations on genetically modified organisms (GMOs) in agriculture

GMOs can be used in farming as reproductive material (seeds), pesticides (additives), fertilisers (nitrogen-fixing bacteria) or forage (maize). The first three relate to direct use in the environment of live GMOs. Conversely, forage is destined to be consumed by livestock and generally is only indirectly transferred into the environment.

Direct use of GMOs in the environment (experimental release, crops), beyond the opportunities (such as abandoning pesticides) and the benefits (production) that it brings, may produce undesirable environmental effects. The consequences can be varied (» F6.1). One example of a direct effect is the changes to the food chain brought about by GM plants that have been made resistant or even poisonous to certain insects. Cultivating this type of plant has a direct impact on the insects that rely on them. Genetic modification may also have indirect consequences. Tolerance of genetically modified plants to herbicides now enables the products that affect all other plants to be used (total herbicide). In the long term, this type of crop brings about a decline in adventitious flora (growing in crops without having been sown) sensitive to herbicides, as well as the associated fauna.

Spontaneous dispersal in the environment of genetically modified plants or animals susceptible to transmitting their genetic imprint to other organisms is another problem. Transmission to wild plants takes place through pollen dispersal, when wild species cross with genetically modified crops. Plants issued from these wild species can inherit the genetic modifications, for example, becoming resistant to insects, and may then dominate other plants. The transmission of genetic material to other plants cultivated in the neighbourhood, and the risk of GM crops blending with non-modified products during conditioning are also considered to be problematic. This blending limits the GMO-free product range available to consumers. However, these risks are currently almost inexistent in Switzerland.

In total, only three experimental dispersals of GM plants in the open air took place up to the end of 2006, and only on very small areas.

Following the acceptance on 28 November 2005 of the initiative on the moratorium[1], GMOs may not be used directly in the environment, particularly as seeds. This moratorium is effective until 2010. When it expires, measures will be enforced to protect human beings, animals, and the environment, as well as biodiversity and its sustainable use during cultivation of GM crops, as anticipated by the Federal Law relating to Non-human Gene Technology (Gene Technology Law)[2] and the Ordinance on the Release of Organisms into the Environment[3] based on this law. Meanwhile, experiments of GMO release in progress remain possible even during the moratorium.

[1] People's initiative "in favour of food produced without having been genetically manipulated"; transitory provisions art. 197, fig. 7 (new) of the Federal Constitution of the Swiss Confederation, 18 April 1999, RS 101.
[2] Federal Law of 21 March 2003 relating to Non-human Gene Technology (Gene Technology Law, GTL), RS 814.91.
[3] Ordinance of 25 August 1999 on the Release of Organisms into the Environment (Release Ordinance, RO), RS 814.911.

Animal manure contributes 70 % of the total sources of phosphorus, while 27 % come from mineral fertilisers and recycling, and 3 % from other sources. The figures show a significant trend towards a decrease (» G6.3), which is mainly due to a reduction in the use of mineral fertilisers. Thus, the annual phosphorus excess, which was approximately 24,000 t in 1985, fell to 7,000 t in 2004, or 6.6 kg phosphorus on average per hectare of agricultural area used (AAU). Surface water pollution by phosphorus from farming decreased by 10 to 30 % between 1990 and 2005. In areas of intensive farming, particularly in central and eastern Switzerland, soils are so rich in phosphorus that it is leached out and carried away each time it rains.

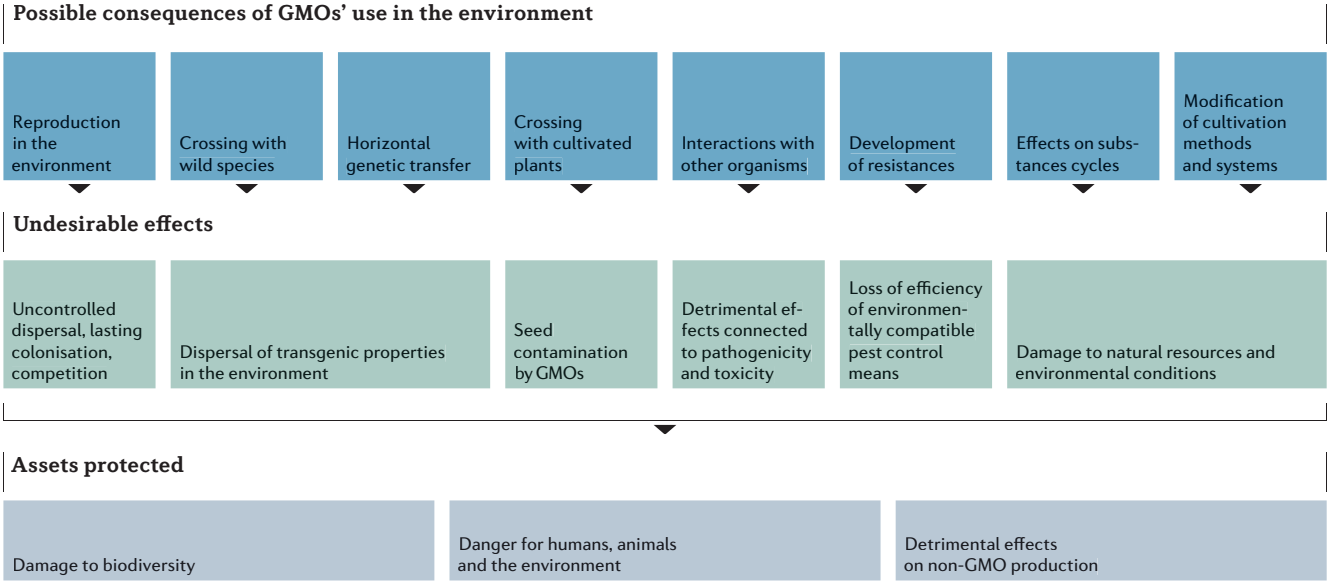
Pesticides

In Switzerland, over 350 active substances are used in pesticides. In 2005, about 1,400 t of such products were sold (FOAG)[2], of which 45 % were fungicides, bactericides and seed disinfectants, 45 % herbicides, 9 % insecticides and 1 % other products. A decrease in quantities sold has been observed over several years; in 1990 it was about 2,300 t. This decrease is not necessarily associated with a reduction of environmental burden, as old products have been replaced by more efficient ones used in lower doses.

Pesticides are harmful to the natural ecosystems of treated areas as well as to the areas affected by drift (when

[2] www.blw.admin.ch » Durabilité » Monitoring agroenvironnemental.

F6.1 Risks connected to dispersal of genetically modified organisms (GMOs)



Source: FOEN

they are carried away by wind or water). These substances are detected by groundwater monitoring stations, and in 2005 their maximum concentration sometimes exceeded 0.1 µg/l (» Chapter 10). It is mainly in rainy weather that high concentrations of some substances – up to several micrograms per litre – are found in small streams close to an area that has been sprayed.

Environmental concentrations of substances from pesticides are known only for a few substances. Although frequently used, many of them have either not yet been investigated or are detected by only a few, rare monitoring stations, through lack of adequate analysis methods or because they are too costly. Similarly, many decomposition products from pesticides, sometimes present in high concentrations in groundwater, have not yet been closely investigated (» NAQUA 2005).

Impact on landscape and biodiversity

Intensive farming has resulted in the loss of many landscape elements such as wetlands, rough pastures, streams close to their natural state, hedges and coppices, dry-stone walls, ponds etc. This more intensive production system brought about a notable decrease in the diversity of species. An attempt to reverse the trend was initiated in 1993, with the introduction of direct subsidies associated with ecological compensation measures. These areas are paramount to the conservation of biodiversity. A survey comparing 42 meadows established a concrete impact on the number of plants, grasshoppers, bees and bumblebees species, but not on the number of varieties of spider (» Knop et al. 2006). Another survey performed only on the plain (» Herzog et al. 2005), revealed, among other things, that the vegetation of most meadows in ecological compensation areas (ECA) still showed signs of the intensive farming which had taken place previously. On the other hand, the majority of littered areas (areas located in wet and swampy zones that are cut once a year) in ECA exhibited vegetation of a good ecological quality, and breeding birds were more numerous on or near this type of area. Ecological efforts were also made to curb the disappearance of standard fruit trees – which are less and less profitable – but were however, unable to stop the trend.

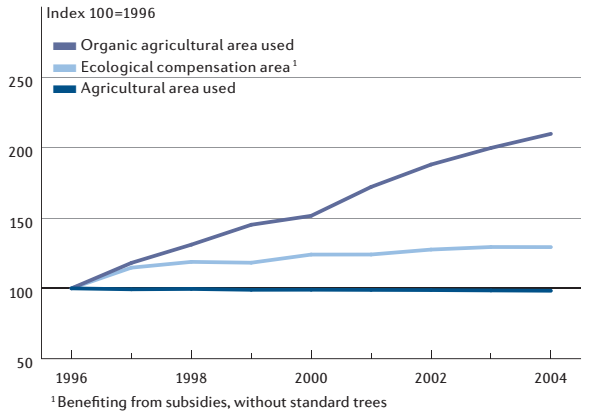
Measures in place and their impact

In addition to the sustainable use of environmental resources, the main environmental role of Swiss agriculture is to conserve and promote the diversity of species and the rural landscape. The main stages in achieving this are:

- Significant increase in the number of good-quality ecological areas integrated in a network
- Balanced use of fertilisers, including in intensive livestock farming
- Implementation of technical measures to reduce ammonia emissions
- Measures to stop pesticides infiltrating the ground water system
- Other energy-saving and air and soil pollution control measures (» Chapters 2, 7 and 11)

Since 2002, the total ECA has been stable, with a surface of 116,000 ha. During the same year in the plains, there was still a shortfall of 8000 ha in the 65,000 ha target planned for 2005. On the other hand, the share of ECAs integrated within an efficient biological network has been increasing since 2001. This heartening phenomenon can be explained »

G6.4 Agricultural area used and ecological compensation areas



[1] Benefiting from subsidies, without standard trees

Source: FSO

SI FS

› by the introduction of a system of result-based subsidies, via the Ordinance on Ecological Quality (OEQ[3]). This demand for clearly defined natural values motivates farmers to produce in a focused manner. The OEQ has led to the planning of many networking projects. However, the ecological compensation plan still presents extensive deficiencies on both the qualitative and the quantitative side, especially in the plain areas. Economic models predict a large increase in ECAs, since they are becoming more attractive as a result of the fall in product prices. But in order to tap into this potential and thus make up the extensive qualitative and quantitative deficits, coaching and consultancy efforts must be redoubled (» Chapter 12).

In Switzerland, a very large number of farms use organic farming methods (more than 11 %). They are regarded as environmentally friendly because they use neither artificial pesticides nor water-soluble fertilisers, and because they attach particular importance to soil balance and fertility, diversified crop rotation and balanced use of fertilisers. It is mainly in large-scale farming areas that they achieve positive environmental effects compared with traditional farming. In mountain areas where grassland areas predominate the effect is mitigated.

In order to reduce pollution from pesticides, technical measures addressing spraying (use of modern sprayers) and cleaning of equipment, and the satisfactory disposal of pesticide residue, should be encouraged. Furthermore, former active products should be reassessed and those with an inadequate ecotoxicological profile should be rejected. Farming methods adapted to the characteristics of the site, working techniques that limit soil erosion and buffer zones should be put in place. This should be complemented by an emphasis on coaching and consultancy activities and the introduction of financial incentives.

[3] Ordinance on the regional promotion of quality and the implementation of ecological compensation areas in agriculture (Ordinance on Ecological Quality, OEQ), RS 910.14.

According to the Ordinance on Air Pollution Control, technical measures must be taken to limit excessive ammonia emissions from liquid manure storage and spraying. If these measures were fully implemented, emissions could be reduced by 30 to 40 %. However, recent data show that this is far from being the case. Thus,

- in 2000, the proportion of animal manure stored in the open was 20 %, and had not changed as compared with 1990 (» Reidy, Menzi 2005);
- in 1990, in the majority of cases, liquid manure was being spread by means of deflectors – the most emission-generating system. In 2000, 88 % of spreaders were still fitted with these systems.

Large regional surpluses of phosphorus and nitrogen are still found, particularly in the intensive farming areas of central and eastern Switzerland. In order to transfer surplus farm fertilisers to regions with low farming density showing signs of deficits in nutrients, in a targeted way, the overall management of farm fertilisers – including associated techniques – should be improved.

Constructing farm installations likely to create serious environmental problems requires an environmental impact assessment (EIA). Essential improvements (rearrangement of parcels) as well as large cattle-sheds and cattle-breeding installations are directly concerned by this measure. •

7. Air quality

The quality of the air has greatly improved over the last 20 years thanks to the numerous measures adopted. However, the threshold limits set or nitrogen dioxide, ozone and particulate matter are still being exceeded, sometimes significantly. The same observation applies to acid and nitrogen fallout in fragile ecosystems.

Air pollution is a threat to our health; it endangers ecosystems and generates costs amounting to several billion francs each year.

Further reduction in emissions is therefore necessary, especially of nitrogen oxide, volatile organic compounds, breathable fine particles, carcinogens and ammonia.

Emissions of air pollutants

Major pollutants and their sources

The composition of our atmosphere has remained practically unchanged for thousands of years. As air is a balanced mixture of gases, it meets the needs of humans, animals and plants. Human activities, by their very nature, have always affected the composition of the air. But it is only relatively recently, with the rapid increase in motorisation, the great increase in consumption of fossil fuels and the release of new substances resulting from chemical processes, that the global balance has begun to be affected.

Air pollutants are pumped out by chimneys and exhaust pipes, and released through evaporation, friction or vorticity. This process of pollutant release is called "emission". Pollutants mix with the air and are carried away by atmospheric circulation. While they are being transported, these substances can undergo chemical or physical changes through the action of radiation or by reacting with other pollutants and thus forming new ones (for example ozone and secondary fine particles). "Transmission" refers to the dilution, transport and transformation of pollutants. Finally, the diluted pollutants mixed with air come into contact, as "immissions" (concentrations, deposits), with humans, plants, animals, soils, water and materials, and can then develop their harmful effects (» page 71).

Air pollution

Immissions

Smoking chimneys, fumes from exhaust pipes and cities covered by smog are clear signs of air pollution. However, even with a clear blue sky and when our nose does not detect anything abnormal, harmful concentrations of pollutants can still be present in the atmosphere. This is why the composition of the air is continuously analysed and monitored: the NABEL[1] monitoring network evaluates air pollutants as well as contaminants that settle in ecosystems at representative locations, based on certain indicator pollutants[2]. As well as having an overview of the situation in the whole of the country, it is essential to have regional and local information; cantons and communes therefore also operate measurement networks and stations.

Air pollution is evaluated using the threshold limits set in the Ordinance on Air Pollution Control (OAPC)[3]. Threshold limits for sulphur dioxide (SO_2) and carbon monoxide (CO) immissions, and lead, cadmium and zinc in particulate matter (PM10) are generally respected. However, those set down for nitrogen dioxide (NO_2), for ground-level ozone (O_3)

[1] Data from the Swiss National Monitoring Network for Air Pollution (NABEL): www.environnement-suisse.ch » Topics index » Air » Air pollution » NABEL monitoring network.

[2] This means pollutants that are good indicators of specific effects and that are released into the atmosphere in large quantities and from a large number of sources.

[3] Ordinance on Air Pollution Control (OAPC) of 16 December 1985, RS 814. 318.142.1.

Main pollutants

The main pollutants that cause problems are nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3) and breathable fine particulate matter (PM10).

- *NO_x cause high ozone quantities, acidification and eutrophication of natural ecosystems such as marshlands and forests, and the formation of secondary particulates (PM10). Road transport is the main source of NO_x (» Chapter 3).*
- *NMVOCs contribute to the formation of ozone and secondary particulates. Trade and industry are the main sources (» Chapter 4).*
- *NH_3 plays a major part in the eutrophication of natural ecosystems and the formation of secondary particulates. Agriculture is the main source (» Chapter 6).*
- *PM10 cause respiratory and cardio-vascular disorders and lead to premature death (» page 71 and Chapter 17). Carcinogenic compounds contained in exhaust fumes from diesel engines or wood combustion are particularly toxic. Agriculture and forestry, road transport, and trade and industry are the main sources of PM10.*

formed from NO_x and VOC precursors (» Main pollutants) and for PM10 are greatly exceeded in some cases; 40 % of the population is currently exposed to excessive amounts of particulate matter (» G7.1 and M7.1).

Furthermore, the critical values set at international levels for acid and nitrogen fallout are still currently exceeded in many places in Switzerland. In some places, the critical thresholds are often in the range of 10 to 20 kg of nitrogen per hectare per year. More than 90 % of forest areas and nearly 55 % of the area of other ecosystems close to a natural state are polluted by excessive quantities of nitrogen (» M7.2).

Summer smog

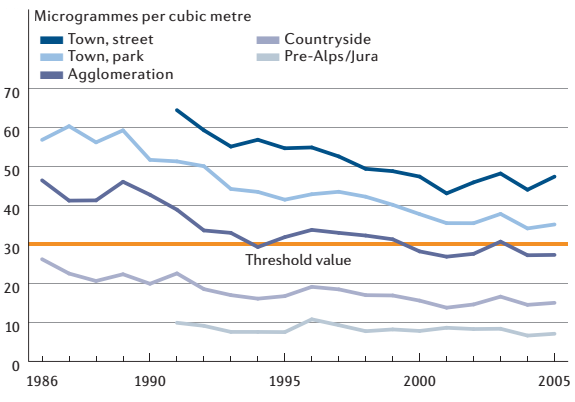
Summer smog is atmospheric pollution caused by precursors (mainly NO_x and VOCs). These substances are chemically modified by strong solar radiation. Ozone (O_3) is the main pollutant that this photochemical reaction produces. It is used as a reference when evaluating pollution by summer smog. Other pollutants are also created at the same time as O_3, in particular formaldehyde, peroxyacetyl nitrate and nitric acid. Summer smog and the associated high concentration of O_3 are indicators of excessive air pollution. This type of pollution harms not only human health but also buildings, materials and the climate.

Ozone: one substance – two effects
Concentrated in the stratosphere at an altitude of between 20 and 40 km, ozone protects us from UVB radiation.
However, when it forms in the troposphere near the ground in summer, it irritates the eyes and the respiratory system. It also damages plants.

Winter smog

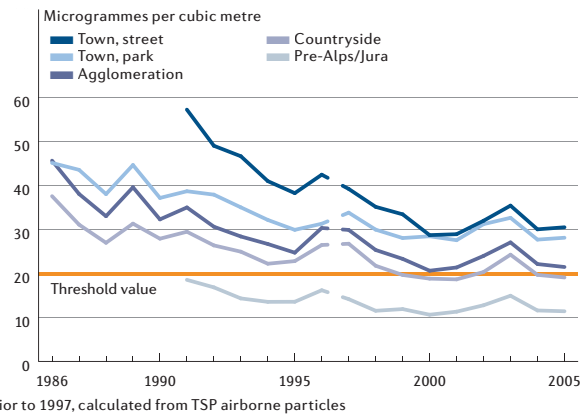
The air we breathe always contains tiny airborne dust particles (PM10). In winter, in conditions of high pressure and moderate winds, when a "cover" prevents the stirring of air »

G7.1a Annual averages for nitrogen dioxide (NO_2) immissions



Source: FOEN, NABEL monitoring network

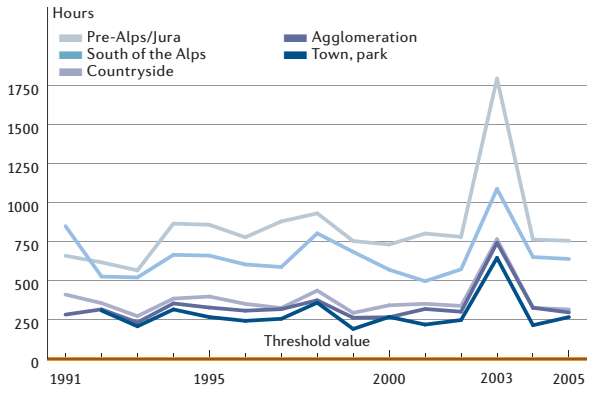
G7.1b Annual averages for particulate matter (PM10) immissions



Prior to 1997, calculated from TSP airborne particles

Source: FOEN, NABEL monitoring network

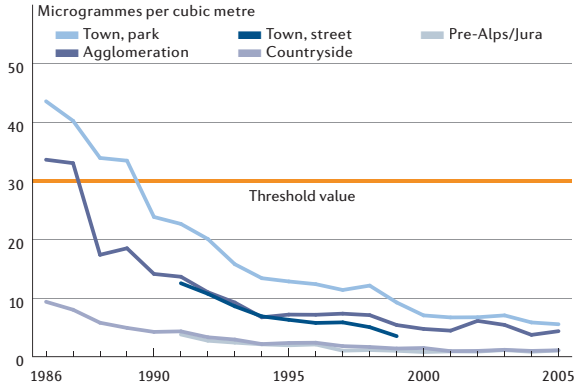
G7.1c Exceedences of the hourly ozone (O_3) immission threshold value[1]



[1] Hourly immission threshold value: 120 microgrammes per cubic metre; must never be exceeded more than once a year. In 2003, the ozone content was extremely high because of the heatwave.

Source: FOEN, NABEL monitoring network

G7.1d Annual averages for sulphur dioxide (SO_2) immissions



Source: FOEN, NABEL monitoring network

› masses (thermal inversion), high concentrations of fine particulate matter and nitrogen oxides can reach high levels (winter smog). Then, for several days, they exceed the thresholds set in the OAPC. The maximum level of PM10 can reach two to four times the permitted daily value, which is 50 µg per cubic metre.

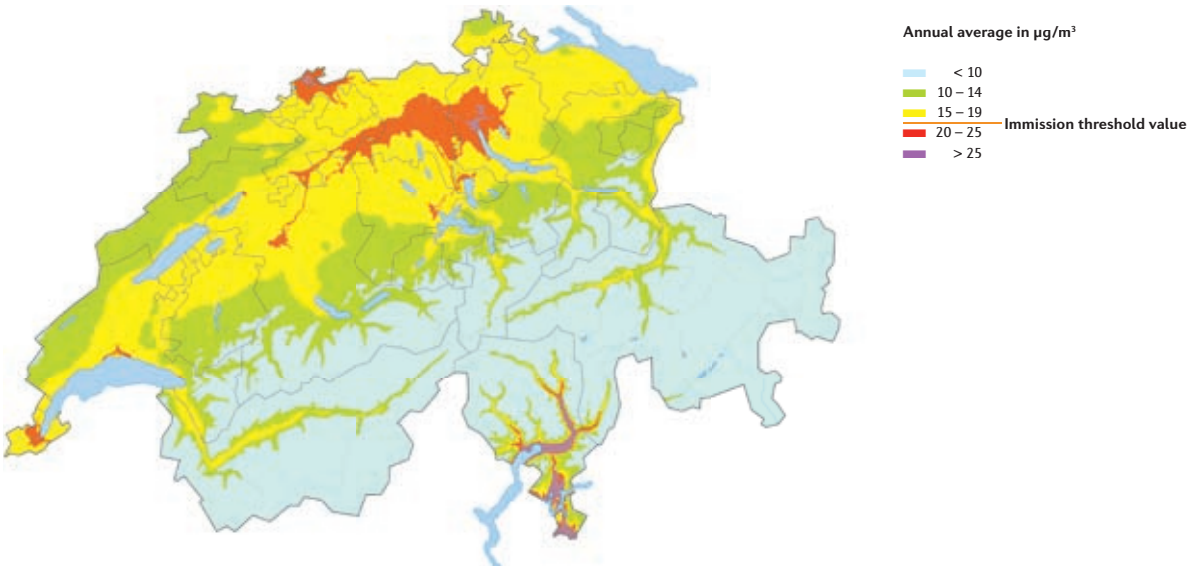
PM10 consists of primary and secondary particles. Primary particles are emitted directly into the air, while secondary particles are formed in the atmosphere from other air pollutants. Primary PM10 are generated by combustion processes, or produced by the abrasion of tyres, brake pads or rails, fugitive dust and natural sources. Secondary particles are formed from gaseous precursors (NO_x, NH_3, VOC).

In Switzerland, the annual level of PM10 is too high. Three million inhabitants live in areas where the annual average exceeds the threshold of 20 µg per cubic metre.

Impact of air pollution in Switzerland

The current level of air pollution in Switzerland produces respiratory and cardiovascular diseases and causes some 3,700 premature deaths each year, more than 300 of which from lung cancer. The polluted air we breathe causes approximately 39,000 cases of acute bronchitis in children each year, and about 1,000 new cases of chronic bronchitis in adults. Furthermore, some 1.7 million days of reduced activity in adults are attributable each year to air pollution (» ARE 2004a) (» Chapter 17).

M7.1 PM10 concentration in Switzerland between 2000 and 2005



Source: FOEN/Meteotest 2006

Humans are not the only living organisms who suffer from bad air quality. Air pollutants are transported over long distances and infiltrate the sensitive water and soil ecosystems as sediments (» Chapter 11). For example, nitrogen and sulphur fallout produces acidification of Alpine lakes and streams at altitude, and also acidify the soils of forests irrespective of the altitude (» Chapter 13). Additionally, eutrophication resulting from excessive nitrogen input has harmful effects on many ecosystems (» Chapter 6). Currently, about two thirds of nitrogen intake in sensitive ecosystems comes from ammonia emissions in agriculture, and one third from the NO_x generated by combustion. One of the consequences of this excess nitrogen intake in forests is nitrogen leaching (transport of chemical elements in the soil following dissolution) as nitrates, from forest soils to underground water (» Chapter 10).

In high concentrations, air pollutants have direct acute and chronic effects on plants (» Chapter 6). In agriculture, air pollution results in crop losses of up to 15 %: for example, in summer, high ozone concentrations inflict visible damage on tree leaves. Buildings, historic monuments and materials are also attacked, bleached and destroyed by acid pollutants and photooxidants.

Each year, in Switzerland, air pollution occasions costs of several billion francs. These external costs, not covered by the polluters, relate to health, crop losses in agriculture, as well as damage to materials and buildings. Healthcare costs are estimated at CHF 4.2 billion per year.

Measures in place and their impact

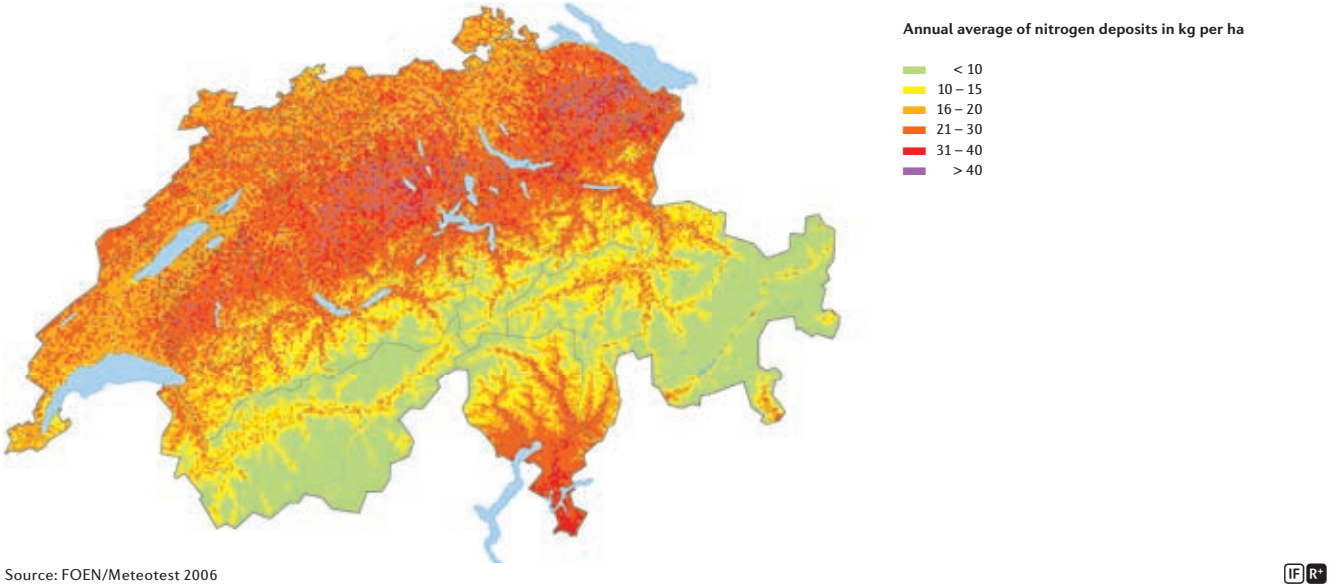
Reduction in the emission of air pollutants

The Environmental Protection Law[4] (LPE) compels the Confederation and the cantons to protect humans, animals and plants, their biocenosis (set of living organisms that inhabit a given ecosystem) and biotopes from harmful or troublesome air pollutants. To accomplish this, the authorities have conceived a two-stage approach: the first consists of limiting pollutant emissions as a preventive measure, as far as technological status and operational conditions allow, and as long as it is economically viable (prevention principle). Thus, air pollution must be kept as low as possible although they may not yet pose an environmental risk. Emissions will be more severely limited if it is established, or if there is reason to believe, that the effects will be harmful or troublesome given the existing environmental situation. In this second stage, the protection of humans and their environment will overtake economic considerations. Another important principle is that of causality (» The causality principle, page 59). The main objective of the LPE has been embodied in the OAPC, the Federal Council's strategy against air pollution (» Federal Council 1986) and further initiatives (» Federal Council 1999, SAEFL 2005b), as well as in the objectives set by international agreements (for example, the Geneva Convention on long-range transboundary air pollution[5]).

Since the legislation on air protection came into force, the Confederation, cantons and communes have taken a large number of measures in order to reduce pollutant emissions. At federal level, the main measures relate to strict provisions on emissions from heating, industrial installa- »

[4] Swiss Federal Law of 7 October 1983 relating to the Protection of the Environment (Environmental Protection Law, LPE), RS 814.01.
[5] Convention of 13 November 1979 on Long-Range Transboundary Air Pollution (Geneva Convention), RS 0.814.32.

M7.2 Nitrogen deposits in Switzerland between 2000 and 2005



Source: FOEN/Meteotest 2006

Incentive tax on VOCs

In 2000, Switzerland introduced the incentive tax on VOCs, thus complementing her environmental policy with a tool of the market economy. The tax on VOCs is a financial incentive to encourage firms to reduce emissions. Until the end of 2002 the tax was CHF 2 per kg of VOC; since then it has increased to CHF 3. This increase aims to contain the demand for VOCs and contribute to changing consumers' habits. Companies should choose processes, substances and products that respect the environment. The incentive tax is a flexible mechanism: each company decides if, and to what extent, it wants to make efforts to reduce the use of VOCs. The proceeds from the tax are distributed evenly across the population, through the compulsory health insurance. It is not, however, a subsidy for health insurance premiums: the health-insurance system is used solely as an administrative channel, as no other system takes stock of the population in such a comprehensive way. Emissions of VOCs targeted by the incentive tax decreased by one third between 1998 and 2004, from 78,000 to 51,900 t. Other incentive taxes include the tax on the sulphur content of "extra-light" heating oil.

tions and motor vehicles, as well as provisions relating to the quality of combustibles and fuels. They also include incentive taxes, such as the heavy goods vehicle tax (HGVT) and the incentive tax on VOCs (» Incentive tax on VOCs), as well as promoting the use of public transport (» Chapter 3). The cantons are responsible for enforcing the provisions of the Ordinance on Air Pollution Control. The cantons and communes have taken thousands of decisions relating to cleaning up companies in trade and industry and heating installations. The implementation of these measures is therefore well advanced. The cantons have also developed protective measures at local level, aimed at reducing excessive air pollution. These additional provisions relate particularly to programmes promoting public transport, spatial planning measures such as the choice of location and installations generating an important traffic or parking areas (» FOEN/ARE 2006), constraints on wood-burning heating systems with high emission levels, and measures to slow down traffic. Furthermore, the cantons can require the Federal Council to provide supplementary measures if these are within the Confederation's jurisdiction, such as the action plan against fine particulate matter adopted in 2006. This specifically supports federal air protection measures.

Thanks to the measures taken by the Confederation, cantons and communes, the emissions of SO_2 have decreased by 85 %, and those of NO_x and VOCs by 50 to 65 % over the last 25 years. The reduction recorded for PM10 is about 40 %.

Prevention of air pollution

Evaluation criteria for air pollution are the immission thresholds (IT) defined in the OAPC and, for acid and nitrogen inputs and O_3, critical amounts and levels (United Nations Economic Commission for Europe). For values below these critical thresholds focused on the effects, there is generally no reason to expect harmful or troublesome effects. On the

other hand, the more the thresholds are exceeded, the more harmful the effects on health and environment will be.

In the last 25 years, the air that we breathe has become cleaner: the OAPC immission threshold for 11 out of the 18 pollutants has been respected over the whole of the country. However, the remaining problems related to ozone, fine particulate matter and nitrogen will be resolved in a sustainable manner only if emissions are reduced further. This applies particularly to NO_x, VOCs, PM10 and ammonia (NH_3). These pollutants require further measures with sustainable effects, in particular the option of using better technology for vehicles, industrial and agricultural installations and heating systems. Economic and social considerations must also be taken into account. Continuing with the incentives, such as the HVT and tax on VOCs, is also a necessity. However, emission of pollutants also depends on the development of mobility, energy use, industrial and agricultural production and consumption. There have as yet been few economic incentives to adopt a respectful attitude towards the environment, which would lead to a decrease in the consumption of fuels and combustibles. Measures that achieve this might include the development of an adequate tax on CO_2 or "road-pricing".

Long-range air pollution must be lowered by means of sustainable measures in other European countries. Supplementary efforts have therefore also been requested at international level under the Geneva Convention (» Chapter 18). •

8. Climate change

Average temperatures in Switzerland increased by 1.5 °C between 1970 and 2005, which is approximately 1.5 times faster than the increase observed in the land areas of the northern hemisphere. Glacier recession, thinning of the snow sheet in the highland and changes in the vegetation are evidence of climate change. As an Alpine country, Switzerland is vulnerable to climate change.

In 2005, greenhouse gas emissions have decreased by 0.5 % compared to 1990; this is mainly due to measures linked to energy policy. These emissions are principally caused by traffic, households, industry and agriculture.

In order to meet the objectives of the Kyoto Protocol, Switzerland needs to introduce new measures to reduce its emissions of greenhouse gases by 8 % of the 1990 values, by 2010.

Greenhouse gases

Emissions

The greenhouse effect plays a crucial role in climate change. This natural phenomenon is intensified by greenhouse gas emissions generated as a result of human activity. The Kyoto Protocol to the United Nations Framework Convention on Climate Change[1] (Kyoto Protocol) covers the following greenhouse gases or groups of greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), partly halogenated fluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). HFCs are primarily used as substitution products for chlorofluorocarbons (CFCs), which are responsible for the depletion of the ozone layer and also affect the climate. Although they also play a part in global warming, CFCs are not covered by the Kyoto Protocol; instead they are covered by the Montreal Protocol on ozone-depleting substances (» Chapter 9).

In 2004, 53 million tonnes of greenhouse gases were released into the atmosphere in Switzerland (emissions expressed in **CO_2 equivalents** – » G8.1). This figure does not include emissions from international air traffic, which amount to 3.5 million tonnes. In Switzerland, forests are carbon sinks. The increase in wood stocks in forests is thus particularly important (» Chapter 13).

Since 1990, the global emissions of greenhouse gases have remained more or less stable. CO_2 emissions have increased slightly. Emissions of methane and nitrous oxide have decreased, and emissions of **synthetic gases** have noticeably increased (in particular HFCs). Graph » G8.1 also shows CO_2 emissions from fuels and combustibles resulting from the consumption of fossil fuels. They correspond to the definition in the Swiss Federal Law on the Reduction of CO_2 Emissions (CO_2 Law)[2]. CO_2 emissions from combustibles decreased by about 1.1 million tonnes between 1990 and 2004, while emissions due to fuels increased by 1.2 million tonnes.

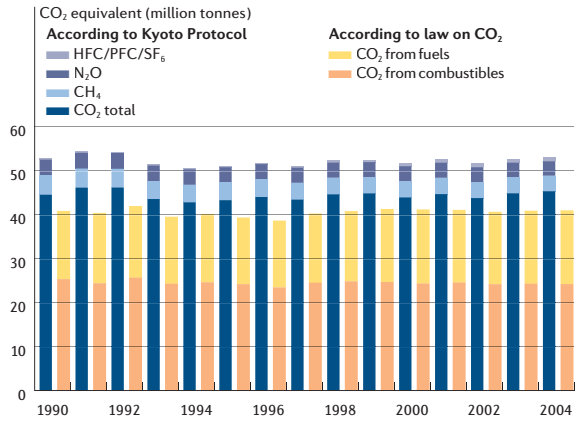
Sources

CO_2, by far the most prevalent greenhouse gas, is released primarily as a result of the combustion of fossil fuels, and is responsible for 76 % of total greenhouse gas emissions. Combustibles account for 44 % and fuels 32 %. Other CO_2 emissions (10 % of the total of **CO_2 equivalents**) result from the production of cement, incineration of waste and chemical processes. Other gases account for 14 % of the

[1] Kyoto Protocol to the United Nations Framework Convention on Climate Change of 11 December 1997 (with appendices), RS 0.814.011.

[2] Swiss Federal Law on the Reduction of CO_2 Emissions 8 October 1999 (CO_2 Law), RS 641.71.

G8.1 Greenhouse gas emissions in Switzerland



Source: FOEN, Swiss Greenhouse Gas Inventory

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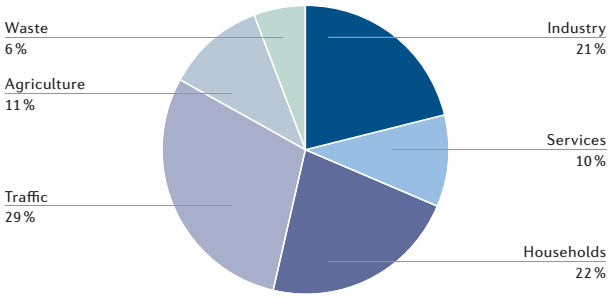
G8.2 Greenhouse gas emissions by source in 2004



Source: FOEN, Swiss Greenhouse Gas Inventory

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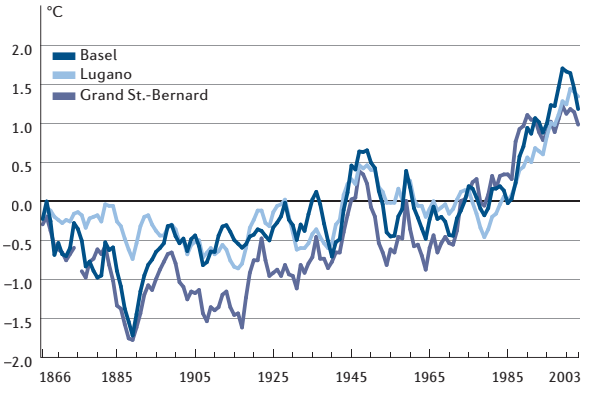
G8.3 Evolution of temperatures – Differences compared with the 1961–1990 average

Mean averages over a 5-year period



Source: MeteoSuisse

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total CO_2 equivalents. Agriculture is the largest producer of methane and nitrous oxide. Methane comes mainly from cattle breeding, and nitrous oxide from the use of mineral and farm fertilisers (» Chapter 6). Relatively large quantities of methane are also released into the atmosphere by waste dumps. Synthetic gases (HFCs, PFCs and SF_6) are used in refrigeration and high-voltage technologies. Emission distribution by source group is shown in graph » G8.2.

Climate change

Signs of climate change

The Earth's average temperatures are rising, which causes sea levels to rise slowly but steadily. According to current scientific knowledge, a concomitant increase in extreme climatic events (floods, droughts, heatwaves, storms etc.) is quite conceivable. Given the rarity of such events and the magnitude of natural variations of meteorological phenomena, it has not yet been possible to provide statistical evidence of this (» Chapter 14). The subtle changes we can expect in connection with global warming have economic and social impacts that are as important as the extreme events. These include:

- Changes in the nature, intensity and frequency of rainfall in many parts of the world (including their impact on fresh water supplies, agriculture and natural ecosystems);
- Desertification of already dry areas;
- Salinification of underground water and the increasing risk of floods in heavily occupied and populated coastal areas;
- The temperature-related spread of infected carriers and pathogenic agents to new areas.

The increases in average global temperatures observed since the 1970s can no longer be explained by natural factors. The pattern of global warming and its effects since that period must be attributed in the first instance to human activity, and in particular to the ever-increasing release of greenhouse gases.

From a scientific standpoint, it is impossible to ascertain precisely from which moment a modification in the climate should be classified as dangerous. The same applies to the issue of knowing at which level of global warming we can expect irreversible or sudden modifications. In international political debates, an increase of 2 °C in average global temperatures, compared to the pre-industrialised situation, is often considered as a threshold that must not be exceeded (» EU Council 2005).

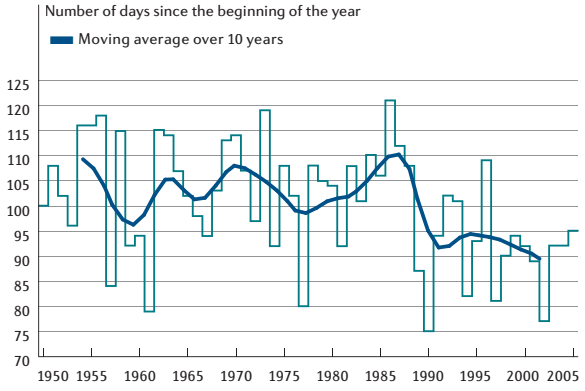
In Switzerland, temperatures have increased significantly since 1970 (» G8.3). Annual averages over five years recorded recently are 1.5 °C higher than those measured before the period 1930 to 1940 in all regions of the country, which corresponds to an increase approximately 1.5 times faster than the average in the land areas of the northern hemisphere. In the 20th century, precipitation increased by 20 to 30 % in the northern and western regions of the country during the winter, and decreased in the same pro- »

› portions in the south of Switzerland during the autumn. During the same period, an increase of 20 to 80 % in the frequency of intense daily precipitation was observed by most measurement stations north of the Alps.

The most obvious sign of climate change that we can observe on the planet is glacier recession in mountain areas. The cumulative average loss in ice thickness recorded since 1967 on nine glaciers in the Alps studied in detail is almost 18 metres. Since the mid–1970s, the volume of Alpine glaciers has been shrinking progressively by about 1 % annually. During the heatwave of summer 2003 and the following year, some 10 % of the remaining volume of the glaciers – 3.5 metres of average ice thickness (which is between 30 and 35 metres) melted. If this trend continues or becomes more pronounced, three out of four glaciers in the Alps will have disappeared by the middle of the 21st century. The melting of permafrost is another visible sign of global warming, whether at altitude or in high latitudes.

The spread of subtropical plants from gardens and parks to the forests of Ticino is another indication that Switzerland's climate is changing. The same observation applies to the pine forest dieback in the Rhone valley, and to the seasonal growth of some types of plants. Given that this evolution depends on a large number of environmental factors, the longer-term trend observed convincingly shows the modifications of the climatic effects that have been observed at a given location. For example, in Liestal (BL), cherry trees now flower approximately 15 to 20 days earlier than they did in the 1970s (» G8.4). This tendency towards early occurrence of the phenological phases (budding, flowering) in the spring has been observed in the whole of Switzerland for many plants over the period from 1951 to 2000.

G8.4 Date for beginning of cherry-tree flowering in Liestal BL



Source: MeteoSuisse

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Consequences

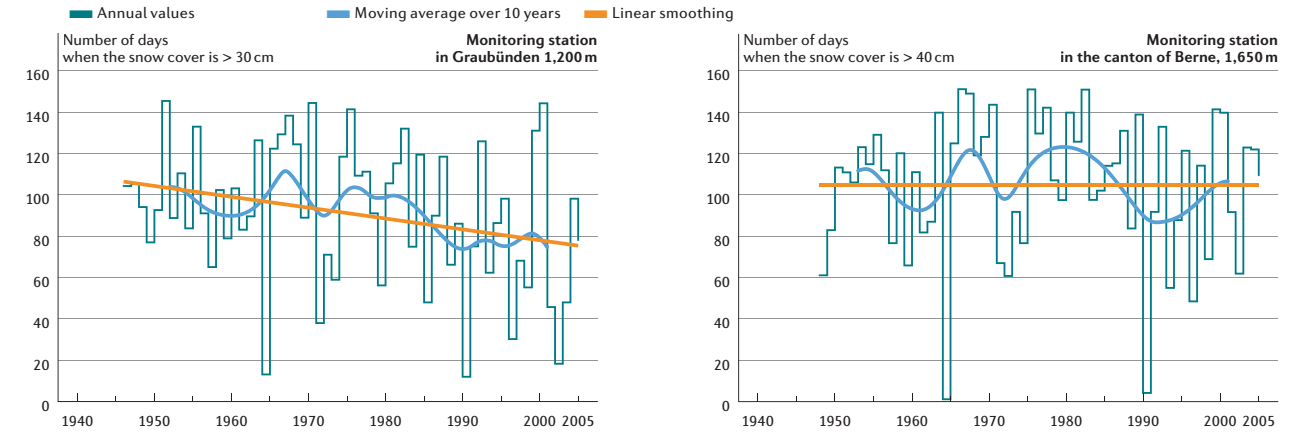
Climate change and the modification of the rainfall profile affect many economic and social areas. Water resources, agriculture, tourism, energy, human health, insurance and infrastructures are especially sensitive to this. Over the last few years, the authorities, scientists and economists have examined in depth the consequences of these changes and established appropriate adaptation strategies. It is moreover essential to take into account the fact that many other factors, such as changes in international competition and structures, also have an impact on the development of the areas under scrutiny. Climate change can nevertheless intensify existing trends and exacerbate the pressure for adaptation or evolution.

Tourism provides a good illustration of the climate's importance for the economy. In mountain areas, summer tourism could benefit from global warming if heatwaves were more frequent on the Central Plateau and in other tourist areas. But conversely, glacier melt and the draining of streams would diminish the attraction of mountain areas. The same applies to risks of landslides and rockfalls in high mountain zones, which could increase locally as a result of permafrost melt. Regarding winter tourism, where the economic impact is much greater, the problems are different. In this case, the challenge comes from the snowfall boundaries, which are rising progressively. It is rarely possible to move skiing stations to higher altitudes. Furthermore, the possibilities of compensating for insufficient snow cover with artificial snow are limited because its production also requires low temperatures and the availability of water. Regrouping of facilities in areas where the snow is guaranteed and finding solutions that do not depend on snow could become a priority for this sector. Skiing resorts in the Alps are considered as having "guaranteed snow" if they have snow cover of at least 30 cm during at least 100 days between 16 December and 15 April, for seven years out of ten. Since the end of the 1950s, the number of days has gone down in many resorts located beneath 1200 or 1300 metres. On the other hand, in winter resorts located over 1500 to 1600 metres, no clear trend is noticeable (» G8.5).

The 2003 summer heatwave clearly demonstrated that global warming could also have consequences for human health. In Switzerland, the mortality rate increased by about 7 % between June and August 2003 (» Chapter 17). Water supplies, and therefore fishing, hydroelectric power stations, nuclear energy production and navigation, were also affected by the accompanying drought. There was a shortage of water for irrigating crops. The Institute for Atmosphere and Climate of the Federal Institute of Technology

G8.5 Safety of the snow cover in skiing areas situated at two different altitudes

Changes to the limit of "guaranteed snow" (December–April)



Source: SLF/ENA

in Zurich calculated that comparable conditions could occur every other summer by the end of the 21st century. Specific measures of adaptation to situations of extreme heat and drought could therefore become necessary in the medium term.

In addition to heat and drought, high rainfall causes events that produce considerable damage. In the event of progressive global warming in the Alpine region, we can expect an increase in violent and continuous rainfall likely to cause, for example, mudslides, landslides and floods, especially in winter (» Chapter 14).

Measures in place and their impact

Reduction of greenhouse gas emissions

In Switzerland, greenhouse gas emissions have decreased by approximately 0.5 % since 1990 (» G8.1). In the majority of industrialised countries, an increase was observed during that period. The reason why this was not the case in Switzerland is that economic growth was lower than the international average; as well as the various measures put in-place. The principle measures, based on CO_2 Law and the Energy Law[3], are the ENERGY 2000 programme and its successor, the SWISS ENERGY programme (» Chapter 2). It is also worth mentioning the voluntary economic measures taken, the efforts of the cantons with regard to construction work, and the heavy goods vehicle tax. These measures have resulted in a slight decrease in emissions generated by combustibles. On the other hand, in spite of the voluntary measures and the heavy goods vehicle tax, CO_2 emissions from fuels increased between 1990 and 2000 but have been more or less stable since (» G4).

Methane and nitrous oxide emissions generated by agriculture have decreased since the beginning of the 1990s. The development of the market, technical progress, and the ecological performance necessary to obtain direct payments have resulted in a decline in numbers of livestock and a cutback in the use of fertilisers. In recent years a reduction in methane emissions generated by waste has also been recorded – this is due to the ban on dumping combustible waste. Since 2000, this type of waste must be disposed of in household waste incineration plants (HWIP).

The use of synthetic gases (HFC, PFC, and SF_6) increased greatly during the 1990s. To avoid this progression continu- »

[3] Swiss Energy Law of 26 June 1998 (ENG), RS 730.0.

› ing, in 2003 the Federal Council revised the laws on chemical products[4]. Since then, the use of these gases is not authorized unless no replacement process or product respectful to the environment is available, according to the current state of technological progress.

Without additional measures, greenhouse gas emissions will decrease only moderately between now and 2010. This estimate is based on the expected effect of the measures put in place by the end of 2004. It does not take into account the effect of a CO_2 tax or the "climate cent"[5], or that of other planned measures. According to this scenario, the reduction in greenhouse gas emissions would correspond to 3.2 % for the period from 1990 to 2010, whereas the objective fixed by the Kyoto Protocol is a reduction of 8 %.

Limitation of the effects of climate change

Adapting to modified climatic conditions could present real challenges to certain particularly affected economic sectors. It remains to be seen to what extent it will be left to politicians to take up this challenge (» SAEFL 2002c). The Confederation and cantons give first priority to protection against natural hazards and the management of extreme events. However, in an increasing number of cases, preventive measures supplant disaster management (» Chapter 14). Within this approach, it is essential to take more account of new risks that could be the result of gradual climate change. •

[4] Ordinance on the Reduction of Risks Reduction in Dealing with Certain Particularly Dangerous Substances, Compounds and Objects, of 18 May 2005 (ORRCHEM), RS 814.81.

[5] The centime for the climate ("climate cent") on petrol and diesel is a voluntary measure in the terms of the CO_2 Law. It is intended to fund measures that affect Switzerland's climate positively, as well as that of other countries.

9. Ozone layer

Over the last 20 years the ozone layer has deteriorated and UVB radiation has become stronger.

Between 1986 and 2004 the measures taken by the international community and Switzerland contributed to decreasing the regulated part of the consumption of ozone-depleting substances by 99 % in Switzerland and 93 % at international level.

The continuation of these efforts should enable the regeneration of the ozone layer in around 60 years from now.

Ozone-depleting substances

In order of importance, the ozone-depleting substances (ODS) are: CFCs (chlorofluorocarbons), halons, carbon tetrachloride, trichlorethane, HCFCs (hydrochlorofluorocarbons), methyl bromide and bromochloromethane. The first four substances were mainly produced between 1960 and 1996. However, their emissions – estimated at around 1.7 million tonnes in 1990 – were still some 220,000 t in 2004 and some of them will probably not cease before 2040 (» WMO/UNEP 1998). Indeed, the use of CFC and halons in existing refrigeration and firefighting equipment was still authorised in Europe and Switzerland until recently; it still is in some other industrial and developing countries. In addition, the synthetic foam compounds used until the end of the 1990s, in particular for the insulation of buildings and refrigerators, will continue to emit CFCs for several decades.

Ozone: one substance – two effects
Concentrated in the stratosphere at an altitude of between 20 and 40 km, ozone protects us from UVB radiation.
However, when it forms in the troposphere near the ground in summer, it irritates the eyes and the respiratory system. It also damages plants.

In 1990 HCFC emissions were about 180,000 t, but currently they are peaking at over 600,000 t. In 2005 emissions of methyl bromide were about 15,000 t and should stop by 2020 (» WMO/UNEP 1998; UNEP 2005).

Evolution of the ozone layer

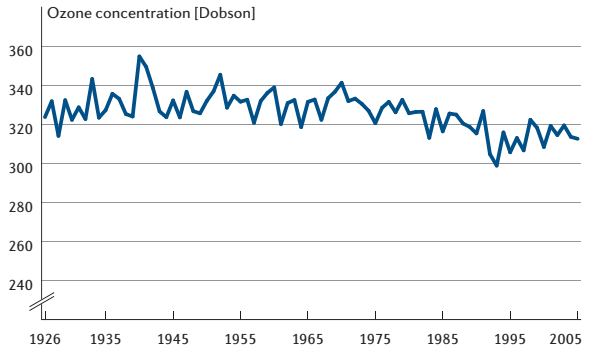
As a result of the destructive effects of the ODS, the concentration of stratospheric ozone in our geographical region is about 4 % below that prior to 1980 (» G9.1). In the Antarctic, during September and October, when the hole in the ozone layer is created, the reduction is about 50 %. In the Arctic, the reduction can be as much as 15 % during the coldest winters. Small "ozone holes" can then appear (» F9.1). Sometimes they move and remain over Switzerland for a few days (» UNEP 1999).

UVB radiation

The reduction in the ozone layer increases UVB radiation in our geographical region by an average of 6 %, rising to 50 % when the small "ozone holes" pass over (» Edouard et al. 1996). Once the "ozone hole" has been created (» F9.1)[1], the increase in the radiation is over 20 % in the Arctic and up to 130 % in the Antarctic. The increase in radiation has an adverse effect on human health (more frequent and serious sunburn, skin cancers and eye damage, » Chapter 17) as well as on land and aquatic life forms. It also accelerates the ageing of polymer materials. Without the Montreal Protocol on Substances that Deplete the Ozone Layer, it is estimated that UVB radiation would increase by over 100 % in our geographical region up to 2050. This would mean that any direct exposure to the sun would be dangerous, and »

[1] NASA, Ozone Hole Watch, http://ozonewatch.gsfc.nasa.gov
KNMI/ESA, www.knmi.nl/gome_fd/tm3/gif_archive/2003/03011412np.gif

G9.1 Changes in annual averages of the ozone concentration measured in the column of air over Arosa



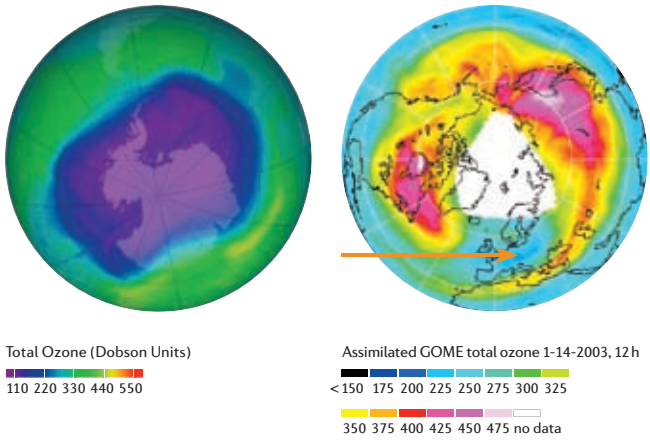
The Dobson Unit [DU] refers to a layer of pure ozone that would be 0.01 mm thick when measured at ground level at a temperature of 0 °C and a pressure of 1 atmosphere. For example, if all the ozone contained in a column of air was brought down to the surface of the Earth, 330 DU would represent a layer 3.3 mm thick.

Source: FITZ, Institute for atmosphere and climate studies

F9.1 Ozone holes

a) Ozone hole over Antarctica at its maximum size in 2006

b) Small ozone hole over Europe on 1-14-2003



Source: NASA, KNMI/ESA

› the number of cases of skin cancer would double (currently approximately 400 cases per million inhabitants and per year, » UNEP 2003; VMO/UNEP 2003; OMS[2]).

Measures in place and their impact

The depletion of the ozone layer is a global problem. The substances that cause it do not recognise national boundaries. The international community has therefore decided to protect stratospheric ozone by enforcing two multilateral treaties: the 1985 Vienna Convention for the protection of the ozone layer, and the 1987 Montreal Protocol (» Chapter 18). In the Vienna Convention, the signatory states committed to monitor the ozone layer and to individually and jointly take the necessary protective measures. This ensures the long-term monitoring of the atmosphere's chemical composition and physical parameters, as well as the continuity of measurements of the ozone column, which began in 1926 in Arosa with the Global Atmosphere Watch initiative. The Montreal Protocol reinforces this commitment by banning the production and usage[3] of the main ODS from 1996 in industrialised countries and from 2010 in developing countries. The production and use of methyl bromide have been banned since 2005 in industrialised countries and will be banned from 2015 in developing countries. However, some specific uses of carbon tetrachloride and methyl bromide are not covered by the Montreal Protocol. They produce emissions in quantities of approximately 100,000 t per year. The use of HCFCs will cease only as of 2020 in industrialised countries and 2040 in developing countries. It is expected that the ozone layer will return to its pre-1980 value around 2065 as long as the Montreal Protocol is strictly applied and no other environmental disturbances (in particular climatic) are present.

Except for one substance – HCFCs – Switzerland has progressively banned, between 1991 and 2005, the commerce of ODS used in sprays, synthetic foams, solvents, for refrigeration or fire protection. Thanks to this ruling, the quantity of ODS subject to authorisation since 2004 and imported annually decreased from 14,000 t in 1986 to approximately 200 t – mainly HCFCs – in 2004 (» G5). CFC imports after 1996 were compensated by the destruction of used CFCs in order to maintain their consumption level[1] at zero. Imports of HCFCs intended exclusively for existing refrigeration equipment will continue until 2010, and will be definitively banned by 2015. The late ban on HCFCs makes any post–2040 forecast unreliable. Approximately 20 t of used ODS are recovered and destroyed every year in Switzerland.

As regards the substitution of ODS, the Swiss authorities actively encourage the adoption of solutions that are overall more respectful of the environment. Several provisions of the ORRCHEM[4], implemented in August 2005, limit the use of synthetic greenhouse gases, in particular as substitutes of the ODS, to the strict minimum (» Chapter 18). •

[2] www.who.int » WHO sites » Ultraviolet radiation… » Frequently asked questions » Skin cancers.

[3] Usage refers to the statement on the quantities of ODS produced, imported, exported and destroyed annually at national level.

[4] Ordinance on the Reduction of Risks Reduction in dealing with certain Particularly Dangerous substances, Compounds and Objects, of 18 May 2005 (ORRCHEM), RS 814.81.

10. Water quality

In Switzerland, 80 % of all drinking water comes from groundwater springs and is generally of good quality.

Most surface waters are of adequate quality. Some problems remain, however, such as eutrophication of the lakes in the Central Plateau.

Some problems have recently been observed with groundwater, such as undesirable traces of pollutants. These result from micropollutant emissions from agriculture and wastewater treatment, and should not be ignored.

Daily changes in stream flows, insufficient annual residual flows or structural deficits are a menace for most watercourses.

Water supplies

Switzerland has 6 % of Europe's freshwater reserves (» SAEFL 2001b). Only about 2 % of precipitations volume is used as drinking water (» SSIGE 2005).

With a share of over 80 %, groundwater is by far the most important source of drinking water in the country (» G10.1). Water supply is thus guaranteed without any major problems, thanks to water drawn from the water table, the distribution network and large supply installations pumping water from the lakes. Of course, this does not eliminate the risk of shortage in the event of a drought, but it is mainly small suppliers and those who are not connected to a network or rely on springs who are affected. On the whole, water catchments and consumption have decreased since 1976, in spite of population growth. Households and small businesses are the main consumers of water (» G10.2).

Threats to water quality

Water is a fragile resource and its quality can be affected by residues from fertilisers, pesticides, combustibles, fuels, industrial chemicals and other substances.

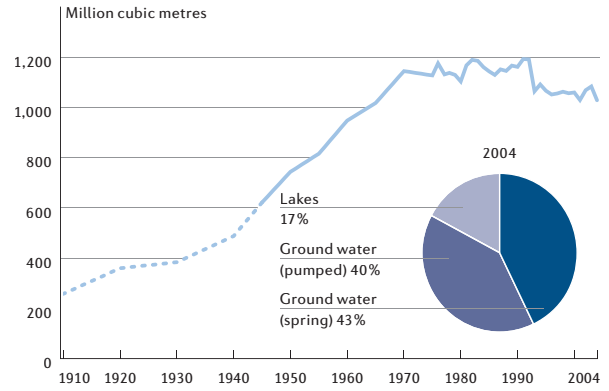
Groundwater

In Switzerland, unpolluted groundwater only contains a few milligrammes of nitrates per litre (mg/l). More than 80 % of the stations surveyed complied with the value of 25 mg/l laid down in the Ordinance on Water Pollution Control (OWATER)[1]. Problems arise mainly in agglomerations and areas where intensive farming is practised, this being by far the most important cause of high nitrate concentrations (» Chapter 6). In fact, a little over 15 % of the monitoring stations surveyed showed concentration levels of between 25 and 40 mg/l, and 4 % of the aquifers measured showed maximum values exceeding the tolerance threshold (40 mg/l) permitted for drinking water (» G21).

Of the 400 active substances that make up the different pesticides used in farming, only a few dozen can be traced by routine analytical processes (» Chapters 4 and 6). The presence of their residues in groundwater is not usually persistent and can even vary greatly from year to year. In 2002 and 2003, traces of pesticides were detected by approximately 60 % of stations (» SAEFL/FOWG 2004). Over 12 % of all the stations exceeded the threshold set by OWATER. Atrazine, a total herbicide, and its decomposition compounds, accounted for 72 % of the substances found. As with nitrates, the areas worst affected are extensive farming zones and settlement areas located in valleys where intensive farming is practised (» M10.1). »

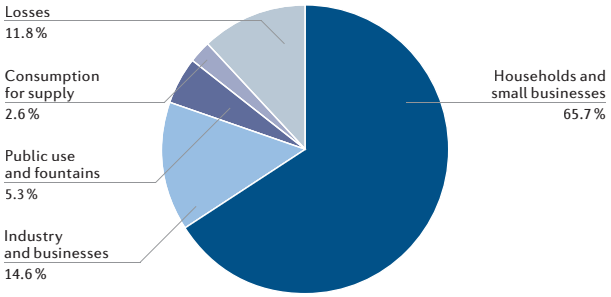
[1] Ordinance of 28 October 1998 on Water Pollution Control (OWATER), RS814.201.

G10.1 Water catchment in Switzerland



Source: SSIGE 2005

G10.2 Water consumption in 2004



Source: SSIGE 2005

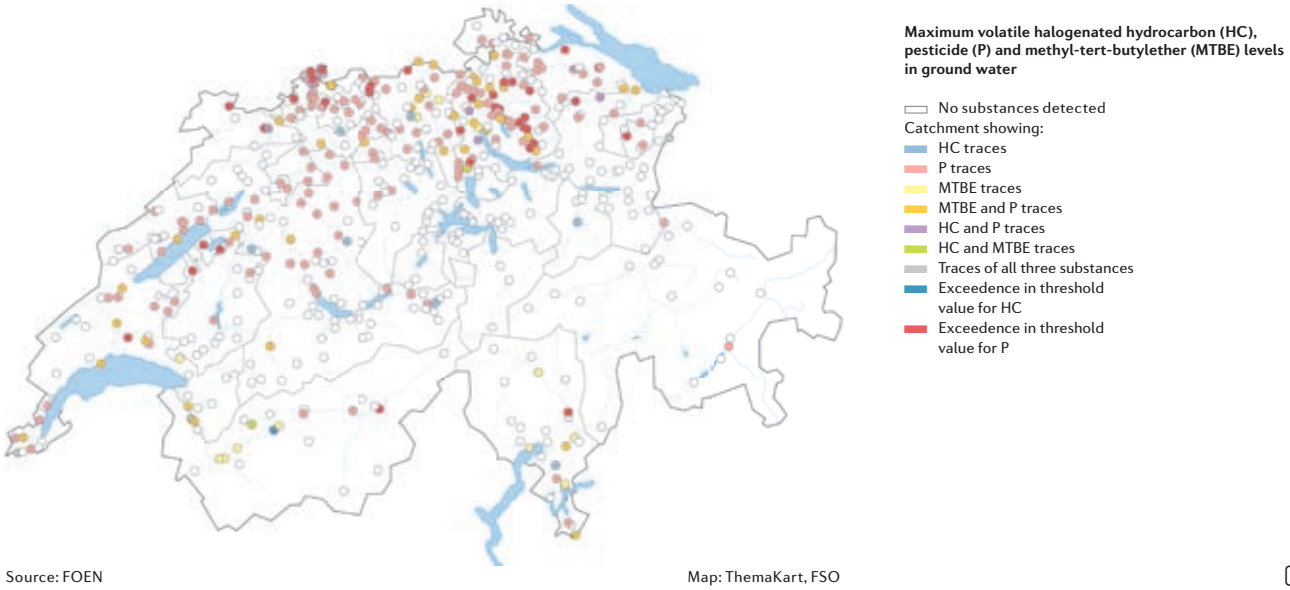
› The hydrocarbon substance most frequently found is methyl-tert-butylether (MTBE), closely followed by tetrachlorethene and trichlorethene (Per and Tri). MTBE is an anti-knock additive, which replaced lead in petrol and is thus used extensively – nearly 100,000 t are sold per annum (» Chapter 3). Although this substance is only slightly toxic, minimum concentration levels can make water unfit for consumption. The values measured up to now in groundwater are however significantly lower than the critical values (» M10.1).

Surface waters

Nitrate and phosphorus levels decreased considerably during the last decades, resulting in a big improvement in the quality of surface waters. This progress is due, in particular, to the expansion of the water purification network. Although eutrophication is still too high in the lakes of the Central Plateau, efficient measures have enabled the lakes of Constance and Neuchâtel to be remediated; the situation in Lakes of Geneva and Sempach is constantly improving (» G10.3).

Indigenous fish populations are an important indicator of the state of our watercourses and lakes. For some years, they have been decreasing in many places (» Fischnetz 2004). This is caused primarily by an infectious disease – proliferative kidney disease (PDK) – the poor state of the habitats, as well as by chemical pollution and a recent phenomenon: micropollutants. These substances can be harmful to the environment even at extremely low concentrations (of the order of a microgramme or nanogramme per

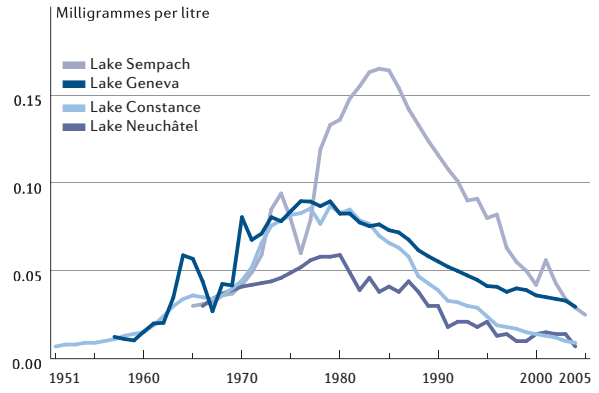
M10.1 Ground water pollution in 2005



Source: FOEN

Map: ThemaKart, FSO

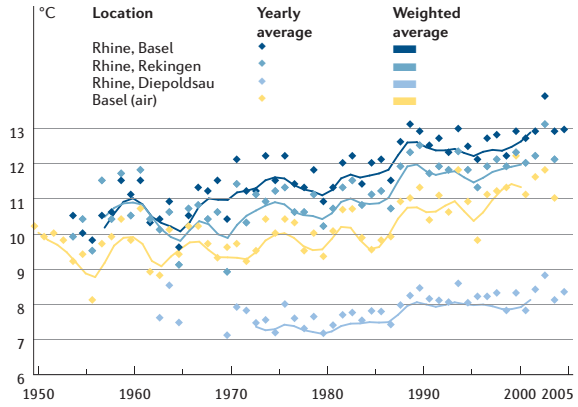
G10.3 Total quantity of phosphorus in lakes



Source: FOEN

G10.4 Water temperature in River Rhine

Comparison with air temperature in Basel



Source: FOEN

litre). They are used particularly in the manufacture of drugs and cosmetics, and for pesticides used in farming (» Troublesome pesticides). It is currently difficult to evaluate their environmental impact because data are available for only some of them (» EAWAG 2005) (» Chapter 4).

Water temperature is a major factor in assessing the status of surface waters, as it is one of the main regulating elements of the vital processes that take place. In the River Rhine, near Basel, water temperature increased by more than 2 °C in the last 50 years (» G10. 4), and a similar change was observed in the waters of the Central Plateau. The main contributing factors are climate change (» Chapter 8), intake of hot water (from showers, washing machines, cooling circuits etc. (» Chapters 2 and 5), and the changes in the water flows (caused, for example, by dams and draining). Aquatic life forms are sensitive not only to this general increase, but also to continuously high temperatures in the summer: trout, whitefish, grayling and other noble fish (salmonids) display stress symptoms at temperatures between 18 and 20 °C, and temperatures over 25 °C can kill them. Additionally, with temperatures over 15 to 16 °C, the infectious MRP disease could affect freshwater trout.

Quantitative and structural deterioration

Groundwater

Material extraction, civil engineering constructions and foundations reaching groundwater level can be detrimental to water supply as they reduce aquifer storage volumes and therefore the quantity of water available. They may also interfere with outflow – to the point of retaining or even lowering the water table – and modify the direction of flow. Tunnels and galleries can also present a danger, for example through a draining effect and the lowering of mountain water level, thus threatening to destroy precious biotopes such as springs and wetlands.

Surface waters

Watercourses need a minimum amount of space to fulfil their many functions (biotope, water table supply, natural purification, and containment in the event of severe flooding). However, wherever there is human activity, this space was lost almost everywhere a long time ago (» SAEFL/FOWG 2003). In Switzerland, many streams and rivers regularly dry »

Troublesome pesticides

Pesticide concentrations measured in Swiss surface waters are very high, and this is not a recent phenomenon. Direct payments of grants to impose ecological measures in agriculture were introduced from 1993, with a view to improving the situation. The goal at that time was to halve the proportion of pesticides in water by 2005 (» Chapter 6). However, this has not been fully achieved: in fact, the results of an analysis performed in the region of Greifensee (ZH), show that the measures implemented to decrease the proportion of pesticides in runoff water have not produced the desired results (» Singer 2005). As residues from these substances in surface waters are harmful, and as the Ordinance on Water Pollution Control does not currently take account of differences in toxicity between the 400 active substances authorised – the quality criteria being set globally at 0.1 µg per litre for each – EAWAG proposes the use of a risk assessment system based on toxic effects.

› up as a result of being drained, whether the water is used for energy production, crop irrigation, refrigeration and cleaning of industrial installations, or the supply of drinking water.

The habitat of many aquatic organisms can also be adversely affected or destroyed when the flow rate is subject to sudden fluctuations. Sluicing concerns a large number of alpine rivers downstream from storage power plants, up to their estuaries in the lakes of the Pre-Alps. Sluicing means the high flow resulting from pumping water, which is followed, during periods of reduced electricity demand (usually at night and at the end of the week), by a minimum flow. Sluicing operations create daily, artificial flooding during which water level, current speed and river width change. When the flow increases, aquatic organisms are carried away by the current, and when it decreases they are washed up on the banks.

Other human activities – in particular damming, unauthorised dumping, gravel extraction and hydroelectric power stations – have an impact on watercourses' bedloads. The effects of these activities are reflected on their structure (riverbeds and banks), substrate (constituents) and their dynamic. Changes in their ecosystem and interactions between surface waters and groundwater are also associated with this. In addition, bedloads can also affect flooding. For example, with hydroelectric power stations, alluvial silt settling in large dams creates flooding, which can be prevented only through good management of these watercourse deposits or regular flushing.

An additional important factor in water quality is structure (ecomorphology). The Swiss river system includes 65,300 km of streams and rivers, of which 10,600 km are much changed, or even artificial, with about 5,200 km underground. Until 2001, the number of watercourse stretches contained in farming zones was also this high. But at the same time, more and more stretches have been revived since the 1980s, so that a slight increase in the number of streams close to their natural state was observed from 1990 (» FOEN/ARE 2007). in addition to stretches with bad water structure, Switzerland has about 88,000 artificial sills over 0.5 m high. They present obstacles to fish and other aquatic organisms. These problems do not apply evenly to the whole of the river system. Watercourses in plains subjected to intensive usage are most affected. Below 600 m, 50 % of them present insufficient structure diversity, against only 2 % above 2,000 m. Moreover, some long stretches situated above artificial sills are not accessible to fish. However, either because of lack of space in settlement areas, or for technical reasons in case of steep gradient, it is impossible to revive all the watercourses concerned.

Structural modifications to watercourses affect animal and vegetal habitats (» Chapters 12 and 14): the adjustments and damming to which they are subjected impoverish and standardise habitats, which results in a decline in biotope diversity. Riverbeds have also become watertight, which impacts infiltration and prevents renewal of groundwater.

Draining and treatment of wastewater

Wastewater is water whose composition has changed as a result of being used for a domestic, industrial, business, farming or other purpose, and to which is added rainwater running off from waterproofed surfaces. Polluted water is wastewater prone to contaminate the aquifer in which it flows; it must therefore be treated first. Polluted wastewater is divided into three categories, according to its origin:

- Municipal wastewater, mainly from households, of which about 1.45 billion cubic metres a year are generated in Switzerland
- Industrial wastewater, from industry and small businesses, as well as wastewater from hospitals and laboratories, of which about 500 million cubic metres a year are generated in Switzerland
- Other wastewater, including all wastewater not falling into the first two categories, whose volume cannot be quantified

Measures in place and their impact

In Switzerland, water pollution benefits from a very good legal baseline: the Water Protection Law (LWATER)[2], but its enforcement is sometimes difficult (» G23).

Limits to water quality deterioration

Groundwater is subject to a series of regulations aimed at maintaining its quality: land use measures to mark out groundwater preservation zones and perimeters, provisions regarding conservation and use, restriction on livestock density in farming, and provisions on the storage of substances likely to affect water quality. Whenever a canton notices a case of pollution, it must assess its nature, extent and origins and apply appropriate measures. If the latter are insufficient, the Confederation awards grants for measures taken by farmers to prevent running off and leaching of substances (art. 62a LWATER).

LWATER sets ecological objectives as well as requirements for surfaces and groundwater quality (appendices 1 and 2 LWATER). The conditions must be adhered to at all times. Consequently, if the authorities notice that the conditions are not implemented, it is their duty to order that necessary measures be taken.

Limits to quantitative and structural deterioration

According to LWATER, groundwater levels can be reduced for short periods only. When it is serviceable, groundwater must not be affected by construction, and extracting materials from below the water table level is prohibited. A natural layer at least 2 m thick must remain above the water table level. These regulations aim to preserve water for future generations. Within this context, the cantons have had to submit an inventory of existing water consumption to the Confederation.

[2] Swiss Federal Law of 24 January 1991 on the Protection of Waters (Water Protection Law, LWATER), RS 814.20.

LWATER also imposes a minimum guaranteed residual rate of discharge for drainage from rivers and streams, in order to preserve the various functions of watercourses. At the end of 2004, 10 % of drainings indexed by the cantons and bearing major ecological importance satisfied this requirement. In the case of drainings where the concession was granted before 1992 (when LWATER came into force), minimum residual rates of discharge will have to be respected when it is renewed. By then, as far as economically viable, the stretches with residual rates will have been treated. The ecological outcomes of minimum residual rates of discharge are favourable (» SAEFL 2004c).

The guidelines applying to Swiss watercourses (» SAEFL/FOWG 2003) define the main points of the policy adopted by Switzerland for surface water pollution control. In particular, it aims return watercourse stretches back to their natural state, benefiting from space, sufficient water discharge rate and quality. Indeed, it is not possible to save watercourse ecosystems by focusing the measures on water quality alone: their viability also relies on the structure of the bed, whose diversity ensures interactions between water and land (e. g. cut-offs or secondary courses, artesian springs, fast flowing stretches, slower flowing stretches etc.). Such ecosystems promote biodiversity and are less vulnerable to disturbances. In addition, watercourses close to their natural state and with a balanced bedload guarantee exchanges between groundwater and surface waters, thus greatly contributing to the catchment of drinking water. They also provide leisure spaces for the population and add value to tourism.

Disposal and treatment of wastewater

Over the last 50 years, the construction of water treatment plants has enabled water quality to be improved significantly. Between 1965 and 2000, most sewer networks were modernised and extended, but there are still many incompletely watertight pipes. These are old water mains laid down a long time ago using old techniques. It will thus be necessary to make some investments in this field (renewal and adjustment of water treatment plants for example).

In the years to come, it will become essential to solve the problems caused by micropollutants and to enforce sustainable management of water in built-up areas.

Wastewater treatment is not the only way to enhance the draining of municipal water. An extensive water pollution policy also includes measures to reduce the disastrous outcomes of certain drainings. In particular, solutions will have to be found to avoid draining sewers to unload them in times of heavy precipitation, or letting water from very busy thoroughfares run off into streams. •

11. Soils

Soil is a limited and non-renewable resource. However, 11 ha of arable land are lost in Switzerland every day.

Chemical damage to the soil can be effectively combated with existing measures. The guideline values are considerably exceeded for 1 % of soils, moderately exceeded for 9 % and slightly exceeded for 90 %.

On the other hand, more systematic application of the planned measures to reduce physical damage to the soil – particularly hydric erosion, compaction and remodelling of land – is called for.

Soils have been created over thousands of years by degradation of the bedrock. They have been shaped by climatic conditions, by vegetation and by the activity of organisms living in the lower layers or on the surface, as well as by human activity. Soils are essential in that they enable human beings, animals and plants to meet their vital food needs, and they also fulfil indispensable functions in natural cycles, acting as filters, water and nutrient reservoirs, exchange-promoting environments and biotopes. They should therefore be used with care to preserve their fertility and their ability to provide these different functions.

Occupation and use of soils

Factors such as economic and demographic growth, the concentration of human activity, increased mobility and rationalization of agriculture – among other factors – have placed greater demands on soil than ever before. It is therefore gradually losing its functional capability.

According to Swiss Area Statistics (» FSO 2001), Switzerland lost 11 ha of arable land per day, i.e. nearly 1.3 m^2 per second, over the last 20 years of the 20th century. About two thirds of this land are used for residential and infrastructure purposes, mostly on the Central Plateau. The remaining third consists mainly of grassland and pasture left to go wild, on which forests are gradually encroaching. On the Central Plateau and in the alpine valleys, housing, transport infrastructure, shopping centres, trade and industry compete for the remaining plots (» T11.1) – particularly the prime sites – to the detriment of arable land. In the 1980s and 1990s, 303 km^2 of arable land were lost in permanently settled areas (» Chapter 6), with over 94 % of it used for housing and infrastructure. Graph » G11.1 shows the four main areas of land use and how they changed between 1979 and 1997.

While the problem of competition does not affect summer pasture in the mountains, large areas north and south of the Alps are being left to go wild. Admittedly, alpine pasture still accounts for 5,378 km^2 (35.3 %) of the productive agricultural area, but 179 km^2 were lost in the 1980s and 1990s. Abandoned alpine pasture consists mainly of land that is less accessible and hard to farm. Since then, 81 % of it has been gradually taken over by forest, wooded areas, brush and scrub.

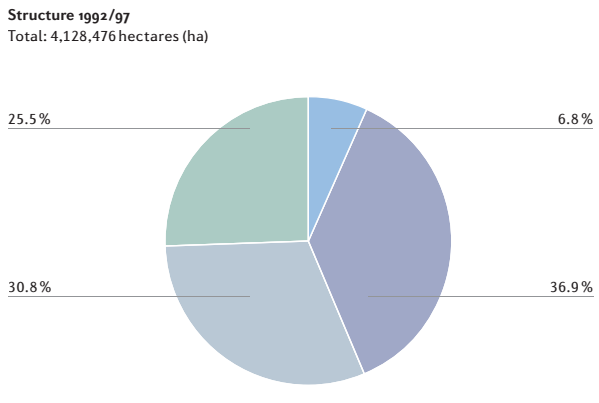
If the changes in land occupation observed in the 1980s and 1990s continues at the same rate, reserves of arable land – as a national average – will be exhausted in about 370 years, and even in around 100 years on the southern slopes of the Alps (» FSO 2001).

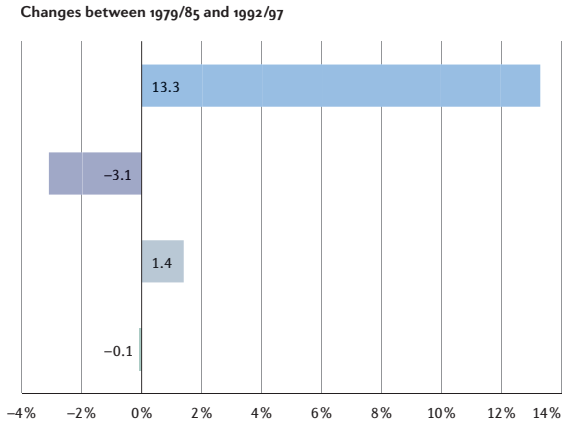
Damage to the soil and what causes it

Physical damage

Rationalisation of forestry and agriculture, and more specifically the use of increasingly heavier tractors and harvesters, tends to increase damage to soil through compaction (» Chapter 6). This problem is also found in the construction industry, where inappropriate use of site plant and vehicles can cause serious damage. As measures are not comprehensive and some evaluation methods are still at

G11.1 – G11.2 – T11.1 The four main types of land use





Housing and infrastructure areas 279,095 ha		Agricultural areas 1,525,119 ha		Wooded areas 1,271,645 ha		Unproductive areas 1,052,617 ha	
Buildings	38,508 ha (0.9 %)[1]	Wine growing	15,436 ha (0.4 %)	Dense forest	1,025,223 ha (24.8 %)	Lakes	142,235 ha (3.4 %)
Land adjacent to buildings	99,050 ha (2.4 %)	Fruit growing	41,480 ha (1.0 %)	Open forest	76,933 ha (1.9 %)	Water courses	31,732 ha (0.8 %)
Industrial buildings	7,292 ha (0.2 %)	Horticulture	4,036 ha (0.1 %)	Bush woodland	60,514 ha (1.5 %)	Unproductive vegetation	263,051 ha (6.4 %)
Land adjacent to industry	12,941 ha (0.3 %)	Grassland and arable land	837,355 ha (20.3 %)	Other wooded areas	108,975 ha (2.6 %)	Rocks, sand, landslides	480,842 ha (11.6 %)
Special infrastructure areas	16,113 ha (0.4 %)	Local pasture	89,011 ha (2.2 %)			Glaciers, firn	134,757 ha (3.3 %)
Green and leisure areas	15,860 ha (0.4 %)	Summer alpine pasture and mown alpine meadows	32,316 ha (0.8 %)				
Roads	79,297 ha (1.9 %)	Rough alpine grazing	505,485 ha (12.2 %)				
Railways	8,449 ha (0.2 %)						
Airports	1,585 ha (0.0 %)						

[1] In brackets: percentage of total area of Switzerland

Source: FSO, Area Statistics

OS EE

the experimental stage, it is not possible at present to assess the degree of compaction suffered by soils, which, in any case, react in very different ways depending on their type and condition.

Hydric erosion mainly affects fields on slopes with little vegetation cover, particularly in spring and autumn. It is estimated that 20 % of land used for the rotation of crops is under threat. Under heavy rain, arable soil (farmable) can lose up to 50 t of fine earth per hectare, which corresponds to a layer of up to 5 mm.

A further soil protection problem stems from some types of land remodelling, starting with unauthorised landfills in agriculture. These are often carried out under the pretext of better mechanised operations, whereas they are really designed to enable construction firms – in agreement with farmers – to dispose of their debris and other excavated material, without checking the quality. Many Swiss cantons are now having to deal with this type of pollution. To a lesser extent, removing topsoil (humus), which deprives nature of precious nutrients for re-establishing marginal biotopes, and levelling ski runs in the Alps to cover them with artificial snow are further land changes that take their toll on soils.

The construction of energy pipelines, communication routes and buildings also has harmful potential (» Chapters 2 and 3). Here, damage is due to site plant, removal of excavated materials, the storage and use of earthy materials, and the temporary occupation of soils by huts and site access roads.

Chemical damage

The findings of cantonal and national surveys on chemical substances at some 14,000 stations can be summarised as follows (» FOEN/FOAG 2006) (» G20):

- There are no uncontaminated soils left in Switzerland.
- Almost 90 % of loose ground is slightly polluted, 9 % moderately and 1 % heavily.
- The main causes of soil degradation are lead, copper, zinc and cadmium.
- Pollution mainly concerns residential areas and infrastructure, i.e. gardens, parks and green spaces. It is also high near roads, metal constructions treated with anti-corrosives (e.g. pillars, bridges), metallurgical factories and shooting ranges, as well as special crops (e.g. vineyards).
- Contamination by certain organic substances such as polycyclic aromatic hydrocarbons (PAHs) – released in any combustion process – is increasing.
- The level of dioxins in Swiss soils is low.

The presence of most of these chemical substances is attributable to economic activity over the past few decades. »

Living creatures in the soil: key players that are still little known

There is an average of 150 g of organisms and microorganisms – i.e. 260 million individuals – for every 1 m^2 of meadowland. These include 50 to 400 earthworms, 20,000 to 400,000 acarids and 1 to 30 million nematodes or roundworms. In pasture, the biomass of earthworms (1,000 to 1,500 kg/ha) may be on a par with that of cattle. Earthworms are also a key factor in turning over the soil; they are commonly called "soil engineers". In this part of the world, all the earth in the first 15 cm of soil may pass through their digestive tract in 10 to 20 years. These organisms are obviously not the only players in the soil, but share it with algae, fungi, bacteria, protozoa and the roots of plants. Bacteria are extremely numerous with some 10^{11} to 10^{14} individuals per 1 m^2.

Although the part that many of these living organisms play in the soil is simply not yet known, most of them help decompose organic matter (detritus chains). Their "dustman" function is therefore crucial for the disappearance of litter, dead wood, dead animals and faeces, which, without them, would accumulate in nature and would put a stop to the biogeochemical cycles which enable the biosphere to function.

Physical and chemical damage to the soil impacts on the presence and abundance of the living organisms that inhabit it. Obviously, changes due to human activity in particular affect the process of decomposition of organic matter. Given the extremely complex interaction between the various organisms, it is currently difficult to accurately gauge the effects of these changes. However, we should take better care to avoid overly disrupting the work of these myriad dustmen (» Edwards 2004, Gobat et al. 2003).

It dates in fact from the era of leaded fuel, unfiltered chimneys, anticorrosion coatings with a high heavy metal content, and the large-scale spreading of sewage sludge and domestic waste compost as fertiliser in agriculture. All these substances have settled and spread in the soil over the years.

Biological damage

Biological damage to soil may be due to genetically modified or alien organisms. This type of threat is still relatively slight, but we should remain on the alert. Through globalisation, goods travel round the world very quickly, bringing with them all kinds of "stowaways" such as organisms that may undermine the fertility of our soils (» Chapter 12).

Consequences of damage to the soil

Physical damage

Compaction of soils changes their structure. It destroys the pores, hampering the circulation of gases as well as water retention and dispersal ability, to the point of compromising the proper functioning of biological processes. Rainwater seeps in more slowly, stagnates on the surface and saturates the soil. Its run-off increases the risk of erosion and flooding. Roots have difficulty penetrating the subsoil to obtain the nutrients they need. Meanwhile, crop yields fall and it is harder to till the soil. Compaction of the lower soil layers is usually irreversible and thus causes long-term damage.

Erosion primarily damages the plot concerned but also has an adverse effect on the immediate vicinity. The land affected becomes less fertile and less productive due to loss of humus and nutrients. The layer of soil that roots have to

penetrate also becomes thinner and water retention capability is reduced. If erosion is intense, plants are uprooted and buried. Plots then have to be redeveloped and reseeded. Roads, paths, ditches and drainage systems nearby are polluted and clogged. In addition, the fine earth with its rich nutrient content may end up in special biotopes and watercourses, which it impairs and eutrophicates.

Land remodelling, chiefly landfill, almost always reduces the quality of the soil. Studies have, in fact, shown that it was improved by such activities in only 10 % of the cases (» FaBo [Soil Conservation Unit] 2003). This deterioration causes a reduction in plant growth, an increase in contaminant concentrations, saturation of soils, compaction, difficulties in working the land and disruption of air circulation.

Mismanagement of soil on building sites causes compaction, poorer-quality earthy materials and – in the event of botched reinstatement – lower yields and impaired functional capability.

Chemical damage

The repercussions of damage caused by chemical substances fall into three categories: damage to soil fertility, plant growth problems, and health risks for humans and animals through consumption of contaminated harvested products and the ingestion or inhalation of polluted soil.

To measure the extent of chemical pollution, the Ordinance relating to Impacts on the Soil (OSOL)[1] sets guideline values, investigation thresholds and decontamination values. If the pollutant content exceeds one or more of the guideline values, long-term fertility of the soil is no longer guaranteed: several of its functions have thus been destroyed and the growth of certain plants inhibited. It should be remembered that, in Switzerland, 90 % of soils are not threatened in this way. On the other hand, investigation thresholds may be exceeded in some zones. In such cases, depending on circumstances, this may be prejudicial not only to the health of children playing and animals grazing there, but also to the quality of food and fodder crops. Finally, if the decontamination threshold is exceeded – fortunately, a rare occurrence – the consequences for the health of humans and animals are much greater (» G20).

Measures in place and their impact

Many types of chemical and physical damage are irreversible. As it is often virtually impossible to define the tolerable level of any particular impact, it is important in soil protection to apply the precautionary principle, aiming to avoid as far as possible any potentially fatal damage to soils wherever they are under threat – on construction sites, in forests, fields, gardens and green spaces.

Protection against physical damage

The physical protection of soils is governed by the OSOL. Under the terms of this Ordinance, soils must be treated in such a way that neither their use nor construction work should cause irreversible damage. To comply with this requirement, the Confederation and the cantons have developed a set of instruments and taken a number of preventive measures, in cooperation with representatives of the construction industry, forestry and agriculture.

In particular, these measures include:

Training soil protection specialists to give on-site advice to large-scale construction project developers

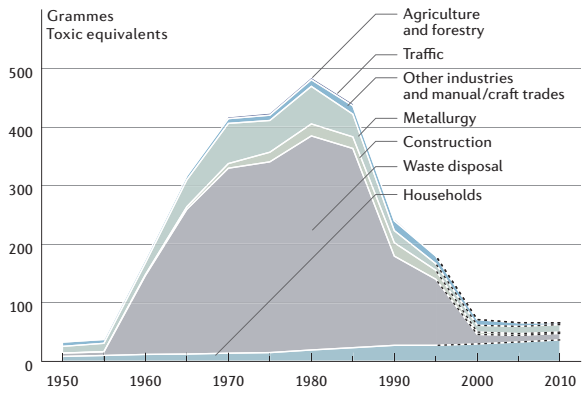
- The use of tyres and the development of regulators for tractors, harvesters and site plant to equalise pressure on contact surfaces
- Increased use of new soil-conserving cultivation methods (e. g. sowing under litter and direct sowing)
- Publication of training manuals and information brochures for construction, agriculture and forestry to make the various players aware of their responsibilities
- Inclusion of soil-protection aspects in construction standards, e.g. the excavation standards of the Swiss Association of Road and Transport Professionals (VSS)
- Practical advice for various soil users (e. g. archaeologists, golf course designers, organisers of open-air events)

Similarly, the ecological requirements in agriculture include minimum plant cover in winter and erosion protection measures. Direct grants are dependent on these conditions (» Chapter 6).

Protection against chemical damage

The precautionary principle also plays a key role in protecting soils against chemical damage, as this is mostly irreversible as well. The marked drop in pollutant input recorded over the past 20 years thanks to the numerous measures introduced is expected to continue. »

G11.3 Dioxin and furan emissions



Source: SAEFL 1997

[1] Ordinance of 1 July 1998 relating to Impacts on the Soil (OSOL), RS 814.12.

› These measures include:
- Banning lead in petrol
- Systematic purification of fumes emitted by incineration plants (» G11.3)
- Banning plant protection products that are not readily degradable, as well as herbicides for highway maintenance; using less aggressive herbicides and changing the spreading method and the quantities used along railway lines
- Banning anti-corrosive paints containing heavy metals and introducing an obligation to enclose metallic structures with sheeting when the protective coat is renewed
- Banning the use of sewage sludge in agriculture
- Discontinuing the composting of household waste
- Reducing the cadmium content of phosphate fertilisers
- Checking earthy materials before removal to avoid poor-quality materials being used for development
- Reducing the lead content of cartridges and using artificial bullet shields
- Using infiltration installations for street-wash and roof rain run-off

These measures, most of which have been enacted by law, are supplemented by voluntary activities on the part of countless players concerned about soil protection. For example, some amateur gardeners restrict their use of pesticides and fertilisers (organic and inorganic), or even stop using them altogether. The general public must be made more aware of what is at stake in soil protection.

The problems of chemical damage have not, however, been completely solved. Soils are still being contaminated – for instance, by medicines administered to animals, which end up in the soil with farm manure, and by organic pollutants released by combustion, which also penetrate the soil. •

12. Landscape and biodiversity

Urban sprawl and the intensive use of land fragment ecosystems and the landscape, while making the latter tamer and more uniform.

With some 50,000 animal and plant species, Switzerland is home to considerable biological diversity.

Species diversity is steadily diminishing. What is more, 30 to 50 % of native fauna and flora are seriously endangered to varying degrees.

The problem of exotic organisms, introduced deliberately or accidentally, could escalate and compromise biodiversity.

The growing number of areas used to construct roads, railway lines and buildings is fragmenting and destroying natural animal and plant habitats. Together with the intensive use of land for agriculture, this phenomenon is the main reason for declining animal and plant species diversity. Over the last decade, many of them have seen their numbers fall and their distribution area shrink.

The landscape is a vital resource both for people's quality of life and for the national economy, as a factor in tourism. This resource is being wasted instead of being upgraded and developed sustainably. Urban sprawl and ecological depletion undermine the value of nature, as does the expansion of sports and leisure facilities. This "taming" of the landscape affects both ecologically rich rural regions and built-up areas, where the landscape's scenic value is important for the wellbeing of the people who live and work there.

Nature, landscape and biodiversity in Switzerland

Human beings have always shaped their habitats and have encouraged landscape diversity and multiple species for centuries. After reaching its peak at the start of the industrial era, the diversity of rural landscapes has gradually declined, a trend that has gathered pace since the mid-20th century.

Switzerland still possesses varied natural and rural landscapes, some of which are regarded as being of international importance. The Jungfrau-Aletsch-Bietschhorn region (Cantons Berne and Valais) is a case in point. It has been on the UNESCO World Heritage List since 2001, and a request for a 50 % extension was lodged in 2006. The Monte San Giorgio (Canton Ticino) has also been included in the List since 2003 and the Entlebuch (Canton Lucerne) – alpine foothills marshland site – was recognised as a Biosphere Reserve by UNESCO in 2001.

The Federal Inventory of Landscapes, Natural Sites and Monuments of National Importance (IFP) came into effect in 1977. It currently includes 162 sites covering 19 % of the country. The sites listed in the IFP are mostly rural landscapes that are virtually in their natural state as well as examples of varied agricultural use and of Switzerland's cultural wealth. The IFP is a binding instrument, particularly for the Confederation (» Protection of the landscape, page 94).

Biotopes and marshland sites of national importance are strictly protected. They account for 3.4 % of Switzerland's surface area and are listed in inventories of high and low marshlands, alluvial areas, dry meadow and pasture (in preparation) and amphibian breeding sites. Nevertheless, their ecological quality is often inadequate. The marshes, for instance, suffer from eutrophication and are gradually drying out. According to the Red List of endan- »

› gered mosses (» SAEFL 2004d), the specialised species of these biotopes have however survived. Many of the alluvial areas suffer from the lack of water dynamics. Amphibian breeding sites lose their value, particularly for pioneer species (species that first populate unoccupied habitats). Sunlit expanses of water once constantly renewed in dynamic alluvial areas are now rare, and maintenance measures are essential to keep them in a state conducive to breeding. Lastly, as maps made since 1970 show, dry-meadow area has been reduced by 20 to 30 %.

There are an estimated 50,000 species of animals, plants and fungi in Switzerland. As part of work on preparing Red Lists, about 12 % of these species have so far been surveyed to assess their conservation status.[1] Almost half of them are at least potentially endangered (» G15), and 237 have disappeared or are extinct. The position is little known or completely unknown for 60 % of the species, but there is almost no doubt that most of them are declining. Information about the status of and changes in biodiversity is provided by the Swiss Biodiversity Monitoring Programme (BDM-CH) (» Protection of species and biotopes, page 95).

Changes in the landscape

In the 1980s and 1990s alone, almost 48,000 hectares of farming land were lost, representing 3.1 % of the productive area (» Chapters 6 and 11) and corresponding to the area of Canton Obwalden. A third of this land disappeared on the Central Plateau at between 400 and 600 metres above sea level, where the fertile soils are found (» G12.1). It mainly consisted of meadow and arable land as well as orchards of standard trees located on fairly level ground, which was therefore easy to work.

Farming land is also declining at other altitudes. On the Central Plateau, it is making way for buildings, roads and leisure facilities, while in the mountains, meadow and pasture is being abandoned. The forest is spreading at a rate of up to 15 km² a year (» Chapter 13). This development has both negative and positive effects. On the one hand, the conversion of meadow and pasture to brush land ultimately entails the disappearance of communities of species and landscape diversity. On the other, the forest brings back the original vegetation of the natural landscape, and biodiversity can increase for a while (» Chapter 6).

Areas covered by housing and infrastructure increased by 27 km² a year in the 1980s and 1990s. During the Area Statistics observation period (12 years), growth reached 13 % – equivalent to an area bigger than Canton Schaffhausen (» G12.2). Areas covered by housing account for nearly half of the total (47 %), followed by special infrastructure areas such as building or mining sites (20 %) and transport areas (18 %).

Despite the 3.1 % drop recorded over 12 years, arable land remains the primary use of soil at 15,300 km² (37 % of

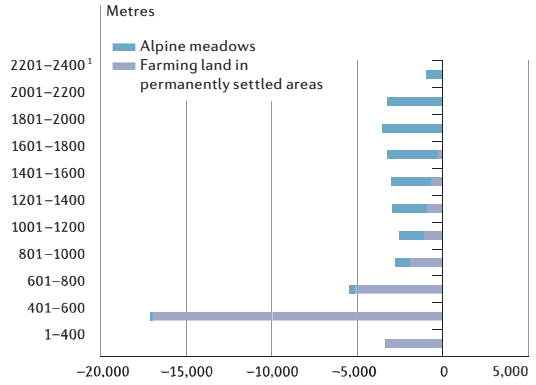
[1] The old Red Lists cannot be directly compared with the more recent ones, as the latter are being prepared on the basis of norms set by the World Conservation Union (IUCN).

T12.1 Group of species according to the Red Lists

Group of species	Species on Red Lists
Animals	40 %
Mammals	37 %
Breeding birds	39 %
Reptiles	79 %
Amphibians	70 %
Fish and crayfish	54 %
Molluscs	33 %
Insects	40 %
Flowering plants and ferns	31 %
Mosses	38 %
Lichens	38 %
Flora and fauna in Switzerland	38 %

Source: FOEN

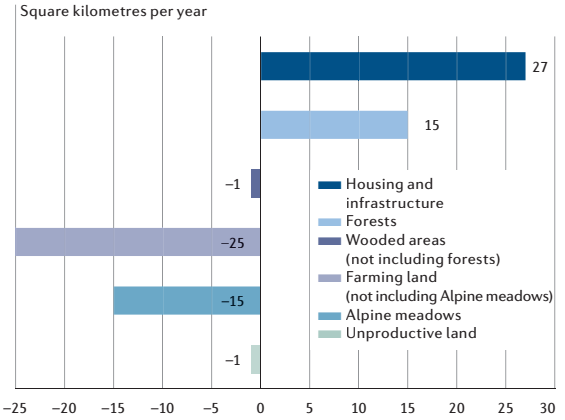
G12.1 Effect on the landscape of dwindling farming land
Change from 1979/85 to 1992/97



[1] High-altitude land is virtually unusable for agriculture.

Sources: FSO, Swisstopo

G12.2 Land use: changes between 1979/85 and 1992/97



Source: FSO, Area statistics

Switzerland's total area). While the number of standard fruit trees has fallen by a massive 26 % (» Chapter 6), high added-value intensive cultivation has gained ground, reaching 19 % in horticulture and 7 % in wine growing.
In the Alps, considerable investment is required to protect communication routes and housing from natural hazards (» Chapter 14). For instance, avalanche barriers and flood protection structures take up 50 % more space now than in the 1980s, indicating that land use is increasingly intensive, particularly for tourism purposes. Here, it is not so much the demand for land that is the problem as the damage to the landscape and the loss of natural dynamics.

The rationalisation of agriculture continues to cause the disappearance of small structures of vital importance to the landscape and the environment, such as standard fruit trees, copses and hedgerows.

In the IFP regions, agricultural land retreated less over the last few decades than in other rural areas (» CPA 2003), and the area covered by forest increased very slightly. On the other hand, the number of alpine meadows fell by about 3 % in both types of area. The IFP has practically no influence on the increase in buildings and transport areas, which is almost as high for IFP and non-IFP sites (» G17). There has been a much bigger growth in industrial sites and leisure facilities in the IFP regions (» FSO 2004).

Urban sprawl, increased fragmentation of land and hence noise pollution (» Chapter 16) are cutting into quiet areas, at the same time reducing the recreational value of landscapes (» FOEN/ARE 2007).

Between 1972 and 2001, some 6,300 km of new roads were built in Switzerland (» FOEN/ARE 2007). Development was particularly rapid in the 1970s, then slowed before taking off again from 1990, particularly for third-class roads and streets in residential areas (» G12.3 and Chapter 3).

The expansion of the road network (» Chapter 3) is one of the main causes of fragmentation of the natural environment, where the total area is falling. Animal and plant populations which were once grouped together are now split up into small units with virtually no contact with each other. However, the smaller and more isolated a population is, the more vulnerable it becomes. An epidemic, a lower reproduction rate for a few years or high mortality during a particular winter would be enough to wipe it out. Restocking is possible if an isolated habitat is reattached to neighbouring populations by natural structures. Otherwise, this habitat is no longer used, even though it is still suited to the species found there.

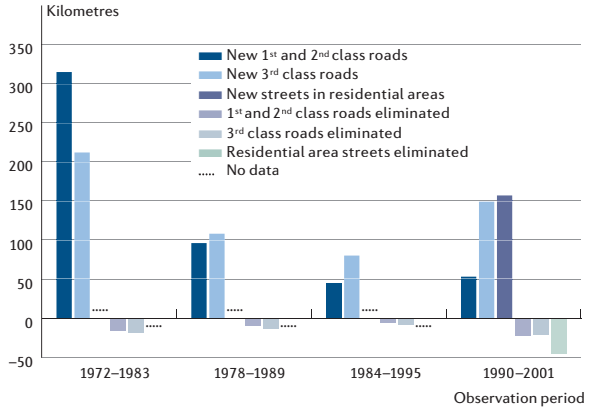
Fragmentation of the landscape is determined in particular by its "effective mesh size". This unit expresses the probability of two places selected at random in a given area not being separated by barriers such as roads or constructions (» Bertiller et al. 2007). This mesh size has shrunk over the last 70 years (» G12.4).

In general, IFP sites are less fragmented than other rural spaces (» G12.5).

The destruction, degradation and increasing fragmentation of the natural environment have a direct impact on biodiversity (» G15). Indirect repercussions are also due to

G12.3 Expansion of the road network between 1972 and 2001 (annual growth)

Construction of new roads



Source: FOEN/ARE 2007

F12.1 Examples of small landscape structures: orchards and hedgerows

Source: swisstopo

› human interference with ecosystems – for instance, the contribution of pollutants (» Chapter 7) or climate change (» Chapter 8) – which jeopardises the survival of many species.

Fauna and flora are also affected by a phenomenon which has not been extensively analysed to date, but which is growing all the time: the presence of exotic organisms (neobiota), introduced by man on purpose or by accident, outside their natural ecosystem. Whether they be plants (neophytes) or animals (neozoa), some are much more invasive than others and quickly spread in their new environment, where they compete with indigenous species and take over their habitat. They flourish at the expense of the native species, may transmit new diseases and hence jeopardise the existence of indigenous flora and fauna.

To date, 575 neobiota have been recorded in Switzerland, only a few of which represent a threat: about forty plants of this type feature in a Black List and a Watch List[2]. Among neozoa, the populations of four species of alien crayfish are now already bigger than those of the three native species. The crayfish – from North America – are more threatening in terms of competition, and also because they are carriers of crayfish plague, to which they are immune, unlike European species.

A highly alarming case of expansion of aquatic invertebrates was noted recently in the River Rhine near Basel, where alien species – from the catchment area of the Danube, for instance – rapidly came to make up the majority of the biomass (» G12.6).

Measures in place and their impact

Protection of the landscape

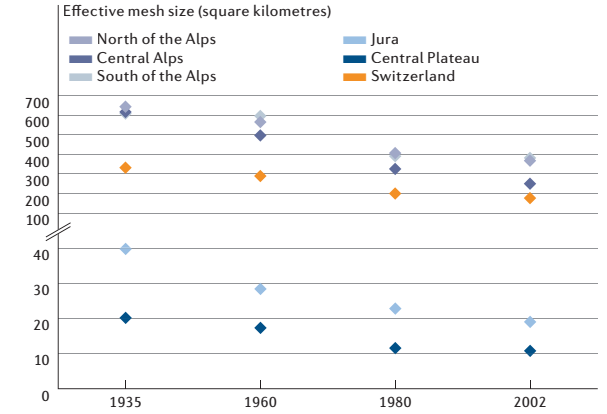
A landscape capable of providing habitats for all animal and plant species and in which humans feel at home and can flourish: that is the vision set out in the guiding principles of the "LANDSCAPE 2020" project (» SAEFL 2003a). One of these principles prescribes a new management system for small watercourses. Covering them over is now prohibited; those that have been covered over must be reopened, and those that have been embanked must be revitalised (» Chapters 6 and 10). This renaturalisation objective is also one of the main ideas for Swiss watercourses (» SAEFL/FOWG 2003).

The sites of national importance in the IFP Inventory are currently being re-evaluated. Descriptions will be more detailed, and protection and development objectives will be formulated in a more precise and differentiated way on the basis of specific regional features. If possible, these objectives will be included in spatial planning policy, and more active participation by local authorities and inhabitants in the conservation of IFP regions will also be sought. Monitoring of protection measures carried out by the Confederation in 2002/2003 showed that they had been more effective over the past ten years (» CPA 2003).

[2] www.cps-skew.ch

G12.4 Fragmentation of the landscape: areas under 2,100 metres

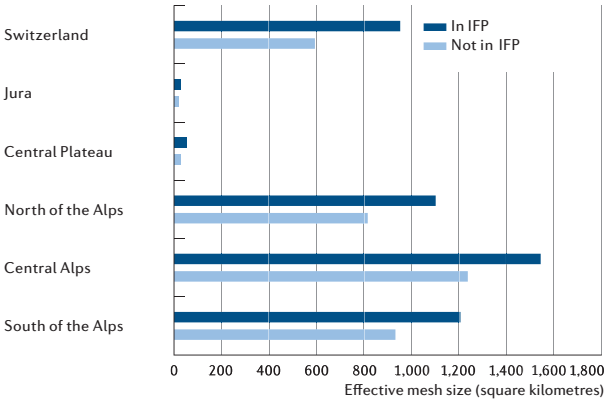
Reduction in non-fragmented zones



Source: Bertiller R., Schwick C., Jaeger J., 2007

G12.5 Fragmentation of the landscape in 2002

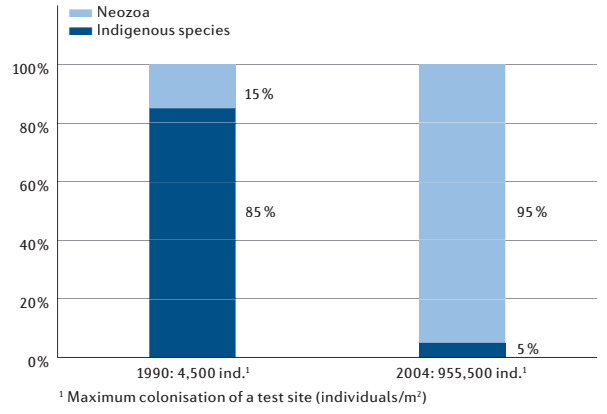
Federal Inventory of Sites, Landscapes and Natural Monuments (IFP)



Source: ARE/FOEN/OFROU

G12.6 Spread of alien animal species

Rhine, near Basel



[1] Maximum colonisation of a test site (individuals/m²)

Source: SAEFL 2005d

The Confederation is required to treat the landscape and species-rich habitats with care. When it implements, approves or subsidises construction projects, the work involved is authorised only if it can be justified by major public benefit. The Confederation must then ensure the complete conservation of the site affected, or at least spare it as much as possible. Each year, therefore, the FOEN examines over 500 projects to determine their impact on nature and the landscape. It then proposes compensation payments and planning solutions to the appropriate federal authorities, liaising with them on the ecological fine-tuning of the projects. The vast majority of FOEN proposals are approved.

There are plans to create parks of national importance, divided into three categories, in the near future. National parks will make it possible to protect large natural areas, regional natural parks will promote the use of local resources on a sustainable basis, and periurban natural parks will provide leisure areas near large towns. These new parks offer an opportunity for regional development.

Protection of species and biotopes

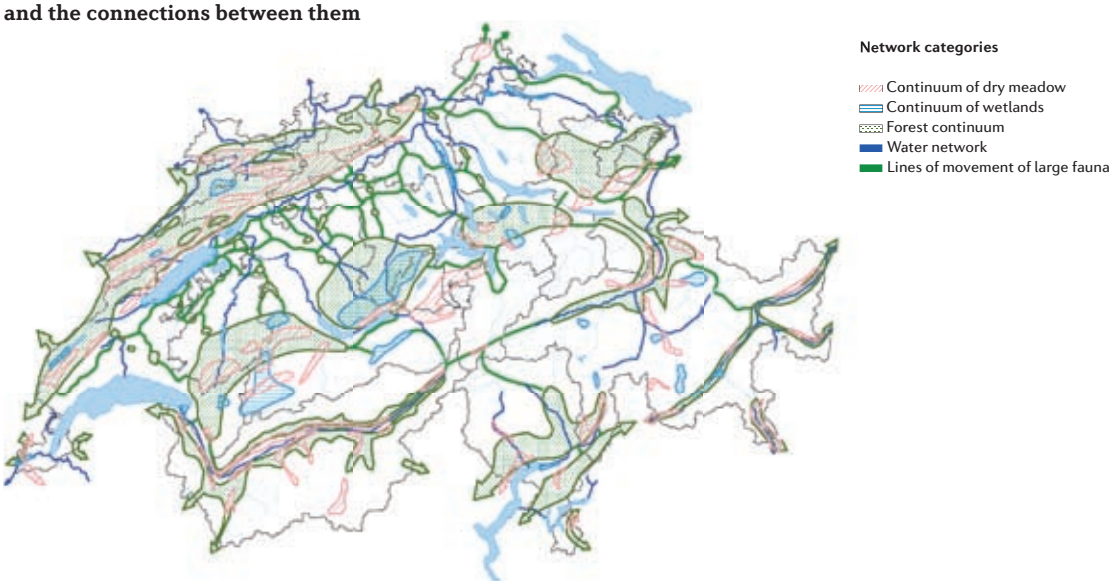
Species protection is monitored by observation programmes, the most important of which are monitoring biotopes of national importance and the Swiss Biodiversity Monitoring Programme (BDM-CH)[3]. They are designed to detect fauna and flora development trends at an early stage and to take effective measures to protect and promote species diversity.

The BDM-CH is based on 33 indicators that provide information on the status of biodiversity, the measures taken in this field, and influencing factors. Monitoring started in 2000 and the first surveys have been available since 2005. They show that diversity is still high in the Alps, where measurements taken on 10 m^2 squares revealed an average of 40 to 50 plant species in meadow and pasture; surprisingly, there is greater biodiversity on north-facing slopes than on south-facing ones, although the latter receive more sun. While results were less clear-cut in the Central Plateau, with an average density of only 25 to 30 plant species per 10 m^2, the ecological potential there is higher: in some places where measurements were made, there are as many plant species as in the mountains.

Development of this potential depends largely on ecological compensation in agriculture (» Chapter 6). Under the terms of the Ordinance on Ecological Quality (OEQ), farmers keeping grasslands, fallow land and other agricultural land that is particularly species-rich are granted additional subsidies and also receive a quality bonus when certain indicator species flourish on their land. The latter have obviously been selected wisely, because areas located in the BDM measurement network meeting the OEQ criteria are home to 49 species, compared with only 27 per 10 m^2 in other areas. »

[3] www.biodiversitymonitoring.ch

M12.1 National Ecological Network: Simplified map of main areas with ecological continuum potential and the connections between them



Source: FOEN

IF R+

› The first BDM survey gives a picture of the status of biodiversity in Switzerland at the turn of the millennium. Obviously, we need several surveys before we can ascertain any trends, but the influence and measurement indicators would seem to be a sign that species diversity is heading in the right direction in the most impoverished regions of the country, i.e. in the Central Plateau. These hopes are based on the developments observed in forests and on cultivated land. According to the National Forest Inventory, the afforested areas containing native trees – which in the Central Plateau are hardwoods rather than spruce – are spreading all the time, and the forest is regenerating more spontaneously than through reforestation. As for farming areas, the ecological compensation measures should start to produce results, mainly thanks to the OEQ.

Several bird-monitoring projects run at the Sempach-based Swiss Ornithological Institute document the changes in the population of breeding birds. Combined data for group species are available from 1990. Information from the Swiss Bird Index (SBI®) (» G14) shows that the situation has deteriorated since 1990 for breeding species in agricultural areas and wetlands, as well as for species on the Red List. However, no trend has emerged for all regular species.

Unlike birds, for which a great deal of information is available, little is known about invertebrates, except for some of the most popular groups of insects such as dragonflies and butterflies. As taxonomy is practically not taught at universities any more, there will soon be no more experts capable of determining the species of invertebrates, and we shall no longer have the elementary knowledge for taking measures to conserve biodiversity.

In Switzerland, inventories of biotopes and ordinances designed to protect them constitute a basic instrument. Designating biotopes of national importance was an extremely important decision for the native animal and vegetable kingdoms. Without this measure, species dependent on specific habitats would be on the way to extinction. All that remains now is to complete these inventories and implement them.

The National Ecological Network (REN) (» M12.1), which ensures the interlinking of large-scale biotopes, serves as the basis for OEQ application. It has to be taken into account in landscape development concepts (LDCs) and cantonal master plans. The connecting axes must meet stringent quality criteria to avoid favouring only universal species with no specific needs while specialised biotopes continue to be isolated.

Programmes aimed at promoting biodiversity in agricultural areas, riverscapes, forests, and residential and infrastructure areas should continue to be developed.

If the various instruments described fail to provide sufficient protection for some species, specific measures should be taken to preserve, re-establish and upgrade their habitats. Moreover, action plans and strategies are already in hand for several species of birds, butterflies and mammals, as well as for plants, lichens and mosses.

In ratifying the Rio Convention on Biological Diversity (» Chapter 18), Switzerland undertook to halt the decline in biodiversity from 2010. It is not, however, certain that it will manage to keep its pledge.

At present, the main obstacle is the shortage of funds and the lack of political will to introduce effective measures. •

13. Forests

Forest covers 1.25 million hectares of Switzerland, with proportions varying from region to region.

Only two thirds of the annual growth of usable timber are used. Forestry operations therefore need to be optimised.

Deposits of atmospheric pollutants are a long-term threat to forests.

Swiss forests perform ecological and economic functions as well as providing protection against natural hazards (» Chapter 14). They are irreplaceable habitats for fauna and flora, as well as an essential landscape-shaping factor and a key player in biological diversity (» Chapter 12), climate (» Chapter 8) and drinking water (» Chapter 10). They also contribute to our wellbeing and security and perform an economic role by generating added value. The economic, social and ecological functions of forests are therefore forest management policy priorities. The 1991 Federal Law on Forests (LFO)[1] specifically provides that they must be able to fulfil their protective, social and economic roles (» G18). In particular, their social functions include supplying good-quality drinking water because they act as a filter, producing oxygen and serving as carbon sinks, as well as leisure and recreation areas.

Forest economy

Wood is a renewable primary resource that can be used in construction instead of steel and concrete, as well as an energy source in place of fossil fuels. As one of Switzerland's rare energy sources (» Chapter 2), it enables the reduction of environmental damage.

In 2005, 5.3 million cubic metres of timber – roundwood – were harvested in Swiss forests (» SAEFL 2005e)[2], while annual usable timber growth totals 7.4 million cubic metres (» WSL 1999). Production costs are often higher than the revenue from harvesting the timber. In referring to wood growth, we distinguish between the volume of timber that can actually be used (e.g. harvested in managed forests) and that in forest reserves, which cannot (» G18).

The rise in the price of timber observed in 2005 continued in 2006, helping companies to reduce their overall deficit. The forest economy and the timber industry are major employers, particularly in regions well away from economic centres. The number of full-time employees in the forest economy is falling steadily. 5,900 people worked in forestry operations in 2005: 4,100 in publicly owned enterprises and 1,800 in private forestry enterprises. The timber industry consists of some 12,000 businesses employing about 80,000 people – 2.4 % of all persons in employment.

If we include the transformation of imported semi-finished products, the timber industry generated about CHF 6.4 billion, or 1.5 % of the GDP, in gross value added in 2001.

Forests play an important part in filtering water, providing very pure water at a reasonable price. Thanks to the application of semi-natural forestry, the forest economy contributes substantially to maintaining the good quality of water tables (» SAEFL 2005f).

Forests and their edges are highly rated leisure areas, particularly for people living in built-up areas. Both are regarded as public amenities in the sense of right of access to other people's property (article 699, Swiss Civil Code). As the value of these social services is difficult to quantify, their impact (especially on the health of the population) is often underestimated.

Condition of Swiss forests

Forests cover one third of Switzerland's surface, i.e. 1.25 million hectares. Areas south of the Alps are particularly rich in forest, while the Central Plateau has somewhat »

1 Federal Law of 4 October 1991 on Forests (Law on Forests, LFO), RS 921.0.
2 FSO Forestry Statistics: www.agr.bfs.admin.ch

› less (» G13.1). In recent years, the area covered by forest has grown by about 4 %. This increase is, however, confined to agricultural land in mountain areas that are no longer farmed. Forests remain under pressure in densely populated lowland areas (» SAEFL 2005f). The increase in the forested area affects the landscape, biodiversity, the forest's protective function and its role as a carbon sink.

The condition of Swiss forests depends on several factors, particularly bark beetles, fire and drought. Since the 1980s, defoliation of crowns (the upper parts of a tree, except trunk base) has increased, with wide variations in recent years. Many trees are under chronic stress which makes them more vulnerable to disease and extreme weather conditions.

The forest plays a decisive role in Switzerland's biodiversity (» Chapter 12), as nearly half of native animals and plants – about 20,000 species – depend on it (» G13.2).

The proportion of endangered species in forests is lower than in the other ecosystems. While the general picture is favourable, forests still have some ecological deficits. There is not enough dead wood which thousands of species need as their habitat. At the same time, a number of varieties requiring light and warmth suffer from the darkening of forests that are no longer managed and from the homogenisation of the edges of forests. Expansion of the area covered by forest can also prejudice ecologically valuable rural landscapes, starting with the wooded pasture of the Jura and the Alps (» Chapter 6).

In addition, forest reserves promote biodiversity. Switzerland has 672 forest reserves under contract, representing 2.5 % of the total area of forest (» G19).

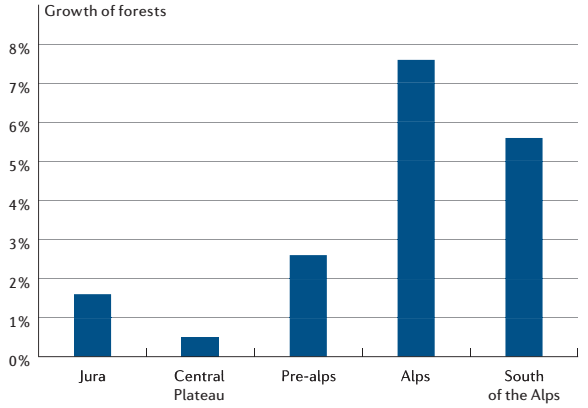
Forests are more strongly affected by deposits of atmospheric pollutants than open terrain, because trees retain substances present in the air (» Chapter 7). The highest values are recorded near sources of emission such as traffic, housing and agriculture (» SAEFL/WSL 2005).

Soil in forests shows particularly high concentrations of acids and nitrogen. These pollutants can damage forest plants directly, through the ambient air, or indirectly, by being deposited in the soil (» G13.3). Forests polluted in this way can no longer fully perform their water-table filtering function, and nitrogen levels are too high in 90 % of the forest area (» Chapter 7).

Protective measures and forest management

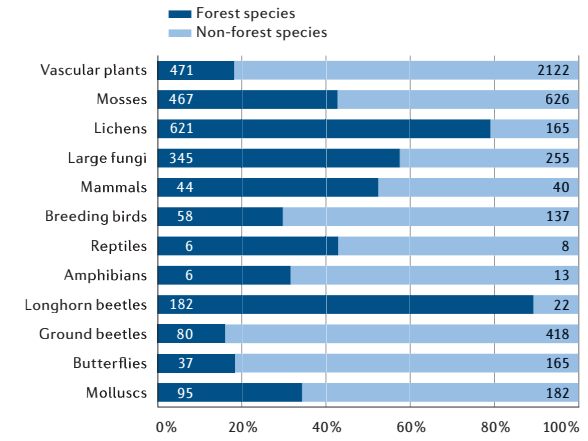
The main protective measure for forests is the ban on clear-cutting laid down by law. To ensure compliance with this provision, management of forest development in mountain areas requires active cooperation between those in charge of forests, spatial planning and agriculture. Switzerland has set itself the long-term objective of dedicating 10 % of total forest area to forestry reserves in order to achieve a balance between timber growth and use (» SAEFL 2004e). As part of the Reorganisation of Financial Equalisation (RFE), the forest economy's production capacity will be boosted. For this purpose, Confederation resources should in future focus

G13.1 Growth of forests in afforested areas between 1985 and 1995



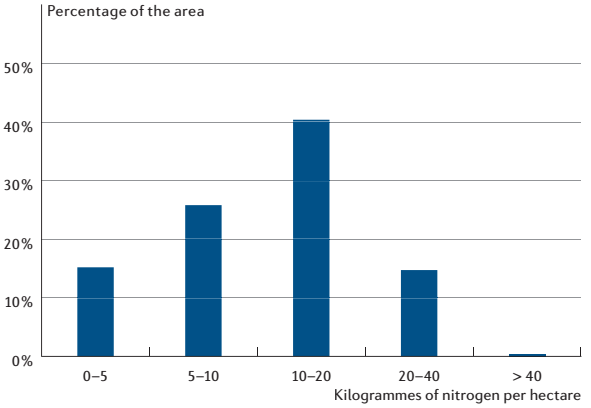
Source: WSL, Swiss Forest Inventory

G13.2 Percentages of different organism groups found in forests in 2004



Source: SAEFL 2005f

G13.3 Nitrogen deposits in forest ecosystems in 2000



3.5 % of the area does not exceed the critical load

Source: SAEFL 2005f

on promoting operational unit efficiency, timber logistics, bases for forestry planning and the nurture of young forests. The "WOOD 21" and "SWISS ENERGY" programmes, together with the Fund for the Promotion of Forest and Wood Research, support innovative projects for timber transformation and use. Developing the use of wood benefits the forest economy and the timber economy and has a substantial ecological and economic impact. •

14. Natural risks

More and more damage is being caused by natural disasters because of the steady increase in the assets and property exposed to them, the vulnerability of infrastructures, and extreme meteorological events.

To prevent floods on the scale of summer 2005, riverbeds need to be regenerated and widened.

Seismic protection measures should be applied more systematically to reduce the potential impact of earthquakes.

Targeted, sustainable maintenance by professionals is the only way of preserving the protective function of forests.

Security is a basic human need and a prerequisite for social prosperity, and managing natural hazards is part of it. In Switzerland, movements of water, snow, ice, soil and rocks have always constituted a danger in the form of flooding, mudflows, avalanches, rockslides, landslides and earthquakes (» G14.1). They are compounded by extreme meteorological events that trigger violent gales, hail, storms, droughts or forest fires.

Natural disasters

Natural disasters are not just confined to mountain regions but also affect the country's Central Plateau and the Jura range. On an international scale, the risk of earthquakes in Switzerland is low to moderate. However, a major earthquake like the one that hit Basel in 1356 (magnitude of 6.9 on the Richter Scale) would today wreak considerable damage (over CHF 60 billion worth of damage and 1,500 victims). Canton Valais, the Basel area, Central Switzerland, the Engadine and the Rhine Valley upstream of Constance Lake are the regions at greatest risk (» M14.1). In statistical terms, an earthquake with a magnitude of 5 can be expected every ten years, one of 6 every hundred years, and one of 7 every thousand years.

In the past, Switzerland has experienced dramatic natural disasters such as the Basel earthquake and the Goldau (SZ) landslide. But over the past 50 years or so, no single event has claimed more than 30 lives (» T14.1).

No clear trend has yet emerged for an increase in the number of sudden rises in water levels, mudflows, landslides or avalanches in Switzerland (» G14.1). In contrast, extreme meteorological events have caused serious damage in Switzerland in recent years, such as heavier rainfall, which has triggered more violent spates. During the summer of 2002, for instance, the Napf region (BE/LU) experienced heavy rain, and numerous landslides were recorded in Canton Appenzell. 2003 was characterised by a period of summer drought and a heatwave, whereas 2004 can be regarded as a disaster-free year. In August 2005, torrential rainfall caused damage in 17 cantons.

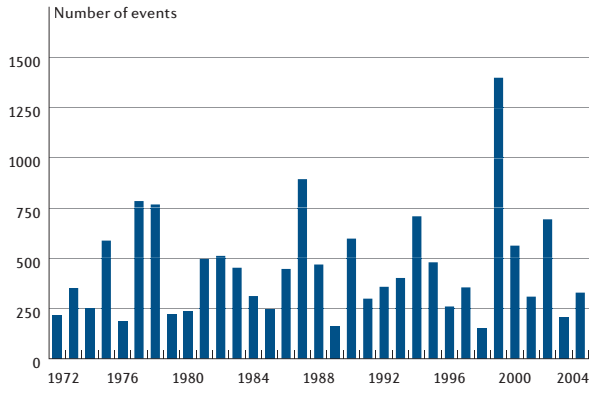
Climate change could alter the intensity and geographical distribution of extreme meteorological events, causing insecurity and hazards (» Chapter 8). In future, the consequences for Switzerland could be as follows: an increase of around 10 % in winter rain/snowfall; worse spring floods because of the higher flow rates of most rivers in winter; rockfalls, landslides and mudslides because of soil warm-up and melting **permafrost**[1] (» OcCC 2003).

Causes

The damage caused by natural disasters is steadily increasing. There are many reasons for this: higher-value assets and property concentrated in one place; vulnerable infrastructures; inappropriate spatial planning; greater demand

[1] Project of the Advisory Board on Climate Change (OcCC) "Switzerland in 2050": www.occc.ch/projects_e.html

G14.1 Natural hazards (spates, mudflows and landslides)



Source: WSL, ENA

T14.1 Major natural events from 1356 to 2005 and their consequences

		Deaths	CHF million
1356	Basel earthquake	1,500	–
1806	Goldau (SZ) landslide	500	–
1868	Floods in the Alps	50	–
1881	Elm (GL) landslide	115	–
1910	Floods in central and eastern Switzerland	11	–
1947	Summer of drought	–	–
1951	Winter of avalanches	97	120
1987	Floods in the Alps	4	1,200
1999	Floods on the Central Plateau	2	580
	Winter of avalanches	17	750
	Hurricane Lothar	14	2,000
2000	Floods in Valais and Tessin	16	670
2002	Bad weather	4	350
2003	Summer of drought and heatwaves	975	100
2005	Floods in the Alps	6	2,500

Source: PLANAT 2005

for mobility and communications; and the growing intensity of extreme meteorological events, which is probably linked to climate change.

Assets and property are concentrated in a very limited area, so a river flooding in an urban area, or the impact of a rockslide or landslide on a key communication axis, as happened with the Gotthard Tunnel in June 2006, immediately have substantial financial repercussions. Urban sprawl and soil that has been rendered impermeable further worsen the situation (» Chapter 11).

Damage

The number of victims claimed by natural disasters has been slashed since the 1970s. Recent events have underlined the relevance of spatial planning measures, technical measures, the protective function of forests, and action to ensure effective protection of persons in the event of disasters.

The average cost of the damage caused (prices index-linked to 2002) between 1972 and 2005 was around CHF 330 million per year. These statistics clearly reveal the damage suffered in 1978, 1987, 1993, 1999, 2000 and 2005 (» G24).

For instance, the 2005 floods caused the greatest damage in the past 30 years, claiming the lives of six people and incurring costs of CHF 2.5 billion throughout the national territory. In the private sector, the damage totalled CHF 2 billion. In principle, these costs are covered by insurance or donations. In the public domain, they amount to some CHF 500 million.

Preventive measures

The resources earmarked in Switzerland solely for preventing natural disasters correspond to approximately 0.6 % of gross domestic product (GDP), or to 4.7 % of Confederation expenditure, 3.7 % of cantonal expenditure and 5.7 % of local authority expenditure.

Switzerland dedicates at least CHF 2.5 billion every year to managing natural hazards (» PLANAT 2005) – 32 % for floods, 19 % for gales and 14 % for storms, with the remainder of the budget being spread over the other natural hazards.

Investment in preventing natural hazards represents 41 % (CHF 1.02 billion) of management expenditure (» G26), while management of residual risks covered by insurance (CHF 0.83 billion), intervention (CHF 0.37 billion), repair or rehabilitation (CHF 0.16 billion), and improvements in basic data (monitoring networks, hazard maps, CHF 0.09 billion) account for the remainder.

More than half the expense of managing natural hazards (56 %) is borne by the private sector, including 33 % paid for insuring damage caused by natural events, while 15 % is borne by the Confederation, 13 % by the cantons and 16 % by local authorities.

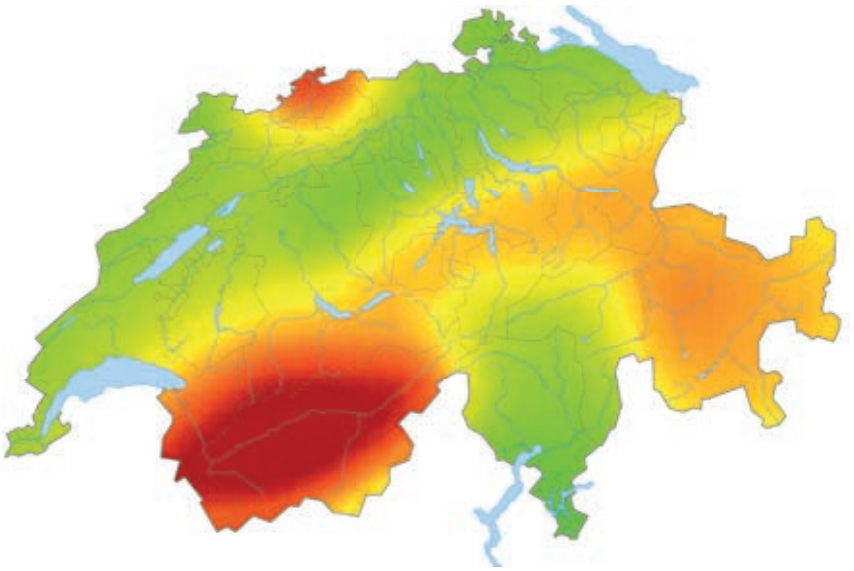
Management of protective forests

Protective forests play a fundamental role in countering natural hazards, especially in the Alps: acting as an ecosystem, they are an effective protection against avalanches, rockfalls, landslides and mudslides (» SAEFL 2004e) (» Chapter 13). The quality of this protection depends on the stand structure because only healthy forests can fully perform these functions (» SAEFL/WSL 2005).

It is therefore vital to maintain these protective forests in a condition that enables them to serve this purpose comprehensively and on a lasting basis. Practical guidelines show how long-term forest protection can be provided at low cost using public funds[2] more efficiently than to date (» SAEFL 2005f). In future, protective forests will have to be demarcated, and the measures taken will have to be moni- »

[2] Federal Law of 4 October 1991 on Forests (Law on Forests, LFO), RS 921.0.

M14.1 Risk of earthquakes in Switzerland



NB: Geographical distribution of maximum horizontal ground acceleration in accordance with Standard SIA 261 for an earthquake with a return period of 500 years. The regions at greatest risk are Canton Valais and the Basel area.

Source: SED-FITZ

RI FS

› tored in accordance with standardised national criteria (» SAEFL 2005g).

Protection against sudden rises in water levels

Over 200 years ago, major flood-bank work was carried out on Swiss rivers. Today, the opposite is called for. Riverbeds now have to be widened and more space set aside for flood-water channels. This will make it possible to limit damage and enhance security while creating habitats for numerous species of flora and fauna. It also encourages river/stream bank regeneration (» Chapter 10). Experience has shown that the violence of torrents has been underestimated, as the sudden rise in the level of the Glyssibach stream near Brienz (BE) in August 2005 demonstrated.

Spatial planning

It is only since 1997 that spatial planning has taken serious account of natural hazards. Using hazard maps, this planning aims to limit increases in potential damage, to avoid aggravating it in risk areas, and even to reduce it in the longer term.

The principle of hazard maps is to divide the territory into four areas (zero, low, medium and high hazard), using objective criteria based on the intensity and frequency of natural events (sudden rises in water levels, landslides, mudslides, avalanches). The effectiveness of such maps was proved during the bad weather in August 2005 when they enabled the Cantons of Nidwalden and Obwalden to avoid huge damage. If work goes to plan, all Swiss cantons will have completed their hazard maps by 2011 (» G25).

To forestall the potential repercussions of climate change in Switzerland, regions at risk must be indicated on a hazard map. Thus, in 2006, the FOEN commissioned a map of Switzerland's permafrost regions.

The Federal Law of 21 June 1991 on Stream Management stipulates that the cantons must guarantee protection against spates by maintaining rivers and streams and by taking spatial planning action. If these methods do not achieve the desired results, the cantons must resort to other means such as dykes, corrections, bed load retention installations, flood barriers etc.

Example: the River Aa at Engelberg

In 2005, customised flood protection on natural lines proved its worth near Engelberg on the lower reaches of the River Aa, which flows into Lake Lucerne near Buochs (Canton Nidwalden). In this river, the maximum water flow had not exceeded 125 m^3/s since 1916. On 22 August 2005, however, it was within a hair's breadth of 300 m^3/s. Measures taken in 1998 – widening of the riverbed, reinforcement of the dykes and flood diversion upriver from Buochs – meant that disaster could be averted. An investment of CHF 26 million made it possible to avoid damage in excess of CHF 100 million.

Compensation, warning systems and coordination
Switzerland's cantons provide protection against natural hazards by means of maintenance, planning and other technical measures. The Confederation compensates them for all this work in line with their financial capability. In several cantons, setting up a Natural Hazards Committee has proved extremely useful. Such committees are composed of interdisciplinary groups of specialists who are at the disposal of the cantonal services involved in such work (forestry, watercourses, geology and spatial planning).

An intercantonal measurement and information system (IMIS) for avalanche alerts involving some 70 automatic measuring stations has been set up in the mountain cantons, to complement the networks of METEO SUISSE and of the Federal Institute for Snow and Avalanche Research. The snow and weather data collected by the IMIS enable experts to evaluate the risk of avalanches. All the IMIS stations operate independently and are linked to local, regional and national centres by radio and telephone.

Protection from earthquakes
Given that earthquakes are rare in Switzerland, protection from them is largely neglected, even in the public sector. As for the majority of natural hazards, it is impossible to foresee an earthquake precisely, but construction measures can help to attenuate its impact on buildings, thus reducing the number of potential victims. Such measures come under the heading of "earthquake mitigation".

Consequently, the latest SIA 260–267 seismic protection standards issued by the Swiss Society of Engineers and Architects (» SIA 2003) define the constructional principles for effective protection from earthquakes. To date, only the Cantons of Valais, Berne and Basel-Stadt have made compliance with the SIA standards mandatory in their building legislation. When it comes to monitoring the seismic security of existing public structures, 14 cantons and the Confederation play an active part in inventory work, and approximately 3,000 public buildings have been evaluated, i.e. just 0.1 % of Switzerland's total building stock. Thus, there are considerable gaps in seismic security for buildings with more than five floors built before modern construction standards came into effect (SIA 160 dating from 1989). Virtually no private structures are covered by such analyses, and remedying this situation will be one of the challenges to be faced in the next few years.

A Coordinating Office for Seismic Safety was set up at federal level within the FOEN. Between 2005 and 2008, there are plans to continue inventory work, improve the seismic protection of existing buildings as part of structural improvements, and develop the seismic monitoring network (» DETEC 2005b). •

15. Risks of major chemical and biological accidents

In 2005, 2,327 companies in Switzerland were using potentially dangerous substances and were therefore regulated by the Ordinance on Major Accidents (MAO). The communication corridors covered by the MAO comprise 4,000 km of railway track and 7,850 km of national or transit highways.

The MAO rests on the principle of controlled personal liability: facility owners have an obligation to take all appropriate and acceptable measures to reduce risks, and the authorities monitor implementation of these measures.

Major chemical accidents

Major accidents, as defined by the Ordinance on Major Accidents[1] (MAO), are extraordinary events that occur in companies or on communication corridors and have serious impacts outside the facility premises or beyond the corridor proper.

Potential hazards

Major accidents that trigger considerable damage may occur during operation of facilities if they use large quantities of dangerous substances and preparations or special wastes. For instance, Visp in Canton Valais was rocked by the explosion of a storage tank in February 2004.

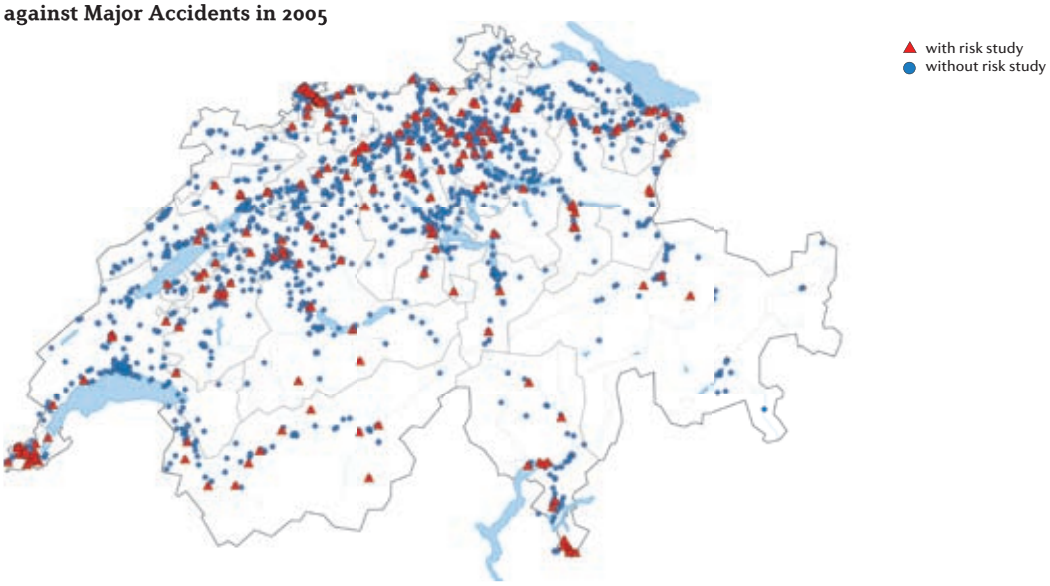
2,296 companies are concerned – a number that has remained virtually the same for several years. (» G11). They are spread throughout Switzerland, but are mainly concentrated in the industrial areas around Geneva, Basel and Zurich, and in the Central Plateau (» M15.1). According to an official evaluation performed in 2005, the owners of 205 of these companies had carried out 247 risk assessments. Most of these companies were chemical product wholesalers or fuel and combustible businesses, chemical production facilities, and installations open to the public (swimming pools, artificial skating rinks).

Major accidents that cause considerable damage may also occur on communication corridors, particularly during the transport of flammable solvents, acids and bases or pressurised poisonous liquefied gases. For instance, a tank wagon containing 25,000 l of heating oil overturned on the A4 highway near Risch in Canton Zug in June 2001. 7,500 l of oil were spilt, part of which polluted Lake Zug. The Ordinance covers 4,000 km of railway track (belonging mainly to Swiss Railways [SBB] and the Berne-Lötschberg-Simplon Railway [BLS]), 1,850 km of national highways and approximately 6,000 km of major transit highways (mainly cantonal roads). Approximately 20 % of the goods transported by rail are dangerous, and two thirds are mineral-oil-based products (» M15.2). On average, 8 % of lorries carry dangerous goods by road

Dangerous goods such as natural gas or liquid fuels are also transported using pipelines, to which the MAO apply by analogy.

[1] Ordinance of 27 February 1991 on Protection against Major Accidents (Major Accidents Ordinance, MAO), RS 814.012.

M15.1 Companies representing a potential chemical risk that come under the Ordinance on Protection against Major Accidents in 2005



Source: CARAM

IF R+

Risk assessment

Scenarios can be used to ascertain which facilities are likely to cause serious damage in the event of a major accident. For this type of facility, the authorities require the owner to conduct a quantitative risk assessment, using scenarios to determine the probability (P) of a major accident occurring and its consequences (scale, S). The risk is represented using these two factors (P, S) in a diagram (» F15.1). The criteria applying to companies and communication corridors have been adapted so that these quantified risks can be assessed in a standardised way (» SAEFL 1996, 2001c).

Major biological accidents

Potential hazards

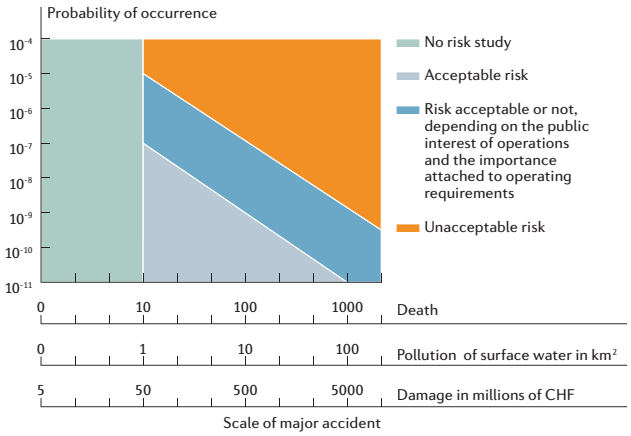
Numerous microorganisms and parasites (organisms) can cause illness in humans, animals and plants. Many illnesses are fairly benign and short-lived, such as salmonella bacteria and cold viruses. However, some organisms can cause permanent damage or even death, such as the Ebola virus or anthrax bacteria for humans, and foot-and-mouth disease for ungulates. »

M15.2 Transport of dangerous goods in 2005

Source: FOT

IF FS

F15.1 Representation and assessment of major accidents risk
Probability Scale (P/S)



Source: FOEN

› Activities involving organisms are divided into four categories (1 to 4) according to their hazard potential. Categories 3 or 4 involve organisms with a high or very high potential risk that could trigger serious and often incurable illnesses. Category 2 activities are less dangerous, while those of category 1 (for instance those concerning lactobacilli) are regarded as harmless.

From what is known today, the activities of category 3 and 4 biotechnology facilities could trigger major accidents. If pathogenic agents were released during such activities, they could spread beyond the immediate vicinity of the facility and constitute a serious threat to the population and the environment. Consequently, the MAO applies to all companies carrying out category 3 and 4 activities. At the end of 2005, there were 31 such companies in Switzerland – a high number compared with other countries. Biotechnology companies are concentrated in the area round Lake Geneva and in the university centres of Zurich, Basel and Berne (» M15.3). Approximately two thirds of these facilities are dedicated to research and production, and one third to diagnostics.

Although there have been several mishaps and incidents in such facilities in recent years, no major accidents have occurred in a biotechnology company to date.

Risk assessment

In principle, the procedure for assessing biological risks is the same as for chemical risks, and also uses scenarios.

M15.3 Companies representing a potential biological risk that come under the Ordinance on Protection against Major Accidents in 2005

Source: CARAM

IF R

Prevention and management of major accidents

The Ordinance on Major Accidents requires the owners of facilities within its remit to take all necessary measures for reducing the potential risk, preventing major accidents and limiting their impact, as a matter of personal liability. The authorities monitor compliance with this prevention obligation in a two-stage checking and assessment procedure. In general, the cantons are responsible for monitoring companies, while the federal authorities monitor railway installations and national highways. The instruments they use are the summary report (first stage) and the risk study if necessary (second stage).

In the summary report, the owner describes the potential hazard and the safety measures adopted. He or she must also estimate the scope of the potential damage to the population at large and to the environment that would result from a worst-case major accident.

If the estimated scope of the damage is regarded as being too high, the authorities require the owner to carry out a risk assessment to evaluate the risk posed by the facility in quantitative terms. If the enforcement authority considers that this risk is unacceptable, the owner must take additional security measures. If the required level of risk acceptability cannot be obtained with these measures, the necessary operational or transportation restrictions are imposed.

Preventing major accidents is not a static process. Companies are permanently undergoing economic and technological change, and the flow of dangerous goods circulating on communication corridors fluctuates constantly. Architectural, technological and organisational safety measures are progressing all the time. They include retention installations for liquids that could present a threat to water supplies if they were to escape in a major accident; detectors for measuring concentrations of toxic gases; and coordination between company and municipal fire-fighting services. Analyses of major accidents that have occurred in Switzerland and in other countries, as well as cooperation within the framework of international agreements (such as the Convention on the Transboundary Effects of Industrial Accidents [2]) also provide fresh knowledge. Construction work or changes to zoning plans also affect facility surroundings and call for reassessment of the risk. Consequently, major accident prevention should be taken into account at the spatial planning stage, which is thus an ongoing, challenging task for both facility owners regulated by the MAO and the authorities. •

[2] Convention on the Transboundary Effects of Industrial Accidents, signed in Helsinki on 17 March 1992, RS 0.814.04.

16. Noise and vibrations

In Switzerland, one person in seven is exposed to excessive noise levels.

Despite remedial measures, noise levels are increasing because of growing traffic.

Chronic noise and vibrations are harmful to health and detrimental to property exposed to them. The external costs of this noise pollution total CHF 1 billion per year.

Protection of the general public against noise and vibrations is still inadequate.

Significance of noise and vibrations

In Switzerland, approximately one million people are bothered by noise that exceeds the thresholds (noise limit values)[1] (» G13). At the same time, the number of people experiencing vibrations close to these guideline values is estimated by the FOEN at around 25,000 (Federal Council 2005).

Surveys have revealed that 64 % of the population, i.e. approximately 4.7 million people living in Switzerland, feel disturbed by noise (subjective assessment). Road traffic noise is one of the main problems mentioned. Considered objectively, this noise source is indeed responsible for the most significant noise pollution.

Despite the precautionary principle and the remedial programmes that are underway or in the pipeline, the population is still only partly protected. Even after remedial work, many people still claim to be bothered by noise and vibrations for the following reasons:

- Technical progress in the automotive industry is more than offset by the increase in traffic; in towns, the only possible remedy is to install soundproofed windows (» Replacement measures, page 110).
- The law authorises noise sources to exceed the limit values under certain conditions (eased requirements), and this option is widely used in practice.
- The degree of protection against noise laid down in the Environmental Protection Law (LPE)[2] covers only some of current individual requirements in terms of health and quality of life.
- The substantive legal basis for limiting vibrations and structure-borne noise (» Vibrations and structure-borne noise, page 109) will come into effect in 2007 at the earliest.

Sources of noise pollution

Traffic constitutes the main source of noise in Switzerland (» G13 and Chapter 3). In this category, roads generate more than half of cases where limit values are exceeded, with railways and airfields in second and third place. They are followed by shooting ranges, industrial installations and workshops, machines and appliances, as well as the sounds of daily activities (neighbourhood noise, excessively loud music, lawnmowers etc.).

Railways are the main sources of vibrations and secondary structure-borne noise (» Vibrations and structure-borne noise, page 109).

[1] These values vary according to the level of sensitivity assigned to the specific area and to the period under consideration (day, night).

[2] Federal Law of 7 October 1983 relating to Protection of the Environment (Environmental Protection Law, LPE), RS 814.01.

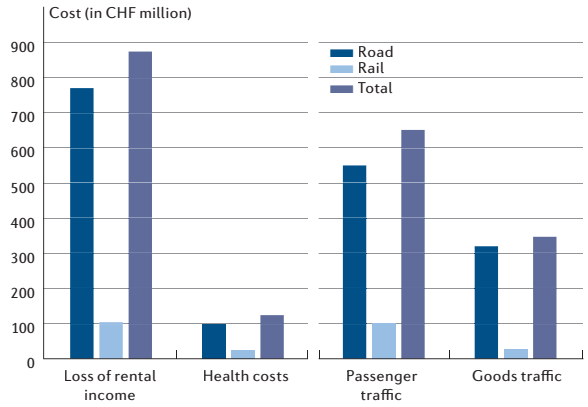
Consequences

Exposure to excessive, chronic noise or vibrations makes people ill. The consequences range from mere disruption of communication and disturbed sleep to a higher risk of death by heart attack, as the result of high blood pressure. Noise also causes health problems even before it is perceived as a nuisance. The received idea that "you get used to noise" is wrong. Our nervous system reacts to it subconsciously by secreting stress hormones, especially at night (» Chapter 17).

Noise also has a negative economic impact (» G16.1) in that it causes depreciation in property exposed to it, makes noisy areas less attractive, and undermines people's health. The external costs ascribable to noise are estimated at around CHF 1 billion per year, 90 % for property depreciation and 10 % for costs of healthcare (» ARE 2004a).

Generally speaking, rising noise levels go hand in hand with a change in the demographics of the location concerned. People who can afford to do so move away to quieter districts, resulting in social segregation.

G16.1 Cost of noise, distributed by field in 2000



Source: ARE 2004a

IF E

Measures in place and their impact

Switzerland has based its strategy for combating noise on three basic principles: action at source, preventive measures and rehabilitation. The main legal bases applicable are the LPE[2] and the Noise Abatement Ordinance (NAO)[3]. For their part, the cantons draw up cadastral noise maps to simplify planning and decision making.

Spatial planning

Far-sighted spatial planning is one of the most effective factors in noise abatement, helping to nip many problems linked to noise in the bud. Appropriate coordination of the regions intended for residential settlements and work, installations generating heavy traffic and the necessary transport infrastructure can help prevent increased traffic and consequently noise and vibrations. The regulatory framework is specified in the legal texts on noise abatement and spatial planning, to which the cantons and local authorities must refer. Sectoral plans are further effective tools for avoiding noise problems at the planning stage.

Measures at source

Noise should be combated at source (limitation of emissions) (» SAEFL 2002d): in principle, noise emitted by permanent installations should be limited when this is feasible in technical and operational terms and is economically viable. Permanent installations that make a substantial contribution to exceeding immission limit values must undergo remedial work, though the enforcement authority may nevertheless ease the requirements.

Many different kinds of measures are taken at source to reduce traffic noise:

- Measures on vehicles, including low-noise tyres
- Sound-absorbing road surfaces
- Operational measures (traffic reduction and transfer, low-noise driving etc.)
- Information campaigns
- Promotion of public transport and environment-friendly mobility (» Chapter 3)
- Construction measures (sound-absorbing surfaces and traffic noise barriers)

New constructions have to be designed so as to provide dwellings with maximum protection or to place premises that are noise-sensitive on the side facing away from the noise emissions. »

[3] Noise Abatement Ordinance of 15 December 1986 (NAO), RS 814.41.

Vibrations and structure-borne noise

Vibrations are mechanical oscillations in solid bodies. Secondary structure-borne noise is the noise triggered in the air by solid bodies subjected to vibrations. For instance, a moving train produces vibrations that spread through the ground and make buildings vibrate. Construction components that vibrate, such as ceilings and dividing walls, transmit the oscillations to the air, and the building's inhabitants perceive this secondary structure-borne noise as a dull rumbling.

Combating railway noise in figures (status 2006)

At the beginning of the rehabilitation period, approximately 265,000 people were exposed to values in excess of the limit. After completion of the rolling-stock remedial programme and the construction of sound barriers, two thirds of these people will be effectively protected, and soundproofed windows will be installed for the remaining third. Ninety percent of the old passenger carriages (1,140 carriages) have been reconditioned. In spring 2005, the SBB started fitting their goods wagons with stress-reduced wheels and plastic brake shoes; 20 % of this category of rolling stock have been equipped to date. Of the 260 km of noise barriers planned along railway tracks, 35 kilometres have already been installed and 90 km approved. Thus, by the end of 2005, 85,000 people had been effectively protected (» FOT 2006).

› Measures taken on vehicles to reduce noise emissions are a very efficient way of combating noise at source, because they are effective everywhere and not just in specific locations.
There is enormous potential for reducing noise in road, rail and air traffic:
- In road traffic, the emphasis is on developing low-noise vehicles and tyres. However, the Confederation's room for manoeuvre in this connection is limited because the emission limit values in force in Switzerland have to coincide with the levels adopted by the European Union. Promoting the development of appropriate technology will also be indispensable.
- With regard to railway traffic, all rolling stock will be adapted and fitted with silencer systems between now and 2009. To combat vibrations, ballast mats, sleeper shoes and spring-mass damper systems[4] are being installed on the whole network.
- For air traffic, aircraft emission limit values have been set at international level. Nevertheless, Switzerland has some room for manoeuvre in issuing regulations (for instance, restrictions on operations in the event of excessive emission values).

Replacement measures
Under the Noise Abatement Ordinance[5], replacement measures must be taken (e.g. soundproofed windows) when the alert thresholds cannot be observed. In this case, the owners of the noisy facility must pay for the installation of such windows provided this does not generate disproportionate costs and that weightier interests do not speak against these measures. •

[4] This technology in particular deadens the tracks and prevents vibrations (SAEFL 2005h).
[5] Noise Abatement Ordinance of 15 December 1986 (NAO), RS 814.41.

17. Environment and health

Some environmental factors can affect human health. However, it is difficult to isolate a specific environmental factor for a given pathology.

Extreme meteorological situations, air pollution, noise and radiation constitute risks to health, causing premature death, lost years of life or illness.

At present, there is no systematic, long-term monitoring of the impact of environmental factors on health, particularly of chronic exposure of the population to low concentrations of pollutants.

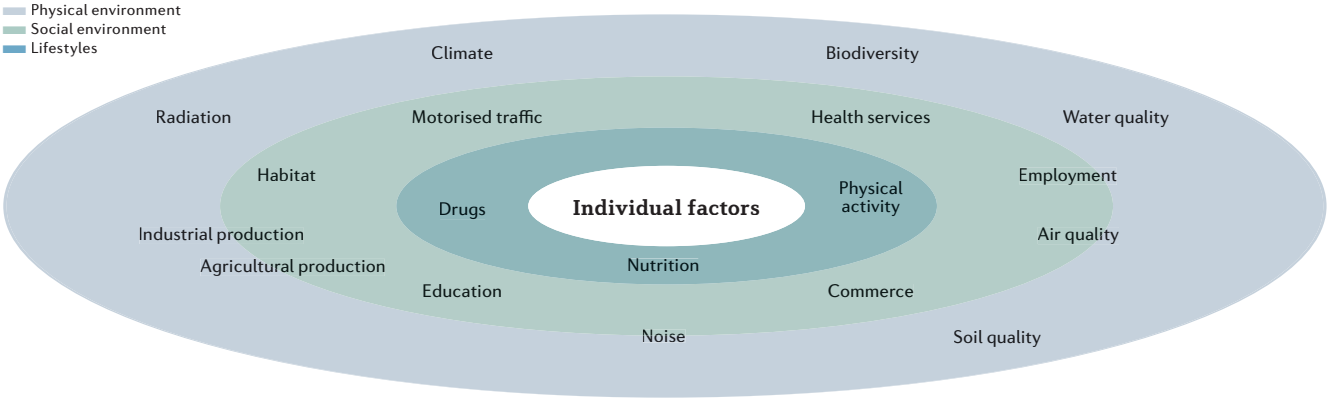
Health problems linked to the environment

One of the prerequisites for good health and wellbeing is to live in an unpolluted, harmonious environment in which physical, physiological, social and aesthetic factors are given the importance they deserve (» WHO 1999).

Health is determined by several, dynamically interlinked factors: the physical and social environment influences lifestyles and conversely, the latter influence the environment (» F17.1). Identifying the pathogenic role of such factors is not always simple. On the one hand, their impact on health is not easy to determine, while on the other, the pathologies observed are often due to a variety of different causes (environmental, social and individual).

Environmental health comprises the study and prevention of health risks linked to the environment, as well as encouraging human behaviour that promotes a healthier environment. Environmental factors with potential repercussions for health are physical, chemical and biological and stem from natural or man-made sources, whether »

F17.1 **Factors determining health**



Source: FOPH

T17.1 Main air pollutants and their effects on health

Pollutants	Sources	Effects on health
Airborne particles (PM10)	Transport (especially diesel) Industry and crafts Agriculture, forestry	Fine particles and soot: respiratory and cardiovascular diseases, increase in mortality and cancer risk
Dust fallout		Dust deposits (fallout): migration of heavy metals, dioxin and furan in the food chain
Ozone (O_3)	Transport Industry and crafts	Irritation of respiratory system lining, breathing difficulties, decrease in lung capacity, possible factor in mortality increase
Nitrogen oxides (NO_X)	Transport (mainly road)	Respiratory illnesses
Volatile Organic Compounds (VOC)	Industry and crafts Transport (mainly road)	Irritation of respiratory system lining, headaches, vertigo and fatigue
Benzene	Transport (mainly road) Combustibles Combustibles storage and transfer	Cancer (leukaemia) In case of high concentration, severe effect on the eyes, respiratory system and central nervous system
Sulphur dioxide (SO_2)	Combustibles	Illnesses and irritation of the respiratory system

› chronic or accidental. The term "environment-related illness" is used to describe any health problem triggered by an environmental factor.

Not everybody is equally affected by the environmental factors that determine health. According to the Environmental Protection Law (LPE), the risk groups are people who are particularly sensitive, such as children, sick people, elderly people and pregnant women. For instance, people with respiratory problems and children are more vulnerable to air pollution.

Generally speaking, the health of the Swiss population has never been better in terms of life expectancy and access to healthcare. However, certain environmental factors are taking an increasingly negative toll on the population's health, playing a direct or indirect part in numerous ailments (such as cardiovascular disorders, various forms of cancer, lung problems, stress-related illnesses and cerain allergies). Lifestyles that influence health, such as diet and physical activity, are partly dependent on the environment too.

Exposure of the population and effects on health

Outside air

The main air pollutants are suspended particulate matter, deposited dust, ozone, nitrogen oxides, benzene, volatile organic compounds and sulphur dioxide (» T17.1).

The current level of atmospheric pollution in Switzerland causes respiratory and cardiovascular ailments as well as roughly 3,700 premature deaths a year, including no fewer than 300 from lung cancer. Every time we inhale, gases such as nitrogen oxide and ozone, as well as thousands of fine particles, get into our respiratory tract and lungs, where they settle in the bronchia and the pulmonary alveoli. The finer the particles, the deeper they penetrate into the lungs. Excessive exposure to pollutants exacerbates respiratory problems and disorders among children and adults, such as chronic coughing with expectoration, bronchitis, both chronic and non-chronic, as well as respiratory infections. Respiratory and cardiovascular disorders due to atmospheric pollution are responsible for some 15,600 days spent in hospital per year. Every year, approximately 39,000 cases of acute bronchitis among children and about 1,000 new cases of chronic bronchitis among adults, as well as 1.7 million days of reduced activity among adults, can be ascribed to air pollution. Among those who are already ill, atmospheric pollution is an additional detrimental factor; the higher the level of pollutants, the shorter the symptom-free intervals. Inhaling polluted air reduces average respiratory capacity and results in more emergency consultations and hospital referrals for respi-ratory tract ailments, as well as reducing life expectancy[1] (» T17.2).

The health costs generated by air pollution are around CHF 4.2 billion per year, i.e. CHF 600 per capita.

The threshold values set in the LPE and the Ordinance on Air Pollution Control (OAPC) aim to protect the population against harm to their health by reducing atmospheric pollution at source wherever possible.

Air inside buildings

Healthy, well-aired rooms are essential for health and well-being. Air pollution inside buildings is mainly generated by human activity (especially tobacco smoking); chemical substances contained in building materials and cleaning products; natural sources such as damp and radon (» Ionising radiation, page 114 and Chapter 2); or by pets, cockroaches, mites and mould (» Roulet 2004); and, of course, by external air pollution.

[1] A death is regarded as premature when it occurs before a predetermined age that corresponds, for instance, to the life expectancy at birth in the population under consideration. The number of potential years of life lost due to a specific cause of death in a population is the sum, for all people who die of that cause, of the years they might have lived if they had survived until the age corresponding to their life expectancy.

T17.2 Overview of cases of diseases and number of life-years lost as a result of air pollution in the year 2000

Effect on health	Overall polluting charge	Road traffic	Railway traffic	Industry and other
Number of life-years lost	42,400	15,400	1,000	26,000
Number of days in hospital because of respiratory diseases	5,900	2,130	140	3,630
Number of days in hospital because of cardiovascular diseases	9,800	3,550	240	5,990
Cases of acute bronchitis (children)	39,000	14,090	900	24,010
Cases of asthma attacks (adults)	41,080	14,910	980	2,590

Source: ARE 2004a

T17.3 Overview of life-years lost and cases of diseases attributable to noise in the year 2000

	Ischemic[1] heart diseases by sources of noise in daytime			Diseases associated to hypertension by sources of noise at night		
	Road	Rail	**Total**	Road	Rail	**Total**
Number of life-years lost	270	60	**330**	710	190	**900**
Number of activity-years lost	20	5	**25**	30	10	**40**
Number of days in hospital	760	150	**910**	3,650	970	**4,620**
Number of day-treatments	100	20	**120**	10,600	2,800	**13,400**

[1] Decrease of blood inflow due to constriction of arteries.

Source: ARE, 2004b

T17.4 Distribution of healthcare costs attributable to noise (in CHF million, at price value year 2000)

	Passenger traffic	Freight traffic	**Total**
Road	62.7	36.4	**99.1**
Rail	19.5	5.2	**24.7**
Total	**82.2**	**41.6**	**123.8**

Source: ARE, 2004b

Passive smoking constitutes the highest indoor threat to health. The cost of passive smoking in Switzerland can be estimated at around 10 % of the cost of active smoking, i.e. at roughly CHF 500,000 per year (» ASCR 2005a).

"Sick building syndrome" is the umbrella term for vaguely defined pathologies linked to the pollution of indoor areas, which translate into rhinitis, migraines, nausea, eye and skin irritations. In Switzerland, the problems of damp and mould are common and concern approximately one dwelling in four. The risk of respiratory disorders is practically twice as high in damp apartments (» Roderick et al. 2004).

The impact on health of volatile organic compounds (VOCs) such as formaldehyde and other volatile chemical pollutants (residual monomers emitted by plastics, biocides, plastics or fire retardants) is difficult to assess. These substances are used in building materials, furniture and domestic products. The presence of VOCs – even at low concentrations – can trigger skin irritation, headaches, fatigue and nausea. The long-term effects of VOCs on human health are not yet known.

Noise

Disorders caused by excessive noise can be of a physical nature (auditory lesions, hormonal changes, high blood pressure, risk of heart attack) and/or psychological (feeling ill at ease, stress reactions, communication problems, sleeping disorders). Most auditory lesions are linked to leisure pursuits (discos, shooting, fireworks) or work (for instance, on building sites). The length of exposure plays a considerable role.

The problem of noise increases with the growth of traffic (» Chapter 16). In 2000, more than 2.2 million people were exposed to over 55 dBA during the day on account of road traffic. At night, 2.1 million people were subjected to noise pollution of over 45 dBA. Rail traffic constitutes a nuisance for 275,000 people during the day and 310,000 at night (» ARE 2004b). The number of years lost[1] and cases of illness that can be attributed to noise are considerable (» T17.3) as are the costs generated by noise pollution (» T17.4).

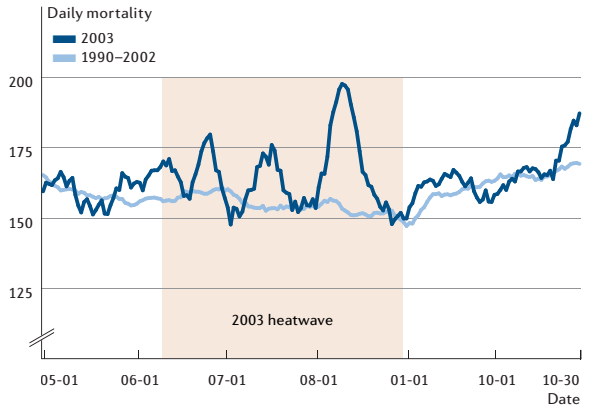
Climate

Extreme meteorological conditions can lead to excessive mortality (» ISPM 2004). For instance, the 2003 heatwave caused 975 deaths more than the average (+7 %) for summers between 1990 and 2002. This phenomenon was particularly pronounced in cities and built-up areas: +24 % in Basel; +17.5 % in Geneva; +13.5 % in Lausanne.

Climate change disrupts the ecosystem, for instance by promoting increased atmospheric pollution, propagating airborne pollens and parasites.

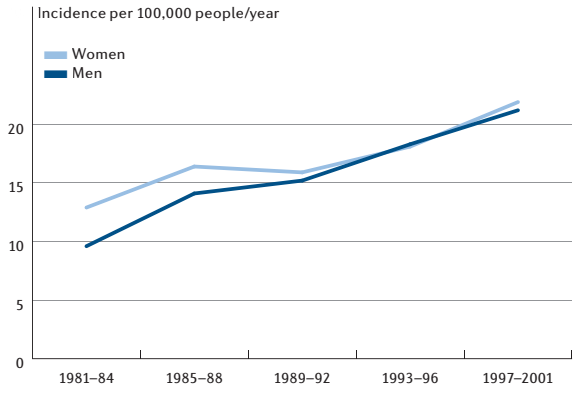
During the summer of 2003, the concentration of low-level ozone (summer smog) (» Chapter 7) reached levels that constituted a health hazard (OPAC value: 120 µg per m^3). According to an initial estimate 130 to 300 of the 975 premature deaths observed were due to ozone overload (» Federal Commission for Air Hygiene 2005). »

G17.1 Number of deaths during the 2003 heatwave compared with the average for 1990 to 2002



Source: Grize et al., 2005

G17.2 Incidence of melanoma in Switzerland between 1981 and 2001



Source: ASCR, 2005b

› In parallel with climate change and human activity, new species which are likely to impact negatively on health are emerging (» Chapter 12), with Goldenrod being a case in point. Insects like ticks are migrating to intermediate mountain areas, while mosquitoes are becoming increasingly prevalent during very hot periods. The Asian tiger mosquito which carries dengue fever (a tropical flu-like illness) has appeared in Switzerland.

Ionising radiation

The most carcinogenic source of indoor pollution is radon, a colourless, odourless gas. A product of radium, it is produced by the decay of uranium. Once released, it penetrates into buildings through gaps between floorboards and cracks in concrete and in walls. On average, radon constitutes 40 % of total exposure to radiation in Switzerland. The regions with the highest concentration are the Grisons, the karst areas of the Jura foothills, Canton Valais and Ticino (» M17.1). It is regarded as the most common cause of lung cancer after tobacco (» Roulet 2004). In Switzerland, 240 deaths per year are ascribed to radon out of a total of 2,800 deaths from lung cancer. The Radiation Protection Ordinance (RPO)[2] sets a threshold value of 1000 Bq/m^3 and a guideline value of 400 Bq/m^3 for dwellings; remedial work is called for if the threshold value is exceeded. The cantons draw up cadastral maps of regions with higher concentrations of radon gas and ensure these are periodically updated.

Radiation from nuclear power stations in Switzerland does not significantly increase the background level of radiation (» Chapter 2). Nevertheless, the repercussions of the Chernobyl reactor disaster persist in Switzerland and could cause 200 cases of terminal cancer, or even thyroid disorders (» FOPH 2006).

Non-ionising radiation

Non-ionising radiation affects humans differently according to its frequency and intensity. The effects of high-intensity radiation – which does not normally exist in the environment – are well documented scientifically. Low-frequency, very intensive fields can trigger nerve impulses and involuntary muscle spasms. In contrast, high-frequency radiation can cause human tissue to heat up, and international threshold values have been defined to protect people against its effects (» Chapter 2).

Various studies have recorded biological reactions at below these threshold values. Experiments on low-frequency fields have shown, for instance, effects on the behaviour, learning capacity and hormone systems in humans and animals. These fields also affect growth, metabolism and the genetic make-up of cells. As knowledge currently stands, it is not yet sure whether, and under what conditions, these effects constitute a threat to health. The International Centre for Cancer Research has classified low-frequency magnetic fields as potentially carcinogenic and feels that, even if this is not probable or proven, it is possible that these fields create a risk of leukaemia in children.

Experiments with low-intensity, high-frequency radiation fields showed that these affect the brain's electrical activities and sleep in humans, behaviour in animals and the physiology of cell cultures (» SAEFL 2003). However, from what we know today, it is impossible to say whether and how they are harmful to people's health.

Unlike the regions close to the South Pole, the thinning of the ozone layer (» Chapter 9) is probably not the main cause of the increase in disorders linked to UV rays in Switzerland, where they are more likely to be caused by people's changing habits as regards sunbathing, beach holidays, winter vacations and tanning parlours (» FOPH 2003).

[2] Ordinance of 22 June 1994 on Protection against Non-ionising Radiation (Radiation Protection Ordinance, RPO), RS 814.501.

Ragweed – an invasive alien plant

Ragweed, originally a North American plant, is spreading very fast on fallow ground (building sites, fields, empty waste land, waysides and roadsides). Transport of its seeds along motorways has created sizeable clusters in Switzerland, especially in Ticino and in Canton Geneva.

Ragweed pollen is highly allergenic and more aggressive than that of other plants. It can trigger skin irritations, rhinitis, conjunctivitis, bronchial inflammation and – in severe cases – asthma attacks. The ragweed's pollination period, from mid-July to mid-October, prolongs the traditional pollen allergy season by several weeks. The presence of this plant leads to an increase in the number of people with allergies and to higher consumption of medication. For Switzerland, the annual costs generated have not yet been calculated but by analogy with the calculations made in other countries, they could total several million Swiss francs.

Excessive exposure to UV rays results in sunstroke, damages the gene pool, causes ocular lesions and malfunctioning of the immune system. UV rays can also trigger skin cancer (melanoma and non-melanoma); there has been a steady increase in the number of cases of melanoma – the more dangerous of the two types – over the past 50 years or so. In Switzerland, there are 1,540 cases of melanoma-type cancers, with 240 deaths ever year (average 1997–2001), and 11,500 cases of non-melanoma cancer, with 140 deaths every year (average 1996–1998).

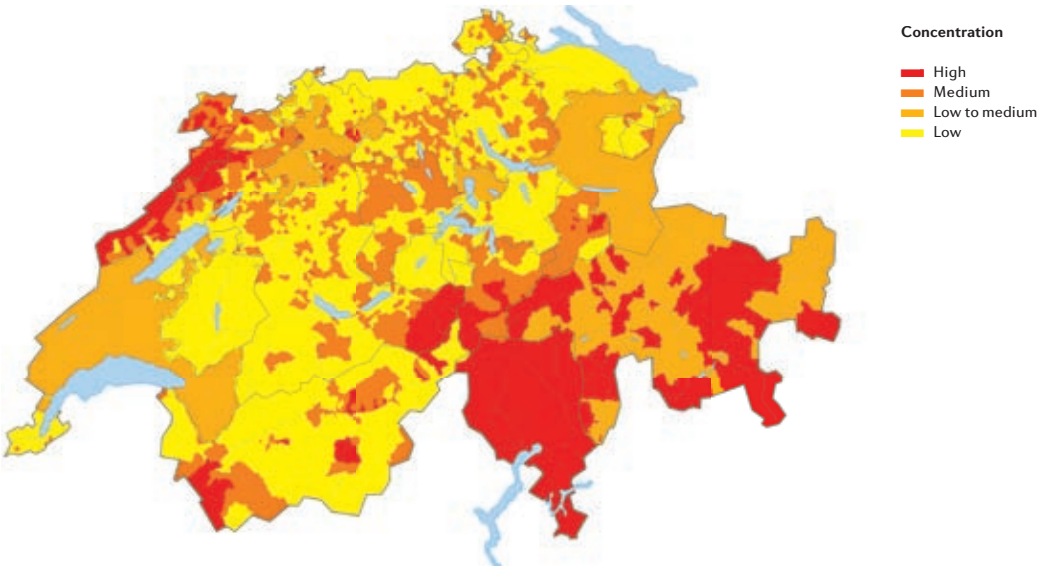
Other risk factors

The development of new technologies such as genetic engineering or nanotechnologies (» Chapter 19) also involves health risks that have not yet been evaluated. For instance, the repercussions on health of consuming genetically modified organisms are still unknown.

Health protection measures

Human health is a priority environmental policy issue in Switzerland. Protecting people against harmful effects – excessive exposure to noise, dangerous substances and organisms, non-ionising radiation and air pollution – is an established objective of environmental legislation. The Environmental Protection Law (LPE) defines the impacts that could harm the environment and human health, under the precautionary principle. Preventive measures must be taken to reduce these impacts. In addition, the Federal Council issues ordinances with the threshold immission values applicable for assessing harmful effects on the basis of the latest scientific knowledge. In doing so, it also takes account of the effect of immissions on particularly sensitive categories of persons. The FOEN contributes to directing human implication in the environment so as to minimise harmful repercussions on health. »

M17.1 Radon concentration in 2006



Source: FOPH

› In the 1990s, the World Health Organization (WHO) advocated establishing an action plan for health and the environment in Europe (» WHO 1994). Its main components were the drawing up of national action plans and the definition of priority sectors for public health and environmental protection. Switzerland's action plan for the environment and health (» FOPH 1997) systematically addresses interactions between the environment and health and encourages research and the coordination of the various federal and cantonal sectoral policies in the field of environmental health. As part of the Confederation's budget cutbacks, implementation of the action plan that gave priority to children's health and the environment will be discontinued.

Systematic long-term monitoring of the impact of environmental health determinants should be established because data about environmental health is currently lacking or incomplete, especially as regards chronic exposure of the population to low concentrations of pollutants. •

III. Trends and outlook

General trends are outlined on the basis of an assessment – developed in Parts I and II of the report – of the changes that are likely to threaten human beings and the environment.

At national level, Switzerland has already taken numerous measures to limit environmental damage; but as this damage does not stop at our borders, an overview is provided of Switzerland's involvement at international level.

New technologies present opportunities that should be seized, but they may also have harmful repercussions on our environment that must not be ignored.

Finally, Part III goes beyond thematic distinctions to look at socio-economic and spatial perspectives and the environment.

18. Global ecological problems and Switzerland's commitment

Global ecological problems are an increasing threat to our habitat and our planet. Pollution knows no borders, and competition standards should be more equitable. Countries have no choice but to take action together.

Switzerland is committed to drawing up a global environmental policy and to strengthening international environmental governance. Moreover, it has to meet the commitments undertaken in global environmental agreements.

Global environmental issues

Context

With its emphasis on a comprehensive, consistent strategy, the 1992 Rio Earth Summit marked a crucial step forward in global environmental policy. Economic and social development must be based on sustainable use of natural resources and must not jeopardise the natural basis for life of future generations. The international community confirmed this concept and give it concrete shape in an Action Plan, known as Agenda 21[1]. The Earth Summit also paved the way for adoption of the Convention on Biological Diversity[2], the Framework Convention on Climate Change[3] and the Convention to Combat Desertification[4].

This Summit had considerable political and institutional repercussions. During the 1990s, environmental policy became a major field of foreign policy activity.

The Millennium Development Goals formulated at the UN Millennium Summit in 2000 confirm the need for ensuring a sustainable environment. This concept covers access to clean drinking water for poor population groups and demands the inclusion of environmental issues in all sectoral policies. These Goals oblige donor countries, including Switzerland, to do more to join forces on resolving the major problems of development.

The latest conference to date was the Johannesburg Summit on Sustainable Development, held in 2002, and the execution of sustainable objectives was adopted in its Action Plan.

In the UN system, the new international political situation also augments the importance of issues related to security, good governance and poverty reduction. This also means stronger backing for the need to aim for sustainable development and for international environmental protection efforts. Pursuing development and implementing international governance in the environmental sector are particularly important because none of the world's major ecological problems has been resolved to date.

Global ecological problems

The best-known problem that affects Switzerland very directly is climate change (» Chapter 8). Research regularly produces new findings that confirm the changes affecting the world's climate system. Analysis of gases trapped in ice has shown that the concentration of greenhouse gases in the atmosphere has never been so high for 650,000 years.

[1] www.un.org » Welcome » Economic and Social Development » sustainable development, human settlements and energy.
[2] Convention on Biological Diversity. Signed in Rio de Janeiro on 5 June 1992. RS 0.451.43.
[3] United Nations Framework Agreement of 9 May 1992 on Climate Change (with annexes), RS 0.814.01.
[4] United Nations Convention to Combat Desertification in those countries experiencing serious droughts and/or desertification, particularly in Africa. Signed in Paris on 17 June 1994, RS 0.451.1.

Some climate models also indicate that the Earth – and in particular its oceans – are now absorbing more energy than they emit. As a result, there could be an even sharper increase in the number of extreme meteorological events than was previously feared (» UNEP 2006).

Greenhouse gas emissions are continuing to rise worldwide, and the reduction efforts of countries that have ratified the Kyoto Protocol[5] are not enough to halt global warming.

Other problems on which progress to date has not been adequate have undeniable effects on Switzerland. It has, however, been possible to reduce the use of substances that deplete the ozone layer, in order to lessen the threat to stratospheric ozone (» Chapter 9). The decline in biodiversity (» Chapter 12) is continuing, although the protected areas on continents and in territorial waters are growing steadily (15 %). Finally, dangerous chemical products remain a real threat (» Chapter 4), and the deforestation problem remains as acute as ever.

Switzerland's commitment

Overview

Switzerland pursues an active, committed foreign policy on the environment, for which the FOEN is responsible under its Federal Constitution mandate[6] (articles 2 and 73). This work is also directed by the need for any coherent foreign policy to include the environmental aspect. In its November 2000 report on foreign policy (» Federal Council 2000), the Federal Council made environmental foreign policy one of the five priority fields of Swiss diplomacy, thus confirming the objectives already set in its 1993 report (» Federal Council 1993). Environmental policy is gaining in importance in the area of security strategy in particular, because ecological hazards are a weighty factor.

Incorporating environmental policy into the Federal Council's foreign policy priorities has enabled Switzerland to resolutely defend its interests, both at political and technical level. Its political strategy focuses in particular on three activities: negotiating legal instruments, strengthening these instruments and the institutions concerned for solving environmental problems.

Legal instruments

Basically, diplomatic issues in connection with the environment are discussed within the framework of negotiations in which many countries participate (multilateral negotiation process), most of them members of the UN system. For one thing, the negotiations conducted are strongly influenced by large groups of countries like the EU or the Group of 77 (developing countries), and by the United States of America. For another, Switzerland can take an independent stance, just like the other groups of countries involved. By forming its own negotiations group with the other OECD countries, Switzerland has been able to wield the political presence needed to have its objectives accepted, particularly during the decisive phase of final negotiations.

Reinforcement of the international environmental system

Switzerland participates in developing international environmental policy in most of the international organisations involved in the environment and sustainable development. These include the United Nations Environment Programme (UNEP), the UN Commission on Sustainable Development (CSD), the UN General Assembly (Second Committee) and various European forums such as the UN Economic Commission for Europe (UNECE).

Switzerland is lobbying for strengthening the UNEP to make it the central body for the international environmental system. The aim is for the environment to speak with a single voice in the chorus of different political demands. The consistency of the policy and solutions aimed at is particularly vital, given the large number of conventions and protocols and the broad range of competencies and decision-making structures. A first milestone was reached in this field with the decisions taken at the Global Ministerial Environment Forum (GMEF) held in Cartagena (Colombia) in 2002. Switzerland stresses the need for effective implementation of these decisions, in particular improving UNEP's financial basis, making each UN member country a member of this programme and strengthening UNEP's role in policy organisation activities. Switzerland would also like UNEP to adopt a list of key global environmental objectives, to boost the importance and profile of international environmental policy by analogy with what has been achieved with the Millennium Development Goals.

From this point of view, Switzerland's efforts to make Geneva an "international capital" are also very important. Basing the secretariats of the chemical Conventions in Geneva (» Hazardous chemical products and waste, page 120) has made it possible to group several international environmental organisations there.

Finally, Switzerland has also fought for better account to be taken of UN work in the regions – especially in the UNECE – by the international bodies of the UN system. Specifically, biannual UN regional conferences could, for instance, discuss the results obtained and any gaps still noted in application of the Johannesburg decisions and of the Action Plan. Their findings would then be forwarded to the UN Secretariat in New York.

Convention on Climate Change

Climate change (» Chapter 8) dominates the debate about the world's environment. At international level, Switzerland is committed to strengthening the existing instruments, i.e. the UN Framework Agreement on Climate Change (» Global ecological problems, page 118) and the Kyoto Protocol. We want to see consistent implementation of the commitments undertaken by the industrialised countries under this Protocol, which came into effect in 2005 and was ratified by Switzerland in 2003. The greenhouse gas emission reduction targets to which the industrialised countries committed must be reached by 2012 at the latest (initial »

[5] Kyoto Protocol of 11 December 1997 to the United Nations Framework Convention on Climate Change (with annexes), RS 0.814.011.

[6] Federal Constitution of the Swiss Confederation of 1 April 1999, RS 101.

› commitment period). For the next commitment period, i.e. after 2012, effective extension of the Kyoto Protocol has to be negotiated, and during these next negotiations, it will be important to incorporate the emerging major economic powers, such as India and China, as well as the United States and Australia into the international system of climate rules. Moreover, Switzerland ensures that the negotiated solutions do not clash with the efforts made in other environmental fields. For instance, climate policy must not threaten biodiversity.

Convention on Biological Diversity

It has not yet been possible to halt the decline of biodiversity that has been observed worldwide (» Chapters 12). A Johannesburg Summit decision calls for a significant reduction in loss of biodiversity by the year 2010, but, though realistic, this objective is not easy to achieve. The principle of using biodiversity for agricultural or pharmaceutical research is not called into question. However, as not all countries have a comparable degree of biodiversity, the issues of access to genetic resources and the sharing of the benefits are addressed in the Convention on Biological Diversity[7] and the Cartagena Protocol[8]. As the Convention does not provide for binding measures in this connection, these matters were dealt with in the Bonn Guidelines[9], on Switzerland's initiative.

Hazardous chemical products and waste

The introduction of sound, consistent environmental regulations for hazardous chemical products and waste is one of Switzerland's foreign policy priorities. In recent years, this system has been strengthened largely due to Switzerland's efforts. In order to guarantee a comprehensive, coherent approach on chemical products and waste at international level, our country has made a major contribution to the negotiation process launched in 2003 to develop the Strategic Approach to International Chemicals Management (SAICM). The SAICM was adopted early in 2006 and comprises a strategy and a plan of action. A Quick Start Programme to which Switzerland is contributing CHF 3.1 million was approved for implementing this strategic approach. This amount is earmarked for creating the institutions necessary for SAICM application in four developing countries. The SAICM Secretariat is based in Geneva.

Within the framework of the Basel Convention[10], a direct partnership with industry was launched on Switzerland's initiative in connection with the electronic waste generated by the disposal of mobile phones. Since then, this subject has been built into the Convention's work programme. The Rotterdam[11] and Stockholm[12] Conventions have also just come into effect.

With a view to reinforcing synergies and consistency within the international system of rules for chemical products and waste, Switzerland is lobbying in favour of even closer linkage between the Basel, Rotterdam and Stockholm Conventions under the leadership of one person.

Ozone layer

Protection of the ozone layer is based on two multilateral treaties: the Vienna Convention[13] signed in 1985 and since ratified by 190 countries, and the Montreal Protocol[14] signed in 1987 and since ratified by 189 countries (» Chapter 9). Switzerland ratified these treaties in 1987 and 1988 respectively, as well as the four amendments to the Montreal Protocol. From the outset, Switzerland has played an active role at diplomatic level, and its development and cooperation work on drafting and implementing these treaties gives priority to taking comprehensive and non-sectoral account of the environment. In particular, it has lobbied for choosing alternatives to substances that deplete the ozone layer so as to minimise environmental impacts, such as climate change, as far as possible.

Forests

Forestry policy does not yet have effective international instruments. There is no convention on protecting forests. At the UN, forestry issues are debated within the framework of the United Nations Forum on Forests (UNFF) but, so far, definition of a clear procedure has not been possible. For Switzerland, the technical work done is therefore all the more important: the encouragement of economic instruments (for instance the certification of timber from sustainably managed forests) is one of the main contributions to rational use of forests. Switzerland has worked actively on the forestry dossier as part of other processes and organisations, in particular with the United Nations Food and Agriculture Organization (FAO), the Convention on Biodiversity (CBD), the Framework Convention on Climate Change (UNFCCC) and the International Tropical Timber Organization (ITTO), whose task is to promote sustainable trade in tropical timber. In 2006, the ITTO adopted a new mandatory basic Agreement that takes greater account of ecological criteria.

Water

The International Year of Freshwater 2003, launched by the UN, provided an opportunity to support initiatives for sustainable use of this resource. In particular, they focused on the development by all countries of integrated water-resource management plans by 2005, in line with the Johan-

7 Convention on Biological Diversity. Signed in Rio de Janeiro on 5 June 1992. RS 0.451.43.
8 Cartagena Protocol of 29 January 2000 on preventing biotechnological risks in respect of the Convention on Biological Diversity (with annexes), RS 0.451.431.
9 Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising out of their Utilization.
10 Basel Convention of 22 March 1989 on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (with annexes), RS 0.814.05.
11 Rotterdam Convention of 10 September 1998 on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC Convention, with annexes), RS 0.916.21.
12 Stockholm Convention of 22 May 2001 on Persistent Organic Pollutants (POP Convention, with annexes), RS 0.814.03.
13 Vienna Convention of 22 March 1985 on the Protection of the Ozone Layer (with annexes), RS 0.814.02.
14 Montreal Protocol of 16 September 1987 on Substances that Deplete the Ozone Layer (with annex), RS 0.814.021.

nesburg Summit objectives. The ecosystem approach to water-resource use is a further example. The protection of whole ecosystems is crucial for hydrologic regimens, and compensation measures are being looked into for those who contribute to protecting such ecosystems.

Consumption
Sustainability criteria have to be applied more to the production and consumption of goods and services. Switzerland supports the Marrakech Process, which grew out of the Johannesburg Summit and creates a framework for international efforts. The instruments available – integrated policy on production, consumption that complies with sustainability criteria, labels and certification – must be supported (» Chapters 1, 4 and 5).

Air protection
In cooperation with 47 other European countries, the United States of America and Canada, Switzerland plays an active part in the UNECE Convention on Long-Range Transboundary Air Pollution[15] in order to reduce emissions of pollutants responsible for acidification, eutrophication, ground-level ozone and breathable fine particles, as well as heavy metals and persistent organic pollutants. As air pollution knows no borders, it must be ensured that concrete commitments are also taken in neighbouring countries so as to diminish polluting concentrations and deposits in Switzerland. Eight Additional Protocols to the Convention have been adopted, and the obligations they contain are implemented by the parties thereto.

Funding/technical cooperation
Implementing international and regional environmental conventions calls for investment and for the creation of both technical and organisational capability. This international cooperation can take bilateral or multilateral forms. Switzerland provides part of its contribution under the head of programmes managed by the Swiss Agency for Development and Cooperation (SDC) and the State Secretariat for Economic Affairs (SECO). It also pays a periodic contribution to the Global Environment Facility (GEF), which was set up in 1991 and finances projects in developing or transitional countries, one prerequisite being that the projects directly benefit the world environment – for instance by protecting the biodiversity of tropical forests or combating desertification. In particular, the GEF strives to promote the major conventions on climate change and biodiversity. Support is also given in other fields[16], specifically for international waters, combating desertification, persistent organic pollutants and protecting the ozone layer. Switzerland has a seat on the GEF's executive board and can therefore actively influence GEF policies.

GEF is funded by the donor countries. The third instalment (2003–2006) totalled USD three billion, and Switzerland contributed CHF 100 million. This sum was approved by the Swiss Parliament in 2003, in the form of a framework credit. At the same time, Swiss environmental protection legislation was supplemented by an article that laid the legal foundation for future credits and contributions to international environmental funds (article 53a LPE). Discussions about the fourth replenishment of GEF funds should be completed in 2006.

The Multilateral Ozone Layer Protection Fund was established in 1990 to provide developing countries with the necessary technical and financial assistance to implement the Montreal Protocol. By the end of 2005, it had enabled the funding of over 5,000 projects in 139 countries to the tune of nearly USD two billion. From 1996 to 2000, Switzerland sat on the Multilateral Fund's Executive Board. Its contribution to the Multilateral Fund for 2006 to 2008 totals CHF 2.47 million per year (1.5 % of the total budget), and for more than ten years, it has also been participating bilaterally in implementing projects to replace substances that deplete the ozone layer in certain developing countries.

Reinforcing environmental aspects in institutions
Environmental problems also concern financial organisations and institutions in which other issues have priority (for instance the OECD, the World Trade Organization [WTO], the WHO, development banks, FAO and the UNDP). Incorporating ecological aspects into other sectoral policies is designed to promote the automatic inclusion of environmental policy considerations in the decision-making of these organisations. The results obtained, by development policy in particular, must be compatible with the environmental policy objectives and secure progress already made in the long term. To guarantee consistency at national level, the FOEN, SDC and SECO maintain close contacts within the federal administration.

This consistency is also a Swiss trade policy objective, and it is thanks to Switzerland that the issue of the link between international trade and multilateral environment agreements was tabled at the WTO. Our country favours an approach where measures destined to protect the environment that impact on trade are taken into account in multilateral agreements on the environment. These measures must, however, in no way be discriminatory or protectionist. At the same time, Switzerland believes that the WTO's central principles, such as non-discrimination, should not be redefined in the environmental agreements because this question clearly comes within the WTO's purview.

Integration and European cooperation
As part of its negotiations with the EU (Bilateral II Negotiations), Switzerland joined the European Environment Agency (EEA) in April 2006[17], thus acceding to a European network of experts as well as to information about the status of the Swiss environment compared with that of other »

15 Convention of 13 November 1979 on Long-Range Transboundary Air Pollution, RS 0.814.32.
16 www.gefweb.org
17 Agreement of 26 October 2004 between the Swiss Confederation and the European Community on Switzerland's participation in the European Environment Agency (EEA) and in the European Environment Information and Observation Network (EIONET, with annexes), RS 0.814.092.681.

› European countries. The EEA has an information and environmental observation network and provides the key data needed to define European environmental policy. Thus, Switzerland benefits from additional information for its national environment policy decisions, as well as from important data for its international commitment.

The EU's expansion eastwards has radically altered the continent's political architecture, and this has also had repercussions on European cooperation in the environmental field. The Environment for Europe process emphasised Central and Eastern Europe during the 1990s but has shifted its attention to other regions, now that eight Eastern European countries have joined the EU. Following the Kiev Conference of Environment Ministers in 2003, the countries of the former Soviet Union have become its priority. Environmental policy in these countries requires support in different fields through cooperation programmes that are financed both by bilateral donors, such as Switzerland and the EU member countries, as well as by international organisations (UNEP, UNECE).

However, UNECE activities are not just confined to environmental cooperation. It also manages the secretariats of five European agreements in the following fields: water, industrial waste, transboundary atmospheric pollution, environmental impact assessment (EIA), as well as environmental information and public participation in environmental decision-making, thus making a major contribution to pan-European cooperation.

At European level, the initiative of the EU and of the European Space Agency on Global Monitoring for Environment and Security (GMES)[18], approved in 2001, is designed to rationalise European activities and resources with regard to Earth observation. The system makes it possible to provide reliable, independent information about the environment and security to the public sector, European research scientists and – from 2008 – to private industry. Through its membership of the European Space Agency, Switzerland is participating in GMES development. •

18 GMES: Global Monitoring for Environment and Security: **www.gmes.info**

19. New technologies and risks

New technologies offer a wide range of applications and opportunities. They may also be beneficial and useful to the environment.

On the other hand, they may have harmful consequences, and their impact on people and the environment are largely unknown.

In the face of this uncertainty, public debate on and assessment of these risks is necessary. We have to know the risks involved in the new technologies, such as nanotechnology, and take appropriate precautionary measures for their safe use.

New technologies

New technologies, such as UMTS (Universal Mobile Telecommunications System) and nanotechnology, have opened up areas with enormous application potential and can be both beneficial and useful for the environment (for instance, through more sensitive use of resources thanks to new materials that economise on raw materials or energy and generate less waste). However, they can also have harmful repercussions because their impacts on people and the environment are largely unknown. Research bases and experience are lacking or incomplete. For instance, we are not able to predict the impact of advances in biotechnology and genetic engineering on human health, biodiversity and the cohabitation of species. However, public mistrust and rejection of new technologies is mainly due to uncertainty about the scale and probability of possible damage. Consequently, the potential and limits of all new technologies must be ascertained, and their advantages compared with any risks incurred. The Centre for Technology Assessment (TA-SWISS) evaluates the consequences of new technologies, for instance in biomedicine or information technologies, conducting scientific studies and presenting new technologies, their application, development prospects, disadvantages and risks (» TA-SWISS, 2006).

Risk acceptability

A "risk society"

In industrial societies, considerable progress has been made on security in connection with natural hazards (» Chapter 14), but technological development has also triggered new risks that can be ascribed to human activity. However, as for natural hazards, exposure to such risks is generally independent of individual choice.

New and confirmed risks

Natural and technological risks are becoming better and better known. This makes it possible to update existing preventive measures and develop new, more technically and financially effective ones. The new risks include major technological risks such as an explosion on an industrial site or the contamination of a river by chemicals. However, there are other categories of risk which require close supervision, such as health and food risks. Air and soil pollution also constitute threats because the accumulation of pollutants around us can affect the food chain. But knowledge about such risks is often still quite fragmentary, and research is needed to identify better preventive measures. The Federal Council has launched a programme of research into the effects of electromagnetic rays generated by mobile phones »

› or broadcasting on health and the environment (NRP 57 » Chapter 2). Evaluation of the consequences of new technologies and research into risks needs to be improved. Technological progress cannot contribute to a better future if it jeopardises our safety.

The inherent uncertainty of new technologies

New or emerging technologies such as genetic engineering and nanotechnologies are creating even greater uncertainty. Experts term these risks "potential". For instance, the scale of the threat to human health and the environment from the spread of genetically modified organisms (GMOs) is still largely unknown, even if it is taken very seriously. Thus, the new Gene Technology Law (GTL) obliges GMO users to take all the necessary precautions to avoid undesirable mixes (» Chapter 6). To fill this gap, the FOEN and the Swiss National Science Foundation are financing research projects in the area of biosafety. In the face of this uncertainty, the Environmental Protection Law (article 1, paragraph 2) provides application of the precautionary principle as a fundamental point of reference, the aim being to manage risks in a conscientious, responsible way while remembering that there is no such thing as zero risk (» FOEN 2006b). The LPE authorises the State to take measures to reduce any potential damage to people and their environment. Having said this, in practice, the conditions for applying this principle remain controversial. The debate on the five-year moratorium on the agricultural production of GMOs – the period approved by the Swiss electorate in November 2005 – perfectly illustrates this situation.

The work of the Centre for Technology Assessment (TA-SWISS) is used by Parliament and the Federal Council for advance scientific and technological assessment of the uncertainty inherent in the new technologies.

Risk perception and ethics

The development of human societies is inseparable from the use of technology and the interaction between it and nature. In this context, it is impossible to eliminate dangers altogether. The problem is therefore to know under what conditions a risk becomes acceptable. A distinction should be made between two aspects of the question: perception of the risk, and ethical reflection on it. Studies have revealed a significant divergence between the apprehension of dangers by the general public and the actual risk. The potential risk of new technologies is generally overestimated, and everyday risks, such as the dangers of traffic in particular, are underestimated. The more distant an event is in time or space, the less people are likely to associate it with risk. Awareness of danger is also heightened if it is imposed on the individual by outside forces or deliberately chosen (spreading of GMOs in the environment compared with using mobile phones, for instance). These few observations show the importance of communication and dialogue among all stakeholders: the scientific community, economic circles and civil society. Similarly, the development of procedures for grass-roots participation in technological choices is of prime importance.

Ethics is an essential part of the debate. It strives to ascertain the conditions under which it is morally acceptable to expose oneself or others to risk, thereby providing reasons for justifying or prohibiting certain actions that are potentially dangerous for the public or the environment. At present, the FOEN is encouraging such reflection as part of a biosafety research programme, more specifically with respect to gene technology in the non-human sector, which will also be useful for the ethical evaluation of risks in other fields.

Nanotechnology as an example of new risks

At the intersection between physics, chemistry, bioengineering, medicine, IT and materials sciences, nanotechnology makes it possible to manipulate or produce material surfaces and structures with sizes ranging between a few atoms and approximately 100 nanometres. To do so, it uses specific physical or chemical properties that are not visible on a larger scale. Nanotechnology is often regarded as the key technology of the 21st century. All over the globe, private companies and public authorities are investing billions in nanotechnological research and development (» TA-SWISS 2006). For its part, Switzerland is conducting intensive research under the national "Nanosciences" research focus. At the same time, the revenue expected from this field is rising steadily.

These expectations are explained by the wide spectrum of possible applications which could also impact positively on environment and health in several respects, such as:

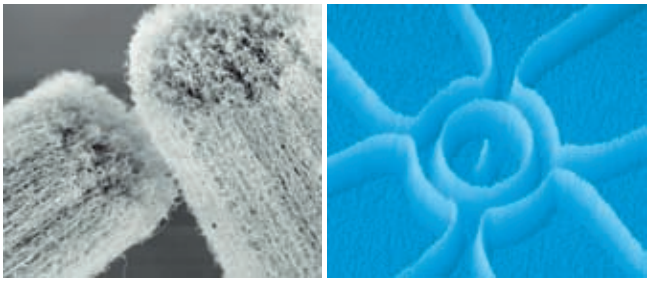
- More efficient materials (e.g. use of less platinum in catalytic converters)
- Greater energy efficiency (e.g. lighter materials resulting in energy savings during transport, or reduced axle friction in machines)
- Substitutes for toxic substances (e.g. replacement of heavy metals in electronics)
- Pharmaceutical applications (e.g. better administration of active substances in cancer treatment)

However, nanotechnology may conceal risks. What is harmless at micrometric scale may become dangerous in the form of nanoparticles. Basically, there are fears about risks to health and the environment as a result of using synthetic nanoparticles. It is early days for studies on the health-related and environmental consequences of these technologies. The fact that there are many questions still to be answered shows the importance of research into the risks. What are the main sources of nanoparticles? How do they behave in the environment and how can they be measured? Which properties determine whether nanoparticles are absorbed by human beings and how toxic are they? What mechanisms do they use to obtain effects in organisms? Can they accumulate in food chains?

At present, no country has specific regulations on nanotechnologies. For its part, the EU is following the action plan for 2005–2009 entitled "Nanosciences and nanotechnologies" (» EU 2005). It also provides for risk assessment and risk prevention measures. Moreover, test methods and

F19.1 Nanoparticles: realm of the infinitely small

Carbon nanotubes – stronger than steel (left)
Circular nanostructures (right)



Sources: Professor C. Schönenberger, Nanosciences NRP, Basel University, Professor K. Ensslin, Nanosciences NRP, FITZ

strategies for danger and risk assessment are also the subject of intensive debate in the OECD. In Switzerland, a committee of experts has been set up to coordinate national and international risk assessment and management work. It has also been charged with proposing supplementary measures. The Swiss action plan will be implemented between now and 2009, and the main areas covered are:

- Establishing an overview of the use of nanoparticles in Switzerland and preparing scenarios of exposure to these particles (comparison with the current situation as regards ultrafine particles, such as diesel soot)
- Coordinating and facilitating dialogue between the various interest groups concerned: the general public, political circles, research, government and economic circles, including investors and insurance companies
- Establishing the scientific groundwork needed to evaluate dangers and risks
- Drawing up definitions, measurement methods and validated test procedures for assessing dangers and risks, in cooperation with the OECD, the EU and the International Organization for Standardization (ISO)
- Encouraging the development and application of self-regulatory measures by research and industry
- Adapting legislation as necessary to guarantee safety
- Implementing of immediate measures designed to protect people employed in industry and research •

20. Socio-economic and spatial outlook for Switzerland

Switzerland is becoming increasingly urban and mobile. The major cities (Zurich, Geneva, Basel) are growing at the expense of the peripheral areas, thus causing regional imbalance. Some regions now have what amounts to a recreational function (tourism areas in the Alps).

These changes aggravate pressure on the environment, as well as demand for resources such as clean air, water, land, tranquillity and energy.

Over the next 15 years, the challenge for resource policy will be to overcome the apparent contradiction between environmental protection and the economy, in order to conserve and use natural resources in a sustainable fashion.

All the considerations set out in the previous chapters, as well as spatial changes, and economic and geographic trends, make it possible to outline Switzerland's environmental perspectives, and define the necessary measures.

Developments and outlook

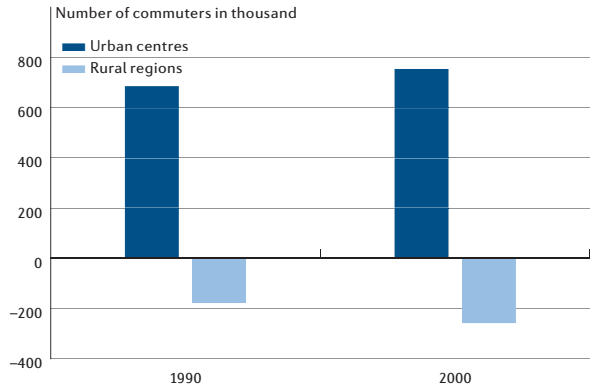
Spatial development

In recent decades, Switzerland has been characterised by the phenomenon of urbanisation, with the percentage of people living in cities rising from 36 to 73 % between 1930 and 2004. Conurbations (» M20.1) and subsequently – through expansion and interdependence – metropolitan areas (Zurich, Basel, Geneva-Lausanne, Berne and Ticino-Milan) have grown and become the country's economic drivers. Increasingly, the impetus of urban growth is transcending institutional borders, be they regional, national or international. Some conurbations develop dynamic transnational links, with the result that urban sprawl is eating into the countryside, leading to the imperceptible rise of an intermediate territory neither urban nor rural, and without a clear, distinctive character. The different factors mentioned generally include the growing division of labour at international level[1], the increasingly pronounced concentration of services in urban centres, and rising mobility (» FSO 2005f).

Spatial disparities (particularly in terms of growth) tend to become greater, with development concentrating mainly in urban centres and their immediate vicinity, which act as focal points for growth of new activities. The phenomenon of metropolisation triggers a geographical concentration of wealth, skilled jobs and higher education, as well as of their associated lifestyles. For instance, in 2001, built-up areas accounted for 82 % of jobs in the secondary and tertiary sectors. In contrast, peripheral regions are declining, losing their inhabitants and becoming poorer. They are thus at risk of becoming marginalised in the face of the strong resolve of the urban centres to obtain recognition of their role as economic drivers (» FSO 2007b).

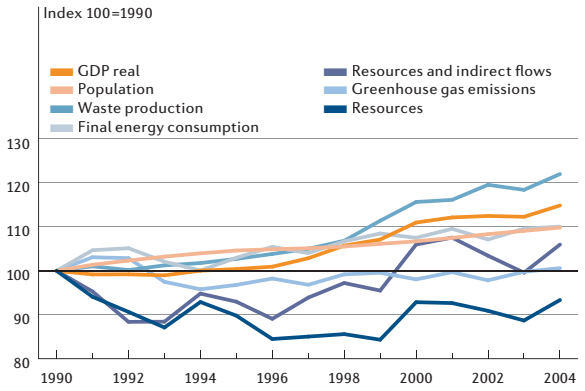
[1] This refers specifically to the physical international division of labour, in which the stages leading to the finished product are specialised and located in separate regions to increase productivity.

G20.1 Commuter balance sheet: agglomerations versus rural regions



Source: FSO

G20.2 Uncoupling between economic growth and use of resources



Source: FSO, FOEN, FOE

At the same time as urban sprawl, the development of leisure pursuits and, above all, functional geographical segregation (separation of home and work) are generating a marked rise in mobility and commuting. The big conurbations have strengthened their role as convergence zones, with an increase in the number of commuters. This development leads to rising mobility and further reinforces urban sprawl. Between 1970 and 2000, the percentage of employed people who worked outside their home commune rose from 31 to 58 % (» G20.1).

Differing financial capacity and tax levels between the cantons also generates geographical disparities, not just between the centre and the periphery, but also between language regions.

Social segregation phenomena are more pronounced in large cities, with disadvantaged groups usually living in particular inner-city areas, while wealthier people prefer to live in the nearby "countryside". However, there is also a desire to upgrade urban centres, allied with a tendency to return to the cities, with the result that social status[2] is particularly high in the outer suburbs of major conurbations (» M20.2) and lower in the residential districts of major cities, as is also the case in regions with no economic centres (» FSO 2005g).

The countryside provides quality residential areas, places for recreation, land for farming and forestry, and a tourist attraction. It is also home to flora and fauna and is the main resource of rural areas. It consists of landscapes that humans have cultivated and shaped over centuries. When the use of these regions alters, landscape and environmental diversity change too. Over the past 50 years, economic and social upheavals involving rapid change have had a particularly radical effect. For rural areas, development of the landscape can be summarised as follows: greater expanses of denser forests, receding farmland and less landscape diversity, expanding urban areas (» Chapter 12). However, not all rural areas are affected equally, with use intensifying in favourable regions while use of peripheral or less viable areas (such as barely accessible mountain regions) is being dropped.

These trends trigger regional imbalances and are incompatible with sustainable management of natural resources, including landscape management. This results in fragmentation between home, place of work and leisure, and increased use of land (more living space per person, more space reserved for transport etc.) consequently produces a growing demand for resources such as soil, energy, water, clean air and tranquillity.

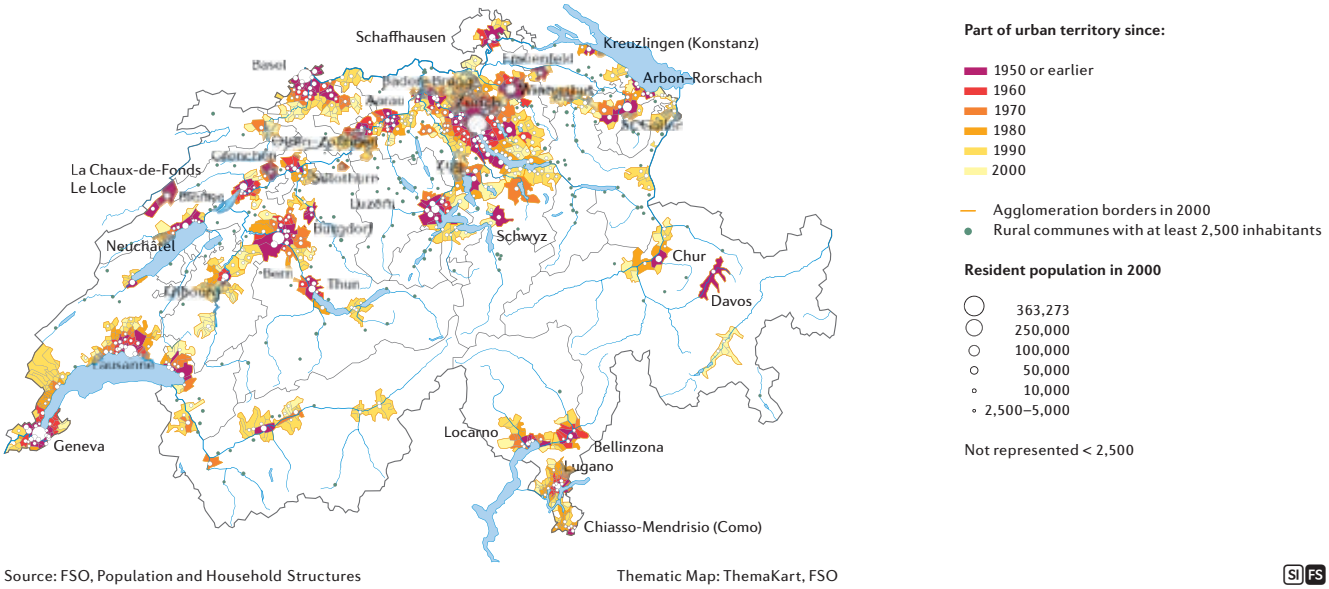
Demography

Over the next 15 years, demographic growth is expected to continue, with the Swiss population increasing from its present 7.4 million residents to 8 million in 2020, according to the scenario based on current trends. Without immigration, the population would stabilise at slightly under 7.6 million inhabitants, and start falling from 2015. With strong migration, a higher increase up to 8.5 million people is also conceivable (» FSO 2006d). Declining fertility over the past 30 years, in conjunction with increased mortality due to the population's age structure, are already causing an excess of deaths in the population who are Swiss nationals. Although births still outnumber deaths over Switzerland's total population, this is due to the foreign population.

Longer life expectancy and the population's current age structure will accelerate the ageing of the population over the next 20 years (even assuming fertility rises slightly again). Thus, the number of people of the third or fourth age will increase faster and faster. The working-age population will start declining from 2019, and its average age will rise. »

[2] Definition in the map. The Social Status Index is calculated on the basis of level of education, professional standing and net income. The population groups considered are people aged 25 and over, people in employment and taxpayers. (Source: SFO 2005g).

M20.1 Urban areas and rural communes with 2,500 inhabitants or more in 2000



Source: FSO, Population and Household Structures — Thematic Map: ThemaKart, FSO

› The trend towards smaller households, as well as changing lifestyles and family models, is also expected to continue in the years ahead. While there are admittedly no grounds for assuming that the present changes will continue in linear fashion, in the medium term at least, the size of families will decrease and the number of couples without children, single persons and one- or two-person households will increase.

International migratory flows will continue to rise, causing growing integration and acceptance problems for the host countries. UN experts estimate that, over the next decades, net migration to the more developed regions of the world could increase to 2.2 million people a year (» UN 2005). In future, intercontinental migration towards countries in the northern hemisphere, and hence to Switzerland, will probably grow.

Economy

There are several economic forecast scenarios that depend on various factors, such as international economic growth (Switzerland is an exporting country), the political environment and technological development. The scenario used by the Federal Administration forecasts average long-term economic growth of 0.9 % per year (» SECO 2005). This means that economic benefits in 2020 would be 19 % greater than in 2006, so that one fifth more would be available for consumer spending.

An important structural change towards a service society is taking place in the Swiss economy. International distribution of work results in the export of many kinds of production with a considerable ecological impact. Services that affect the environment less, such as financial services, are becoming even more important (» Chapters 1 and 4). However, it is not yet possible to say whether this trend will continue in the long term. It amounts to environmental load transfer to other countries. Grey energy, or the indirect flows linked to imports, are constantly increasing (» G1.5 and G20.2) and should be included in global audits. In Switzerland, many industries are now turning to specialisation and products requiring advanced know-how to ensure they remain competitive on the world market.

Economic growth and use of resources

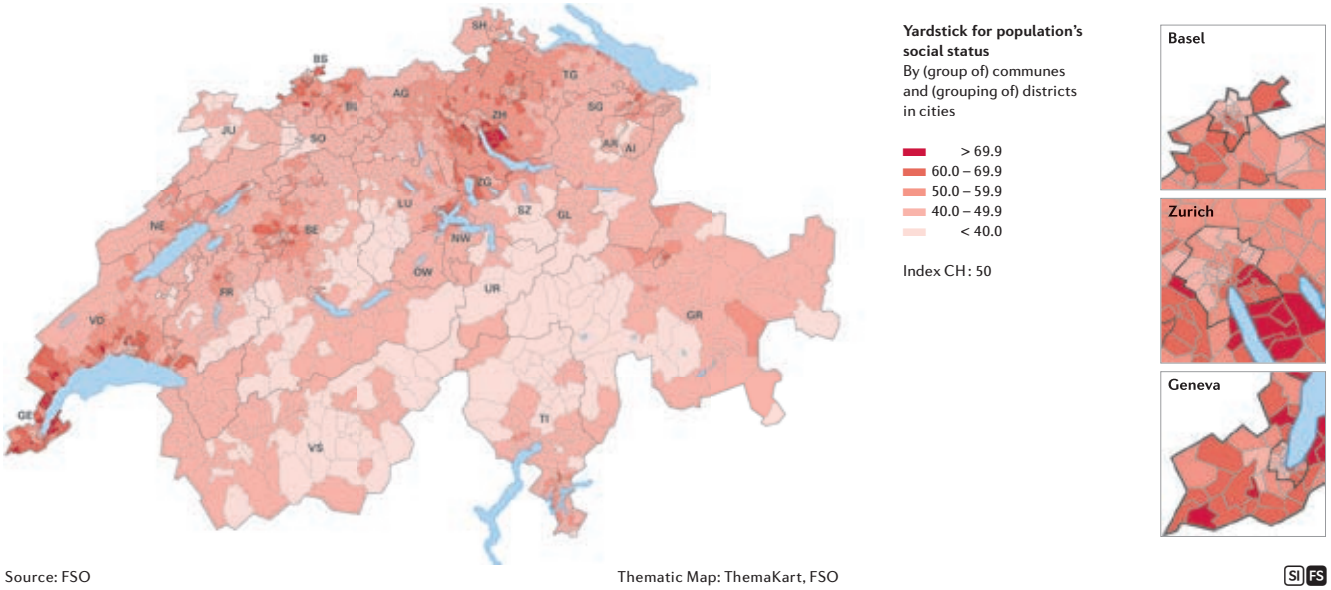
To guarantee a sustainable future for people in Switzerland and for the planet as a whole, the economy should expand, while reducing the overall consumption of resources and pressure on the environment. So it is absolutely essential to uncouple economic growth from consumption of resources and environmental impacts.

In Switzerland, uncoupling has been observed over the past 20 years (» SAEFL, 2005j), and for materials used directly by our economy, it was total for a brief period (» Chapter 1). When account is taken of the indirect flows generated either in Switzerland or abroad for consumption of materials and energy needed for the production of imported goods, this uncoupling is now only relative. On the other hand, there is no indication that energy consumption and economic growth are becoming uncoupled (» G20.2). Investigation of environmental impacts is more positive, with a relative uncoupling emerging for greenhouse gas emissions, for instance (» Chapter 4), and a total uncoupling from emissions of atmospheric pollutants, although immission threshold values are still commonly being exceeded in this area (» Chapter 7). In contrast, no uncoupling has been observed in waste production (» G20.2).

Other effects and uncertainties

Today's consumption of resources on top of economic and demographic perspectives and developing geographical disparities (»Territorial development, page 129) point to the

M20.2 Social status in Switzerland, 2000



Source: FSO
Thematic Map: ThemaKart, FSO

difficulties Switzerland will face if the efforts undertaken are not continued and intensified. In addition to demography and the economy, many other factors are involved, including:

- Economic policy, environmental policy and sectoral policies
- Lifestyles with, for instance, the growing number of households, particularly small households, triggering increased consumption (» Chapter 5)
- The availability of technologies and their effective use (technological progress (» Chapter 4)
- Structural change that "tertiarises" the economy, producing a service society (» Chapters 1 and 4)
- Price movements, such as the increase in oil prices (» Chapter 3)

Moreover, our country has a global responsibility towards the rest of the world. Even though tertiarisation of the economy may have positive effects in Switzerland, it may trigger environmental load transfer to other countries (» Chapter 1).

Action needed and room for manoeuvre

Territorial development

At a time when the trend is for growth to concentrate in urban centres, the roles and potential of the country's different regions should be rethought in an effort to seek complementarity. Despite their catch-all name, "rural" regions are comparatively diverse (oriented more towards tourism or farming, mountainous, periurban, industrial etc.) and have their own characteristics that are essential for Switzerland. They have valuable landscape and environmental qualities, as well as being home to the majority of farms and tourist attractions and to numerous small and medium-sized enterprises, many of them specialised (» ARE 2005b).

Among other things, spatial development policy advocates boosting the regions' innovative capability and competitiveness in order to stimulate their economic growth potential. There is a trend towards greater specialisation of the location, promoting the positive use of existing differences, strengths and weaknesses, to develop each region's own identity further.

More marked territorial differentiation should be accompanied with a nationwide networking of urban centres, in particular by optimising accessibility. Revitalising weaker regions depends in particular on their links with the dominant regions. Functional connections between centres and the periphery are also worth rebalancing, as the burdens on big cities (especially in terms of infrastructure and services) often far exceed their institutional limits. Offsetting mechanisms (which already exist in some cases) should be developed or strengthened. Intercommunal, intercantonal and even transnational relations really come into their own in this connection. Clearer territorial differentiation also involves using built-up areas optimally (internal urbanisation), as well as upgrading both towns and peripheral areas.

Rural landscapes should be regarded as an asset and not as an obstacle to economic development. Generally speaking, this means more transverse strategies. Sectoral policies on agriculture and forestry, spatial planning, regional development, natural hazards and protection of nature and the countryside must combine to produce an integrated land-use policy, with objectives suited to the various regions and based on appropriate spatial units.

In view of these requirements, and of the different stakeholders' diverging interests, it is important to intensify dialogue and cooperation between them, as well as between the different sectoral policies. Moreover, informing the public and raising its awareness of the topic of sustainable use »

› of the national territory encourage responsible, environmentally friendly consumption.

The instruments the Confederation has put in place, in particular the new financial equalisation, policy on conurbations, and the new regional policy, are invaluable in working towards national cohesion. The Swiss Landscape Concept (SLC), based on article 13 of the Federal Law on Spatial Planning, emphasises the importance of biological diversity and varied landscapes in the Confederation's sectoral policies. The "LANDSCAPE 2020" guidelines (» SAEFL 2003a) present a situation that is full of contrasts and subject to a wide range of influences and effects. On the one hand, space is being made for nature to develop freely and dynamically in areas where land can no longer be used for economic reasons. On the other, residential developments and land use for farming and forestry adapted to the location must preserve a rich mosaic of cultivated landscapes. The aim is to promote biodiversity and varied landscapes and to avoid uniform combinations of buildings, forests and stretches of land.

Production

Supply (production) – like demand (consumption) – comes into play when the economy grows without increasing the consumption of resources or causing further ecological damage. Increased production is not necessarily linked to more intensive use of the environment (» Chapter 4), but can be achieved through the value of the products rather than by increased quantities.

To date, environmental markets have experienced above-average growth, according to studies conducted at European level (» Eurostat 2005). The outlook is also positive. For Switzerland, domestic environmental markets in the existing sectors have also made faster-than-average progress (» SAEFL 2005i). Thus, companies' material and energy efficiency should continue to increase, but progress will become increasingly difficult as the appropriate measures are introduced. However, it is not known whether or not this improvement will be offset by a rise in the quantities produced.

Consumption

Higher income opens up new possibilities for consumption. However, consumption (including transport and accommodation) conceals extensive potential for environmental damage (» Chapters 2, 3 and 5). Higher income does not necessarily result in greater damage to the environment if the importance attached to ecological issues (demand for environmental commodities) grows too.

In the past, efforts to make consumption more ecological had only a limited effect. The "green electricity" market, for instance, accounts for only 4.6 % of total electricity consumption (» AEE 2005). The same applies to organic produce, which makes up only 4 % of the total food market, although we can assume that it still has high potential for growth (» Richter 2003). Demand for private vehicles tends to favour comfort, safety and power over fuel savings and clean air (» Chapter 3). The substantial improvements in technical efficiency made since 1990 have been almost completely wiped out by the increased weight of vehicles (» FOEN 2006).

Without suitable framework conditions, ecological products cannot prevail in most markets. Admittedly, people who buy "green" products expect benefits, such as healthier eating, lower fuel costs or just a clearer conscience (» Chapter 5). A large number of the positive spin-offs from this ecological consumption do benefit other consumers, as those who buy conventional products also enjoy better environmental quality, in the form of a diversified landscape, cleaner air or greater safety thanks to climate protection. Use of an environmental commodity is often associated with a material disadvantage or loss of comfort, without the organic consumer's environmental situation showing a considerable improvement. Consequently, behaving ecologically is also based on the hope that other consumers will follow suit. This phenomenon is called the "socio-ecological dilemma". As a result, structural corrections are needed, which implies that the costs borne by third parties or even by future generations (external costs) should be taken into account in the price of products (cost internalisation » Chapter 3).

Resources policy

The main challenge of resources policy lies in overcoming the apparent contradiction between environmental protection and the economy, in order to focus its activities on their common goal: conserving and using natural resources. Environmental protection should not be considered as an end in itself but must produce measurable results in terms of impacts. Improved safety (for instance, in terms of natural hazards » Chapter 14), health protection (» Chapter 17), or biodiversity conservation (» Chapter 12), are examples of these results, as is economic performance (long-term conservation and sustainable use of natural resources), and high-quality settled areas. It has also been recognised that it would cost much more not to do anything than to take preventive action. It is estimated that, at international level, the overall costs and risks of climate change will be equivalent to a loss of at least 5 %, or even 20 %, of annual GDP if no action is taken, when the cost of taking action can be kept to 1 % (» Stern 2006). Seen from this point of view, the environment and environmental policy provide essential services, both for the economy and for society, as well as for future generations.

For such values to influence future development, a price should be assigned to the contribution these goods make. There is a tendency to waste things for which we do not pay the true price. Economic instruments make it possible to eliminate the antithesis between environmental protection and the economy, encouraging consumers and companies to reduce environmental impacts where the best results are obtained at the best price. They leave greater room for manoeuvre for the individuals who do not make the legal provisions, while making polluters pay the cost of environmental impacts (» Chapters 3 and 5).

Introducing taxes in line with the polluter-pays principle (» The causality principle, page 59) for waste and waste-

water disposal has improved coverage of the real costs (» G23), without transferring all external costs to the actual polluters. The tax on VOCs (» Chapter 7) and the mileage-related heavy vehicle fee (MRHVF » Chapter 3) have already borne fruit. Nevertheless, environmental costs estimated at between CHF 0 and 21 billion per year are not yet covered (» SAEFL 2005c). Nearly half of prevention and disposal costs are still financed out of fiscal revenue, which in a way is equivalent to subsidising environmental damage.

However, economic instruments are not a panacea. The regulations and agreements reached between government and the private sector also help to put a value on the environment, although consumption of environmental resources cannot be curbed unless explicit efforts are made, by conducting a genuine resources policy. Thus, several European countries have set themselves the objective of cutting their resource consumption by a factor of 2 or 4 over a 20-year period. A policy of this kind, however, is still only in its infancy in Switzerland.

To obtain the results hoped for, any resources policy must be based on reliable knowledge. For instance, the exact effect of the population's geographical distribution on environmental damage is not yet known, nor the role played by the sharing of responsibilities between the Confederation, the cantons and local authorities in resolving the environmental problems that affect certain regions more than others. Research is therefore still necessary, and criteria will also have to be drawn up to encourage sustainable production and consumption models. •

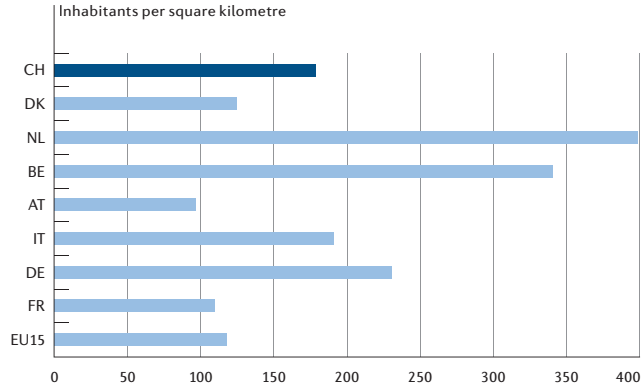
IV. Comparison with some European countries

Using a set of 16 indicators, most of which have already been presented and analysed in the previous parts, Switzerland's situation is compared with that of several European countries. This summary presentation focuses on themes such as resources, energy, transport, agriculture, waste, air, climate, water, biodiversity and forests.

Comparison with some European countries

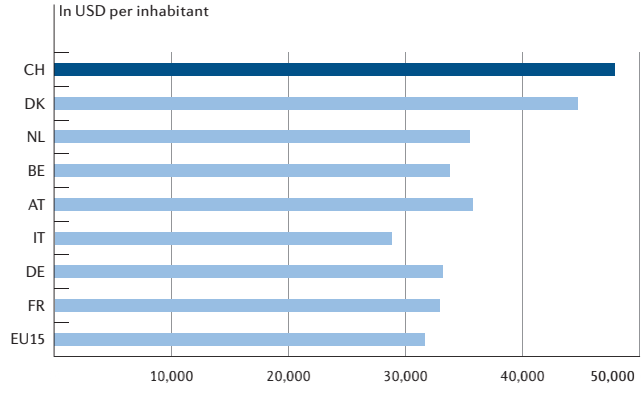
The first three parts of the report focus on the state of and developments in the environment in Switzerland. However, international comparison is important because environmental problems know no borders. No thorough comparison has been made because our country is not a member of the European Union (EU) and did not join the European Environment Agency until April 2006. Consequently, a pragmatic approach was adopted in choosing the proposed indicators. The data available in Switzerland are not always compatible with the European data, most of which are taken from the EUROSTAT and OECD databases available online.

GIV.1 Population density in 2004



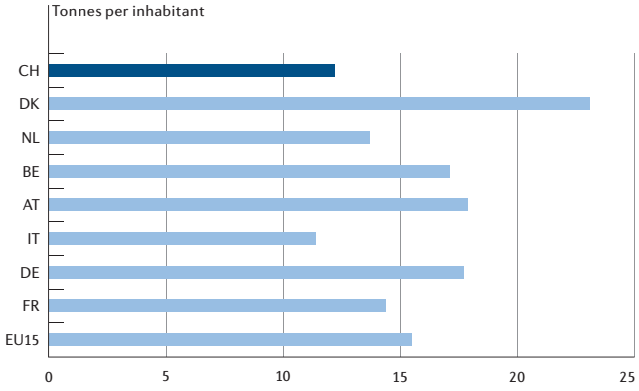
Source: OECD

GIV.2 Gross domestic product per inhabitant in 2004



Source: OECD

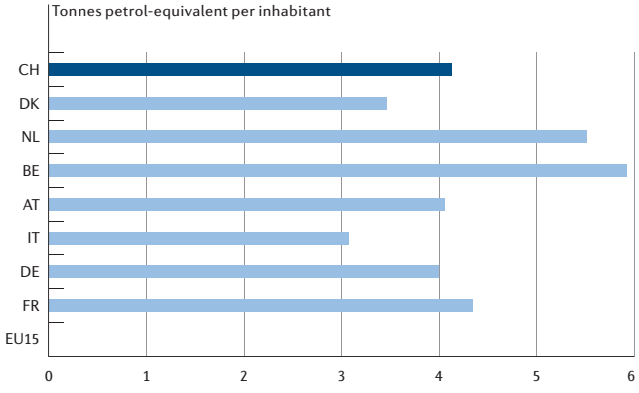
GIV.3 Domestic material consumption (DMC) per inhabitant in 2001 (» Chapter 1)



Source: Eurostat 2006, FSO

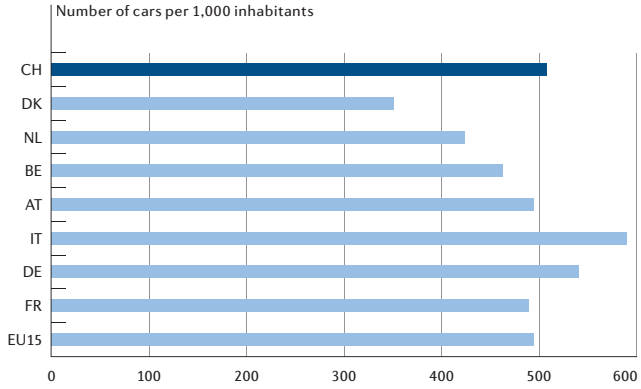
GIV.4 Primary energy consumption per inhabitant in 2002

(» Chapter 2)



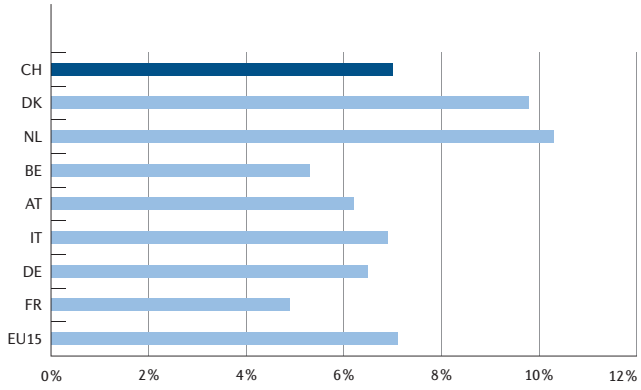
Source: FSO

GIV.5 Private cars per 1,000 inhabitants in 2002 (» Chapter 3)



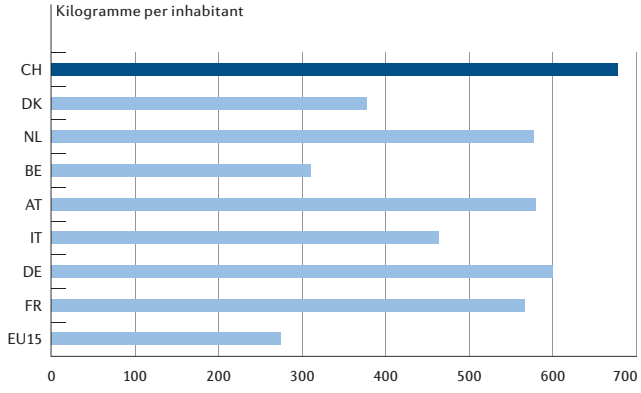
Source: Eurostat

GIV.6 Environmental tax revenue in total taxes and social contributions revenues in 2004 (» Chapter 4)



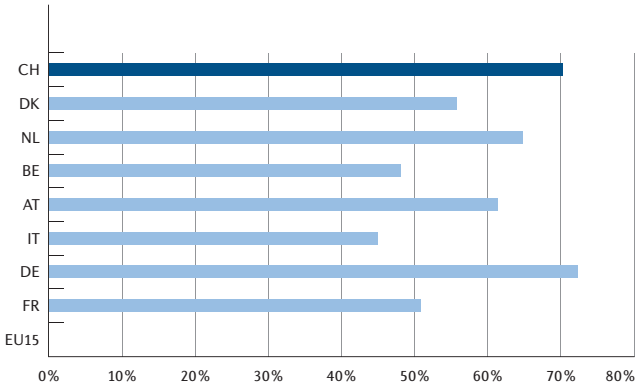
Source: Eurostat

GIV.7 Municipal waste in 2004 (» Chapter 5)



Source: Eurostat

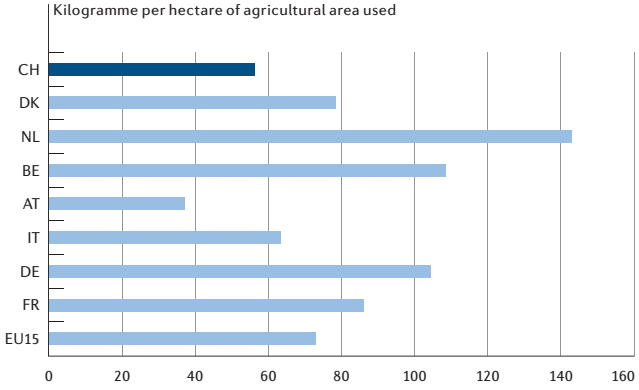
GIV.8 Paper and cardboard recycling rate compared with 2002 consumption (» Chapter 5)



Source: OECD

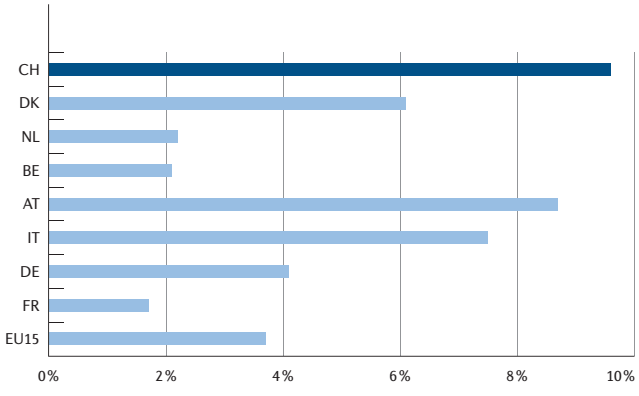
GIV.9 Commercial nitrogen fertiliser consumed in agriculture in 2001

Nitrogen from commercial fertilisers (» Chapter 6)



Source: Eurostat, FSO

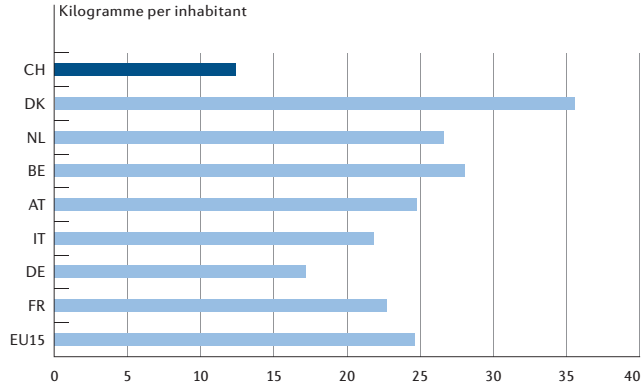
GIV.10 Proportion of organic farming in agricultural area used in 2001 (» Chapter 6)



Source: Eurostat, FSO

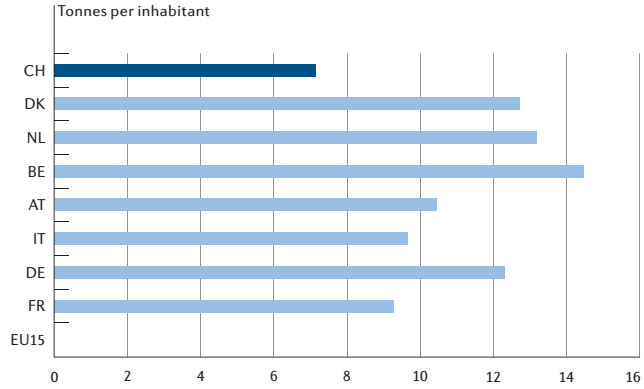
GIV.11 Nitrogen oxide emissions per inhabitant en 2002

(» Chapter 7)



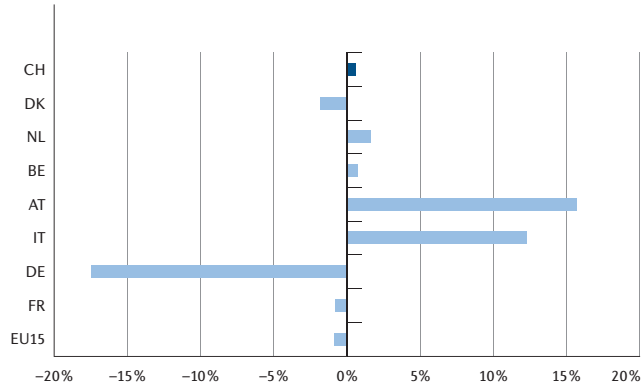
Source: OECD

GIV.12 Greenhouse gas emissions in 2002 (» Chapter 8)



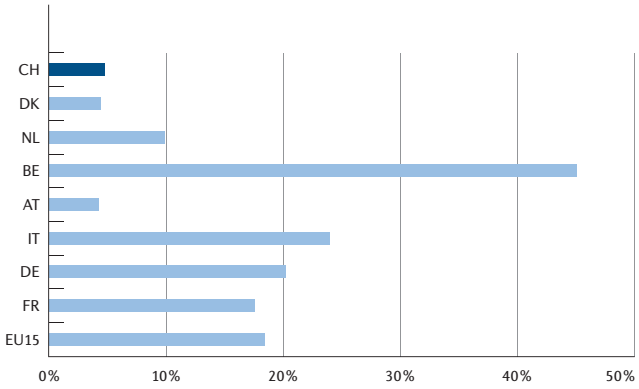
Source: Eurostat

GIV.13 Changes in greenhouse gas emissions between the base year as per the Kyoto Protocol and 2004 (» Chapter 8)



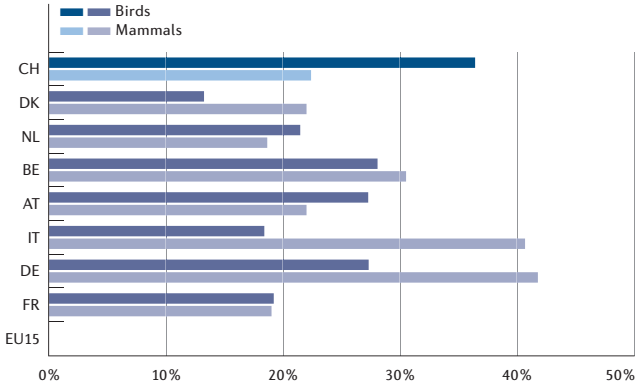
Source: EEA 2006, FOEN

GIV.14 Water withdrawal compared with gross annual available supply (last year available) (» Chapter 10)



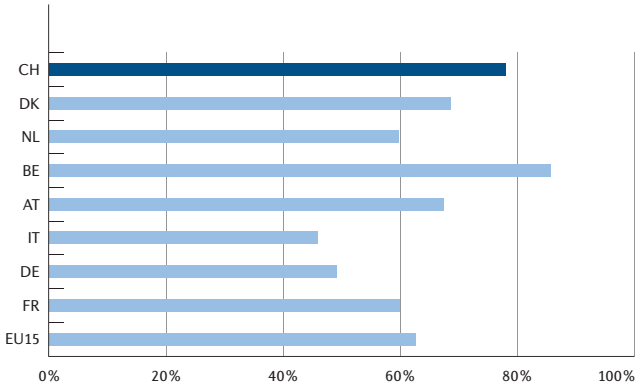
Source: OECD

GIV.15 Endangered species compared with known species (last year available) (» Chapter 12)



Source: OECD

GIV.16 Use of forest resources compared with annual growth (last year available) (» Chapter 13)



Source: OECD

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Abbreviations

ARE	Federal Office for Spatial Development
BDM	Biodiversity Monitoring
BLN	Federal Inventory of Landscape and Natural Monuments of National Importance
BLS	BLS Lötschbergbahn AG
DETEC	Federal Department of the Environment, Transport, Energy and Communications
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
EEA	European Environmental Agency
EU	European Union
EUROSTAT	Statistical Office of the European Union
FAO	Food and Agriculture Organization of the United Nations
FDHA	Federal Department of Home Affairs
FOAG	Federal Office for Agriculture
FOCA	Federal Office of Civil Aviation
FOE	Federal Office of Energy
SAEFL	Swiss Agency for Environment, Forest and Landscape (until 2005)
FOEN	Federal Office for the Environment (since 2006)
FOPH	Federal Office of Public Health
FOT	Federal Office of Transport
FSC	Forest Stewardship Council
FSO	Federal Statistical Office
GDP	Gross domestic product
HSK	Swiss Federal Nuclear Safety Inspectorate
HWIP	Household waste incineration plants
ISO	International organization for standardization
NABEL	National Air Pollution Monitoring Network
NABO	Swiss Soil Monitoring Network
NAMEA	National Accounting Matrix including Environmental Account
NAQUA	National Groundwater Quality Monitoring Network
OECD	Organization for Economic Cooperation and Development
OFCOM	Federal Office of Communications
PLANAT	National Platform for Natural Hazards
SBB	Schweizerische Bundesbahnen
SECO	State Secretariat for Economic Affairs
SLF	Swiss Federal Institute for Snow and Avalanche Research Davos
SSIGE	Schweizerischer Verein des Gas- und Wasserfaches
UN	United Nations
UNEP	United Nations Environment Programme
WHO	World Health Organization
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research

Glossary

Agricultural area used (AAU) Total agricultural area farmed, excluding summer pastures.

Alert thresholds See noise limit values.

Area Statistics At the request of the Federal Council, the Federal Statistical Office (FSO) has published a simplified picture of land use and of the nature of the soil every 12 years since the 1980s, thus reproducing a kind of imprint of society on the landscape. To date, two nationwide surveys have been published, the first based on aerial photos taken from 1979 (Western Switzerland) to 1985, and the second on photos from 1992 (Western Switzerland) to 1997. The third, which will cover 2004 to 2009, began in 2005 and will be available by 2011 at the earliest, but interim findings in French can be consulted on the SFSO website (www.bfs.admin.ch » français » Thèmes » 02 Espace, environnement » utilisation et couverture du sol).

Biosphere Complex of Earth's ecosystems comprising living things and their habitats. It includes the parts of the atmosphere, hydrosphere and lithosphere where there is life.

Black List The Black List registers the neophytes (plant species) that are invading Switzerland and currently harming biodiversity, health and/or the economy, and whose spread must be stopped.

Brominated flame retardants Synthetic (flame-resistant) materials used since the 1970s to replace PCBs for fireproofing, mainly in synthetic materials, building materials, furniture, clothing and electrical appliances. There are more than 70 known brominated flame retardants. Depending on their chemical and physical properties, they may penetrate the environment, through either the air or water. Some of them are not readily degradable and accumulate in the food chain. They are found both in fish and in human adipose tissues.

Carbon sink Using photosynthesis, trees synthesise wood, which stores CO_2 absorbed from the atmosphere in the long term. The carbon sink balance, i.e. the binding or release of biomass carbon through forestry or farming, may reduce emitted CO_2.

Causality principle The person at the origin of a measure prohibited by law supports the costs incurred by it. See also polluter-pays principle.

Cinder Ash residue produced by incineration that collects at the bottom of incineration ovens.

CO_2 equivalents Greenhouse gas emissions other than CO_2 (CH_4, N_2O, HFC, PFC and SF_6) are converted into CO_2 equivalents according to their global warming potential (GWP) to ensure better comparability. One kilogramme of CH_4 corresponds to 21 kg of CO_2, and one kilogramme of N_2O is equivalent to 310 kg of CO_2 (conversion values valid for a 100-year period, according to the 1996 IPCC Guidelines).

Combustible A substance that, in the presence of oxygen and energy, may combine with the oxygen (which acts as a combustive oxidiser) to create a heat-generating chemical reaction.

Constant prices Real-value, i. e. inflation-adjusted prices compared with basic or reference data. Constant francs, real prices or real terms.

Current expenditure See current prices.

Current prices Prices as indicated at a given point in time, applying the so-called nominal value.

Eased requirements Noise producers may benefit from eased requirements (i. e. waiving of duty to take remedial action) where:
a) remedial action excessively hampers operations or entails disproportionate costs;
b) overriding interests – particularly with regard to protection of historical monuments, nature and the landscape, traffic safety and safety of operations or general defence – argue against remedial action.
However, private installations or contractors may not exceed alert thresholds .

Ecological/international environmental governance Joint management of pollutants and imbalances that are a common threat (» Roch 2003).

Ecosystem A complex made up of an association or community of living things (biocenosis) and its geological, soil and atmospheric environment (biotope). The components of an ecosystem develop a network of interdependencies that permit life to be maintained and developed.

Efficiency Measures the production of value added per unit of resource necessary or environmental impact. For instance, material efficiency corresponds to the amount of Swiss francs produced per kilogramme of material consumed. Opposite of intensity.

Emissions Atmospheric pollutants, noise, radiation and other similar phenomena arising from a natural or anthropic (man-made) source are called emissions when discharged by installations.

Eutrophication Depletion of oxygen in bodies of water due to decomposing vegetable matter. This occurs when the input of nutrients normally present in low quantities (mainly phosphorus) results in excessive aquatic plant growth.

External costs Costs that are borne by someone other than those who caused them, in the course of either production or consumption.

GDP (gross domestic product) Measures the performance of a national economy in the course of a year. The GDP measures the values of goods and services produced in the country, provided they are not consumed in the production of other goods and services. In other words, it defines the value added. The GDP is calculated using current and constant prices for a given year. At constant prices, real economic development is represented without taking account of the influence of prices.

Gene transfer Transmission of gene material. A distinction is made between vertical and horizontal gene transfer. Vertical gene transfer describes crossings that stay within the species barrier, by means of sexual reproduction. In contrast, horizontal transfer may take place other than by sexual reproduction and independently of existing species barriers. Under certain conditions, horizontal gene transfer, for instance from a plant to soil bacteria, is possible in principle but this phenomenon is extremely rare under natural conditions.

GMOs (genetically modified organisms) Organisms (animals, plants, fungi, microorganisms) whose genetic characteristics have been modified by splicing or natural genetic recombination in a way that would be impossible under natural conditions.

Goldenrod An invasive exotic plant found on waste ground (pioneer vegetation on land disturbed by human activity), fields or grassland that spreads rapidly at the expense of native species. Two species of goldenrod (giant goldenrod and Canada goldenrod) currently feature on the Black List.

Grey energy A concept developed to calculate the energy impact of a product. The calculation takes account of the maximum number of factors involved in product manufacture, use and recycling. These additional factors make it possible to establish a numerical value and thus ascertain a product's approximate energy consumption.

Guideline values The Federal Council can set guideline values and remediation levels for assessing soil damage. Guideline values indicate the seriousness of the damage levels beyond which – according to current knowledge or experience – long-term soil fertility is no longer guaranteed.

Fuel Mixture of combustible hydrocarbons in liquid or gaseous form that, when combined with air, causes internal combustion in engines.

Immissions Atmospheric pollutants, noise, vibrations and radiation are termed immissions in the place where they take effect.

Intensity Measures the quantity of resources needed, or the environmental impact produced, per unit of value added. For instance, energy intensity corresponds to the quantity of energy per unit of GDP (per CHF). Opposite of efficiency.

Limit values Limit values apply for assessment of harmful or unpleasant exposure and take account of the impact of immissions on categories of people who are particularly sensitive, such as children, sick people, elderly people and pregnant women. These values are determined for atmospheric pollution, noise, vibrations and radiation.

Nanomaterials Materials with special properties because of their nanometric structure, i.e. one billionth of a metre. They are normally the product of nanotechnology.

Noise limit values The Noise Abatement Ordinance distinguishes between three levels of exposure limit values:
- Immission limit values (ILVs) are the limits above which noise is regarded as harmful and a nuisance
- Planning values (PVs), which are 5 dBA lower than the ILVs and apply to new facilities, which must prevent noise levels rising to the point where they become a nuisance
- Alert thresholds that are 5 to 15 dBA higher than ILVs; if these thresholds are exceeded, remedial action is considered to be urgently required

Permafrost Permanently frozen subsoil found where the climate is comparatively cold, either in high latitudes (polar regions) or at high altitudes.

Polluter-pays principle Principle designed to have polluters pay all costs (including external costs).

Radionuclides Atoms of radioactive elements.

Ratification Confirmation of the signature at the bottom of a document concluding an agreement with a foreign country. Generally, depositing the instrument of ratification constitutes the definitive validation of an international treaty.

Real See constant prices.

Red Lists Register endangered species for which urgent action is required. There are Red Lists for animals, flowering plants, mosses, ferns, lichens and fungi. The species are subdivided into several categories, depending on the severity of the threat to them.

Sectoral policy Policy stemming from a socio-economic sector such as transport or energy.

Sectors Sectors are divided into:
- Primary sector: agriculture, forestry and fishing
- Secondary sector: industry and construction
- Tertiary sector: services

Substances with endocrine effects Substances that influence the hormone balance of organisms.

Summer/winter smog The term "smog" was created by contracting the two words "smoke" and "fog". It describes a weather situation characterised by no wind and a concentration of pollutants that increases to the point where sunlight becomes diffuse and seems to come through a cloud of fog.

Synthetic gas Liquid gas, derived from the conversion of natural gas, which contains no sulphur, paraffin or aromatic compounds.

Uncoupling Uncoupling occurs when the use of resources or environmental pressures develop more slowly than economic growth. It is described as relative if the use of resources or emissions stagnates or rises. It is described as absolute when they fall.

UV Ultra-violet rays (UV) are divided into three wavelengths: UV-C (100–280 nm), UV-B (280–315 nm) and UV-A (315–400 nm). Ozone absorbs UV between 200 and 330 nm, i.e. mainly UV-B.

Value added (VA) Value added is the value created as part of a production process by a unit or branch of the economy. It is measured by comparing the value of goods and services produced less the value of intermediate consumption (excluding salaries) used to produce them. Value added is gross because it is calculated without subtracting the value of fixed capital consumed during production. After adjustment (for taxes, subsidies etc.), the sum of the gross value added corresponds to the gross domestic product (GDP).

Watch List List of invasive neophytes (plants) in Switzerland with harmful potential, whose spread must be monitored.

Index