2018 | Environmental Studies Climate

Climate-related risks and opportunities

A synthesis for Switzerland — short version





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Extended summary of the publication "Klimabedingte Risiken und Chancen. Eine schweizweite Synthese" www.bafu.admin.ch/uw-1706-d

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Abstracts

The present brochure is the short version of the synthesis¹ which identifies and prioritises climate-related risks and opportunities for Switzerland until 2060. The results from eight regional case studies conducted with the participation of numerous experts from science, industry and administration have been merged into a Switzerland-wide synthesis and supplemented. On the one hand, they serve the review and further development of the Confederation's adaptation strategy. On the other hand, the cantons and regions can use the results, along with the methodology used, to develop their own strategy and adaptation planning.

Keywords:

Climate change, impacts, adaptation, risk analysis, risks, opportunities

Die vorliegende Zusammenfassung des Berichts¹ identifiziert und priorisiert die klimabedingten Risiken und Chancen für die Schweiz bis 2060. Die Ergebnisse von acht regionalen Fallstudien wurden unter Mitwirkung zahlreicher Experten aus Wissenschaft, Wirtschaft und Verwaltung in einer schweizweiten Synthese zusammengeführt und ergänzt. Sie dienen einerseits der Überprüfung und Weiterentwicklung der Anpassungsstrategie des Bundes. Andererseits können sie, zusammen mit der verwendeten Methodik, von Kantonen und Regionen genutzt werden, um eine eigene Strategie und Anpassungsplanung zu entwickeln.

Stichwörter:

Klimawandel, Auswirkungen, Anpassung, Risikoanalyse, Risiken, Chancen

Le présent du rapport¹ répertorie et priorise les risques et opportunités liés au climat susceptibles de se présenter en Suisse d'ici 2060. Établi avec le concours de nombreux experts issus de l'administration ainsi que des milieux scientifiques et économiques, il regroupe et complète, dans une synthèse à l'échelle de la Suisse, les résultats de huit études de cas régionales. Il sert non seulement à vérifier et à poursuivre le développement de la stratégie d'adaptation de la Confédération, mais peut aussi être utilisé par les cantons et les régions pour élaborer leur propre stratégie et leur propre planification en matière d'adaptation.

Mots-clés:

changements climatiques, impacts, adaptation, analyse des risques, risques, opportunités

Il presente riassunto del rapporto¹ identifica i rischi e le opportunità legati ai cambiamenti climatici per la Svizzera e fissa le priorità da qui al 2060. A tal fine sono stati riuniti in una sintesi nazionale e completati con la partecipazione di numerosi esperti del mondo scientifico, dell'economia e dell'amministrazione i risultati di otto casi di studio regionali. Da un lato tali risultati servono a verificare e sviluppare ulteriormente la strategia di adattamento della Confederazione e dall'altro i Cantoni e le regioni possono utilizzarli, unitamente alla metodologia adottata, per elaborare la loro strategia e pianificare il loro adattamento.

Parole chiave:

cambiamenti climatici, impatto, adattamento, analisi dei rischi, rischi, opportunità

Introduction

The CO_2 Act of 23 December 2011 assigns the Confederation the task of coordinating measures for the prevention and management of damage that may arise as a result of the increased concentration of greenhouse gases in the atmosphere. At the same time it is to provide for the development and procurement of the bases necessary to take these measures.

The synthesis is the result of a comprehensive risk assessment that makes an important contribution to this task. It is based on eight case studies that have examined the consequences that can be expected if the global rise in greenhouse gas emissions in the next few decades continues to an extent comparable to that of the past. The results of these case studies were transferred to the major regions of Switzerland and used as a basis for determining the priority climate-related risks and opportunities for the country. They provide guidance for the further development of the Federal Council's first adaptation strategy adopted in 2012 and make it possible to focus efforts even more precisely on those areas where the greatest benefit is to be expected. In addition, a methodology is provided and initial options for action identified so that cantons and regions can now further develop their own strategy and adaptation plan.

The report relies on the best information currently available about the effects of climate change on Switzerland. It recognizes that there are knowledge gaps about future climate conditions and their impacts on nature, society and the economy. At the same time a great deal is at stake: for human health, for certain sectors, but also for Switzerland's natural habitats and biodiversity. Remaining inactive in this situation would be irresponsible. Not only the existing and emerging risks of climate change must be taken into account, but also the arising opportunities must be seized.

Around 360 science, industry and administration experts have participated in elaboration of the present risk assessment. They have contributed their expertise to the development of methods, participated in workshops, commented on draft reports or provided information on specific questions. It is this spirit of openness and willingness to cooperate across professional and institutional boundaries that is needed for Switzerland to be prepared for the challenges associated with climate change.

Summary

The climate in Switzerland has changed in recent decades. The impacts on humans and the environment are already evident today. They may become more pronounced as climate change advances.

In order to contribute to limiting the global rise in temperature, thereby avoiding the most dangerous effects of climate change, Switzerland is pursuing an active policy of reducing greenhouse gas emissions. As a complement, the Federal Council has adopted its strategy for adaptation to climate change, consisting of two parts (FOEN 2012, FOEN 2014). Their goal is to reduce existing risks and minimise future unavoidable risks. In addition, the opportunities of climate change should be exploited and Switzerland's adaptive capacity increased.

Climate change affects nature, society and the economy in several ways. In order to use the limited resources efficiently and effectively, priorities must be set. This allows the Confederation, cantons, municipalities and other stakeholders to implement adaptation measures in a coordinated manner.

As the basis for adaptation to climate change, the Federal Office for the Environment (FOEN) has assessed climate-related risks and opportunities across Switzerland. Eight case studies were conducted in the cantons of Aargau, Basel-Stadt, Fribourg, Geneva, Graubünden, Jura, Ticino and Uri, which cover the six major regions Jura, Swiss Plateau, Foothills of the Alps, Alps, South of the Alps and large urban zones. On the one hand, the risks and opportunities were determined under today's climatic conditions. On the other hand, their extent by 2060 (reference period 2045–2074) was estimated using a climate scenario that assumes strong climate change.

No new climate projections or model calculations were made for the case studies. The results are based on available research results and publications that have been merged into a single, cross-sectoral framework.² The development of the case studies involved a broad

expert process involving around 360 professionals throughout Switzerland.

The synthesis³ of climate-related risks and opportunities is based on these case studies. In addition, further findings from the scientific literature as well as additional expert knowledge were considered for the synthesis. The result is a comprehensive list of risks and opportunities (see Annex A1) and the identification of Switzerland's priority climate-related risks and opportunities. The present brochure is a short version of this report.

Figure 1 shows the 12 so-called challenges⁴ and around 30 priority risks and opportunities that make up Switzerland's "risk landscape" in adapting to climate change. Roughly summarized, the following conclusions can be drawn from the figure:

- There are significantly more priority risks (left column) than opportunities (right column).
- Several challenges (especially heat, natural disasters, and diseases) affect the health of the Swiss population.
- For agriculture, energy and tourism, there are both risks and opportunities. The effects of climate change abroad on the economy and society in Switzerland must also be considered.
- There are significant risks as well as some opportunities for biodiversity. Certain species and habitats are among the losers, others the winners of climate change.

² Annex A2 and the separate methodological report (Holthausen et al. 2013) document in detail how climate-related risks and opportunities were identified and evaluated.

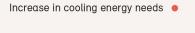
³ published in German (www.bafu.admin.ch/uw-1706-d), French (www.bafu.admin.ch/uw-1706-f) and Italian (www.bafu.admin.ch/uw-1706-i)

⁴ On the meaning of the term "challenge", see Chapter 2 in the Federal Council's adaptation to climate change strategy (FOEN 2012).

Risks

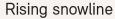
Greater heat stress

- Impairment of human health
- Loss of performance at work





- Harvest losses in agriculture
 - Danger of forest fire
 - Water shortage •
- Decrease in summer hydraulic energy production •



Yield losses in winter tourism •

Greater risk of flooding

- Personal injuries Property damage •
- Decreasing slope stability and more frequent mass wasting
 - Personal injuries Property damage •
 - Impaired water, soil and air quality

Change in habitats, species composition and landscapes

Degradation of biodiversity •

Spread of harmful organism, disease and alien species

- Impairment of human health
- Impairment of the health of farm animals and pets Harvest losses in agriculture

 - Deterioration of forest products and services •

Wild card risks

Risks that are difficult to assess

Climate-related impacts abroad

Indirect risks •

Risks or opportunities

Ambiguous impacts: consequences not (yet) clearly positive or negative.



Change in storm and hail activity

- Personal injuries
- Storm damage
- Hail damage

Positive as well as negative impacts

Positive as well as negative impacts







Positive as well as negative impacts

Opportunities



Improvement of site conditions

- Decrease of heating energy needs
- Increase in summer tourism revenues
- Increase in crop yields in agriculture



- Increase in winter energy production
- Decrease in sow-related property damage and maintenance costs



Change in species composition and landscapes



Priority climate-related risks and opportunities for Switzerland

Twelve pictograms symbolise the so-called challenges of climate change. They are organized according to risks (left, red column) and opportunities (right, green column). For one challenge (storm and hail activity), it is still unclear at the present time whether it will be associated with risks or opportunities (middle, grey column). Assigned to the challenges are priority risks (red dots), priority opportunities (green dots) or cases still unclear (grey dots).

Certain challenges – the rising snowline, changes in habitats, species composition and landscapes as well as climate-related impacts abroad – include both risks and opportunities. They are identified by a connecting line between the left and right columns. The challenge "Improvement of site conditions" is a collective term for various opportunities of climate change.

The example of agriculture clearly shows that the effects of climate change can lead to both, risks and opportunities. While increased drought can lead to serious crop losses (= risk), rising average temperatures can generally have a positive effect on the growth conditions of agricultural crops (= opportunity).



Indirect opportunities

In the following sections, the priority risks and opportunities identified in Figure 1 are briefly characterized in the context of the associated challenges. The description refers to the expected impacts in the period around the year 2060.

Climate models allow a reliable estimation of the effects of climate change on the development of **temperatures**, **rainfall** and the location of the **snowline**. The scientific understanding of future development is significant here and the direct effects on society and the economy are relatively well researched. Concrete adaptation measures can be planned and are already being implemented today. Although the negative effects of climate change predominate, there are also opportunities, especially in terms of the impact of higher average temperatures on site conditions.



Greater heat stress can severely impair the health of some population groups. Especially at lower elevations and in large urban zones, the population will suffer from more frequent and

intense heat waves in the summer. Heat waves have already claimed numerous lives in the recent past. Adaptation possibilities to heat waves are known. Measures that entail additional cooling energy needs should be avoided if possible in the interest of climate protection.



Increasing levels of drought can in the future lead more frequently to local, temporary water shortage and exacerbate conflicts over use. Harvest losses in agriculture and the dan-

ger of forest fires can also increase. Drought exacerbates the competition for drinking water, water for agriculture, industry, energy production and fire service and residual water to preserve habitats in watercourses. Conflicts over use can be avoided with a comprehensive and forward-looking management of water resources.



Less snow endangers the economic efficiency of lower-lying winter sport areas, other areas benefit. The rising snowline leads to a decrease in snow guarantee and shortens the snow

season. Already today, many slopes are supplemented with artificial snow. Artificial snow production is very energy and water intensive, which results in high costs and also does not represent a sustainable solution. Opportunities may arise for hydraulic energy production in the winter because more precipitation falls in the form of rain. The costs of winter services and road maintenance will tend to decrease.



Rising temperatures offer opportunities for various economic and social areas. Higher mean temperatures promote plant growth if adequate water supply in agriculture and forestry is

guaranteed, lead to a lower heating energy requirement and make the mountain area more attractive for summer tourism. Sensitization of the stakeholders involved is important so that the opportunities that arise are recognized in good time and seized consciously.

The course of **natural hazard events** depends on the interaction of numerous situational factors and the extent of damage they cause is strongly influenced by the change in endangered values. Statements about the effects of climate change are associated with relatively large uncertainties. In Switzerland, natural dangers are countered by means of integral risk management. With climate change, localities/regions and times of loss events can shift and processes can change. That is why it is important to regularly reassess natural danger risks influenced by climate parameters.



Risk of flooding is expected to increase slightly; the period during which floods occur is likely to extend. Changes in precipitation and earlier snowmelt cause the potential flood

season to extend and to shift from early summer into the winter half-year. Settlements are also likely to continue to grow, exposing more and more people, property and infrastructure to risk of flooding. The risk-conscious use of vulnerable areas should therefore be given special attention.



The retreat of glaciers and thawing of permafrost can increase the frequency and/or extent of mass wastings.

Mass wastings such as rockslides, rockfalls and landslides are events

that occur above all away from used areas. They can have serious consequences locally and shift to areas not previously affected by this danger. Changes must be observed and identified early, e.g., along roads and tourist areas in the mountains.

Many of the impacts of climate change on ecosystems can hardly be estimated today. The diverse interactions and dependencies between species, their habitats and natural conditions such as temperature and humidity are too complex. Despite the lack of scientific certainty about the expected effects, conditions can be improved so that potentially endangered species or ecologically valuable habitats are able to adapt to changing climatic conditions.



The change in climate has numerous, mostly negative impacts on biodiversity. Temperature rise and increasing drought are stress factors that worsen the condition of several ecosystems.

Aquatic and alpine ecosystems are especially affected. For individual species and habitats, positive or ambiguous consequences are also to be expected. Intact, sufficiently large and networked habitats are more adaptable to changing climatic conditions. Their protection thus is of great importance.

No robust projections exist regarding the change in **storm** and hail activity. Statements on the spread of harmful organisms, disease and alien species, on so-called wild card risks and on the influence of climate-related impacts abroad on Switzerland are also subject to considerable uncertainty. These challenges are characterized by random events and complex chains of effects which can only be modelled to a limited extent. In addition to further research, what matters is being prepared for surprising developments in the best possible way.



Storms can cause large-scale damage — hail can lead to great losses locally. Heavy storms and hail events are relatively rare, but depending on the course they are associated with

high costs for the public and the private sectors. A climate-related increase in storm and hail activity may only be recognized when having reached a significant level. That is why measures should be taken at an early stage to make the economy and society more resilient to storm and hail damage.



The spread of harmful organisms, disease and alien species increases the risk of human and animal illness. Harmful organisms, disease and alien species can also have a negative

impact on agriculture, forestry and biodiversity. Climate change promotes their dissemination, but freight transport and human travel behaviour play a key role. To ensure early detection, surveillance measures are a priority.



Wild card risks are unexpected events with a high potential for damage. Wild card risks describe imaginable, plausible events, whose probability of occurrence and potential impact are

not easily predictable today. Wild card risks include, e.g., risks due to weather conditions not previously observed in Switzerland or critical chains of natural danger events. Scenario analyses are possible tools for a better preparation for wild card risks.



In the globalized economy, climate-related impacts abroad lead to risks and opportunities for Switzerland. Extreme events can disrupt the production of important commodities,

impact imports and exports and lead to political instability in particularly exposed regions. On the other hand, there are opportunities for Switzerland as a service provider in the field of climate adaptation. In particularly climate-sensitive areas, the influence of world trade disruptions on the security of supply must be considered in a forward-looking manner.

The synthesis documents risks and opportunities of climate change for the 2060 time horizon from Switzerland's point of view and how these are to be weighted from today's perspective. It has become evident that the Federal Council's adaptation strategy (FOEN 2012) does not fully cover existing challenges, risks and opportunities. The change in storm and hail activity, the improvement of site conditions as well as wild card risks and climate-related impacts abroad are also to be considered in the further development of the strategy. In addition, two challenges should be renamed: heat stress is not only relevant in cities and large urban zones and drought is not only an important risk in summer.

The risk assessment as a whole provides numerous findings and methodological tools that cantons and regions can use to develop their own adaptation strategies. The approach to the development of the eight case studies can be applied to other areas, and the results of the case studies and the synthesis can be transferred to comparable geographical areas.

The climate-related risks and opportunities were prioritised from a relatively high bird's eye perspective (nationwide). Locally and regionally, other phenomena may be in the foreground. As soon as new or more detailed information is available or important framework conditions change, the risks and opportunities identified should be reviewed and, if necessary, adjusted or supplemented taking local circumstances into account.

Complex interactions within and between natural and socioeconomic systems, non-linear developments, and unknown tipping points can complicate the assessment of some of the impacts of climate change. New climate scenarios, in-depth research into the various impact areas, and the systematic observation of changes that already manifest themselves will allow further reduction of existing uncertainties and a more precise assessment of the need for action. But it would be unrealistic to expect that a more detailed understanding of the process will soon be available so as to allow for tailor-made adaptation measures for all affected areas.

Despite the uncertainties that exist, the present basis makes it possible to design adaptation to climate change

efficiently and use resources selectively. The spectrum of the risks and opportunities identified is very broad. The required procedures are correspondingly diverse — from improving process knowledge, continuously monitoring known risks to developing or initiating concrete measures. In addition to the proactive management of identified risks and opportunities, the ability to handle unexpected and surprising developments is receiving increasing attention.

A Annex

A1 Complete list of all climate-related risks and opportunities

Listed below are all climate-related risks and opportunities identified in the risk assessment, both the priority (highlighted in bold and marked with a coloured bullet point) and the non-priority ones. All risks and opportunities are assigned to a challenge of climate change and then ranked in the following list.

Redundancies arise when listing the risks and opportunities that affect biodiversity. On the one hand, all are listed under the challenge "Change in habitats, species composition and landscapes". On the other hand, for the sake of completeness, individual risks or opportunities are also mentioned under the other challenges, provided that the corresponding challenges impact biodiversity.

Colour legend:



Risk



Opportunity



Risk and opportunity

Challenge

Greater heat stress



Risk/opportunity

- Increase in the impairment of human health
- · Increase in heat-related mortality
- · Increase in heat-related morbidity (heat stress)
- · Increase in ozone-induced effects due to more frequent incidents of summer smog
- · Increase in risk of skin cancer
- · Impairment of the state of health and/or well-being
- Increase in loss of performance at work
- · Increase in loss of performance at work



Increase in cooling energy needs

- · Increase in cooling needs of buildings
- · Increase in cooling needs of industrial plants
- · Increase in cooling needs of private transport
- · Increase in cooling needs of public transport



Increase in the degradation of biodiversity

· Increase in the deterioration of flora and fauna caused by increased heat stress

Increase in the impairment of the health of farm animals and pets

- · Increase in the mortality of farm animals
- · Decrease in the fertility of dairy cattle
- · Increase in yield losses in animal production
- · Increase in fish mortality
- · Increase in occurrence of zoonosis
- · Increase in costs for the supply of drinking water



Risk



Opportunity



Risk and opportunity

Challenge

Risk/opportunity

Decrease in energy and industrial production

- · Reduction in the use of thermal power plants (incl. nuclear power plants)
- · Decrease in the cooling water capacity of watercourses for industrial processes
- · Decrease in energy production due to lower efficiency

Increase in harvest losses in agriculture

- · Increase in the death rate of young plants caused by overheating of the soil surface
- · Increase in phytotoxic stress caused by high concentrations of ozone in the air
- · Increase in the combustion of plants caused by irrigation

Increase in yield losses in forest management

- · Increase in the death rate of young plants caused by overheating of the soil surface
- · Increase in phytotoxic stress caused by high concentrations of ozone in the air

Increase in the deterioration of energy and transport infrastructure

- · Increase in the deterioration of transport infrastructure
- · Increase in the deterioration of the security of supply from the electricity grid

Increasing levels of drought



Increase in harvest losses in agriculture

- · Increase in harvest losses, change in site suitability
- · Decrease in the infiltration capacity of soil

Increase in the danger of forest fire

- · Decrease in the protective effect of the forest
- · Decrease in timber yields
- · Decrease in the forest's CO₂-storage function
- · Decrease in the recreation benefits of forests
- · Increase in damage to buildings and infrastructure

Increase in water shortage

- · Increase in water-use conflicts
- · Increase in the shortage of water for industrial use
- · Increase in the shortage of drinking water

Decrease in summer hydraulic energy production

· Decrease in summer hydraulic energy production

Increase in the degradation of biodiversity

- · Increase in the loss of habitats that depend on adequate water supply
- · Increase in the loss of moisture-loving species

Increase in the deterioration of forest products and services

- · Decrease in the protective effect of the forest
- · Decrease in wood-utilisation potential



Risk



Opportunity



Risk and opportunity

Challenge

Risk / opportunity

Decrease in transport capacity due to reduced shipping

- · Decrease in transport capacity due to reduced shipping caused by declining water levels (Rhine)
- · Increase in the deterioration of lake-access infrastructure caused by declining water levels

Increase in expenditures for drinking water treatment

· Increase in expenditures for drinking water treatment due to impaired water quality

Rising snowline





Increase in yield losses in winter tourism

- · Increase in snow-making costs
- · Decrease in the duration of the ski season
- · Closure of low-lying skiing areas
- · Decrease in overnight stays due to uncertain snow conditions
- · Decrease in customers of cable-car companies
- · Decrease in motivation for winter sports when the winter landscape is missing from the plateau



Increase in winter energy production

- · Increase in hydraulic energy production
- · Increase in energy yield in heat generation from solar energy
- · Increase in solar energy production due to decreasing duration of snow cover



Decrease in in snow-related property damage and maintenance costs

- · Decrease in costs for winter maintenance
- · Decrease in costs of road maintenance
- · Decrease in avalanche damage to infrastructure facilities (incl. economic losses)
- · Decrease in avalanche damage to buildings (incl. economic losses)
- \cdot Decrease in damage to buildings and infrastructure caused by snow pressure
- · Decrease in frost damage to rail infrastructure, water pipes and building infrastructure
- · Decrease in frost damage to roads
- · Decrease in frost damage to vehicles



Change in species composition and habitats

- · Displacement of distribution areas northward and to higher elevations (emergence of relict populations)
- · Change in landscapes (snow cover, glaciers, timber line)
- · Emergence of new habitats in advance of retreating glaciers

Decrease in snow-related accidents

- · Decrease in accidents on snow-covered roads
- · Decrease in personal accidents during snow-sport activities



Risk



Opportunity



Risk and opportunity

Challenge

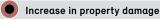
Risk/opportunity

Greater risk of flooding



Increase in personal injuries

- · Increase in deaths, injuries and persons requiring assistance
- · Increase in the deterioration of mental health



- · Increase in damage to buildings (incl. economic losses)
- · Increase in damage to communications infrastructure (incl. economic losses)
- · Increase in damage to transport infrastructure (incl. economic losses)
- · Increase in damage to energy supply infrastructure (incl. economic losses)
- · Increase in damage to water supply and treatment infrastructure (incl. economic losses)
- · Increase in damage to the remaining infrastructure (incl. flood-protection structures)
- · Increase in damage to buildings and infrastructure caused by surface water (incl. economic losses)
- · Increase in damage to cultural heritage
- · Increase in damage to recreational areas
- · Increase in damage to vehicles
- · Increase in damage to buildings and infrastructure caused by sudden glacier eruptions and icefalls (incl. economic losses)

Change in species composition and habitats

· Increase in the emergence of new habitats of pioneer species

Increase in the deterioration of forest products and services and harvest losses in agriculture

- · Decrease in the protective effect of the forest
- · Increase in harvest losses in agriculture
- · Decrease in wood production
- · Decrease in soil fertility due to the leaching of nutrients
- · Pollution of soil due to the leaching of pesticides and other toxic substances
- · Decrease in agricultural potential due to erosion
- · Decrease in the recreation benefits of forests and green spaces

Decrease in hydraulic energy production

- · Reductions is the use of hydraulic energy
- · Decrease in energy production
- · Increase in damage to hydraulic energy facilities due to the increased potential transport of river wash and suspended matter
- · Reduction in the storage capacity of reservoirs due to increasing debris and sediment deposits



Risk



Opportunity



Risk and opportunity

Challenge

Risk/opportunity

Decrease in water quality

- Decrease in water quality upon discharge of wastewater in undersized supply networks and flood-control reservoirs
- · Pollution due to the leaching of pesticides or other toxic substances
- · Pollution of drinking water and groundwater due to the leaching of degraded organic material
- · Pollution of drinking water catchments
- · Increase in groundwater contamination
- · Decrease in the natural groundwater recharge due to runoff losses

Decreasing slope stability and more frequent mass wasting





Increase in personal injuries

- · Increase in deaths, injuries and persons requiring assistance
- · Increase in the deterioration of mental health



Increase in property damage

- · Increase in damage to buildings (incl. economic losses)
- · Increase in damage to communications infrastructure (incl. economic losses)
- · Increase in damage to transport infrastructure (incl. economic losses)
- · Increase in damage to energy supply infrastructure (incl. economic losses)
- · Increase in damage to water supply and treatment infrastructure (incl. economic losses)
- · Increase in damage to vehicles
- · Increase in damage to buildings and infrastructure used for tourism purposes (and indirect damages)
- · Increase in damage to recreational areas
- · Increase in damage to hydraulic-energy infrastructure
- \cdot Decrease in the storage capacity of reservoirs due to increasing debris and sediment deposits

Increase in the deterioration of forest products and services and harvest losses in agriculture

- · Decrease in the protective effect of the forest
- · Increase in harvest losses in agriculture
- · Decrease in wood production
- · Decrease in soil fertility
- \cdot Decrease in the recreation benefits of forests and green spaces



Risk



Opportunity



Risk and opportunity

Challenge

Risk/opportunity

Change in storm and hail activity



Increase or decrease in personal injuries

· Increase or decrease in deaths, injuries and persons requiring assistance

Increase or decrease in storm damage

- · Increase or decrease in damage to buildings (incl. economic losses)
- · Increase or decrease in damage to communications infrastructure (incl. economic losses)
- · Increase or decrease in damage to transport infrastructure (incl. economic losses)
- · Increase or decrease in damage to energy supply infrastructure (incl. economic losses)
- \cdot Increase or decrease in the protective effect of the forest and associated indirect damages
- · Increase or decrease in wood-utilisation potential with an indirect impact on the price of wood
- · Increase or decrease in costs for clean-up work in the forest, pest control and forest rejuvenation
- · Increase or decrease in the sink and storage function of CO2 in forest areas
- · Increase or decrease in filtration capacity of the forest floor with implications on the provision of drinking water
- · Increase or decrease in the erosion protection of forest areas
- · Increase or decrease in damage to agricultural crops and to/in greenhouses
- · Increase or decrease in efficiency of wind power plants
- · Increase or decrease in damage to vehicles
- · Increase or decrease in damage to recreational areas (especially forests)

Increase or decrease in hail damage

- · Increase or decrease in damage to buildings (incl. economic losses)
- · Increase or decrease in damage to vehicles
- \cdot Increase or decrease in damage to agricultural crops and to/in greenhouses
- · Increase or decrease in damage to infrastructure (incl. economic losses)

Change in habitats, species composition and landscapes



Negative change in the composition of species and habitats

- Temporal or spacial decoupling of interdependent species
- · Displacement of distribution areas northward and to higher elevations (emergence of relict populations)
- · Increase in the deterioration of evolutionary processes due to genetic impoverishment caused by isolation and reduction of habitats
- · Increase in the degradation of biodiversity caused by less frequent lake circulation due to higher mean temperatures
- · Increase in the adverse effect of pollination
- · Increase in the loss of species that have a competitive advantage due to their frost tolerance
- · Increase in the deterioration of species that are dormant in the winter
- · Increase in the loss of habitats that depend on adequate water supply
- · Increase in the loss of moisture-loving species



Risk



Opportunity



Risk and opportunity

Challenge

Risk/opportunity

- · Increase in the degradation of native species caused by the emergence and/or spread of alien, invasive species
- · Increase in the degradation of biodiversity due to the spread of harmful organisms
- · Increase in the degradation of biodiversity due to reduced water quality
- · Increase in the degradation of biodiversity due to reduced soil quality
- · Increase in the degradation of biodiversity due to reduced air quality
- · Increase in the deterioration of flora and fauna caused by increased heat stress

Positive change in the composition of species and habitats

- · Spread of adaptable species and generalists
- · Increase in emergence of new habitats of pioneer species after floods n
- · Spread of species that depend on dry habitats
- · Increase in biodiversity due to more frequent forest fires
- · Emergence of new habitats in advance of retreating glaciers
- · Increase in the number of generations per year due to a longer growing season

Change in attractiveness of landscapes

- · Change in landscapes (snow cover, glaciers, timber line)
- · Increase in the loss of the attractiveness of mountain activities due to more frequent natural-hazard events

Spread of harmful organisms, disease and alien species



Increase in the impairment of human health

- · Extension of the pollen season of allergenic plants
- · Increase in the spreading of ticks to higher altitudes
- · Increase in the occurrence of vector-borne diseases as well as water- and food-borne diseases
- · Increase the dissemination of allergenic plants
- · Increase in occurrence of diseases that stem from wetlands

Increase in the impairment of the health of farm animals and pets

· Increase in the impairment of the health of farm animals and pets

■ Increase in harvest losses in agriculture

· Increase in harvest losses in agriculture

Increase in the deterioration of forest products and services

- $\boldsymbol{\cdot}$ Decrease in the protective effect of the forest
- · Decrease in wood-utilisation potential

Increase in the degradation of biodiversity

- · Increase in the displacement of native species by the emergence and/or spread of alien, invasive species
- · Increase in the degradation of biodiversity caused by the spread of pests



Risk



Opportunity



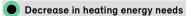
Risk and opportunity

Challenge

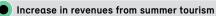
Risk/opportunity

Improvement of site conditions





· Decrease in heating energy needs due to the rise in mean temperature



- · Increase in summer tourism due to fewer days of rain, higher temperatures, more hours of sunshine, and a longer season
- \cdot Increase in attractiveness of mountain regions due to lower temperatures
- · Mediterranisation of the climate
- · Increase in the attractiveness of lake regions during heatwaves
- (Positive or negative) change in the attractiveness of landscapes

Challenge

Increase in agricultural revenues

- · Positive change in site suitability, cultivation of new varieties becomes possible (e.g. viticulture)
- · Increase in agricultural revenues due to the rise in mean temperature
- \cdot Increase in biomass availability (energy)

Change in species composition and habitats

- · Change in landscape (snow cover, glaciers, timber line)
- · Emergence of new habitats in advance of retreating glaciers
- $\boldsymbol{\cdot}$ Spread of adaptable species and generalists
- · Increase in emergence of new habitats of pioneer species after floods
- · Spread of species that depend on dry habitats
- · Increase in biodiversity due to more frequent forest fires

Decrease in the number of cold-related illnesses and deaths

- \cdot Decrease in cold-related morbidity due to illnesses that occur more frequently in winter
- · Decrease / increase in tick-borne encephalitis (depending on region)

Increase in timber growth

- · Increase in wood-utilisation potential due to the rise in mean temperature (extended growing season)
- · Decrease in forest decline caused by snow pressure



Risk



Opportunity



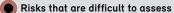
Risk and opportunity

Challenge

Risk/opportunity

Wild card risks





- · Significant negative effects on biodiversity and/or ecosystem services caused by exceeding the tipping points of ecosystems
- · Significant deterioration of human health due to the occurrence of new, previously unknown diseases and new allergenic plants
- · Significant deterioration of native crops and animal production due to new pests and the spread of new diseases
- · Significant degradation of biodiversity caused by new invasive species
- · Significant forest decline caused by the spread of new harmful organisms and diseases
- · Significant deterioration of livelihoods due to unexpected simultaneous failures of several critical infrastructures
- · Significant damage due to the critical sequence of various dangers or an extraordinary accumulation of the
- · Significant damage due to changes in circulation and/or weather patterns (e.g. persistence)
- · Significant damage due to non-assessable impacts of the chain of effects climate change natural hazards (including new process patterns)
- · Significant damage due to changes in the regeneration potential of areas affected by natural-hazards

Climate-related impacts abroad





- · Increase in yield losses due to the endangerment of exports to climate-exposed countries with reduced economic growth
- · Decrease in the security of supply due to the endangerment of imports from climate-exposed countries (e.g. food, animal feed, energy, basic materials)
- · Increase in transport costs due to climate-related destruction of infrastructure
- · Decrease in the productivity of foreign agricultural and forestry systems with impacts, especially on the food, textile, wood and paper industries
- · Increase in the demand for capital due to adaptation and mitigation measures
- · Decrease in political stability and international security
- · Increase in positive or negative effects of climate-induced global migration flows
- · Increase in the demand for emergency aid (after extreme events) and development cooperation
- · Increase in price volatility in agriculture
- · Increase in investment risks as a result of investments having climate exposure



Indirect opportunities

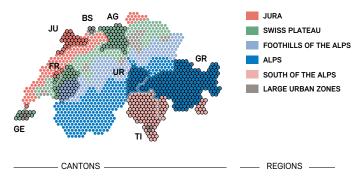
- · Increase in revenues from tourism (summer resorts, relative snow reliability)
- · Increase in the demand for reinsurance services
- · Increase in income from exported technical and planning measures aimed at addressing climate change mitigation and adaptation
- · Increase in income of Swiss hydro-storage power plants due to the stabilisation of fluctuating energy production from wind and solar energy abroad

A2 Methodology

Parallel with the development of the Federal Council's adaptation strategy, in 2010 the FOEN commissioned the development of a method that identifies Switzerland's climate-related risks and opportunities, evaluates them uniformly and compares them across sectors. Due to the diverse topography and the characteristics of densely populated areas, six major regions were defined for the risk assessment and one to two case studies per major region were carried out using this method (Fig. 2).

Fig. 2 Major regions of Switzerland and case studies

Jura (FS6), Swiss Plateau (FS1 + FS3), Foothills of the Alps (FS3), Alps (FS5 + FS8), South of the Alps (FS7) and large urban zones (FS2 + FS4)



The eight case studies (FS1-FS8) are the basis for the synthesis⁵. Their results were transferred in a first step to the major regions. In a second step, the identified risks and opportunities were prioritised, taking further criteria into account. The case studies and the resulting synthesis are therefore based on a uniform, consistent methodological approach.

The methodology developed in the years 2010-2013 for the development of the case studies (including important assumptions, framework conditions and working steps) has been documented in detail (Holthausen et al. 2013). In the course of the implementation of the eight case studies, the originally developed methodology was further developed on a point-by-point basis. For the synthesis, further adjustments were made and a suitable prioritisation method applied. This chapter explains the main

aspects of the original methodology relevant for the synthesis and the new methodological approaches.

A2.1 Use of climate scenarios

To demonstrate the possible range of climate-related impacts, two climate change scenarios were assumed in all case studies – analogous to the strategy of adapation to climate change⁶. The "weak climate change" scenario corresponds to the emissions scenario RCP3PD, the "strong climate change" scenario is based on the emissions scenario A1B of the Intergovernmental Panel on Climate Change (IPCC). The synthesis considers only the "strong climate change" scenario and the risks and opportunities of the case studies derived therefrom.

The emissions scenario A1B assumes that global emissions will continue to rise until 2050 (business as usual) and decline only in the second half of the century. Given current developments in international climate policy and global greenhouse gas emissions, this scenario can be considered realistic to pessimistic. Under the leadership of MeteoSwiss and the ETH Zürich, a climate scenario for Switzerland (CH2011 2011) was calculated from this emission scenario. It describes the expected evolution of temperature and precipitation per season between the average of the period 1980–2009 ("today") and the period 2045–2074 ("2060") within bandwidths, which reflect the uncertainties of the climate models used.

For the "strong climate change" scenario, the average values of these bandwidths were not used. For the temperature projections, the upper values were selected for all seasons; for precipitation projections for winter and spring, the upper values were selected and for summer and autumn the lower values. The "strong climate change" scenario used in the context of the risk assessment thus describes a slightly stronger climate change (higher temperature rise, more winter precipitation and greater summer drought) than the average of possible realisations of the A1B emissions scenario.

For the case studies, MeteoSwiss has not only provided data for the change in temperature and precipitation regime under a "strong climate change" scenario, but

⁵ This brochure is a short version of the synthesis report which is published in German (www.bafu.admin.ch/uw-1706-d), French (www.bafu.admin.ch/ uw-1706-f) and Italian (www.bafu.admin.ch/uw-1706-i).

⁶ The two scenarios are described in Chapter 2 of the Federal Council's Action Plan (FOEN 2014).

also consistent information on the development of other climate indicators such as hot days, tropical nights, heating degree days, days with fresh snow, length of the growing season, etc. In addition, this data is available for the previously defined major regions (MeteoSwiss 2014).

The synthesis serves as the basis for the further development of the Federal Council's strategy and for further adaptation activities. The choice of the "strong climate change" scenario for the synthesis of the risk asssessment is justified by the fact that a strategy based on the precautionary principle should also take into account a more pessimistic evolution of global greenhouse gas emissions. Only then will it have a response to the strong effects of climate change.

A2.2 Identification of risks and opportunities

Biodiversity

Open spaces and green areas

The methodology developed for the risk assessment identified 17 hazards and effects that could manifest dif-

ferently under the influence of climate change. The term "hazard" refers to natural hazards with event character, such as floods, avalanches or heatwaves. "Effects" describe gradual changes such as the rise in mean temperature or the change in the precipitation regime. In addition, nine sectors — so-called impact areas — were identified in which the dangers and effects could have consequences. In the interest of a systematic and comprehensive assessment of climate-related risks and opportunities, a relevance matrix was created for each case study area (Fig. 3).

Using the relevance matrix, the relevant combinations that result in risks or opportunities could be identified and assessed in depth in the case studies (in Fig. 3, exemplary shaded grey). The term risk describes the product of probability of occurrence and extent of damage, and the term opportunity describes the product of probability of occurrence and benefits.

Fig. 3
Relevance matrix: hazards and effects per impact area

The relevance matrix contrasts the nine impact areas (rows) with the 17 hazards and effects (columns).

The Inunderstorms R. avalanches
The Inunderstorms R. avalanches
The Inunderstorms R. avalanches Hazards nse precipitation regime
Charge of the precipitation regime **Precipitation Temperature** Wind Change of the on temperature and effects Beduction of snow director Gende Lanning storms "Landside | Earth flow Linux ing of permatrost Metting of the diccier Intense precipitation Storn / Hurricans Debrission **Impact** areas Health Agriculture Forestry Energy **Tourism** Infrastrure and buildings Water management

In the case studies, the current risk or current opportunity (climate data 1980–2009, socioeconomic data approx. 2010) as well as the risk or opportunity for the period of 2060 (climate data 2045–2074, socio-economic data approx. 2010⁷) were determined. The risks and opportunities of climate change, the so-called climate-related risks and opportunities, arise from the difference between the risk and the opportunity in 2060 and today. The synthesis always evaluates risks or opportunities based on this difference. Exceptions are the risks arising from the dangers of storm and hail. Due to the lack of climate projections for these dangers, in this case the current risk is presented.

In contrast to the case studies, in which the risks and opportunities were identified per impact area (sectorally), the synthesis is more closely aligned with the Federal Council's strategy. The risks and opportunities are therefore structured according to the challenges. The cross-sector challenges of climate change are described in the first part of the strategy (FOEN 2012). Six climate change challenges have been adapted or redefined for the synthesis so that all the identified risks and opportunities can be assigned to a challenge.

Table 3 The challenges of climate change

A2.3 Evaluation and prioritisation of risks and opportunities

In the case studies, where possible, a quantitative (monetised) assessment of risks and opportunities was undertaken, otherwise a qualitative one. In each case study, the estimates were checked for plausibility in a workshop by experts and reviewed in the evaluation of the final report. In a next step, the results of the case study were transferred to the corresponding major region. The scaling up is described in the methodology report (Holthausen et al. 2013).

For the synthesis, the results were collected at the level of the major regions and the case study regions. For some natural hazards, such as flooding and mass movements, the 100-year event has been considered; for slow developments, such as the change in mean temperature and outflow regimes, the annual expected value has been taken into account. In addition, a literature review and expert surveys were carried out to supplement the list of risks and opportunities from the case studies, so that all relevant risks and opportunities for Switzerland are identified to the extent possible. This results in the comprehensive list of climate-related risks and opportunities in Annex A1.

Synthesis	Confederation's adaptation strategy (FOEN 2012)	
Greater heat stress	Greater heat stress in agglomerations and cities	
Increasing levels of drought	Increasing levels of summer drought	
Rising snowline	Rising snowline	
Greater risk of flooding	Greater risk of flooding	
Decreasing slope stability and more frequent mass wasting	Decreasing slope stability and more frequent mass wasting	
Change in storm and hail activity	[Not addressed]	
Impaired water, soil and air quality (priority risks are assigned to the other challenges)	Impaired water, soil and air quality	
Change in habitats, species composition and landscapes, (all impacts on biodiversity, including those of other challenges are discussed)	Change in habitats, species composition and landscapes	
Spread of harmful organisms, disease and alien species	Spread of harmful organisms, disease and alien species	
Improvement of site conditions (only opportunities)	[Not addressed]	
Wild card risks	[Not addressed]	
Climate-related impacts abroad	[Not addressed]	

⁷ For further information on the consideration of socioeconomic development until 2060, see Annex A2.3.

In order to be able to compare the results across various sectors and major regions, a three-level qualitative scale was used: low / moderate / significant increase in risk or opportunity. For the transfer of the quantitative evaluation of the risks and opportunities in the case studies to the level of the major regions, the scale was adapted to the respective major region. For example, many more people and values are concentrated in the large urban zones than in the Foothills of the Alps. If a risk with an annual expectation of over CHF 15 million on the three-level scale is classified as significant in the Foothills of the Alps, then the same risk for the same classification in large urban zones must reach an annual expected value of at least CHF 100 million. If the risk takes into account a 100-year event, the thresholds are increased by a factor of five.

Despite the uniform methodology of the eight case studies, the evaluation of individual risks and opportunities could not be undertaken and compared without reflection. On the one hand, the method was further developed in some aspects between the implementation of the first and last case study. On the other hand, different people were involved in the assessment. Some of them used different data bases, made different assumptions and relied on different expert appraisals. The three-level scale and the evaluation of the individual climate-related risks and opportunities on this scale were therefore checked for plausibility by the case study authors and other experts from science and administration and adjusted, if necessary (see Annex A2.4).

In the next step, the risks and opportunities were prioritised. For this purpose, the qualitative evaluation of the climate-related risk or opportunity was supplemented with five further criteria, which, however, were weighted less heavily in comparison to the climate-related change (weighting factor of more than 40%).

The necessity to consider further criteria for the prioritisation results from the fact that the social acceptance of a risk can vary and that further influencing factors can increase or reduce climate-related risks and opportunities and influence the implementation of appropriate adaptation measures. The following additional criteria were included in the assessment (rounded weighting in brackets):

- the irreversibility of potential damage (20%)
- possibly affected critical infrastructures (10%)

- the influence of socioeconomic change (10%)
- potential conflicts of interest or synergies (10%)
- the adaptive capacity of the affected system (10%)

Irreversibility of potential damage: The criterion of irreversibility of a potential damage is only relevant to risks. Three distinct options emerged: In the event of an incident, the damage can be completely remedied (reversible) / partially remedied / not remedied (irreversible).

Possibly affected critical infrastructures: This criterion makes sense only in the case of risks. A distinction was made between no/isolated/far-reaching expected damage to critical infrastructures in the event of occurrence. The evaluation of the risk using these first two criteria was undertaken by the authors of the case studies and the FOEN.

Influence of socioeconomic changes: This criterion is relevant for all risks as well as opportunities and was divided into three levels. Socioeconomic developments can increase or reduce the risk or the opportunity by more than one order of magnitude/less than one order of magnitude/ not at all. For this evaluation, the results from the case studies were consulted, because in these assessments, socioeconomic development, for example, via population scenarios, was considered separately.

Potential conflicts of interest or synergies: This criterion is relevant to both risks and opportunities and has been divided into five levels. The authors of the case studies and the FOEN evaluated the conflicts of interest and synergies on the basis of the risks and opportunities and possible adaptation measures in the following classification:

- new conflicts of interest and a tightening of existing conflicts of interest
- · a tightening of existing, but no new conflicts of interest
- · no significant tightening of existing conflicts of interest
- a mitigation of existing conflicts of interest or new synergies
- a substantial mitigation of existing conflicts of interest or new substantial synergies

Adaptive capacity of the system affected: Adaptive capacity was assessed under six factors. The basis for this assessment is independent research commissioned

by the FOEN (Jörin et al. 2016). Whether there are potential barriers to adaptation to climate change in terms of knowledge, motivation, legal structure, technology, finance and institutional structure was examined. As part of the research, the experts were able to evaluate the factors on a five-point scale. For evaluating the risks in the synthesis, two levels of scale were combined, resulting in a three-level scale (low/medium/high).

The evaluation per risk or opportunity based on these additional criteria was carried out uniformly for the whole of Switzerland and thus also for each major region. The evaluations of risks and opportunities due to climate change as well as due to other criteria were aggregated. The final classification as priority or non-priority risks and opportunities was based on a determined threshold. The result – the list of priority risks – was checked for plausibility and reviewed by experts from science and administration. This led to individual changes in the prioritisation (regardless of whether the threshold was not met or exceeded). From the comprehensive list of the approximately 50 climate-related risks and opportunities, Switzerland's 29 priority risks and opportunities were identified.

For the evaluation of the risks and opportunities due to climate change and due to other criteria as well as for their subsequent prioritisation, a uniform, systematic and prescriptive approach was chosen. The evaluations and prioritisations were reviewed and reflected on by many experts, which in turn led to adjustments. The result thus no longer corresponds in all respects to this uniform approach, but provides a coherent, consolidated picture of Switzerland's risk landscape.

A2.4 Inclusion of experts

As mentioned in previous subchapters, various phases of the preparation, assessment and synthesis process was built on the broad involvement of experts. This is one of the strengths of this risk assessment.

Experts from the cantonal administrations participated in developing the case studies (incl. the process of transferring the case study results to the major regions), but so did scientific and private-sector experts. They partic-

ipated in workshops and were consulted to clarify specific technical questions. Experts from the cantons and the Confederation and individual scientists were included in the review of final reports.

Likewise in the synthesis, numerous experts were involved:

- In a workshop with the case study authors, the evaluation of the risks and opportunities at the level of the major regions was made plausible in order to enable a comparison between these regions.
- Through telephone interviews with experts from the Confederation, cantons and insurance companies the completeness of the list of risks and opportunities was reviewed, as was the evaluation of the risks and opportunities (especially the adjustments made in the workshop).
- Scientists provided written feedback on the completeness of the list of risks and opportunities, their evaluation and the prioritisation undertaken.
- Experts from the Confederation and two private offices commented on the synthesis.
- During the development of the synthesis, individual experts from the Confederation, from ProClim as well as scientists were consulted about specific questions, individual evaluations and prioritisations of risks and opportunities.

Around 360 experts contributed their expertise to the method development, the case studies and the synthesis. 75 persons were involved in preparing the synthesis. Nearly 290 additional experts were involved in the development of the eight case studies and the method. Of the 360 experts, around 200 represent the public sector (Confederation, cantons and municipalities), around 50 science experts and around 110 associations, companies, consulting and engineering firms. All experts involved are listed by name in annex A3.1 of the synthesis⁸.

A2.5 Limitations of the methodology used and the validity of the results

Statements about the development of complex systems over longer periods are inevitably associated with uncertainties.

8 Published in German (www.bafu.admin.ch/uw-1706-d), French (www.bafu.admin.ch/uw-1706-f) and Italian (www.bafu.admin.ch/uw-1706-i)

Due to partially unavailable data bases or inadequate understanding of the process, simplified, expert-based assumptions had to be made in the case studies. The case study areas differ greatly in size and homogeneity, which also may affect the robustness of the results. The smaller the case study area, the more site-specific data and estimates could be included in the assessment. Assumptions, inaccuracies, uncertainties and evaluations were presented transparently in the case study reports. They can thus be considered when interpreting the results (also for the synthesis) and, if necessary, adapted to new findings.

The aim of the risk assessemnt is to determine the climate-related risks and opportunities. Hence, the condition today was compared with the condition around 2060 under a "strong climate change" scenario with the same socioeconomic situation and without implementation of adaptation measures. Socio-economic development (one of the additional criteria, see Annex A2.3) was taken into account separately. It can decisively increase or decrease a risk or an opportunity and must therefore be taken into account when planning adaptation measures.

The purpose of this risk assessment was not to compare the impact of socioeconomic changes with the one of climatic conditions. So that today's need for adaptation can be assessed, adaptation measures — even if they are very simple to implement — have not been considered. Only certain "autonomous" adaptations — e.g., increased irrigation with an existing irrigation system — were taken into account.

No new projections, additional simulations or impact studies were performed for the risk assessment. The case studies and synthesis provide results derived from existing knowledge from the literature, available data, and expert appraisals.

The main results of the risk assessment are the climate-related risks and opportunities for the period around 2060. The impacts of climate change, however, can reach an action-relevant level at very different times. The distribution of risks and opportunities thus depends heavily on the time period under consideration. This must be taken into account when interpreting the results.

The case studies and the synthesis make it possible to compare the risks and opportunities in order to derive priorities for adaptation. For this purpose, a relatively rough consideration of the risks and opportunities is sufficient. The synthesis focuses on the evaluation and prioritisation of risks and opportunities. The need for action and possible measures are not in the foreground. The evaluation or planning of measures (e.g., in the context of the management of a specific natural hazard situation) requires more detailed examinations taking into account the local conditions.

A3 Lists

A3.1 Experts

The authors would like to express their gratitude to the numerous experts that have contributed to the risk assessment. All experts are listed by name in the extended synthesis report.

A3.2 Literature

CH2011 2011: Swiss Climate Change Scenarios CH2011. Published by C2SM, MeteoSwiss, ETH Zurich, NCCR Climate & OcCC, Zurich: 88 p.

CS1 (case study 1)

Holthausen N., Locher P., Blaser L., Pütz M., Bründl M. 2013: Risiken und Chancen des Klimawandels im Kanton Aargau. Ergebnisbericht. Commissioned by the Federal Office for the Environment (FOEN), Zollikon: 67 p.

CS2 (case study 2)

Füssler J., Betschart M., Schäppi B., Egli T., Mini L. 2015: Analyse klimabedingter Risiken und Chancen in der Schweiz: Regionale Fallstudie Kanton Basel-Stadt. Commissioned by the Federal Office for the Environment (FOEN), Zurich: 167 p.

CS3 (case study 3)

Locher P., Holthausen N., Wili C., Girard C., Tallon L., Darazs O., Lerch J. 2015: Risiken und Chancen des Klimawandels im Kanton Freiburg. Commissioned by the Federal Office for the Environment (FOEN), Zollikon: 193 p.

CS4 (case study 4)

Füssler J., Schäppi B., Betschart M., Martin D., Bondolfi A., Aubron D., Mini L., Egli T. 2015: Analyse des risques et opportunités liés aux changements climatiques en Suisse. Etude de cas Canton Genève et Grand-Genève. Commissioned by the Federal Office for the Environment (FOEN), Geneva: 225 p.

CS5 (case study 5)

Stöckli V., Ammann W. 2015: Klimawandel Graubünden. Analyse der Risiken und Chancen. Arbeitspapier 3 einer kantonalen Klimastrategie. Commissioned by the Federal Office for the Environment (FOEN), Chur: 142 p.

CS6 (case study 6)

Girard C., Monin G., Lehmann D., Moradpour É., Fernex J., Randlett M-È., Studer S. 2016: Analyse des risques et opportunités liés aux changements climatiques en Suisse. Étude de cas du canton du Jura. Commissioned by the Federal Office for the Environment (FOEN), Pruntrut: 167 p.

CS7 (case study 7)

Bernasconi A., Bozzolo D., Baggi S., Ciani A., Martignoni A., Notari N., Fischli M., Stöckli V., Schönenberger N., Schaltegger E., Passardi M., Rivola C. 2016: Analisi die rischi e delle opportunità legati ai cambiamenti climatici in Svizzera. Caso di studio del Cantone Ticino. Commissioned by the Federal Office for the Environment (FOEN), Rivera: 416 p.

CS8 (case study 8)

Füssler J., Betschart M., Schäppi B., Egli T., Vanomsen P., Sturzenegger D., Mini L. 2015: Klimabedingte Risiken und Chancen 2060. Regionale Fallstudie Kanton Uri. Commissioned by the Federal Office for the Environment (FOEN), Zurich: 311 p.

FOEN (Federal Office for the Environment) 2014: Anpassung an den Klimawandel in der Schweiz. Aktionsplan 2014–2019. Zweiter Teil der Strategie des Bundesrates vom 9. April 2014, Bern: 100 p.

FOEN (Federal Office for the Environment) 2012: Adaptation to climate change in Switzerland. Goals, challenges and fields of action. First part of the Federal Council's strategy. Adopted on 2 March 2012, Bern: 64 p.

Holthausen N., Locher P., Blaser L., Perch-Nielsen S., de Haan van der Weg P., Pütz M., Bründl M. 2013: Risiken und Chancen des Klimawandels in der Schweiz. Methodenbericht. Commissioned by the Federal Office for the Environment (FOEN), Bern: 42 p

Jörin J., Patt A., Maestri C., Knüsel B. 2016: Schlussbericht des Forschungsprojekts "Anpassungsfähigkeit der Schweiz an den Klimawandel". Commissioned by the Federal Office for the Environment (FOEN), Zurich: 150 p.

MeteoSwiss (Federal Office of Meteorology und Climatology) 2014: Klimaszenarien Schweiz. Eine regionale Übersicht. Fachbericht Nr. 243. Commissioned by the Federal Office for the Environment (FOEN): 36 p.

A comprehensive list of all the literature used to elaborate the synthesis is given in the extended synthesis report.