Summary

This report describes possible impacts of climate change and vulnerabilities of the environment, economy and society in Switzerland due to the emission of greenhouse gases that are to be expected up to the year 2050. The potential impacts on various areas are discussed, as well as measures and strategies to adapt to the expected changes. Because global emissions reduction can only mitigate the situation in the long run, the expected global warming to 2050 will take place largely independently from such efforts. If greenhouse gas emissions are not reduced considerably within the coming decades, the consequences of warming may turn out to be much more severe in the second half of the century than those presented in this report.

The report assumes a warming of approximately 2 °C (with a range of uncertainty between 1 and 4 °C) in autumn, winter and spring, as well as just under 3 °C in summer (with a range of uncertainty between 1.5 and 5 °C). With regard to precipitation in winter, an increase of about 10% is expected, whereas in summer a decrease of about 20% can be assumed. The number of extreme precipitation events is very likely to increase and therefore also the number of floods and mudslides, particularly in winter but possibly also in summer, despite smaller total precipitation amounts. In summer, heat waves will generally increase, and probably droughts as well. In contrast, cold spells will decrease in winter.

In the future, in particular in the service sector, less heating energy will be required in winter and more cooling energy in summer. This will mean a shift in the energy demand from fuel to electricity. Newer buildings normally possess good heat insulation that reduces the heating demand during the cold season. However, dissipation of waste heat (produced by machines, people, etc.) is limited and requires cooling, in particular with increasing temperatures and heat waves in summer. Energy-efficient devices, air conditioning and sun screens, etc. may provide relief. Construction standards should be adjusted to the future climate. Relief measures are also possible in urban development, for instance, by creating aeration corridors.

The small runoff and decreasing cooling effect on rivers, in particular in summer, will have an adverse effect on hydropower and nuclear energy. Annual production is expected to decline by a few per cent by 2050.

New renewable energy will become more competitive due to higher energy demand, the demand for CO2-free energy and increasing energy prices. As measured by today's consumption, their share in the Swiss electricity supply may rise to over 10% (5500 GWh/year ≈ 20 PJ/year). The focus is primarily on energy gained from windmills and wood. If long-term trends and the development of the forestry and timber industries are considered, the potential of wood may triple. However, the emission of air pollutants related to energy production from wood would have to be reduced.

Climate change means an increasing risk of service interruptions in the energy sector. The emerging supply gap should be reduced as soon as possible, primarily by exploiting the energysaving potential and by promoting renewable energy. The dependency of Switzerland on foreign countries for its energy supply may thereby be reduced. The future energy production should remain as CO2-free as possible.

In comparison to other countries, Switzerland possesses substantial water reserves. Climate change will affect these reserves: Less water will be available in summer and autumn, and this will be more pronounced during drought periods. At the same time, the demand for irrigation in agriculture will increase, causing contention between ecosystems, different users and regions. This may lead to losses in agriculture and in electricity production, mainly in run-of-river power plants. Water supply, however, can probably be ensured by optimised water management.

Infrastructure value at exposed locations has increased considerably. Accordingly, the damage potential of floods, mudflows and landslides

has become much larger during the past 50 years. The growing frequency and intensity of heavy precipitation events further adds to the damage potential. As precipitation increasingly falls as rain instead of snow, floods become more frequent and more severe, particularly in winter. Possible measures include sustainable flood protection by renaturation and broadening of rivers, and limiting damage potential. Adequate management of lakes and the use of storage reservoirs as back-up mean a reduction and shift in fluctuation. The ecological consequences, however, are unknown.

As natural disasters become stronger and more frequent, insurers and reinsurers will be forced to raise premiums or to limit coverage in order to be able to pay in case of loss. Preventive measures, such as adaptation, and implementation of spatial planning and construction standards, will be necessary to make risks insurable again. Alpine regions are particularly under pressure to adapt the development of buildings and settlements, due to the threat posed by natural disasters and the dependency on winter tourism.

Possible consequences of climate change, in particular of extreme events, need to be included in risk modelling to estimate the damage potential of the insurance industry, as well as of any other branch of the economy. Currently, the insurance industry is developing new products to deal with a higher variability of more intense loss events. However, their market share is still very small in comparison to traditional insurance and reinsurance models.

Domestic tourist destinations, mainly at lakes and in the Alps, may become more attractive with increasingly hot summers. In winter, though, the rising snow line means that ski resorts in the foothills of the Alps may not operate profitably anymore. The expected higher number of tourists in summer will not compensate for the loss of income of mountain railways and the hotel sector in winter. Ski resorts situated at high elevations may possibly benefit. In these areas, pressure on the second-home market is to be expected. With the increasing threat to traffic routes from extreme events, the accessibility of tourist resorts in the Alps becomes more difficult. The attractiveness of alpine tourist areas will also be influenced by decreasing snow–reliability and expected changes in the natural scenery, in particular the retreat of glaciers. By 2050, smaller glaciers will probably have disappeared. Melting permafrost means a costly risk for a number of mountain railways, as at higher elevations the foundations of pylons and stations are often anchored in the frozen loose stone. The risk of rock slides increases as well.

In order to maintain the attractiveness of tourist destinations, offerings need to be adjusted to new conditions. It is essential to consider possible climatic and scenic changes in planning.

A moderate warming of less than 2 to 3 °C may have an overall positive effect on Swiss agriculture. The productivity of meadows and the potential crop yield of many cultivated plants will increase as a result of the longer vegetation period, provided that the supply of water and nutrients is sufficient. Livestock farming will profit from this as well. On the other hand, water supply will decrease in summer, weeds and insect attacks will occur more often and damage caused by extreme events will increase. Through the suitable choice of cultivated plants, cultivation methods and management, agriculture will be able to adapt to a moderate rise of 2 to 3 °C of the mean temperature by 2050. The increase in heat waves and drought periods is problematic. Furthermore, more frequent precipitation events will aggravate soil erosion. The demand for irrigation will increase in many regions. These risks may be reduced by diversification of farms and higher insurance cover.

If the temperature rises by more than 2 to 3 °C by 2050, the disadvantages will outweigh the advantages of warming: During the vegetation period, water scarcity will become more frequent, and faster plant development will result in harvest losses for crop and grain legumes. However, liberalisation of the markets and adaptations to agricultural policy will have a stronger impact in Switzerland up to 2050 than climate change.

As the heat wave summer 2003 showed, the increase in heat waves in Switzerland, in combination with an elevated ozone concentration, represents the most important health consequence of global warming. It is possible, though, to counter the increase in mortality caused by heat with adequate measures. Heat waves also impair the efficiency of the working population and thereby have economic effects. The likely increase of other extreme events such as floods, mudslides, and possibly also storms, causes death and casualties but also has severe psychological consequences.

With higher temperatures, the danger of food poisoning due to spoilt food increases. The development of various vector-borne illnesses is rather uncertain. However, in Switzerland, the spread of malaria or dengue fever is quite unlikely. On the other hand, West Nile fever is on the advance. Higher temperatures could also generate new vectors or cause a vector to change its host. With illnesses transmitted by ticks, there may be changes in the range of vectors, infection rates and period of activity.

In Switzerland, the species composition of ecosystems will change in the long run because different species react differently to climate change. Flora and fauna will continue to approximate those at lower elevations and in more southern areas. Heat-sensitive species will move to cooler areas at higher elevations. Less mobile species will be radically reduced or disappear.

The productivity of forests and agriculture, as well as the availability of clean water, may be affected by the combination of high temperatures and low precipitation. At higher elevations, the productivity of forests and permanent grassland will be somewhat enhanced by warming, at lower elevations it will be constrained by summer drought. In the future, water resources will also be of increasing importance to ecosystems, in particular to those situated in valleys and hill country.

From today's perspective, the expected consequences of climate change in Switzerland to 2050 seem manageable without severe societal problems, provided that warming does not exceed the expected magnitude. However, there are not yet any precise estimates of the costs for the adaptations and measures mentioned, which, for some areas, may be of economic relevance. In particular, the tourism sector will have to face drastic changes.

These conclusions should not hide the fact that long-term development in the second half of the 21st century crucially depends on emission reduction measures implemented within the next years and decades, and the consequences in case of a business-as-usual scenario would be much more severe. Moreover, there are many countries in the world, in particular developing countries, that on the one hand will be hit by more serious consequences and, on the other hand, will not posses the financial resources to adapt. The emerging geopolitical developments may well have consequences for Switzerland.