Synthesis

1. Introduction

How will global climate change affect Switzerland in the year 2050? Although nobody knows the future, scientifically based estimates of probable developments allow us to consider smart adaptation strategies early and make anticipatory decisions. After having concretely described and discussed the expected changes in individual sectors in the previous chapters, this chapter will consolidate these reflections and draw conclusions. We comment on the following questions from the perspective of five topics – Creeping changes, extreme events, water, space, and changes for humans:

- What changes await us and why are they important?
- Which adaptations are already observable? Are they advisable against the background of the overall problem or do they represent only superficial or even counterproductive pseudo-solutions?
- What does this mean for a comprehensive and responsible climate strategy?

As humans we are integrated at one and the same time into the material and energy-related cause and effect relationships of the material world and into those of a societal nature. This integration expresses itself in many ways. Thus, the development of techniques for the exploitation of fossil energy sources has set in motion not only a long-term change in economic and social but also in climate and ecological systems – changes which in turn have repercussions for us humans and demand from us adaptation and problem solving.

We know that the most important contribution to solving the problem of climate change consists of drastically reducing the global emission of greenhouse gases. This solution, which approaches the problem from its cause, is called mitigation. There is no alternative to this! The nature of the climate system is such that it demands drastic emission reductions, which will be difficult for us to achieve due to their radical nature. Thus, for the time being, it is still uncertain, when and how we will succeed in taking the necessary large steps in reduction. It is certain, however, that even in the case of quick successes in mitigation, climate change will proceed in the coming decades, due to the increase in greenhouse gas concentrations in the atmosphere (delayed consequences) caused by human activity. Therefore, we need to prepare simultaneously for local and regional restrictions due to climate change. An ideal adaptation strategy includes the greatest possible minimisation of the expected damage and at the same time the maximum utilisation of the resulting opportunities. This damage-limiting strategy is called adaptation. This report focuses on the impact of climate change around 2050 and the question of what kinds of adaptation Switzerland has to achieve in addition to the urgently needed efforts in the area of mitigation.

The statements made in this report in relation to the expected mean changes in the climate system, as well as their impact on society, the economy and ecosystems do not sound particularly dramatic, in part because most of them are likely to be within the range of natural variability in our latitudes around 2050. In most cases, society can react to them with appropriate adaptation measures. This circumstance must not obscure the fact that our actions today will determine the future of the climate, and the massive economic and social costs associated with it after 2050. Between 2050 and 2100, the effects of climate change will be extremely noticeable and cause great damage in Switzerland, as elsewhere. Then the consequences for Switzerland will be far more drastic than presented in this report. That is why immediate action in the areas of mitigation and adaptation is now becoming urgent.

2. Creeping changes

The scenarios for 2050, on which this report is based, mainly focus on mean values. In this case it is expected that winter temperatures will increase by about 1.8 °C and summer temperatures by about 2.7 °C compared to 1990. The related average change in climate caused by these rises will affect various systems, e.g. glaciers, permafrost, the hydrological cycle, vegetation, animals, buildings and human well-being.

Precipitation will decrease in summer and tend to slightly increase in winter. As a result, annual mean precipitation will slightly decrease compared to today. These changes go hand in hand with changes in atmospheric circulation. Thus it is expected that in summer, the Azores high will extend more often over the continent, which will tend to lead to more heat waves and dry spells. In winter, a northern shift of the Westerlies is predicted, with low-pressure systems probably having lower central pressure. This will possibly result in less but stronger westerly storm occurrences. Even just the average warming caused by this and the change in mean precipitation will have grave consequences for various systems, e.g. glaciers, permafrost, the hydrological cycle and vegetation. Many changes will proceed over long periods of time. In some cases, nature and humans will have sufficient possibilities to adapt to the changed conditions. For instance, some species will be able to migrate to regions where the climatic conditions are more suitable to their requirements, if no major obstacles get in the way and if there is enough time. Agriculture will be able to adapt to the changed conditions by adapting its selection of varieties, species and management methods. Other changes, however, will leave irreversible damage behind, although they too will proceed slowly. For instance, many of the smaller glaciers will have disappeared by mid-century, which will change our mountain landscape permanently. Species that cannot migrate to climatically favourable regions will also disappear entirely. In their place, foreign species will immigrate, which as a result of the expected time lag will also lead to permanent long-term changes in the landscape. Skiing regions at lower elevations will not be able to be run economically due to the absence of snow. Some changes, such as a milder climate, will be perceived as positive and offer opportunities for humans. For instance in our latitudes, agricultural yield increases will be possible with a more moderate climate. In various regions, particularly in the mountains, summer tourism will profit from a warmer and drier climate (catchword: “summer retreat”). In winter, the demand for heating energy will decrease considerably.

Whether or not the local impact of climate change to 2050 will have a negative effect on humans and ecosystems, that is, how vulnerable they are, depends on three factors: Firstly, to what extent a system is exposed to climate change (e.g. a heat wave affects the people in the lowlands far more than those in the mountains); secondly, how susceptible a system is to the effect in question (e.g. old people’s health reacts more sensitively to out of the ordinary hot spells than young people’s), and finally; on how well a system can adapt to changed conditions (thus hot spells will affect even susceptible people less if they can retreat into cool rooms). As a rich, politically stable country with a high level of education and great technical, financial and institutional opportunities, Switzerland basically possesses a great capacity for adaptation in the face of climate change. But the necessary adaptation will neither take place nor be financed automatically, and whether it can reasonably be expected or not will have to be discussed on a case-by-case basis. What is certain is that the sooner we recognise our weak points and decide on smart adaptation strategies, the lower the vulnerability of our country will be.

We are used to swift, conspicuous and at times drastic political, economic and social changes, and we have numerous societal adaptation mechanisms at our disposal. In comparison to this, many effects of climate change will start imperceptibly, often with a time delay and occurring in the background, like, for instance, the gradual change of the species composition of a forest, the warming of rivers or the ear-

lier occurrence of the last late frost in spring. However, they will challenge us in a unique way. This is because our patterns of economic utilisation of ecosystems and of space, our architecture and household technology, our daily and seasonal organisation of working hours and leisure time, etc., which we have developed in the past decades or centuries, are based on the assumption of a constant climate within human time horizons and with more or less well-known fluctuation patterns and predictable frequencies of extreme events. With climate change we are faced with changes in these background conditions of our economy and our social life that are not precisely predictable in every detail. Therefore, new and very flexible adaptation mechanisms will be required.

Spontaneous, superficial adaptations will not suffice or will be counterproductive. For instance, we will possibly tend to adapt to higher temperatures and more frequent hot spells by increasingly installing individual air conditioners in existing buildings. This strategy will solve the problem superficially (humans will bear the heat better and remain efficient) but will drive climate change – to the extent that the additional electricity demand is covered by, amongst others, fossil energy sources (EU electricity mix) – and therefore does not represent a sustainable form of adaptation. A sensible long-term strategy will include a consistent push towards modernising current building stock in the direction of the passive house, which offers a comfortable room climate in hot and cold weather, with minimal external energy input, together with the daytime reorganisation of working hours. Although such adaptations are more demanding and require more persistence, they are to be preferred because they simultaneously contribute to the preventive avoidance of major changes in climate.

3. Extreme events

Hot and dry summers as experienced in the year 2003, could already become distinctly more frequent and even more extreme by 2050. It is foreseeable that there will be more precipitation in winter and less in summer, with an expected higher variability and an increase in precipitation intensity. The damage risk for infrastructure such as transport networks, tourist facilities and communities will increase.

Adaptation to mean warming levels and the change in mean precipitation will by their very nature take place relatively slowly. Adaptation to changes in extreme events and the associated natural hazards, however, mostly have to be carried out swiftly and are, in addition, less easy to estimate. As already shown in an earlier report by the OcCC on extreme events and climate change1, it is far more difficult from a scientific perspective to make reliable and concrete statements about the changes in extreme events. Nevertheless, the discussions in expert committees and at workshops have shown that the greatest impact on the areas studied here will come from two types of extreme events: Heat in combination with drought, and heavy precipitation in combination with higher temperatures. There will also be the associated natural events such as landslides, floods, etc.

Heat and drought

Hot and dry summers as experienced in the year 2003, could already become distinctly more frequent and even more extreme by 2050 (see Background chapter). Besides a considerable warming, it is also expected that there will be increasing variability in the summer climate, with a substantial increase in extreme heat waves. Agriculture, natural ecosystems on land and water, Rhine shipping and energy production will be seriously affected (see section 4). Measures to cope with the conflicts arising from competition associated with water shortage will have to be developed.

The effects are particularly noticeable for human health, mainly that of elderly people, those in care and sick people but also for the productivity of the working population. Education about measures to be taken at home, in the organisation of daily life and the support of long-term care patients is an important and simple adaptation measure. Adaptation of construction methods for apartments and office buildings is urgent but will require correspondingly long lead times (see section 5). Adaptation measures that consume additional electricity are seen as inappropriate in any case, since it can be assumed that the European electricity market will be under particularly high pressure in such summers.

Hydroelectric power production in run-of-river power stations will be greatly reduced, since on the one hand, there will be droughts and on the other, there will be little meltwater available in summer from the few glaciers and the scarce snow reserves. Thermal power plants that rely on river-water cooling, such as our nuclear power plants, could produce electricity only to a limited extent, since firstly, there will be too little cooling water available, and secondly, the heated river water should not be artificially heated even more. In addition, with stable high-pressure weather conditions over Europe, wind power will also only be available to a very limited extent.

Tourism in the mountain regions could profit from a revival of people seeking a summer retreat. Many heat-afflicted people from the towns will spend the summer at the lakeside or in the cooler mountain air. Heat and drought will mean an additionally increased probability of forest fires, not only on the southern side of the Alps and in the Valais but as a new phenomenon also on the northern side.

More intensive precipitation and increased temperatures

Precipitation will change all over Switzerland. According to the model calculations available, there will be more precipitation in winter and less in summer. This means that the seasonal variations will become smaller. The average annual precipitation may well decrease by about 5% (i.e. by 75 mm in the north and 120 mm in the south). The variations from year to year or month to month could continue to be considerable and sometimes even intensify. This will mean increasingly drier or wetter periods. Precipitation intensity may well increase in winter and probably also in summer.

As a consequence of this, the frequency of heavy precipitation will increase, particularly in the winter half-year. For summer, the current predictions are less clear. The model results show that precipitation as heavy as it occurs only every 8 to 20 years nowadays, will occur every 5 years on average by the end of the century. However, more intense precipitation does not automatically mean dangerous river levels or even flooding. In the midlands and the Jura as well as the foothills of the Alps below about 1500 m a.s.l., where already today there is danger of flooding in winter/spring, the danger of floods could increase. This is also particularly true for the neighbours further down the Rhine. Associated with this, the rise of the mean snow line caused by warming will also affect the discharge regimes of rivers and their potential for floods.

Natural hazards: Rockfalls, landslides and mudflows

The retreating glaciers leave new large and loose masses of debris in their wake. Additionally, the ground gets warmer: In particular, permafrost will partly thaw and result in landslides and smaller or also larger rockfalls. The new loose debris will accumulate in ditches and riverbeds and, in the case of floods that are triggered by more intensive precipitation falling as rain up to higher elevations, may be carried away and reach valleys and inhabited areas as mudflows. Erosion, bed-load discharge and sediment deposition are very often responsible for the serious damage caused by floods. The potential for such events will increase considerably, however only in mountain areas.

Wet soils on steep slopes can come down as landslides in the case of heavier precipitation. Since in winter in the future, there will be more,

possibly heavier precipitation and at higher altitudes, more of the steeper slopes will be affected and therefore more of this type of landslide will occur. This will mainly affect the foothills of the Alps. Altogether, there will therefore be an increased risk of damage to infrastructure such as transport networks and tourism facilities in mountain areas. In addition, human health may be endangered, be it by injury and death, or also by the psychological effects of the increased risk or loss of property and belongings or of closely related people.

Natural ecosystems such as protection forests can temporarily lose their protective capacity due to this greater volatility. However, in general this will usually not represent a fundamental risk for the ecosystems themselves. However, because of the reduced functionality of the ecosystems, it will affect to a much greater extent the security of human settlements and transport networks.

In particular in the climatic border zones in the mountains, with thawing permafrost or at dry sites, chain reactions including pest attacks can weaken ecosystems. A variety of combinations of species suitable for the particular location can increase the resistance and therefore also the security of human living space in the mountains.

Adaptation measures for the protection of people include comprehensive prevention in adapting land use by avoiding dangerous locations, biological measures such as the management of protection forests and protective measures in the construction industry. Besides prevention, organisational measures before and immediately after the event are also of vital importance. These comprise the introduction and maintenance of warning and alarm systems, and well functioning evacuation and emergency assistance.

4. Water cycle and water resources

In winter, there will more frequently be rain instead of snow up to medium elevations. This will affect winter tourism. In addition, about 75% of the water stored in glaciers will be lost. It can be expected that competition for water will increase during dry periods. The expected changes in discharge will increase the potential for flooding, particularly in winter and spring.

The effects of climate change on the water cycle and water management by 2050 are discussed in the Background and Water Management chapters. The most important changes are summarised here once again:

In winter, there will more frequently be rain instead of snow up to medium elevations and the snow cover will decrease. However, at high elevations (above about 2000 m), where it usually snows in the winter half-year, the snow cover will become thicker due to the expected increase in precipitation.

Three quarters of the water resources that are bound up for the long term in glaciers, will probably have disappeared already as early as 2050. This is about 40 cubic kilometres of water.

Evaporation – the loss term in the water cycle – will continue to increase with the rise in temperature. In summer, more frequent drought periods will prevent water supplies from increasing and, for instance, in the case of glaciers even contribute to an accelerated ice loss. Thus, altogether, the available water resources in Switzerland will decrease.

In winter and spring, there will be more water in the rivers and streams, particularly at medium and lower elevations. More intense heavy precipitation may lead to greater high water levels, above all in the midlands and the Jura, as well as

in the foothills of the Alps below about 1500 m a.s.l. The groundwater levels will be high everywhere. In summer and autumn, less water will flow on average than today. Primarily during more frequent drought periods, the rivers in the midlands and in the Jura but partly also in the mountains will hold significantly less water. In addition, smaller streams may almost or entirely dry up. In particular in the lower reaches of larger rivers, there will be lower water levels in late summer and autumn. With the scarcity of water, the groundwater levels will sink. This will have a critical effect, particularly on smaller aquifers. The trend in flooding is uncertain. In the case of a combination of unfavourable weather conditions, there may be massive flooding also in summer.

Consequences for various water users

The experiences gained in the heat wave summer of 2003 have clearly shown the sensitivity of the Swiss water usage to dry summers.2,3 The changes in the water cycle will affect the different areas in the following ways:

In the energy sector, there will be less water available for hydroelectric power production; the losses may amount on average to about 7% of today's output. However, the supply of water will be more evenly distributed over the course of the year. During periods of drought, there will be less and only relatively warm water available for the (continuous flow) cooling of thermal power plants (e.g. nuclear power plants) or for industry. Losses in electricity production are therefore to be expected. Adaptation measures are difficult. The lost electricity production from hydropower must not be compensated for by fossil energy, since otherwise an undesirable feedback mechanism would be set in motion, which would undermine the mitigation efforts.

In agriculture, the potential annual production of meadows will increase with moderate climate change, due to the longer vegetation period. However, there will increasingly be critical groundwater levels and summer droughts in Switzerland as well as elsewhere. Irrigation would then become necessary at many locations. In view of the limited water availability in drought years, the cultivation of less water-demanding plant varieties will be preferable to irrigation.

Of the natural ecosystems, the low moors in particular will come under pressure and be reduced in area through lack of water. This may well produce a decline in the number of species. Other wetlands will be less affected. Due to the retreat of the glaciers and snowfields, new areas will emerge that will slowly be settled. Overall the flora and fauna will approach that of the Mediterranean. In the forest, productivity will begin to fall due to water shortage. With increasing frequency and over longer periods, the forest ecosystem, which formerly served as a carbon sink, will become a carbon source. As this occurs, less carbon will be stored in the soil in the long term and the affected soils will temporarily break down considerable amounts of organic substances, which will also affect mitigation measures. Countermeasures would be an expansion of forest areas, as well as a more comprehensive targeted sink management of current forest stands.

Rhine shipping will from time to time in summer and autumn be massively constrained in its transport capacity. This will result in an undesirable switch to more expensive and more energy-intensive means of transportation, which, again, is contradictory to mitigation measures in the area of transportation.

Altogether, above all during drought periods, there will be new competition for water in the small and medium rivers of the midlands: Agriculture would like to pump irrigation water; the demand for cooling water will increase; the exfiltration rate of rivers and streams will increase due to sinking groundwater levels; the supply of drinking water will take more water from the total system due to the increased demand for drinking and irrigation water; and ecosystems like rivers and streams will need sufficient and not overheated water in order to

survive. In addition, countries downstream also have legitimate claims on a sufficient water supply. It is quite possible that neighbouring countries will demand an increased water level when there is low water (management of lakes and reservoirs) and the supply of greater amounts of drinking water.

In all areas, effects on mitigation policy have been identified. They can partly be influenced, and partly not. Relevant sustainable strategies will have to be developed well in advance. Important points are: Who has claims on water, who will pay how much? In dealing with these, consumers (irrigation, drinking water), users (cooling water, hydroelectric power production) and nature will have to be considered. Will an individual canton or the Federation decide on the supply of significant amounts of drinking water to neighbouring countries? Who will negotiate with neighbouring countries who border on waterbodies regarding claims on overall water management?

5. Space

The spatial planning and building sectors have to adapt to the expected changes, to take action in good time and to make the necessary adjustments. Transport networks and infrastructure are exposed to increased dangers due to climate change.

The spatial structure of Switzerland determines the framework conditions for society and its robustness or susceptibility to future climate changes. In the area of settlements, buildings and infrastructure changes are associated with very long time scales (typically 30 to 100 years). It is precisely because of the long lead times that spatial planning and building not only face a particular challenge but also an opportunity to focus on sustainability.

Settlement structure

Already today, the settlement structure in Switzerland shows the characteristics of a "Netzstadt". Its development is not primarily determined by climate change but by factors such as demography, economics and the demand for land for settlements. On the other hand, an ecological approach to settlement development could contribute considerably to the attainment of adaptation and mitigation targets. Decentralisation, in the sense of creating strong regional centres with the possibility of satisfying material and intangible needs at a regional level, will shorten transport routes and may increase the degree of self-sufficiency with regard to basic resources such as energy, food and building materials.

Buildings

In buildings of today's standard, the comfort of living and working is affected adversely on hot days if there is no cooling. Good insulation of the building shell not only considerably reduces the energy required for heating but also, above all, for cooling. In summer, heat accumulation will increase, especially in office buildings, since the heat created by people, machines and lighting occurs during the hot time of the day and cannot be dissipated to a sufficient extent from most of today's buildings. In residential buildings, adapted construction can usually make cooling devices unnecessary. In office buildings, the combination of free cooling systems with, for instance, solar cooling offers the possibility of guaranteeing the temperature ranges required to ensure productivity in the workplace with less additional energy. The heat still required should be provided by heat pumps in combination with solar heat, without fossil energy. Geothermal probes can also dissipate the accumulating heat in summer under ground. In addition, measures to protect against direct solar radiation in summer and to protect the building shell against extreme weather events, and the avoidance of extremely exposed locations will become necessary.

Transport networks and infrastructure

Transport networks and infrastructure will be exposed to increased risks due to climate change. In the area of rail traffic, there is the risk of embankment instability, damage to contact wires due to weather events and lateral displacement of rails. Here just as in road traffic, delays due to flooding, landslides and avalanches are to be expected. Besides the immediate damage, there will be an increase in economic losses and costs due to disrupted transport routes and lengthy detours in the affected regions. As well as suitable protection measures, an important anticipatory mitigation measure will consist of generally counteracting a further increase in transport requirement per inhabitant, or achieving a reduction of it via a multimodal, preferably environmentally friendly system of efficient carriers with lowest emissions, in coordination with the development of settlement structure. Extreme precipitation events not only cause damage to obviously exposed areas by flooding but also have indirect consequences, for instance due to increased backwater in sewage systems.

Forest and timber industry

In Switzerland, forests have a wide variety of functions that range from protection zones and the conservation of biodiversity to recreational areas and forestry production. There is consensus that a more intensive use of wood than is practised today is reasonable and desirable for sustainable forest management. Energy wood can make a contribution to the electricity and fuel supply in Switzerland from domestic regenerative energy, which should be utilised in order to increase the degree of self-sufficiency, diversification and therefore security of supply. This would be of greater importance quantitatively, if energy production efficiency were generally increased at the same time. Qualitatively first-class wood as a raw material in the building and other industries can additionally replace emissions from fossil fuels, which quantitatively would be of even greater importance. It is therefore the responsibility of spatial planning to set aside protection and recreational areas on the one hand, and on the other to make possible reasonable timber production in the remaining forest areas for the forest and timber industry, wherever economically and ecologically suitable.

Agriculture

Agriculture has an important role in the sustainable design of the Swiss ecosystem. The production of staple foods will be primarily influenced by the opening of markets but also by the changed climatic conditions (summer drought periods). Arable farming will become more difficult, fodder production, which is important to Switzerland, may profit. The extensive cultivation of second-generation energy crops, with their modest need for soils, fertilisers and water, will remain a niche production. The breeding of agricultural crops adapted to the climate will gain great importance.

6. Changes for humans

More frequent heat waves will negatively affect health. In addition, especially during hot spells, a noticeable decrease in human efficiency and productivity is to be expected.

What are the most important changes for humans? What effects will climate change have on life in Switzerland in the year 2050? Without claiming to be comprehensive, the following lists some already foreseeable changes:

Climate affects attitude to life. The experience of the summer of 2003 showed that during periods with hot days and warm nights, the lifestyle of the Swiss becomes more Mediterranean. During the day, people will increasingly prefer to stay in cool interior rooms and in the shade. Life outside will take place more and more in the evening hours. People who enjoy summer will benefit at first, however, more frequent hot summers are expected to become a burden to a growing proportion of the population.

Winter sport will have to come to terms with worse conditions. Increasing precipitation with simultaneously higher temperatures means that there will be more rain in the midlands. Regular winter sport will be possible only at higher elevations. The expensive infrastructure and the long journey will make snowboarding and skiing even more expensive pleasures.

Above a certain temperature, efficiency is affected. In particular during hot spells in summer, a noticeable decrease in human efficiency and therefore in economic productivity are to be expected. The working environment will adapt to the increase in heat waves. In the service sector, people will increasingly be working in air-conditioned offices. Work outside may be interrupted (siesta) during the midday heat. Some businesses could increasingly close for holidays in midsummer and try to postpone particular kinds of work until cooler periods.

The increase in heat waves will have an adverse effect on health. The incidence of food-borne diseases will also increase with the increase in temperatures. This will primarily affect physically and mentally impaired people, the elderly suffering from chronic illnesses, and people who are economically disadvantaged.

As a result of the warming and the increase in hot spells, the quality of living conditions will decrease in older buildings (flat roofed buildings from the 1970s) during the summer months. The demand for comfortable modern apartments with a good room climate will increase. Inhabitants of older buildings will increasingly install mobile air conditioners and power consumption for air conditioning will increase. At the same time, rising energy prices and local, temporary water shortages will lead to a more economical use of resources.

7. Concluding remarks

Most changes that are described in this report may initially seem unspectacular and at first sight unimportant. But this should not hide the fact that many changes only show their true extent when more closely examined; they are cumulative, sometimes irreversible and only herald other changes still to come. In addition, they do not represent stable conditions but merely present a snapshot of the development towards far more drastic changes.

Climate generally changes only slowly. Delayed effects are not yet visible and are only now coming into being. An illustrative example of this is the runoff in catchment areas that today are strongly shaped by the summer glacier melt. In the medium term, the runoff will increase in spite of decreasing summer precipitation due to the accelerated glacier melt. However, in the second half of this century, many small and medium-sized glaciers will already have disap-

peared and the supply of glacier water will cease entirely (depending on the situation in individual valleys and catchment areas). In combination with reduced summer precipitation, this will lead to a considerable decrease in discharge in summer. A summer in 2050 with temperatures similar to those in 2003 would accordingly result in much more serious water shortages than was the case in 2003. Towards the end of this century, without effective climate protection, most of the large glaciers will also melt so that even "Europe's water reservoir" could regularly suffer from water shortage.

Switzerland has a long tradition of adaptation to natural hazards. Floods, landslides and rockfalls have shaped our landscape and our handling of it. Over the centuries, we have settled in mountain valleys and along rivers at locations where the risk is lowest. Settlements and transportation routes have been protected against floods, rockfalls and avalanches by means of protective structures. The assumed stability of the hazard situation will change with climate change, so that its periodic re-examination will be particularly necessary for settlements and transportation routes in the mountains.

In the future, our country will continue to have the financial means and the technological know-how to adjust to the changed conditions if they do not exceed a certain extent. These adaptation costs will increase in the coming years. We will be able to choose between different strategies and it will be important to assess the various possibilities against the background of all possible effects. It will be indispensable to have a long-term climate strategy, which will include climate protection targets (by emission reductions) as well as targets for the adaptation to changed climatic conditions and protection against changed natural hazards, in order to effect a coherent climate policy.

Switzerland will also be affected by the global effects of climate change. Firstly, we will be directly affected due to our trade relations and dependence on raw material suppliers in various

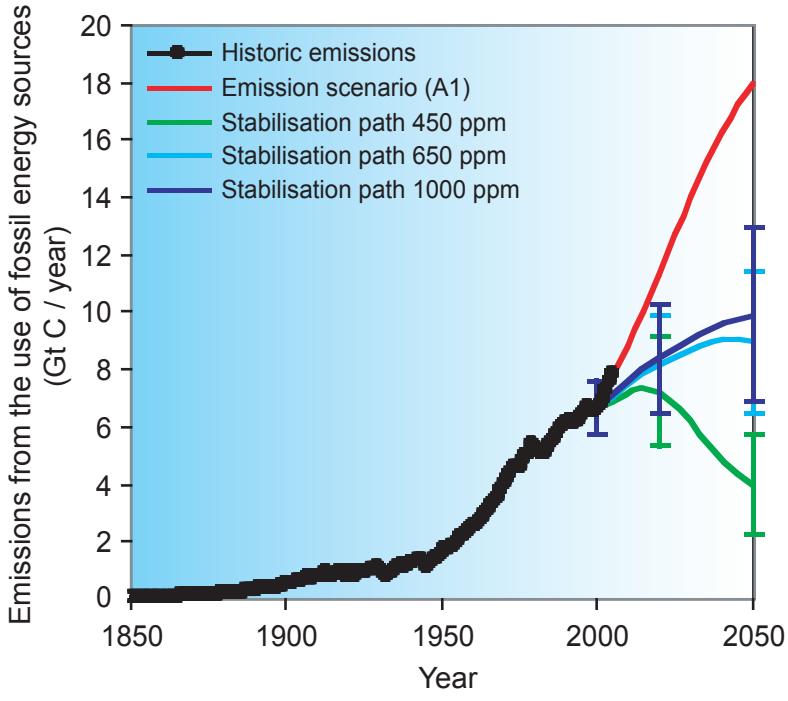

Figure 1: Emission trends according to different emission scenarios. A1 approximately describes today's rapidly growing global economy with a mix of energy sources. In this scenario, the temperature will continue to increase very rapidly for centuries. The other scenarios assume a stabilisation of greenhouse gases at 450 ppm, 650 ppm and 1000 ppm with a temperature increase of about 2 °C, > 3 °C and > 5 °C (pre-industrial CO2-concentration ~280 ppm).
Source: M.R. Raupach, 2006[5])

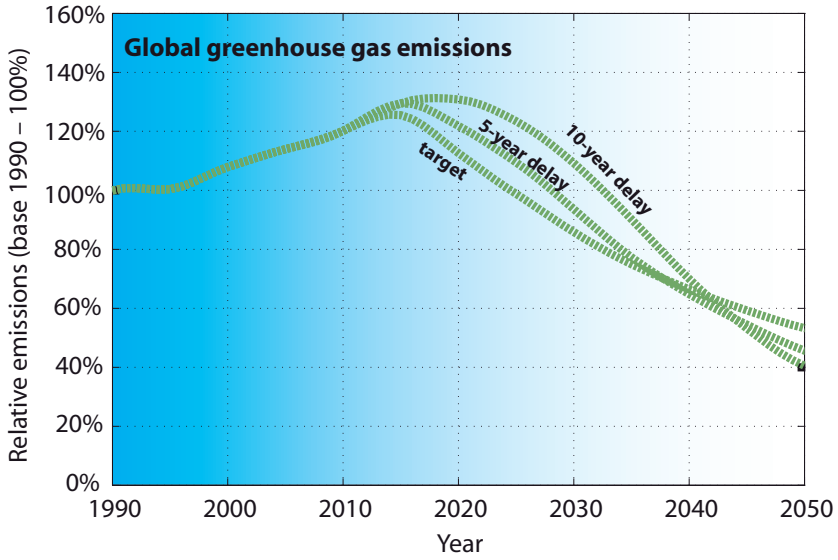

Figure 2: In order to stabilise the global temperature at +2 °C (by 2100), a reduction of global greenhouse gas emissions by 50% (based on 1990 levels) will be required by 2050. This demands immediate action. A delay in taking reduction measures will require a greater and more rapid reduction of emissions in order to reach the target. Thus, annual reduction rates will have to be increased by about 1% for every 5 years of delayed reduction measures.
Source: Modified from Meinhausen et al.[5] and Elzen & Meinhausen[6])

world regions where climate damages may be critical. Secondly, our country will be affected as part of the global economic system, which could suffer considerable damage through climate change. International studies (e.g. Stern review, 2006)7 estimate the economic damage due to climate change at 3-20% of the global GNP by 2100. Damage of such an extent would destabilise the global economic system. This would probably also lead to considerable social upheavals, massive population movements and global political conflicts (among others about water), which might well also gravely affect the Swiss economy.

The only long-term way of limiting the extent of climate-induced consequences consists of combating climate change as the cause. In this regard, the international community is attempting a first step towards a more climate-friendly future with the Kyoto protocol. However, it has always been clear and is now quite evident that these efforts will fall short. Global emissions are currently increasing by 3.2% per year and are developing according to scenario A1 (fig. 1, fossil energy mix). Unfortunately, there are few signs of a comprehensive turnaround towards an improvement in climate change policy. This is, however, urgently required, if a stabilisation target in accordance with the UN climate convention of 1992, which aims to prevent dangerous anthropogenic disturbances of the climate system, is to be attained. The earlier action is taken, the smaller the effects on the climate system and the global economy can be expected to become. However, if emission-reducing measures are delayed, then the reductions required will have to be achieved within a shorter time. Additionally, massive damage will have to be compensated. This can become an unsolvable task, since the economy would have to change over to low-emission production in a very short time. This fact is clearly shown in figure 2.

Therefore, hope remains that on a national as well as on an international level, the decision makers in politics and the economy will recognise the full extent of the problem and manage to decide on a concerted, consistent course of

action. It is an open question, to what extent purely economic considerations will play a role in this or whether ethical aspects will also be taken into consideration, and the answer will vary according to the particular point of view. However, it is generally acknowledged as a precautionary principle that today and in the future, the feeling of responsibility towards humans and the environment, which is of particular importance in climate protection, must play a more central role in relation to our actions. Only with adequate foresight will we succeed in reacting adequately and in time to the challenge posed by climate change.

Literature and notes

1 OcCC (Hg.). Extremereignisse und Klimaänderung. Bern, 2003.

2 BUWAL (Hg.). Auswirkungen des Hitzesommers 2003 auf die Gewässer. Bern, 2004.

3 ProClim (Hg.). Hitzesommer 2003 – Synthesebericht. Bern, 2005.

4 M.R. Raupach. UNESCO-SCOPE: The Global Carbon Cycle. UNESCO-SCOPE Policy Briefs, Oct. 2006. No.2, Paris.

5 M. Meinhausen, B. Hare, T.M.L. Wigley. D. van Vuuren, M.G.J. den Elzen, and R. Swart. Multi-gas emissions pathways to meet climate targets. In: Climatic Change, 75(1-2), 2006, 151–194.

6 M. den Elzen, M. Meinhausen. Multi-gas emission pathways for the EU 2°C Climate target. In: H.J. Schellnhuber (Hg.). Avoiding dangerous climatic change. Cambridge University Press, 2006. 299–311.

7 The Economics of Climate Change – The Stern Review, Cambridge University Press, 2007.

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