

Climate Change in the Swiss Alps

Climate change will increasingly impact everyday life in Switzerland. A marked rise in heat, extreme precipitation, and associated natural hazards is already damaging ecosystems, infrastructure, health, and livelihoods. Collaboration and swift adaptation measures are required to mitigate and cope with the consequences.

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Climate change is not an abstract threat, the consequences of which will affect us at some distant point in the future. Its effects are already felt across the globe, as evidenced in the Intergovernmental Panel on Climate Change's Sixth Assessment Report. The Copernicus Climate Change Service recorded 2020 as the warmest year on record in Europe – at least 0.4 degrees warmer than the previous top-five years, all of which have occurred since 2010. Land-locked regions tend to heat up faster than coastal regions, as they lack the cooling influence of the sea. There is also mounting evidence that higher elevations warm faster than lower elevations. The impact of climate change on alpine regions, such as the Alps, is particularly noteworthy.

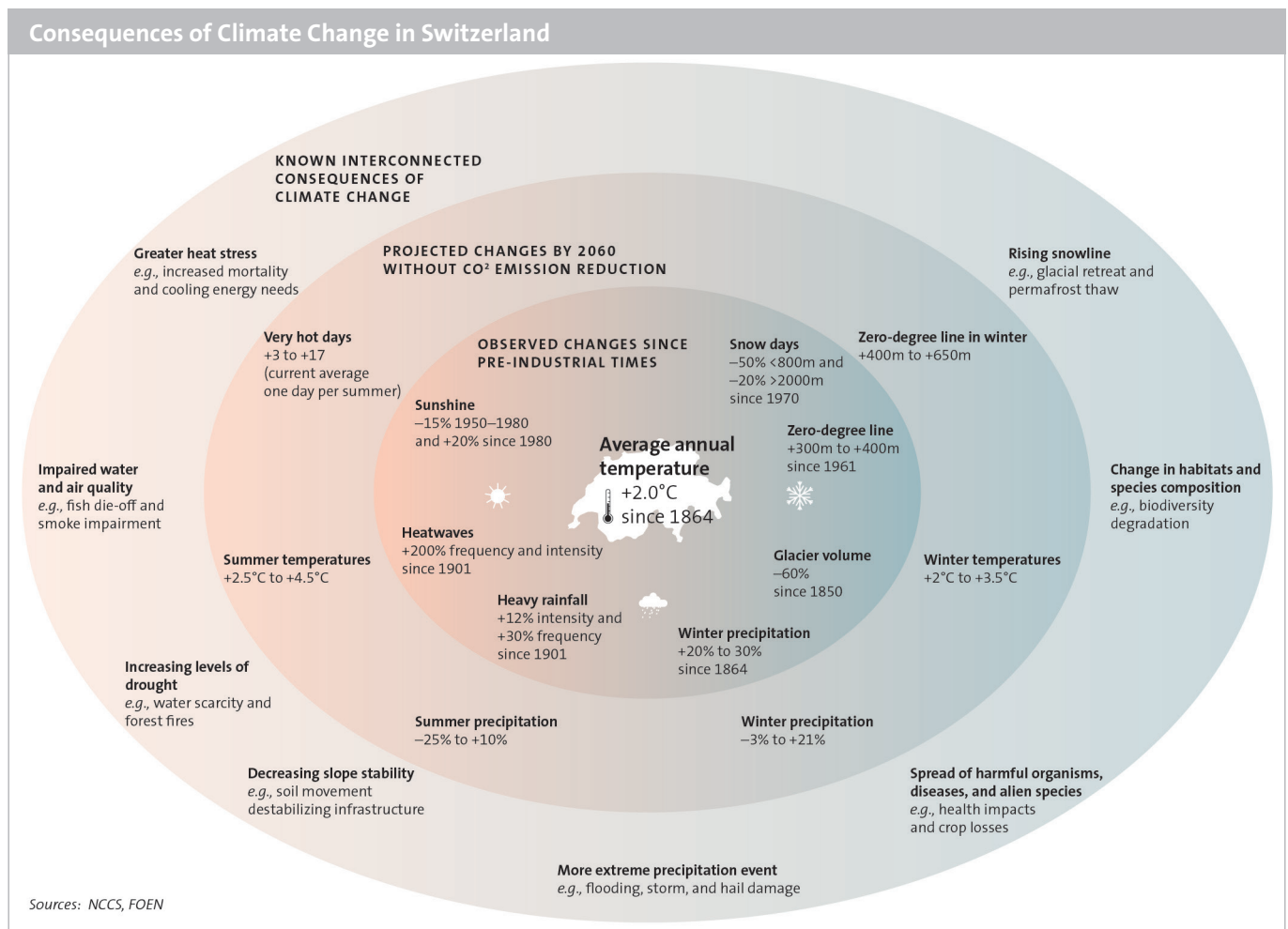
In Switzerland, the annual average temperature has increased by nearly 2 degrees Celsius since the pre-industrial era – almost twice as much as the average global temperature increase. Other important consequences of climate change are the changes in frequency, intensity, and variability of extreme weather events. The CH2018 Climate Scenarios for Switzerland produced by the Swiss National Centre for Climate Services (NCCS) indicate likely climatic changes under various conditions by 2060 and by the end of the century respectively.



Mud in a vineyard next to the Losentze river after a flash flood in Chamoson, Switzerland in August 2019.
Denis Balibouse / Reuters

Without concerted efforts to mitigate greenhouse gas emissions, a further increase in the annual average temperature of 2–3 degrees is possible in Switzerland by 2060. In summer, this would mean more frequent and extreme heat waves and hot days, and days that are on average up to 4.5 degrees warmer than today. Summer months would also have less precipitation on average, with fewer rainy days and more

evaporation leading to drier soils and waterbodies. However, warmer air can absorb more moisture, which is one of the reasons extreme precipitation events like those experienced in parts of Europe this summer will be more extreme and frequent in all seasons. Winter months would be up to 3.5 degrees warmer on average than today, with the zero-degree temperature line being up to 650 meters higher, and with less



snowfall and snow cover overall. The year-round warmer temperatures in the Alps will also accelerate the retreat of glaciers and the thawing of permafrost.

Exploring how these climate scenarios will likely play out in the Swiss Alps provides insights into the broader consequences for natural hazard management and everyday life in Switzerland. It also highlights some of the coping mechanisms available locally, regionally, and internationally.

Natural Hazards Intensify

As an alpine country, the pressure of global warming is particularly pronounced in Switzerland. Climate change will, for example, directly affect the frequency and intensity of natural hazards in the Alps. Societal changes over time exacerbate the impact of the climatic changes outlined above. It is helpful to understand these changes as “compounding issues” and “cascading effects” in order to visualize how climate change will likely play out in concrete terms.

For example, farm abandonment in the Alps has resulted in a gradual expansion of forested land since the mid-19th century, while societal changes have simultaneously seen more people participating in more types of recreational activities in the mountains. Abandoned farms and expanding forests equal more flammable vegetation, and more recreational activities often equals more sparks that can set this fuel alight. These are compounding issues to the cascading effects of climate change.

The effects of climate change are cascading because one change results in, or interacts with, another change like a series of falling dominoes. A warmer and drier climate results in drier vegetation and soil, water scarcity during summer months, along with more high-fire danger days and longer forest fire seasons – not just on the southern side of the Alps where forest fires have traditionally been more common but also north of the Alps. These conditions exponentially increase the risk, frequency, and

intensity of uncontrollable forest fires, which in turn disrupt lives and livelihoods through associated economic impacts and the health consequences of heat and smoke particles that can travel far and wide.

Mountain slopes that have been destabilized by drought and forest fire have reduced stability. Together with more intense precipitation events, this will result in soil erosion and more frequent landslides and rockfalls. The debris – as well as larger volumes of water (in the form of heavy rain, hail, and snow) – endangers downslope regions and increases the risk of tidal waves and flooding in water catchment areas.

Another scenario that will unfold in parallel to the changes outlined above is the spread of harmful organisms, diseases, and alien or invasive species. Climate change, like warmer temperatures or reduced snow cover, promotes their dissemination, as does the presence of more people travelling in and through the Alps. They increase the

risk of animal and human illness (for example via the spread of ticks and tick-borne diseases), and can have a disastrous impact on biodiversity, agriculture, and forestry (such as tree dieback caused by the mountain pine bark beetle). The unique biodiversity of Alpine ecosystems is vulnerable to the loss of habitat and invasive species with temperature rises, less snow, and the receding zero-degree temperature line. It is therefore particularly important to protect remaining habitats and to connect fragmented habitats, as intact and networked habitats are more adaptable to climate change.

Consequences for Swiss Society

The cascading effects of climate change in the Alps will soon shift from having an occasional to a perennial impact on everyday life across Switzerland. The health impacts of heat and smoke stress will not only be an inconvenience for daily routines. They will also add pressure on the healthcare system and increase the mortality rate, particularly for elderly and vulnerable members of society.

Lower elevations and large urban areas act as heatsinks during heatwaves. This will result in higher energy consumption for cooling purposes in summer months when hydropower production is expected to decrease due to water scarcity. Conversely, the change to milder winters with less snow and more rain, and an increase in extreme precipitation events, will both result in an increase in hydropower production and a decrease in heating energy consumption during winter months.

Heat and water scarcity will also result in more restrictions on households' everyday water consumption, and the die-off of fish and crayfish with high water temperatures. Agriculture, viticulture, and forestry crop losses will increase due to drought and favorable conditions for harmful organisms and diseases. However, higher mean temperatures also lengthen the growing season and promote plant growth if adequate water supply is available.

The loss of glaciers and permafrost with the rise of the zero-degree temperature line will affect infrastructure. Warmer mountain slopes will cause soil subsidence, which will destabilize buildings, railway tracks, and roads. The sediment, nutrients, and pollutants carried away by soil erosion and surface runoff also cause problems as they amass in aquatic ecosystems. Moreover, landslides and soil subsidence on mountain

slopes endanger the electricity lines and gas pipes that transport energy from abroad and within Switzerland. On the upside, the costs of winter services and road maintenance will likely decrease due to less snowy and icy conditions.

Depending on the concentration of CO₂ emissions going forward, between 63 and 94 per cent of the volume of ice in the Alps' glaciers is expected to disappear by 2100. This will not only be a heartbreaking loss of Swiss environmental heritage with negative impacts on tourism, it will also mean the loss of significant water reservoirs and the balancing effect glaciers have on runoff in downstream watercourses. While higher average temperatures may make the mountains more attractive for summer tourism, the economic and recreational viability of winter sport and winter tourism will decrease with reduced snow conditions. The production of artificial snow is energy and water intensive, which makes it an expensive and environmentally unsustainable temporary solution. Lower-lying winter sport areas are already feeling the pinch.

Responding to Climate Change

How can we avert or at least partly mitigate these gloomy future scenarios? Scientific knowledge clearly shows that reducing greenhouse gas emissions could effectively stem climate change. The Paris 2015 Agreement aims to facilitate this reduction by limiting global average surface temperature increases to no more than 2 degrees above pre-industrial levels. If the signatory states meet the reduction targets, the NCCS estimates that approximately half of the expected climatic changes in Switzerland could be averted by mid-century and two-thirds by the end of the 21st century.

As a signatory state and an Alpine country that is particularly affected by climate change, Switzerland would do well to ensure that it achieves or even exceeds the targets of the Paris Agreement domestically, while also working to ensure that this is the case internationally. In any case, Switzerland has to take stock of its current capacity to respond to, mitigate, and prepare for the known consequences of climate change.

In Switzerland, civil protection is the primary instrument for dealing with natural, technological, and social hazards. It is organized as an integrated system that brings

together five partner organizations: police, fire, healthcare, technical services, and the civil protection organization (*Zivilschutz*). The cantons are responsible for these organizations on their territory, while the federal level mainly coordinates and provides specialized support. This system has proven its worth in the past. However, in the near future Swiss civil protection will be confronted with the more frequent climate-related hazards outlined above, for which it has only limited theoretical and practical experience and capacities.

More exchange and increased cooperation in the field of civil protection with other countries could therefore be advantageous. As early as 2001, EU member states created the Union Civil Protection Mechanism (UCPM) – a multilateral initiative to strengthen cross-border cooperation in disaster preparedness and response. Member states voluntarily pool their civil protection resources to support countries in need. The UCPM also aims to improve international disaster preparedness and prevention activities by facilitating the exchange of knowledge, best practices, and by strengthening cooperation through training. Participation in the UCPM is open to non-EU member states for an annual fee. There are pros and cons as well as long-term op-

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portunities for Switzerland should it become a participating state of the UCPM (see [CSS report](#)).

Bilateral agreements also offer a possible insurance policy in disaster management. Switzerland currently has agreements with all of its neighboring countries, which provide the legal basis for mutual aid in the event of a major incident via cross-border cooperation, joint preparedness measures through exercises and training workshops, and the integration of cross-border emergency services at different administrative levels. Apart from Liechtenstein, all neighboring countries are member states of the UCPM. Over the past two decades, they have developed common standards and systems for cross-border deployments in the EU – a process Switzerland has not been a part of. Neighboring countries now have less incentive to conduct joint exercises and to formalize expert and knowledge

Forest Fire 2020

In response to society's decreasing tolerance for damage and the expected increase in forest fires due to climate change, the **canton of Ticino developed the concept of "Forest Fire 2020"**. It defines principles and objectives in four core areas of forest fire management: 1) **"prevention"** targets public awareness raising and forestry measures, among others; 2) **"technical and organizational measures"** concern the set-up of all agencies involved in firefighting, and the provision of required infrastructure in and around forests; 3) **"firefighting action"** aims to minimize the direct damage to people and property from forest fires; and 4) **"post-fire management"** identifies measures such as how to restore forests after a fire.

The concept builds on a cantonal history of successfully implementing absolute fire bans on high-fire danger days and forest fire suppression, as well as a recognition that climate change will exacerbate existing risks. It applies to the entire canton and thus allows the planning, implementation, and evaluation of measures according to uniform standards.

exchanges with Switzerland, as they do this on a much broader basis within the UCPM. These bilateral agreements are nevertheless an important aspect of Swiss civil protection, warranting timely updates.

Adaptation and Innovation

In 2012, the Federal Council adopted the two-part strategy "Adapting to Climate Change in Switzerland" to enable Switzerland to take advantage of the opportunities presented by climate change, minimize the risks, and increase socioeconomic and environmental adaptability. The first part of the strategy defined goals, challenges, and fields of action for the management of water resources, natural hazards, agriculture, forestry, energy, tourism, biodiversity,

health, and spatial development. The second part of the strategy consists of two action plans with concrete adaptation measures to be implemented between 2014–2019 and 2020–2025 respectively.

By 2020, 14 measures had been implemented, 28 others were in progress, 19 were in the initial phase, and 2 measures had been postponed. An evaluation noted that the strategy has created a common framework for coordinated action between the Confederation and the cantons, and by raising awareness, it has compelled the federal offices responsible for the targeted areas to act. For example, the Federal Office for Spatial Development is working on spatial planning options that mitigate the build-up of heat and increase the capacity to absorb rainwater by creating more open and green urban spaces. Complementary efforts by the five partner organizations of Swiss civil protection to adapt and innovate at a cantonal level can also reduce the specific risks and concrete impacts of climate change. For example, the cantonal authorities in Ticino, in cooperation with the Swiss Federal Institute for Forest, Snow, and Landscape Research WSL, developed the concept "Forest Fire 2020" to mitigate the frequency of forest fires as well as their consequences (see textbox).

In addition to these official efforts, local and regional initiatives and projects can serve as impetus and models that enable society to better meet the challenges ahead. Individuals, neighborhoods, organizations, and businesses can all play a significant role in mitigating climate change through decisions and actions that range from recycling of waste, sustainable water usage, installation of solar panels for electricity generation, and sustainable investment strategies,

to aiding biodiversity via beehives placed in gardens and on urban rooftops. Such local actions are more likely to succeed with official encouragement and support.

Outlook

Climate change has already led to many changes. In the coming years, it will become an all-encompassing challenge for Switzerland, affecting and shaping all layers, sectors, and regions of society, especially in the Alps. It is no longer possible to

It is no longer possible to prevent climate change, only to limit its scale and consequences.

prevent this development, only to limit its scale and consequences through rapid change, mitigation, and adaptation.

Switzerland is not alone in facing these challenges. Collaboration and cooperation on national and international levels are important to halt unchecked climate change. Bilateral and multilateral agreements in the fields of civil protection, disaster management, and environmental protection aid capacities to cope with the already unavoidable consequences of climate change. Given its geography, the compounding social issues, and the tangible cascading effects, Switzerland should support existing and emerging efforts to mitigate climate change.

For more on perspectives on socio-technical resilience, see [CSS core theme page](#).

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