Climate Risk Analysis for Switzerland

Basis for adaptation to climate change. Abridged version.

Schweizerische Eidgenossenschaft
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Confederaziun svizra

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The cover picture shows Untersee at low water level, taken on 13 August 2022 in Triboltingen (TG). The water level is 394.8 metres above sea level, the lowest it has been since records began in 1886.
Photo: Gian Ehrenzeller / Keystone

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This is an abridged version in English of the publication 'Klima-Risikoanalyse für die Schweiz',[1] which is available in German *www.bafu.admin.ch/uw-2502-d*, French *www.bafu.admin.ch/uw-2502-f* and Italian *www.bafu.admin.ch/uw-2502-i*.
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Contents

Abstracts

The present brochure is the abridged version of the Climate Risk Analysis for Switzerland,[1] which identifies and assesses climate risks and climate-related opportunities for Switzerland up to the year 2060. The content and methodology of the first climate risk analysis published in 2017 was comprehensively reviewed and updated with the involvement of numerous specialists from the administrative, academic and business fields. The results serve as a basis for the Federal Council's future adaptation strategy and for developing adaptation strategies and action plans in the cantons and regions.

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

Die vorliegende Broschüre ist die Kurzfassung der Klimarisikoanalyse für die Schweiz,[1] welche Klimarisiken und klimabedingte Chancen für die Schweiz bis ins Jahr 2060 identifiziert und bewertet. Unter Mitwirkung zahlreicher Expertinnen und Experten aus Verwaltung, Wissenschaft und Wirtschaft wurde die erste Klima-Risikoanalyse von 2017 inhaltlich und methodisch umfassend überprüft und aktualisiert. Die Ergebnisse dienen als Grundlage für die künftige Anpassungsstrategie des Bundesrats und für die Entwicklung von Anpassungsstrategien und Massnahmenplänen in Kantonen und Regionen.

Stichwörter:
Klimawandel, Auswirkungen, Risikoanalyse, Risiken, Opportunitäten, Anpassung

La présente brochure est la version abrégée de l'Analyse des risques climatiques pour la Suisse,[1] qui identifie et évalue les risques climatiques et les opportunités liées au climat pouvant se présenter en Suisse d'ici 2060. Avec le concours de nombreux spécialistes issus de l'administration ainsi que des milieux scientifiques et économiques, la première analyse des risques et opportunités liés au climat, publiée en 2017, a été entièrement révisée et actualisée au moyen d'une nouvelle méthodologie. Les résultats fournissent une base pour le développement de la future stratégie d'adaptation du Conseil fédéral ainsi que pour l'élaboration des stratégies d'adaptation et des plans de mesures au niveau des cantons et des régions.

Mots-clés :
changements climatiques, impacts, analyse des risques, risques, opportunités, adaptation

Il presente opuscolo è la versione breve dell'analisi dei rischi climatici per la Svizzera,[1] che identifica e valuta i rischi climatici e le opportunità legate al clima per la Svizzera da qui al 2060. Il contenuto e la metodologia della prima analisi dei rischi climatici del 2017 sono stati completamente rivisti e aggiornati con il coinvolgimento di numerosi esperti dei settori amministrativo, scientifico ed economico. I risultati servono come base per la futura strategia di adattamento del Consiglio federale nonché per lo sviluppo di strategie di adattamento e di piani di misure nei Cantoni e nelle regioni.

Parole chiave:
cambiamenti climatici, effetti, analisi dei rischi, rischi, opportunità, adattamento

Introduction

There have already been significant changes in the climate both globally and in Switzerland (see fig. 1). In Switzerland, the number of hot days is increasing, summers are becoming drier, heavy precipitation is more intense and there are fewer days of snow. Furthermore, the glaciers are shrinking, the zero degree line is rising and the growing season is getting longer. This harbours many risks for the public, for social cohesion and for our prosperity, and threatens the basis of all life. Switzerland therefore focuses its climate policy on reducing greenhouse gas emissions to net zero by 2050 and on adapting to climate change and protecting against its unavoidable effects. For adaptation strategies and measures to be as effective as possible, the risks and – where they exist – the opportunities of climate change must be identified and priorities set accordingly.

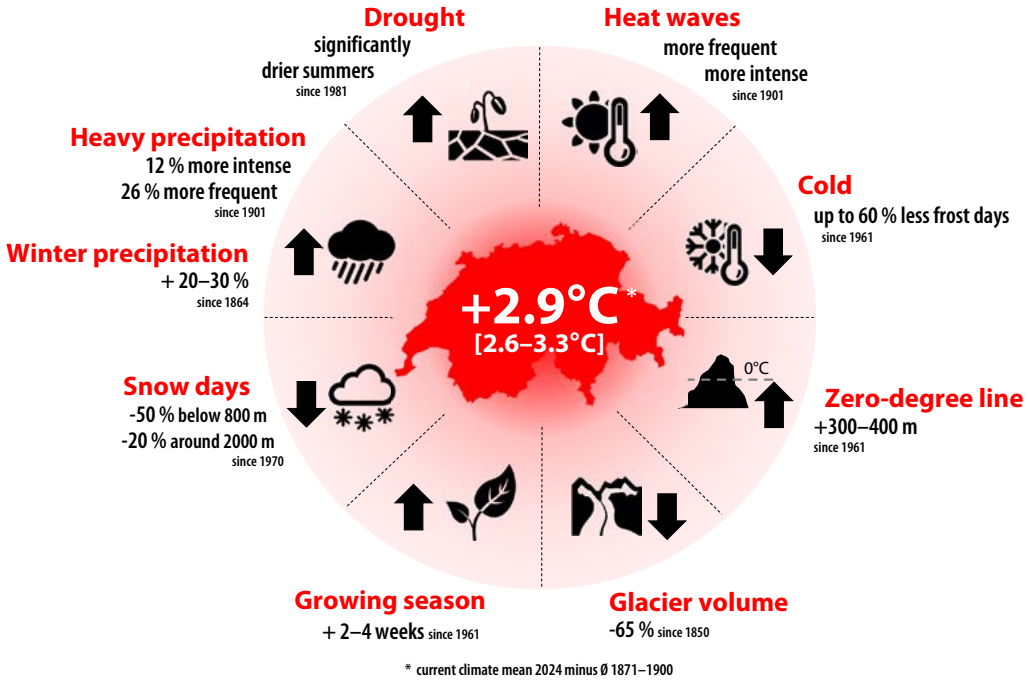
Adaptation to climate change is one of the three principal goals both of the Paris Agreement and of Switzerland's Climate and Innovation Act. The latter requires the Confederation and cantons to take precautionary measures to adapt to and protect against the consequences of climate change. Furthermore, the CO_2 Act states that the federal government is responsible for coordinating adaptation activities in Switzerland and ensuring that the necessary knowledge is established for these activities.

In 2017, the Federal Office for the Environment published its first comprehensive synthesis report on climate risks and climate-related opportunities in Switzerland, based on seven regional case studies.[2] The content and methodology of this Climate Risk Analysis has now been reviewed and updated. The report serves as the basis for the future adaptation strategy and the Action Plan for Adaptation to Climate Change in Switzerland,[3] which will be revised by the end of 2025.

This abridged version brings together the most important findings from the full report.[1] Numerous specialists from the fields of academia, business and the public administration contributed to drawing up the Climate Risk Analysis for Switzerland.[1] The methodology is described in Annex 1 and in a separate methodology report.[4] The Analysis describes

Figure 1

Major changes in the Swiss climate, based on observational data



* current climate mean 2024 minus Ø 1871–1900

Source: MeteoSwiss 2025, *www.meteoswiss.admin.ch/climate/climate-change.html*

the principal impacts of climate change in Switzerland today and those that can be expected in the future. The risks and opportunities identified are listed in Annex 2. On the basis of the impacts of climate change described here, the Confederation's activities can be prioritised and adaptation to climate change in Switzerland effectively shaped. The Climate Risk Analysis also provides a basis for developing cantonal, regional and communal adaptation strategies and action plans.

Summary

The Federal Office for the Environment (FOEN) analysed the climate risks for Switzerland for the second time since 2017, providing a basis for adaptation to climate change. Taking the 2017 analysis as a basis,[2] the risks under current climatic conditions were assessed and predictions made as to how these risks and any climate-related opportunities will change by 2060, assuming considerable changes in the climate. Current scientific literature was analysed and numerous specialists were consulted.

Cross-sectoral challenges of climate change in Switzerland

Thirty-four climate risks and six climate-related opportunities in Switzerland were identified, analysed and assessed. These can be categorised into five cross-sectoral challenges (fig. 2):

High temperatures are already affecting people's well-being, health and performance, especially in the low-lying, densely built-up areas of Switzerland. Periods of heat and very hot days are becoming more frequent and more intense. Risks associated with **greater heat stress** are thus exacerbated. As society ages, more and more vulnerable elderly people and people in need of care will be affected. Heat-exposed economic activities, infrastructure, agriculture and forestry are also affected by increasing heat.

In the current analysis, risks resulting from summer drought are classed as considerably more significant compared to the 2017 climate risk analysis. Dry summers have become more frequent in recent years. This has far-reaching effects on agriculture, forestry, shipping and ecosystems. The risks to agriculture and forestry posed by **increasing summer drought** are likely to grow considerably, partly because such risks often arise in combination with others, such as heat and the emergence and spread of harmful organisms. This combination intensifies the risks. Because of changes in the water regime, various water uses are coming under pressure and are increasingly competing with each other.

Climate change is making heavy precipitation more frequent and more intense. In the High Alpine region, higher temperatures are causing the glaciers to melt and the permafrost to thaw. The **risk potential** is increasing. Population growth, the expansion of settlements into exposed areas and the accumulation of material assets are all contributing factors. Climate-related events can cause injury to persons and damage to property. There may also be indirect costs from lengthy interruptions to business operations. In particular, the risk of surface runoff resulting from more intense and more frequent heavy precipitation is now considered higher than in the 2017 climate risk analysis.

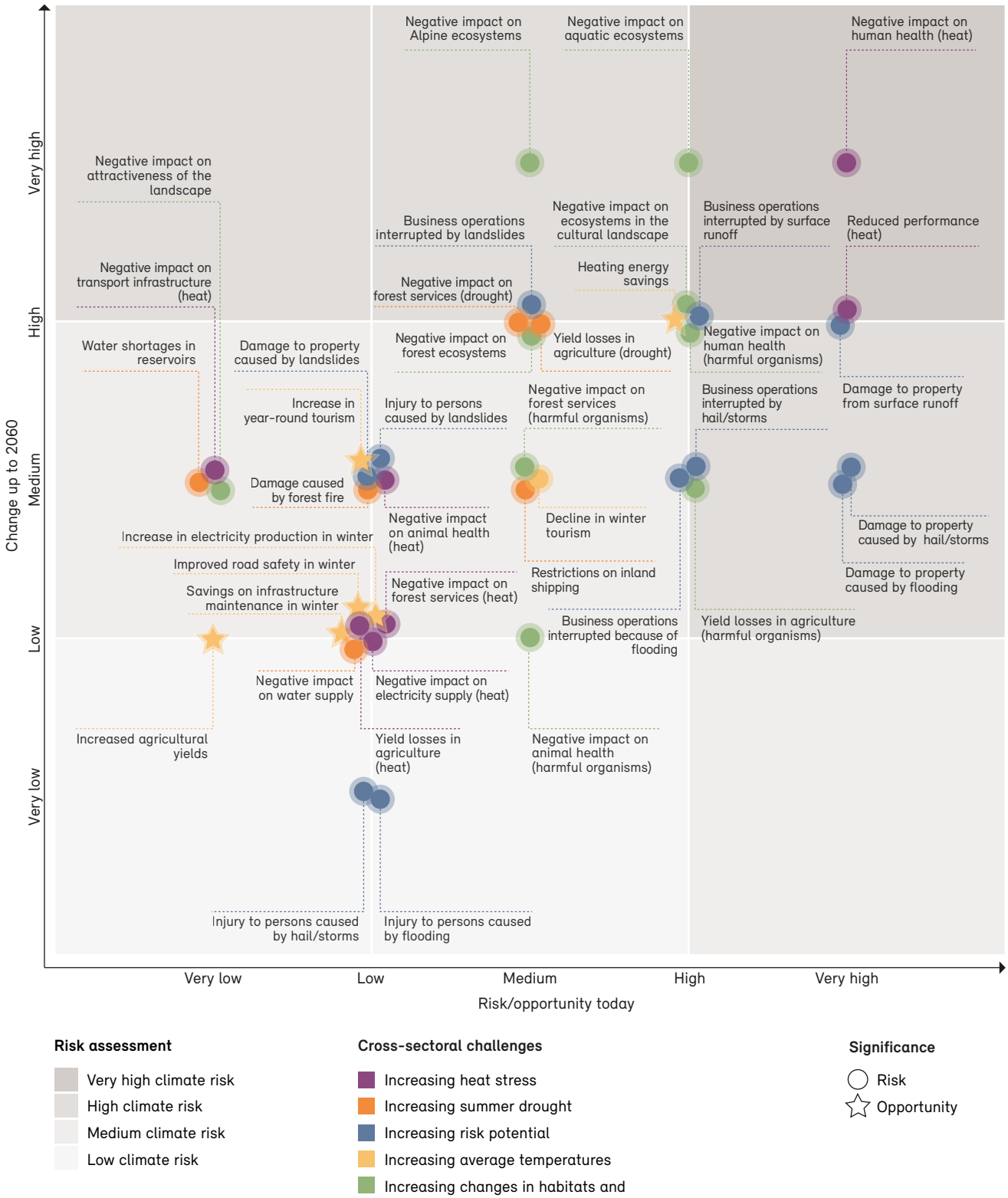
The **increase in average temperatures** in all seasons poses further climate risks. In some cases, this also results in climate-related opportunities, such as the longer growing season for agriculture and better conditions for electricity production in winter. Milder winters and disappearing snow cover are a risk, especially for winter tourism in mountain regions. Milder temperatures are also leading to the emergence of more harmful organisms and to changes in natural hazard processes.

Overall, climate change is leading to **changes in habitats and species composition**. The associated risks for ecosystems and the services they provide, as well as for human health, are among the most important risks of climate change in Switzerland. There is likely to be a decline in vital ecosystem services such as clean water, fertile soils and carbon storage. Moreover, heat-loving, non-native harmful organisms may have a negative impact on human health, agriculture and forestry. Climate change is also altering the appearance of the landscape and some of Switerland's key identifying features.

Figure 2

Assessment of climate risks and climate-related opportunities in Switzerland in the nine-field matrix today (x-axis) and their change by 2060 (y-axis)

Risks from climate change abroad as well as unexpected events and combined risks are not shown here.

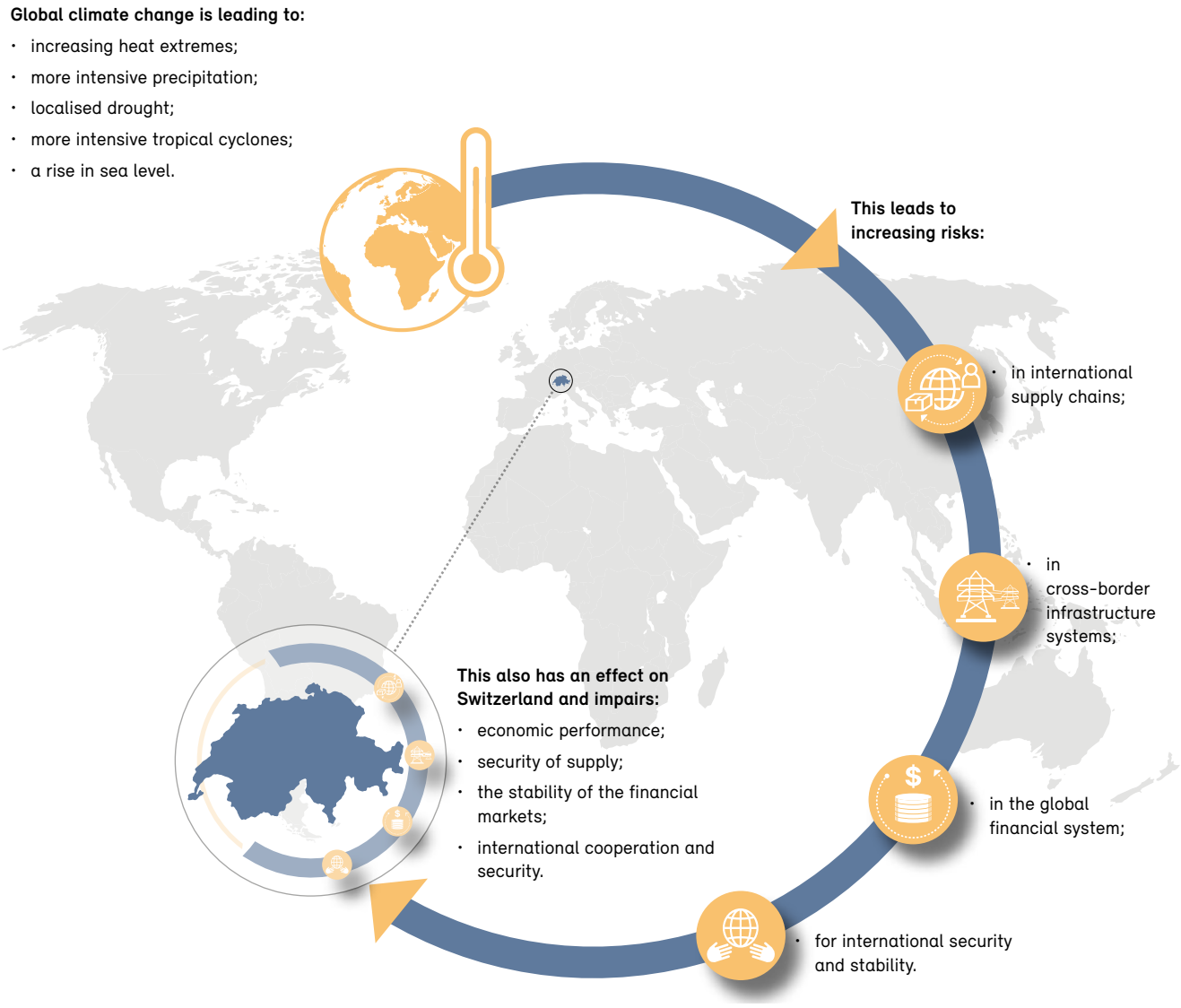


Complex risks of climate change

In addition to the cross-sectoral challenges at home, the **increasing risks posed by climate change abroad** are among the central challenges of climate change for Switzerland (fig. 3). As an open economy with numerous international economic, political and social interdependencies, the country is particularly affected by impacts from abroad: via international supply chains, cross-border infrastructure systems, the global financial system and international security and stability. The report focuses on climate risks in the food and electricity supply sectors.[1]

Figure 3

Overview of risks to Switzerland from climate change abroad



Unexpected events and combined risks are also addressed in the analysis. It is difficult to assess the probability of such events and combinations, but their effects may be very far-reaching or even catastrophic. They include specific combinations of different hazards that occur in the same place or occur consecutively; extreme events that lie outside the range of previously observed events; or so-called tipping points being reached in the climate system, in ecosystems and in society.

Conclusion

The effects of climate change in Switzerland and the challenges and risks it poses are very diverse. Twelve of the 34 risks analysed are already classified as high or very high. Twelve of the risks are expected to lead to major or very major changes by 2060. They will be of varying intensity across Switzerland and affect different population groups to varying degrees. Climate change also brings opportunities in some cases, but these in no way offset the growing risks.

The Climate Risk Analysis serves as a basis for adapting to the effects of climate change in Switzerland. It remains of paramount importance to consistently reduce greenhouse gas emissions to net zero by 2050 in order to avoid the most serious and potentially uncontrollable effects.

Annex

A1 Methodology

Overview

The Climate Risk Analysis[1] analyses and evaluates the risks and climate-related opportunities arising from climate change for the whole of Switzerland. The methodology used aims to map the heterogeneous and complex risk landscape of climate change as comprehensively as possible. It also allows an assessment to be made of climate risks and their impact on Switzerland. The chosen methodological approach is described in detail in a separate methodology report.[4] It is broadly based on the approach taken in the first climate risk analysis from 2017:[2]

- With a criteria-led and semi-quantitative approach, the various impacts of climate change can be converted into a common metric.
- The regular involvement of specialists ensures that broadly supported and consolidated results and core statements are presented.
- The analysis continues to take a precautionary approach and is based on a 'high-emissions scenario' (RCP8.5).
- Finally, climate risks and climate-related opportunities are analysed from two perspectives: the relevance of risks and opportunities in today's context and the expected changes up to the year 2060.

The four sub-steps of the Climate Risk Analysis are described below. These are:

1. identify climate risks and climate-related opportunities
2. analyse climate risks and climate-related opportunities
3. assess climate risks and climate-related opportunities
4. present climate risks and climate-related opportunities

Identify climate risks and climate-related opportunities

The 2017 climate risk analysis contains a list of 49 climate-related risks and opportunities, which in turn are broken down into around 150 sub-risks and opportunities. These were reviewed and updated. Interviews and comparisons with climate risk analyses from other countries were used to regroup some risks and opportunities and add new risks. As in 2017, the risks and opportunities for the Climate Risk Analysis are categorised as follows (tab. 1):

Table 1

Categorisation of risks and opportunities in the Climate Risk Analysis

Cross-sectoral challenges	are at the top of the hierarchy. These are overarching impacts of climate change that affect a range of sectors. For example: Increasing heat stress.
Climate risks and climate-related opportunities	are each assigned to a cross-sectoral challenge. These are overarching risks and opportunities that affect one or more sectors. Assessment and prioritisation are made at this level. For example: Impaired human health and well-being due to heat.
Sub-risks and sub-opportunities	provide more detail of the climate risks and climate-related opportunities and describe specific impact mechanisms and the impact on individual sectors. The sub-risks and sub-opportunities illustrate the item further, but are not assessed and prioritised separately. For example: Heat-related deaths.

Not all risks and opportunities can be categorised in the above hierarchy, as they are not attributable to a single cross-sectoral challenge, but are instead the result of an interplay of the challenges. These are primarily risks from climate-related effects abroad and risks that are difficult to assess. An assessment using the same methodology and the same scales is therefore inappropriate for these risks. Because of their complexity, these are described in terms of their quality and in some cases are only presented as examples.

Analyse climate risks and climate-related opportunities

The methodological approach focuses on analyses of climate risks and climate-related opportunities which themselves are based on extensive literature research, the Swiss climate scenarios CH2018[5] and the findings from interviews with 46 specialists from research institutions, engineering offices, federal offices and cantonal administrations from around Switzerland as well as from the business field, such as the insurance industry and the retail trade.

The analysis of the risks and opportunities is based on the IPCC concept of risk, in which a risk results from the dynamic relationship between the three core components of risk – 'hazard', 'exposure' and 'vulnerability' (tab. 2, fig. 4):

Table 2

Application of the IPCC concept of risk in the Climate Risk Analysis

Hazard	describes the existing influence and the expected changes in the climate. In the Climate Risk Analysis, the term 'climate signal' is used instead of 'hazard' so that it can also be applied to climate-related opportunities. The stronger the climate signal, the greater the climate risk or climate-related opportunity tends to be.
Exposure	describes the extent to which people, material assets, critical infrastructure, agricultural areas and ecosystems could be affected by a climate signal in a given space and time. The greater the exposure, the greater the climate risk or climate-related opportunity tends to be. Statistics and scenarios were used as far as possible to describe future exposure. These included the federal government's reference scenarios such as the Federal Statistical Office's population development scenario and the base variant for the development of the electricity mix in Switzerland found in the Federal Office of Energy's Energy Perspectives 2050+.
Vulnerability	describes the propensity to be affected by a climate signal. It is primarily determined by the sensitivity (susceptibility) of a system; or, in the case of climate-related opportunities, a system's ability to utilise potential advantages for itself. The greater the vulnerability, the greater the climate risk or climate-related opportunity tends to be. The ability to cope and adapt also affect vulnerability (and to some extent exposure). As it is virtually impossible to predict future adaptive capacity and future adaptation measures that reduce vulnerability, only measures that are already established today, such as natural hazard management, are taken into account. It is assumed that these measures will be pursued and will continue to help reduce risk. Measures that are considered to be too expensive or that are not yet technologically feasible are not included in the Climate Risk Analysis.

Figure 4

IPCC concept of risk

A risk is a combination of a hazard, exposure and vulnerability

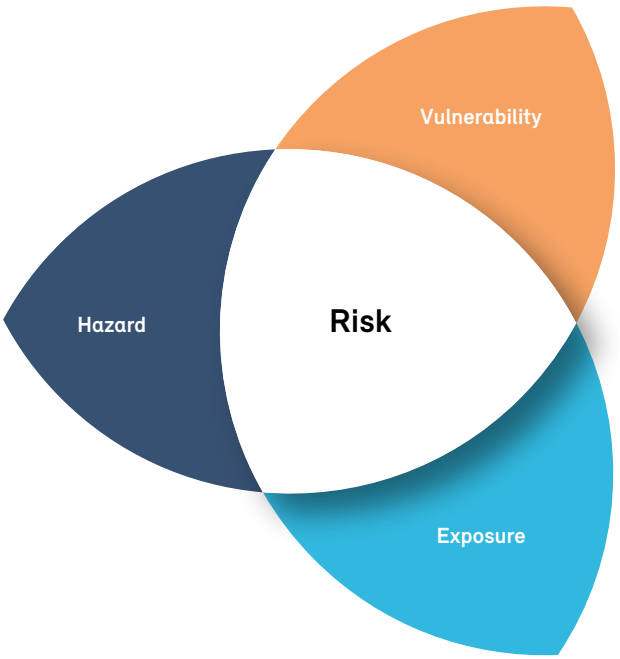


Diagram: FOEN illustration based on IPCC[7]

The findings from the interviews and from two topic-specific workshops (on food supply security in the face of climate change and electricity supply security in the face of climate change) are also incorporated into the analysis of the risks from climate-related impacts abroad and the risks that are difficult to assess. Unlike other climate risks and climate-related opportunities, however, these risks are not subsequently assessed.

Neither are the effects of climate change on certain population groups assessed, but merely described in qualitative terms. The effects of climate change do not affect everyone equally. A wide range of factors play a role, including age, state of health, gender, occupation, socio-economic status and place of residence.

Climate scenarios

The Federal Office of Meteorology and Climatology MeteoSwiss provides regularly updated climate scenarios for Switzerland. The most recent of these, CH2018,[5] was published in 2018 and is currently being updated (CH2025[6]). The CH2018 climate scenarios were taken into account in the Climate Risk Analysis update, along with a number of more recent scientific studies on the impacts of climate change in Switzerland.

Taking a precautionary approach, the Climate Risk Analysis is based on the upper end of the scenarios for emissions development, termed 'high-emissions scenarios'. Switzerland should also be prepared to cope with a scenario in which global efforts to protect the climate are not successful to the desired extent and climate change continues to progress. A high-emissions scenario in a stress test can help us to understand a system and better assess where it is vulnerable to climate change. Moreover, current trends in global greenhouse gas emissions and in regional temperatures are indeed to be found along the upper edge of the range of scenarios. Current research also indicates that the existing regional climate scenarios tend to underestimate some aspects of climate change.[8]

Assessment of climate risks and climate-related opportunities

In order to be able to compare risks and opportunities, their descriptions are rated from – 1 to – 5 (or + 1 to + 5 for opportunities). Similar to climate risk analyses in other countries, since the risks and their interactions are so diverse and complex, the ratings are not strictly operationalised using threshold values. Instead, an approach is taken that allows a diverse data basis and a wide variety of risks and opportunities to be converted into semi-quanti-

Table 3

Scale for the qualitative assessment of climate risks. Opportunities are rated similarly, but from + 1 to + 5

	Designation	Value	Qualitative assessment
Risk/opportunity today	Very high risk	– 5	Very strong climate signal (or existing extreme hazard) combined with high exposure/vulnerability
	High risk	– 4	Strong climate signal (or existing major hazard) combined with high exposure/vulnerability
	Medium risk	– 3	Strong climate signal (or existing major hazard) combined with medium exposure/vulnerability
	Low risk	– 2	Medium climate signal (or existing medium hazard) combined with low exposure/vulnerability
	Very low risk	– 1	Weak climate signal (or existing low hazard) combined with low exposure/vulnerability
Changes up to 2060	Very large increase in risk	– 5	Highly intensified climate signal by 2060 (i.e. very major additional hazard) combined with large increase in exposure/vulnerability
	Large increase in risk	– 4	Intensified climate signal by 2060 (i.e. major additional hazard) combined with large increase in exposure/vulnerability
	Medium increase in risk	– 3	Intensified climate signal by 2060 (i.e. major additional hazard) combined with medium increase in exposure/vulnerability
	Slight increase in risk	– 2	Medium intensified climate signal by 2060 (i.e. medium additional hazard) combined with slight increase in exposure/vulnerability
	Very slight increase in risk	– 1	Very slightly intensified climate signal by 2060 (i.e. very slight additional hazard) combined with slight increase in exposure/vulnerability

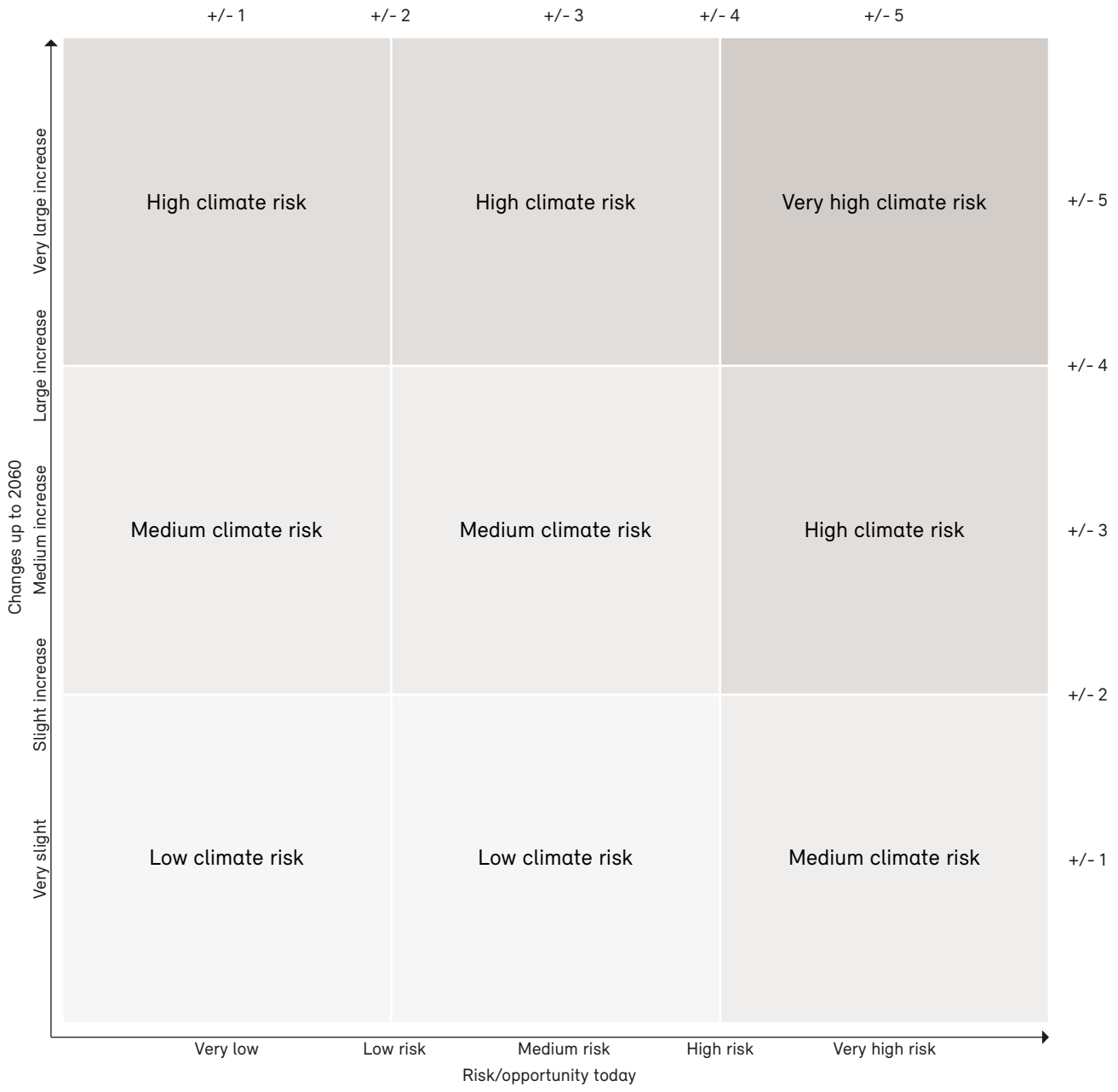
tative ratings. An initial assessment of the ratings according to the scale shown in Table 3 was carried out based on an analysis of climate signal, exposure and vulnerability as well as on the 2017 climate risk analysis ratings. The ratings were then continuously refined in several rounds of revisions, with the involvement of specialists. They were checked for consistency by cross-comparing between the different risks and opportunities.

Present climate risks and climate-related opportunities
The individual risks arising from climate change are then placed two-dimensionally in a nine-field matrix for better comparability (see fig. 5). The matrix axes indicate the assessed level of risk (from – 1 to – 5) and opportunity (from + 1 to + 5):

- **The x-axis indicates the current risk situation:** risks and opportunities that are already significant today appear further to the right in the matrix.
- **The y-axis indicates the change dynamic up to the year 2060:** risks and opportunities expected to undergo major changes appear higher up in the matrix.

Figure 5

Visualisation of climate risks in the nine-field matrix



Very high climate risks are those that are already high or very high today and are also likely to intensify considerably by 2060. *High climate risks* are those that are either already major or very major today and in which slight to medium changes are expected. Alternatively, they are risks that are still classed as very low to medium today, but which could undergo major to very major changes by 2060. *Medium climate risks* are those that are either already major or very major today and which are expected to change only very slightly. Alternatively, they are risks that are currently classed as very low to medium and which are also expected to experience only low to medium change. Finally, *low climate risks* are those that are currently classed as very low to medium and which are expected to change very little by 2060. Opportunities are categorised in the same way, i.e. a very major opportunity is one that is already major to very major today and for which major or very major changes are also to be expected. The Climate Risk Analysis report describes the risks and opportunities that were classed as medium or above.

A2 Complete list of all climate risks and climate-related opportunities

Below are the climate risks and climate-related opportunities with their sub-risks/opportunities for the cross-sectoral challenges within Switzerland, the risks from climate change abroad and risks due to unexpected events and combined risks. The short descriptions used in the 9-field matrix (9FM) are also noted.

Climate risks	Sub-risks
Increasing heat stress	
Negative impact on human health and well-being due to heat 9FM: Negative impact on human health (heat)	· Heat-related deaths
	· Negative impact on human health due to heat (incl. emergency hospital admissions)
	· Negative impact on well-being and mental health due to heat
	· Increased risk of skin cancer due to heat
	· Increased risk of accidents due to increased bathing activity during hot periods
Reduced performance due to heat 9FM: Reduced performance (heat)	· Heat-related reduction in performance at work and in training
	· Heat-related business interruptions and restrictions on heat-exposed economic activities
Heat-related negative impact on livestock health 9FM: Negative impact on animal health (heat)	· Heat-related livestock deaths
	· Heat-related negative impact on animal well-being
	· Heat-related yield losses in the production of animal products
	· Emergence of zoonoses in livestock during hot periods
Negative impact on electricity supply due to heat 9FM: Negative impact on electricity supply (heat)	· Negative impact on functioning of thermal power plants due to reduced cooling water capacity during hot periods
	· Negative impact on security of power supply due to heat
	· Impaired industrial processes due to reduced cooling water capacity during hot periods
Yield losses in agriculture due to heat 9FM: Yield losses in agriculture (heat)	· Heat-related crop losses in agriculture
	· Leaf scorch due to irrigation during hot spell
	· Frost damage due to warm periods followed by frost in spring
	· Reduced quality of agricultural yields due to heat
Negative impact on forest services due to heat 9FM: Negative impact on forest services (heat)	· Reduced wood harvesting potential and changed tree species composition due to heat
	· Protective effect of forest impaired due to heat
	· Recreational service of forest reduced and increased costs of sanitary felling because of heat
Negative impact on transport infrastructure due to heat 9FM: Negative impact on transport infrastructure (heat)	· Negative impact on transport infrastructure and resulting delays due to heat
	· Negative impact on communication infrastructure due to heat (e.g. server centres)

Climate risks	Sub-risks
Increasing summer drought	
Yield losses in agriculture due to drought 9FM: Yield losses in agriculture (drought)	· Drought-related crop losses
	· Change in site suitability and shift in cultivation areas
	· Reduced quality of agricultural yields due to drought
Material damage and impaired forest services due to drought-related forest fires 9FM: Damage caused by forest fire	· Protective effect of forest impaired by forest fires
	· Reduced wood harvesting potential due to forest fires
	· Reduced forest recreational service due to forest fires
	· Damage to buildings and infrastructure due to forest fires
	· Damage to energy infrastructure due to forest fires
	· Reduction in air quality due to forest fires
Water shortage in the public water supply due to drought 9FM: Negative impact on water supply	· Public water supply shortages due to drought
	· Public water supply shortages due to drought-related impaired water quality
Water shortage in reservoirs due to drought **9FM: Water shortages in reservoirs**	· Restricted hydropower production in summer due to drought
	· Reduced winter power reserves reduced due to drought and changes in utilisation requirements in dry summers
Negative impact on forest services due to drought 9FM: Negative impact on forest services (drought)	· Reduced wood harvesting potential and changed tree species composition due to drought
	· Protective effect of forest impaired due to drought
	· Recreational service of forest reduced and increased costs of sanitary felling because of drought
Restrictions on inland navigation due to drought 9FM: Restrictions on inland navigation	· Restrictions on navigation on the Rhine due to low water levels caused by drought
	· Lake mooring infrastructure impaired due to low water levels caused by drought

Climate risks	Sub-risks
Increasing risk potential	
Injury to persons caused by large-scale flooding 9FM: Injury to persons caused by flooding	· Deaths, injured persons and persons requiring support because of flooding
Damage to property caused by large-scale flooding 9FM: Damage to property caused by flooding	· Damage to buildings caused by flooding
	· Damage to communication infrastructure caused by flooding
	· Damage to transport infrastructure and vehicles caused by flooding
	· Damage to energy supply infrastructure caused by flooding
	· Damage to hydropower plants due to increased bed load discharge and suspended sediment from floods and surface runoff
	· Damage to water supply infrastructure caused by flooding
	· Damage to cultural assets, recreational areas and tourist infrastructure caused by flooding
Business operations interrupted because of large-scale flooding 9FM: Business operations interrupted because of flooding	· Business operations interrupted and economic losses because of flooding and surface runoff
	· Reduction in hydropower production due to flooding and surface runoff
Damage to property caused by surface runoff and localised flooding 9FM: Damage to property from surface runoff	· Damage to buildings caused by surface runoff
	· Damage to transport infrastructure and vehicles caused by surface runoff
	· Damage to agricultural crops and erosion due to surface runoff
Business operations interrupted by surface runoff and local flooding 9FM: Business operations interrupted by surface runoff	· Business operations interrupted and economic losses caused by flooding and surface runoff
	· Reduction in hydropower production due to flooding and surface runoff
Injury to persons caused by landslides 9FM: Injury to persons caused by landslides	· Deaths, injured persons and persons requiring support because of landslides
Damage to property caused by landslides 9FM: Damage to property caused by landslides	· Damage to buildings caused by landslides
	· Damage to communication infrastructure caused by landslides
	· Damage to transport infrastructure and vehicles caused by landslides
	· Damage to energy supply infrastructure caused by landslides
	· Damage to cultural heritage and tourist infrastructure caused by landslides
	· Increased maintenance costs due to increased amount of bedload and sediment deposition caused by landslides
	· Reduced storage capacity in reservoirs due to increased amount of bedload and sediment deposition caused by landslides
Business operations interrupted by landslides 9FM: Business operations interrupted by landslides	· Business operations interrupted and economic losses as a result of landslides
	· Reduction in hydropower production as a result of landslides
Injury to persons caused by hail and storms 9FM: Injury to persons caused by hail/storms	· Deaths, injured persons and persons requiring support because of storms and hail

Climate risks	Sub-risks
Increasing risk potential	
Damage to property caused by hail and storms 9FM: Injury to persons caused by hail/storms	· Damage to buildings caused by storms
	· Damage to communication infrastructure caused by storms
	· Damage to transport infrastructure and vehicles caused by storms
	· Damage to energy supply infrastructure caused by storms
	· Damage to forest caused by storms
	· Damage to agricultural crops and greenhouses caused by storms
	· Reduced efficiency and damage to wind turbines caused by storms
	· Damage to local recreational areas (especially forests) caused by storms
	· Damage to buildings caused by hail
	· Damage to vehicles caused by hail
	· Damage to agricultural crops and greenhouses caused by hail
Business operations interrupted by hail and storms 9FM: Injury to persons caused by hail/storms	· Business operations interrupted and economic losses as a result of hail and storms

Climate risks/climate-related opportunities	Sub-risks/-opportunities
Increasing average temperatures	
Savings in heating energy needs due to milder winters 9FM: Heating energy savings	· Savings in heating energy needs due to the rise in average temperatures
Increased yields in agriculture due to milder temperatures in spring and autumn 9FM: Increased agricultural yields	· Yield increases due to the cultivation of new varieties (e.g. in viticulture)
	· Yield increases in agriculture due to the rise in mean temperature
	· Increased biomass availability for energy purposes due to the rise in mean temperature
Economic losses in winter tourism due to milder winters 9FM: Decline in winter tourism	· Business operations interrupted and economic losses in tourism because of lack of snow
	· Fewer people motivated to do winter sports when there is no winter landscape on the Central Plateau due to the rising snow line
Increased earnings in year-round tourism due to milder temperatures 9FM: Increase in year-round tourism	· Revenue increases in summer tourism thanks to fewer rainy days, higher temperatures and a longer season
	· Mountain regions more attractive during hot periods
	· Lake regions more attractive during hot periods
Increase in winter electricity production due to milder winters 9FM: Increase in electricity production in winter	· Increase in hydropower production in winter due to the rising snow line
	· Increase in photovoltaic and solar heat production due to decreasing duration of snow cover
Savings in infrastructure construction and maintenance due to milder winters 9FM: Savings on infrastructure maintenance in winter	· Savings in winter road clearance services due to rising snow line
	· Reduced avalanche damage and less damage to infrastructure from snow pressure as a result of rising snow line
	· Less frost damage to transport infrastructure and vehicles and savings in construction and maintenance costs due to the rising snow line
	· Less frost damage to buildings and savings in construction and maintenance costs due to the rising snow line
	· Less frost damage to water infrastructure and savings in construction and maintenance costs due to the rising snow line
Improved road safety thanks to milder winters 9FM: Improved road safety in winter	· Fewer accidents on snow-covered roads and pavements due to the rising snow line

Climate risks	Sub-risks/-opportunities
Increasing changes in habitats and species composition	
Negative impact on wetlands, aquatic ecosystems and their services 9FM: Negative impact on aquatic ecosystems	· Negative impact on aquatic ecosystems due to increased water temperatures in hot weather
	· Negative impact on aquatic ecosystems due to milder temperatures and lack of circulation in lakes
	· Negative impact on forest services due to drought
	· Negative impact on aquatic ecosystems due to invasive species and harmful organisms
	· Negative impact on water quality due to harmful cyanobacteria in bathing waters during hot periods
	· Negative impact on water quality due to reduced dilution of pollutants as a result of drought
	· Negative impact on water quality due to wastewater due to discharge from overloaded sewage systems and overflow basins during heavy rainfall
	· Negative impact on water quality due to leaching of pesticides, other toxic substances or organic material during heavy rainfall
Negative impact on forest ecosystems and their services 9FM: Negative impact on forest ecosystems	· Negative impact on forest ecosystems due to heat
	· Negative impact on forest ecosystems due to accelerated decomposition of humus resulting from higher temperatures
	· Negative impact on forest ecosystems due to drought
	· Negative impact on forest ecosystems due to forest fire
	· Negative impact on forest ecosystems due to invasive species and harmful organisms
Negative impact on Alpine ecosystems and their services 9FM: Negative impact on Alpine ecosystems	· Negative impact on Alpine ecosystems due to heat
	· Negative impact on Alpine ecosystems due to shift to higher altitudes as a result of milder temperatures
	· Negative impact on Alpine ecosystems due to drought
	· Negative impact on Alpine ecosystems due to invasive species and harmful organisms
	· New habitats arise in foreland of retreating glaciers
Negative impact on ecosystems and their services on agricultural land and in settlement areas 9FM: Negative impact on ecosystems in the cultural landscape	· Negative impact on terrestrial ecosystems due to heat
	· Negative impact on terrestrial ecosystems due to drought
	· Negative impact on terrestrial ecosystems due to invasive species and harmful organisms
	· Negative impact on soil fertility due to accelerated decomposition of humus resulting from higher temperatures
	· Negative impact on soil fertility due to erosion during heavy rainfall
	· Negative impact on soil fertility due to pollution during heavy rainfall
Negative impact on human health and well-being due to heat 9FM: Negative impact on human health (harmful organisms)	· Spread of allergenic plants and longer pollen season
	· Spread of ticks to higher altitudes
	· Emergence of climate-sensitive vector-borne diseases
	· Emergence of mosquitoes that irritate and thus impair people's well-being
	· Emergence of climate-sensitive and water- and food-borne diseases because of higher temperatures
Negative impact on livestock health due to disease vectors and invasive species 9FM: Negative impact on animal health (harmful organisms)	· Negative impact on livestock health due to climate-sensitive vector-borne diseases
	· Negative impact on livestock health from invasive species
	· Emergence of climate-sensitive and water- and food-borne diseases
Yield losses in agriculture due to harmful organisms and invasive species 9FM: Yield losses in agriculture (harmful organisms)	· Yield losses in agriculture due to harmful organisms and invasive species

Climate risks	Sub-risks/-opportunities
Increasing changes in habitats and species composition	
Negative impact on forest services due to invasive species and harmful organisms 9FM: Negative impact on forest services (harmful organisms)	· Negative impact on the protective function of forest due to harmful organisms and invasive species
	· Reduced wood harvesting potential and changed tree species composition due to harmful organisms
	· Recreational service of forest reduced and increased costs of sanitary felling due to harmful organisms
Negative impact on the attractiveness of the landscape 9FM: Negative impact on the landscape	· Change in the attractiveness of the landscape due to the increasing lack of snow cover
	· Change in the attractiveness of the landscape due to glacier retreat in the high mountains
	· Change in the attractiveness of the landscape due to the rising tree line
	· Change in the attractiveness of the landscape due to dried-out meadows and forests
	· Change in the attractiveness of the landscape due to changing plant communities

Climate risks	Sub-risks
Risks from climate change abroad	
Risks in international supply chains due to climate change abroad	· Increase in import price volatility due to the effects of climate change abroad
	· Increase in transport costs due to climate-related damage to infrastructure abroad
	· Reduced availability and quality of imported goods due to the effects of climate change abroad
	· Reduced supply of critical goods such as food, medicines or technical components due to the effects of climate change abroad
	· Changed sales conditions and loss of earnings from products and services manufactured in Switzerland due to the effects of climate change abroad
Risks for cross-border infrastructure systems due to climate change abroad	· Damage and increased strain on cross-border transport, electricity, energy, communication and medical infrastructures due to the effects of climate change abroad
	· Supply disruptions in critical infrastructure systems due to the effects of climate change abroad
Risks to the global financial system due to climate change abroad	· Production and sales losses and physical damage to investment properties and associated investment risks due to climate change abroad
	· Cascading effects and instabilities in property and insurance markets due to the impact of climate change abroad
	· Decline in economic growth and stability in the financial system due to climate change abroad
Risks to international security and stability due to climate change abroad	· Increase in demand for disaster relief and development cooperation as livelihoods of vulnerable and/or poverty-stricken population groups abroad are threatened
	· Increase in global migration flows as the livelihoods of vulnerable and/or poverty-stricken population groups abroad are threatened
	· Climate change and the associated impact on political stability and international security intensify conflict situations

Climate risks	Sub-risks
Unexpected events and combined risks	
Risks from unexpected events and combined risks	· Considerable impacts due to particularly extreme events that significantly exceed the intensity of previously observed measured values
	· Considerable impact on human health due to the emergence of new, previously unknown diseases and new allergenic plants
	· Considerable damage to agricultural crops and animal production due to new harmful organisms and spread of new diseases
	· Considerable reduction in biodiversity due to new invasive species
	· Considerable forest damage due to the spread of new harmful organisms and diseases
	· Considerable damage resulting from the critical sequence of a range of hazards or the unusual accumulation of the same hazard
	· Considerable damage due to uncertain effects of the climate change–natural hazards impact chain (including new process patterns)
	· Considerable damage resulting from changes in the regeneration potential of areas affected by natural hazard processes
	· Considerable impact on livelihoods following unexpected simultaneous failure of several critical infrastructures
	· Considerable damage due to tipping points in the climate system that cause changes in circulation or weather patterns
	· Considerable impacts on biodiversity and/or ecosystem services when ecosystem tipping points are reached
	· Considerable impacts when social tipping points are reached

A3 Bibliography

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A comprehensive list of all the literature used to elaborate the risk analysis is given in the extended report.[1]