Convention on Protection and Use of Transboundary Watercourses and International Lakes

SEMINAR ON THE ROLE OF ECOSYSTEMS AS WATER SUPPLIERS
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National report of Switzerland on the role of ecosystems as water suppliers

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Switzerland is located in the middle of Western Europe, at the centre of the Alpine arc, and is bordered by Austria, France, Germany, Italy and Liechtenstein. Switzerland has 6 % of all freshwater reserves in Europe. Sharing five river basins and some large lakes with its neighbours, it is the source of, or contributes to, several major European rivers that ultimately flow into the North Sea (Rhine, Aare), into the Mediterranean (Rhone), into the Black Sea (Inn, which joins the Danube) and into the Adriatic (Ticino, a tributary of the Po). Switzerland also has considerable reserves of groundwater, and numerous natural and artificial lakes. Lakes and reservoirs contain 50 % of the stored water, glaciers 28 %, groundwater 20 % and rivers 2 %.

Water is one of the few raw materials that Switzerland has.

A : Protection and restoration of water-related ecosystems

Switzerland emphasises the ecosystem approach as the first, cheapest step to **ensure a sustainable water supply of good quality. Ecosystems that naturally capture, filter, store and release water, such as wetlands, forests and soils, should be protected and used in a sustainable manner.**

Protection measures:

Forests for water: In Switzerland, forests, which cover 31% of the territory, are protected or used sustainably, among other objectives, in order to provide water of good quality and to mitigate flooding. The Swiss National Forest Programme (SNFP), an action programme at federal level for 2004-2015, adopted in 2004, was developed during a large interdisciplinary consultation between the federal and cantonal authorities as well as the professional associations, the forest owners, the NGOs, etc. It defines the state's objectives and activities and how to co-ordinate with other sectors (partnerships), including the cantons and the owners of forests. One of its objectives (4) reaffirms the protection of forest soils, trees and drinking water against chemicals (including airborne pollutants), physical agents and unsustainable management. The actual development of timber certification in Switzerland will contribute to maintain the good quality of water. The use of fertilisers in forests is prohibited and pesticides are only allowed in a few exceptional cases such as to protect felled logs from the bark beetle. Landfill sites in forests are forbidden. In forestry, conventional lubricants and fuels are increasingly being substituted in favour of environmentally friendly products. 42 % of groundwater protection zones (zones where activities are forbidden or limited) are located in forests.

The best drinking water comes from the forest
In Altdorf, in the Canton of Uri, the upper watershed is a protected wetland where water collects to form a stream, which soon disappears under the protection forest. This forest not only protects the city from falling stones, landslides and avalanches, but also filters the water through its soil and provides three quarters of the clean drinking water needed. In addition, due to the steep mountain slopes, the water collected turns the turbine of a small hydropower plant providing 1.5 million kWh per year, covering the needs of 300 households.

A natural water filter for the city of Basle
In the city of Basle (166,000 inhabitants), the quantity of groundwater is insufficient to meet the city's needs. Some 120,000 m^3 water per day from the River Rhine are treated through a mechanical filtration installation equipped with a quartz sand filter to remove the sediment. It then runs into small channels through a forest where it is infiltrated into the subsoil and thereby cleaned before reaching the groundwater.

Reforestation for water
The 90,000 inhabitants of the city of Winterthur need some 10 million m^3 of water per year, drawn from groundwater underneath some 1,900 hectares of forests. Forestry machines are not allowed to drive other than on forest roads and extraction tracks. Biodegradable lubricants for chains and hydraulic equipment are compulsory, and their storage and handling are restricted to certain areas. The drinking water is therefore supplied to the whole city without any treatment.

Forests for flood mitigation
In the canton of Ticino, the River Cassarate has caused flooding, mud-flows and rock-falls, endangering the villages in the valley as well as the city of Lugano. The causes were clear: intensive agriculture and over-exploitation of forests. After 120 years of reforestation, extensive agriculture, the surface of the stabilizing forest has been almost tripled, thus reducing the risks.

Soil protection for water quality: It is estimated that around three-quarters of the nitrate leaching into groundwater comes from farmland. The new agricultural policy which links direct payments to ecological performance, corresponding to "integrated production" (IP), implying certain controls on the use of fertilizers and pesticides now encompasses 98 % of the agricultural land according to IP, thus reducing the water pollution. In addition, farmers in areas where the water quality is inadequate, even when all legally required measures are taken, can receive payments (between CHF 800.- and 1'300.- per ha paid from a 60 mio CHF/year by the federal state and the funding from the cantons) to compensate for the loss of earnings when they take part in an integrated remediation project and apply measures beyond standard practice in favour of the quality of groundwater. A nitrate newsletter is published twice a year to inform the agricultural sector on some projects with examples of good practices; giving the newest information and publishing the agenda on the related seminars, meetings. (www.nitrate .ch)

Incentives for nitrate reduction
In the middle of the 1990s, the village of Wohlenschwil in the Canton of Aargau had too much nitrate in its drinking water (53 mg/l). The intensive cultivation of 23.5 hectares of land in was stopped and the arable land was transformed into unfertilised meadows. Thus, the nitrate content was effectively lowered to 25 mg/l. The farmers are compensated for their losses in earnings by means of a payment for ecosystem services of SFr 2,000 per hectare per year.

Residual water flows: Switzerland relies on hydropower for 60 % of its electricity. The residual water flows of rivers downstream from dams shall be increased to a minimal discharge that still ensures the sustainability of aquatic and water-related ecosystems. The Federal Law on Water Protection introduced a regulation at two levels: the law sets minimum water flows and the cantons may set higher minimum flows after weighing up the economic and ecological interests on a case-by-case basis. However, concessions granted before 1991 for periods of up to 80 years only have to be rehabilitated ecologically if the measures are economically bearable for the concessionary, unless the watercourse flows through landscapes or biotopes included in a federal or cantonal inventory, or for reasons of public interest, in which case the owner must be compensated by cantonal funding. In certain cantons, rehabilitation measures are already implemented, whereas this is under study and being discussed with all those concerned. A tax is paid by the hydropower concessionaries into a Federal Trust fund which can be used to compensate cantons that protect areas, excluding them from hydropower use.

Restoration measures:

Renaturalized rivers for ecology and flood control: The renaturalization of a part of the12'000 km of rivers and streams to their natural state, reversing artificial corrections that have been carried out in the past for flood protection is underway, to provide more room for flood plains or to reinstate previous ones, thus improving ecological status and preventing damage from flooding.
The cantons are obliged to designate and establish the necessary amount of land for rivers and streams, to ensure that they can function naturally (width of the river corridor, i.e. river banks and the strips beside the river). These areas must be reserved in the cantonal spatial plans. The federal government makes financial resources available for the ecological rehabilitation through payments for ecosystem services and renaturalization projects linked to flood protection. At present, as flood damages are increasing in Switzerland, it became clear that consequences of extreme floods could only be partly mitigated by structural protective measures. It is now recognised that flood protection and ecological concerns (i.e. space for rivers, eco-morphology of watercourses) have complementary goals.

Additional funding for renaturalization is also being supplied by the cantons. Since 1999, river and stream morphology have been recorded in many parts of Switzerland, identifying any eco-morphological deficiencies, to establish priorities for restoring rivers, and to carry out monitoring. The “Rhine 2020” program contributes to restoring the natural state of the upper reaches of the Rhine. The “Third Correction of the Rhone” project makes an important contribution to restoring the natural state of that river.

Flood plains and other wetlands such as fenlands and raised bogs occupy about 2% of the total area of Switzerland. 90% were destroyed in the last 150 years. In 1977, the popular initiative for the wetlands of Rothenthurm were the turning point when the Swiss population refused to have an exercise army territory built on the wetland, thus introducing a new article in the Swiss Federal Constitution for the protection of

wetlands of national importance. Fenlands and raised bogs of national importance listed in federal inventories are now protected as ecosystems with rich biodiversity. It is nevertheless evident that this protection has a positive effect on the water management and protection, in particular using raised bogs as buffer against floods. Renaturalization programs for raised bogs are being developed to re-establish the hydrology perturbed by drainage. Fenlands have to be managed in order to avoid encroachment and evolution to a forest. The farmers are getting instructions from the canton when to mow and receive in return compensation.

Compensation for river protection
In the canton of Berne, the Brook Lyssbach has undergone various renaturalization steps. A buffer zone was established along the river banks by practising extensive (non-intensive) agriculture, thus reducing the leaching of nitrate and phosphorus while compensating the farmers for these environmental services.

Renaturalization of the River Moesa
In Pascoletto (Canton of Grisons) numerous structures were built in the 1900s to protect the railway line, the national road and farming land from flooding of the River Moesa. The alluvial zone was impacted, the river-bed eroded and the groundwater level lowered. Between 1998 and 2000, 600 m of the river were enlarged, the artificial structures were removed or placed further from the river, and its banks were lowered. At the same time, landfill sites were removed from the alluvial zone. This created new flood plains for the river. These new biotopes provide a habitat for amphibians and typical alluvial vegetation. The whole project, financed by the Confederation, the canton, the communes, the Swiss National Fund for Landscape and Pro Natura (an environmental NGO), cost a total of SFr 810,000.

B: The integrated approach as a development opportunity

The recognition of the social and economic aspects of water-related ecosystems has been embedded in the history of Switzerland. In the 19th century, Switzerland was a poor, developing country, with forests as its main natural resources. To finance its development, Switzerland began massive clear-cutting of its forests: wood for heating, construction, power, transport and even export as a cash crop. The effects of this extensive deforestation were devastating. In 1834, floods, erosion and mudslides ravaged valleys and cities. A scientific study showed the cause to be the poor state of the forests and a sudden increase in rain intensity. In 1876, the Law on Forests, the first environmental law ever enacted in Switzerland, came into force, regulating timber harvesting by means of permits, and providing subsidies for reforestation. One year later, the Law on Hydraulic Engineering was enacted to respond to flood threats.

Swiss water policy developed in four consecutive steps:

I. **Between 1870 and 1908**: protection from floods was the main concern, and this was dealt with in the 1876 Law on Forests and the 1877 Federal Law on Hydraulic Engineering.

II. **Between 1908 and 1953**: the utilisation of hydropower was the key issue relating to water resources management and this was regulated by the 1916 Federal Law on the Exploitation of Hydroelectric Power.

III. **Between 1953 and 1991:** the 1955 Federal Law on Water Protection brought in the protection of water quality.

IV. **Since 1991:** policy and legislation for integrated water resources management, accompanied by concrete measures, are being implemented.

In Switzerland, the Integrated Water Resources Management aims to bringing together three principal sectors

Flood protection – Water use – Water protection

It is fully recognised that measures in one sector will impact on the others and that upstream actions will be felt downstream. Therefore, the spatial reference for integrated water resources management is the catchment area or river / lake / groundwater basin, rather than the political or administrative borders. This approach is integrated as it takes account of other activities impacting on water resources such as spatial planning and agriculture.

The new flood policy outlined in the 1991 Federal Law on Flood Protection and its ordinance issued in 1994 are intended to ensure the protection of human life and of high value property, with minimum structural measures along the watercourse, and integrating environmental concerns into flood protection schemes. It is now recognised that flood protection and ecological concerns (i.e. space for rivers, eco-morphology of watercourses) have complementary goals. Spatial planning, and the maintenance of watercourses to achieve the required level of flood protection are given high priority. Structural measures may be introduced if and only if the aforementioned measures do no meet the required level of protection.

The Federal Law on Water Protection, based on the ecosystem approach, establishes a comprehensive protection of the hydrological cycle, and it establishes a series of qualitative and quantitative targets for the protection of the physical and chemical quality of water, hydrological conditions, human, animal and plant health, supply for essential purposes, the protection of biotopes and landscapes, irrigation and leisure.

If Swiss water policy has developed through many laws and ordinances on and relating to water, including legislation on forest management, it was later strengthened by further acts concerning activities that impact on water, for instance spatial planning, agriculture, nature protection, waste management and chemicals (Annex 2). This is still an on-going process.

One of the important tools for IWRM is the monitoring of water quality and quantity through the National Hydrological Survey, the National Network for the Observation of the Quality of Surface Water, the National Network for the Observation of Groundwater Quality. In addition, with a view to an integrated sustainable protection and use of water resources in Switzerland, a Swiss Water Information System (known by its German acronym “GEWISS”) is being developed, which will allow the collection of federal and cantonal water data, representing the water relevant information of all catchment areas throughout Switzerland.

In addition to the usual monitoring, a supplementary assessment tool, which should improve the implementation of the ecosystem approach, called “Modular step-wise procedure”, is being developed in close cooperation between federal offices, research institutes and the cantons. It is a multidisciplinary assessment of the overall state of the water for individual water bodies and entire catchment areas, taking into account the hydrology, ecomorphology, biology (banks and surrounding vegetation, higher water plants and marsh plants, algae, macrozoobenthos, fish), water chemistry and ecotoxicology.

As it is stated above, in a federal land like Switzerland, IWRM is first a process where the sectoral approach is being changed, where cooperation between cantons is promoted. At the national level, the 1998 Water Protection Ordinance provides for integrated water resources management through regional water management plans (known by the German acronym REP). When the need for co-ordination of measures and among sectors is identified in a river basin, the cantons are required to establish such plans. At the moment, an example of such a REP is being developed for the River Birs, whose basin is shared by five cantons (www.labirse.ch: in German and in French).

Information dissemination and public participation.

The dissemination on best practices is done through the different federal offices, with often common publications such as the Guiding Principles for Swiss Watercourses and the related 3 development goals for the promotion of sustainable watercourse management. The Guiding Principles for Swiss Watercourses explain 3 development goals for the promotion of sustainable watercourse management, namely Adequate Space for Watercourses, Adequate Water Flows and Adequate Water Quality to the experts and outlines measures that can be adopted by cantonal, regional and local authorities for an integrated approach to water management, including show cases of good practice, showing the need for an interdisciplinary approach in the field of river engineering, ecology, spatial and landscape planning and agriculture.

Further information is provided by the research and technology institutes and universities, professional associations, and NGOs. Short and long term curricula at all levels are organised. Numerous workshops on different issues dealing with ecosystems and water. The professional organisations are cooperating with them. The network for information flow among practitioners is wide. Advice is given to the private sector. There is also an extended public information network. In addition, many organisations including the federal offices have magazines for the public where numerous articles on water and ecosystems have already appeared. On the occasion of the International Year of Freshwater, many activities supported awareness raising of the links between ecosystems, biodiversity, soil and water. The International Environment Day is also used to show the interrelationships between the environmental sectors.

Research

Much research on ecosystem approach, especially on forests and water, as well on renaturalization is taking place in Switzerland. It is dealt with by the 2 Swiss federal Institutes of Technology, universities and smaller research structures such as the Swiss Federal Institute for Environmental Science and Technology and the Swiss Federal Institute for Forests, Snow and Landscape Research.

Private sector

The private sector is involved through the farming, forestry and hydropower sectors to maintain water quality and water quantity. Now, it is envisaged to contact the owners of forests (3000 public enterprises versus 240’000 private owners) to see to what extend their forest management could avoid large clear-cut that can bring too large amounts of nitrates into groundwater.

The engagement of the forest owners will be increased through the Swiss National Forest Programme. Although the idea of paying forest owners for the environmental services they provide through their well managed forests, the source of funding will most probably be financed by consumers.

Swiss farmers are compensated financially for the ecosystem services that they provide by switching from intensive to extensive farming, reducing the run-off and leaching of nutrients and pesticides to rivers and groundwater.

Incentives for nitrate reduction
In the middle of the 1990s, the village of Wohlenschwil in the Canton of Aargau had too much nitrate in its drinking water (53 mg/l). The intensive cultivation of 23.5 hectares of land in was stopped and the arable land was transformed into unfertilised meadows. Thus, the nitrate content was effectively lowered to 25 mg/l. The farmers are compensated for their losses in earnings by means of a payment for ecosystem services of SFr 2,000 per hectare per year.

Job creation
The renaturalization of rivers brought new work opportunity to the ecology consultants companies in Switzerland as well as the new assessment tool "Modular step-wise procedure".

C: Legal and administrative dimension

The 1975 amendment to the Federal Constitution included an article on water resources management, prescribing residual water flows in watercourses and streams. According to Article 76 of the 1999 Federal Constitution, "within the limits of its powers, the Confederation shall ensure the moderate use and the protection of water resources, and fight against harmful effects of water" while the cantons dispose of their water resources. The article 78, al. 5 of the Federal Constitution:: "Moors and marshlands of special beauty and national importance are protected objects. Installations must not be built on them and no alterations to the land of any kind may be carried out. Exceptions are installations which serve to maintain the purpose of protection and the existing agricultural use".

Swiss water policy has developed through many laws and ordinances on and relating to water (among others the 1991 Federal Law on Flood Protection and its ordinance issued in 1994, the Federal Law on Water Protection) including legislation on forest management, it was later strengthened by further acts concerning activities that impact on water and water-related ecosystems, for instance spatial planning, agriculture, nature protection, waste management and chemicals (Annex 2). This is still an on-going process.

On coordination:
At national level, the federal authorities responsible for Swiss water policy are the Swiss Agency for the Environment, Forests and Landscape, the Federal Office for Water and Geology and the Federal Office for Public Health (dealing with drinking water regulations and with waterborne diseases).
The cantons are responsible, among others, for water protection, waste management, soil protection, protection from natural disasters, the conservation of nature and landscape and forest management.
Interdisciplinarity is underlying more and more the water policy of Switzerland. The federal authorities are coordinated together with other Federal Offices, such as the one for spatial planning, agriculture, including the cantons relevant authorities, the private sector and NGOs.

The objectives of Swiss water management policy are influenced by co-operation on the management of bodies of water **of international** importance. Switzerland shares five river basins with its neighbours as well as several large lakes (Lake Constance, Lake Geneva and lakes on the Swiss-Italian border), and Switzerland has transboundary responsibilities to provide neighbouring countries with sufficient water of good quality. In this context, Switzerland takes part in the activities of the International Commission for the Protection of the Rhine (ICPR) and in those of the Convention for the Protection of the Marine Environment of the North East Atlantic ("OSPAR Convention").

Switzerland also co-operates with the neighbouring countries in the work of the EU framework Directive on Water, by providing pertinent data. It takes part into the EU Conference of the Water Directors.

Through the United Nations Economic Commission for Europe (UNECE), Switzerland is also active in the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), and its protocols (Protocol on Water and Health and UNECE Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters). The implementation of the Ramsar Convention on wetlands has also a great influence on water as important mountain wetlands are providing drinking water. Other conventions which are not usually linked with water are equally important, such as the UNECE Long Range Transboundary Air Pollution. Indeed, the air pollution absorbed by forests can contaminate the groundwaters when their soil absorption capacities are overwhelmed.

Integrated water resources management at the level of the river basin: Swiss and transboundary co-operation

The River Alpenrhein constitutes the border between Switzerland and Austria and between Switzerland and Liechtenstein. Its valley is a densely populated, highly industrialised area. In the past, water management meant almost exclusively flood protection. In view of its impacts on other sectors and after a hazard re-assessement and risk analysis, a transboundary development plan for the basin, integrating flood protection, groundwater, hydropower and ecological goals is currently being developed (see http://www.alpenrhein.net - *in German).*

The new flood protection philosophy is illustrated by the rivers Thur and Rhone which are currently subject to major projects aimed at harmonising flood protection with ecological goals, the main ecological objective being to revitalise the formerly heavily channelled river courses (see http://www.rhone-thur.eawag.ch/ in *German* and
http://www.vsc.ch/home2/rhone/default.htm in *German and French*).

Annex 1

Switzerland: The water tower of Europe

About Switzerland

Geography: Switzerland is located in the middle of Western Europe, at the centre of the Alpine arc, and is bordered by Austria, France, Germany, Italy and Liechtenstein. Switzerland is a mountainous country covering 41,000 km^2 and has a peak elevation of 4,634 m. It shares five river basins and some large lakes with its neighbours.

Population and human settlements: Switzerland has more than 7 million inhabitants and is densely populated with 171 inhabitants per km^2, but if one considers the habitable land (excluding mountains, etc.) the population density comes to 350 inhabitants per km^2. Two thirds live in urban areas, and nearly a third live in five main cities and their suburbs (Zurich, Basle, Geneva, Berne and Lausanne).

Economy: In 2002, the GDP of Switzerland was SFr 417 billion. Services generated 73 % of GDP, various industries, such as chemicals, pharmaceuticals, watchmaking and machinery, accounted for 25.9 % of GDP, whereas the primary sector (agriculture, forestry, fisheries) only contributed 1.1 %.

Political structure: Switzerland is a Confederation of 26 semi-autonomous members: 20 cantons and six half-cantons. The cantons are made up of 2,842 municipalities (communes).

Legislation: The federal laws are implemented by ordinances, which are equivalent to implementing orders.

Current water situation and trends

Water resources: Water is probably the most important natural resource in Switzerland. The amount readily available is about 3 times the European average, which is sufficient to meet all the essential needs. The climate is varied and precipitation increases with altitude. The average annual precipitation is high (1,456 mm) and evaporation is moderate (484 mm). The permanent snow line is at 3,600 m to the south of the Alps and 3,000 m to the north of the Alps. Switzerland is particularly liable to flooding, especially in mountainous areas, and there are some 10,000 avalanches per year.

Switzerland, the water tower of Europe: Switzerland has 6 % of all freshwater reserves in Europe, and is the source of, or contributes to, several major European rivers that ultimately flow into the North Sea (Rhine, Aare), into the Mediterranean (Rhone), into the Black Sea (Inn, which joins the Danube) and into the Adriatic (Ticino, a tributary of the Po). Switzerland also has considerable reserves of groundwater, and numerous natural and artificial lakes. Lakes and reservoirs contain 50 % of the stored water, glaciers 28 %, groundwater 20 % and rivers and dams 2 %.

Water abstraction (other than for agriculture and hydropower) amounts to 2.6 billion m^3 per annum. The per capita abstraction was 350 m^3 in 2001 and the amount used corresponded to 4.9 % of the available resources. Households and small-scale manufacturing accounted for 63 %, industry and commerce used 17 %, losses represented 12 %, public purposes and fountains used 5 %, and the waterworks themselves used 3 %. There is little irrigation in Switzerland, so water abstraction for use in agriculture was around 100 million m^3.

Drinking water: In Switzerland, the 3,000 public sector water suppliers provide about 1.1 billion m^3 of drinking water through some 53,000 km of pipes, with losses due to leakage at about 13 %. It is estimated that industry and private households use another 0.5 billion m^3 of water from groundwater. Groundwater (including springs) provides 83 % of drinking water. Nearly 47 % of the water from groundwater (mostly from forested catchments) can be distributed without treatment. Another 40 % of groundwater requires only minimal treatment (chlorine, UV or ozone). The 17 % of drinking water drawn from lakes undergoes multistage treatments. Lead pipes have been banned in Switzerland since 1914 and all have now been replaced.

Water consumption per inhabitant per day in Switzerland is about 400 litres. This includes industrial, agricultural and domestic uses of water.

Costs of water: The pre-treatment of water before it is supplied into the distribution pipes in Switzerland costs SFr 130 million per year (SFr 0.20 /m^3). No treatment is needed for some 400 million m^3 of good quality water. The total costs (for public suppliers) of running the water supply system and of maintaining the infrastructure comes to SFr 1.3 billion per year. Swiss water is inexpensive, with drinking water costing between SFr 0.50 and SFr 3.50 per thousand litres (average SFr 1.60). The treatment of wastewater costs between SFr 3.00 and SFr 5.00 per thousand litres. By law, all the costs for water supply and treatment are included in the price of water.

Pressure on water resources - pollution discharges

Thanks to a dense network of wastewater treatment plants, the pollution of surface water by organic substances from **households** is now relatively low. The concentrations of heavy metals and organic micro-pollutants are low. Generally, **water pollution by industry** (chemicals and agro-food) is no longer a problem as their aqueous discharges are of good quality due to water treatment. Nevertheless, in some urban and industrial regions, there are risks of pollution by chlorinated hydrocarbons such as perchloroethylene and trichloroethylene, due to soil contamination from industrial sources or landfill sites. Despite the progress that has been made in the prevention of accidents and in disaster preparedness, the risk of water pollution through an industrial accident still exists.

Transport and water: The presence of MTBE (fuel additive) in numerous lakes and rivers shows that motor vehicles also have an effect on water quality; nevertheless, its concentration remains insignificant. The risk of water pollution by pesticides through their application on railways and roads has been considerably decreased with the ban on the application of triazine along railways and the complete ban on the application of herbicides along roads and pathways. Air pollution is causing the acidification of some lakes and rivers in the southern Swiss Alps.

Transport of dangerous goods, spillage of petrol, losses of grease, the abrasion of roads and tyres also present risks for water quality, with the extensive road and railway network and high traffic density in Switzerland.

Pollution from agriculture remains a major problem for both surface water and groundwater. Long-term phosphate and nitrate pollution from the use of chemical fertilisers and manure from diffuse sources linked to intensive farming continue to cause eutrophication. The concentration of nitrates in groundwater is often above the values stated in the Water Protection Ordinance and in some cases, exceeds the level of tolerance

for drinking water, particularly in areas where there is intensive farming. Some organic micro-pollutants, mostly pesticides (atrazine, simazine, isoproturone etc.), are present in
many groundwater sources. They come from farming and from urban sources. Standards for these substances are exceeded in almost 10 % of springs and wells monitored by means of the national network for the observation of groundwater quality.

Pressure on water resources - water abstraction

Despite sufficient resources, **groundwater** has suffered, occasionally and very locally from over-exploitation, but mostly from projects preventing the replenishment of the water table, such as the restriction of rivers to a channel, drainage, an increase in built-up areas, the extraction of gravel, lowering of the water table by the abstraction of water via tunnels, civil engineering works and construction work.

For surface water, Switzerland has over 100 storage reservoirs (dams). This sometimes consisted of total impoundment for electricity production (60 % is produced from hydropower) and this has almost dried up numerous watercourses with serious consequences on ecosystems. Furthermore, the flow of one watercourse in ten is now controlled for the purpose of electricity production. Ecosystems have suffered from the variable level of the water. Flood protection infrastructure and urban development have led to the alteration, damming, impoundment or burial of 20 % of some 61,000 km of Swiss rivers and streams, disturbing or even destroying the ecosystems and impacting on water quality. Some of those river corrections took place in the 19th century. They also had the purpose of eradicating malaria by the removal of wetlands!

Pressure on water resources – lack of space for watercourses

As a result of work carried out in the past to control flooding, and pressure from various forms of land use and human activities (such as agriculture and urban development), many Swiss rivers have changed from natural river-beds with flood plains to straight, narrow channels. Many other watercourses have even been totally covered and have disappeared from the landscape.

Annex 2

Main federal legislation relating to integrated water resources management

[1876]	[Law on Forests]
1877	Federal Law on Hydraulic Engineering (SR 710.10)
[1902]	[Federal Law of 11 October 1902 on Supervision of the Forest Police by the Confederation] (repealed by the Federal Law of 4 October 1991 on Forests (SR 921.0))
[1909]	[Ordinance on Foodstuffs] (repealed by the Ordinance of 26 May 1936 on Foodstuffs)
1916	Federal Law of 22 December 1916 on the Exploitation of Hydroelectric Power (SR 721.80)
[1936]	[Ordinance of 26 May 1936 on Foodstuffs] (repealed by the Ordinance of 1 March 1995 on Foodstuffs (SR 817.02))
[1951]	[Federal Law of 3 October 1951 on the Improvement of Agriculture and the Maintenance of the Farming Population (Law on Agriculture)] (repealed by the Federal Law of 29 April 1998 on Agriculture (SR 910.1))
[1955]	[Federal Law on Water Protection] (repealed by the Federal Law of 8 October 1971 on Water Protection)]
1966	Federal Law of 1 July 1966 on the Protection of Nature and Cultural Heritage (SR 451)
[1971]	[Federal Law of 8 October 1971 on Water Protection] (repealed by the Federal Law of 24 January 1991 on Water Protection (SR 814.20))
1979	Federal Law of 22 June 1979 on Spatial Planning (SR 700)
1983	Federal Law of 7 October 1983 relating to the Protection of the Environment (SR 814.01)
1985	Ordinance of 16 December 1985 on Air Pollution Control (SR 814.318.142.1)
[1986]	[Ordinance of 9 June 1986 on Soil Contaminants] (repealed by the Ordinance of 1 July 1998 relating to Impacts on the Soil (SR 814.12))
1986	Ordinance of 9 June 1986 relating to Environmentally Hazardous Substances (SR 814.013)
1986	Ordinance of 12 November 1986 on Movements of Hazardous Waste (SR 814.610)
1988	Ordinance of 19 October 1988 on Environmental Impact Assessment (SR 814.011)
1990	Ordinance of 10 December 1990 on Waste (SR 814.600)
1991	Ordinance of 16 January 1991 on the Protection of Nature and Cultural Heritage (SR 451.1)
1991	Ordinance of 21 January 1991 on the Protection of Raised Bogs and Transitional Mires of National Importance (SR 451.32)

1991	Federal Law of 24 January 1991 on Water Protection (SR 814.20) (repealed by the Federal Law of 8 October 1971 on Water Protection)
1991	Ordinance of 27 February 1991 on Protection against Major Accidents (SR 814.012)
1991	Federal Law of 21 June 1991 on Fisheries (SR 923.0)
1991	Federal Law of 21 June 1991 on Flood Protection (SR 721.100)
1991	Federal Law of 4 October 1991 on Forests (SR 921.0) (repealed by the Federal Law of 11 October 1902 on Supervision of the Forest Police by the Confederation)
1992	Ordinance of 28 October 1992 on the Protection of Flood Plains (SR 451.31)
1993	Ordinance of 3 February 1993 on the Disposal of Animal Wastes (SR 916.441.22)
1994	Ordinance of 7 September 1994 on the Protection of Fenlands of National Importance (SR. 451.33)
1994	Ordinance of 2 November 1994 on Flood Protection (SR 721.100.1)
1995	Ordinance of 1 March 1995 on Foodstuffs (SR 817.02) (repealed by the Ordinance of 26 May 1936 on Foodstuffs)
1995	Ordinance of 25 October 1995 concerning Compensation for Losses in Hydropower Generation (SR 721.821)
1996	Ordinance of 1st May 1996 on the Protection of Mire Landscapes of Particular Beauty and National Importance (SR 451.35)
1997	Ordinance of 12 November 1997 on Incentive Taxes on Extra-Light Fuel Oil (SR 814.019)
1998	Federal Law of 29 April 1998 on Agriculture (SR 910.1) (repealed by the Law of 3 October 1951 on Agriculture)
1998	Ordinance of 1 July 1998 relating to Impacts on the Soil (SR 814.12) (repealed by the Ordinance of 9 June 1986 on Soil Contaminants)
1998	Ordinance of 1 July 1998 concerning the Protection of Water Bodies from Liquids Hazardous to Water (SR 814.202)
1998	Ordinance of 26 August 1998 relating to the Remediation of Polluted Sites (Contaminated Sites Ordinance) (SR 814.680)
1998	Water Protection Ordinance of 28 October 1998 (SR 814.201)
1998	Ordinance of 7 December 1998 on Dam Safety (SR 721.102)
2000	Ordinance of 5 April 2000 on Charges for the Remediation of Contaminated Sites (SR 814.681)
2001	Ordinance of 4 April 2001 on Environmental Quality (SR 914.14)