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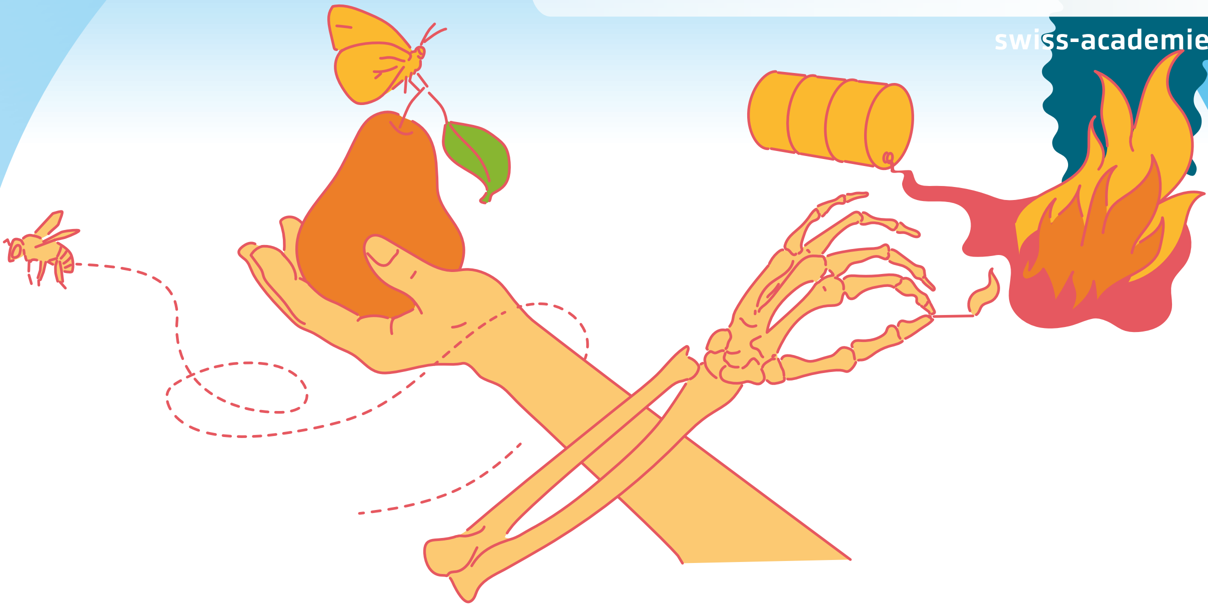

Tackling climate change and biodiversity loss jointly

Climate change and biodiversity loss pose threats to humankind. As these two crises are interlinked and mutually reinforcing, they also need to be tackled jointly. This requires multiple coordinated approaches as well as systemic thinking and action. Measures to combat climate change and biodiversity loss can be mutually supportive; however, if they are not coordinated, there is a risk that the crises may be intensified as a result of unintended effects and conflicts arising from competing goals. The most effective measures are those which address the root cause of both crises – our unsustainable way of life – and involve a fundamental shift towards sustainable resource consumption that respects planetary boundaries. Both at home and abroad, Switzerland is a higher-than-average contributor to both of these crises – but it is also significantly affected by the impacts. In addition to having a major international responsibility, it is therefore very much in Switzerland's own interest to play a pioneering role in efforts to protect the climate and biodiversity.

1 Greenhouse gas footprint is far too high

The global average temperature is now approximately 1°C above pre-industrial levels,[1] while in Switzerland the average temperature has risen by 2°C since measurements began in 1864.[2] This is mainly attributable to the use of fossil fuels, leading to increased emissions of greenhouse gases (GHG).

Switzerland's GHG footprint is many times higher than the global average and significantly above that of EU countries.[3] In 2018, each person in this country was responsible for the emission of over 13 tonnes of CO_2 equivalents, taking into account emissions generated abroad by domestic consumption. This massively exceeds safe boundary levels: respecting planetary boundaries would require annual per capita global emissions not to exceed 0.6 tonnes of CO_2 equivalents.[4] While emissions remain at a much higher level, climate-related risks to health, food security, water supplies and ecosystem stability will continue to increase.[1]

In Switzerland, the impacts of climate change in recent decades have already been all too evident: heatwaves have been more frequent and intense, the zero-degree level has risen by around 300 to 400 metres, and the total volume of Swiss glaciers has declined by more than 60% since 1850.[2] Dry summers, heavy rainfall, tropical days (30°C or more) and low-snowfall winters are likely to become more common.[5]

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2 Millions of species at risk of extinction

Worldwide, species extinction rates are currently around 100 to 1000 times higher than natural background rates.[6] In the coming decades, up to 1 million of an estimated 8 million animal and plant species are threatened with extinction.[7] The global loss of biodiversity since the 1970s has led to a decline in vital ecosystem services: the regulation of climate, water/air quality and detrimental organisms, and the mitigation of extreme weather events, are increasingly impaired.[7] Among the direct drivers of global biodiversity loss are changes in land and sea use, direct exploitation of organisms, climate change, pollution and invasive alien species.[7]

Biodiversity is also under severe pressure in Switzerland.[8] Half of all the habitat types and a third of the 10,350 species evaluated to date are classified as threatened.[9, 10] Particularly affected are aquatic, wetland and farmland species. Among OECD countries, Switzerland has one of the highest proportions of threatened species. In addition, the extent and quality of the country's protected areas are not sufficient to ensure that the conservation goals which it has set for itself are achieved.[11] With its high levels of consumption, Switzerland also contributes to global losses of biodiversity. On a per capita basis, the country's biodiversity footprint also vastly exceeds planetary boundaries.[12]

3 Drivers interact, reinforcing each other

The underlying causes of climate change and biodiversity loss are an unsustainable way of life and economic activity. For decades, humans have been overexploiting natural resources, thus undermining the foundations of human welfare.[7] Such overexploitation gives rise to the direct drivers of both crises. These adverse influences can reinforce each other (Figure 1).

For example, the drainage of peatlands for agricultural purposes leads to the loss of highly specialised species and also to the release of GHG (Box 2). The additional GHG emissions intensify climate change, which in turn impairs the ecosystem services of peatlands, and so forth. At a certain point, changes occurring in ecosystems become irreversible.[13] Such 'tipping points' of global significance include, for example, the thawing of permafrost peatlands at high latitudes,[14, 15] increased shrub cover in the tundra or major forest fires,[16] leading to the release of vast amounts of stored carbon into the atmosphere as GHG.[17]

4 Climate change threatens biodiversity

Climate change influences habitats and the seasonal behaviour of species, altering their growth, productivity and geographical distribution (Box 1). It accelerates changes in community composition, as well as local extinction, in all habitats.[18] Interactions between species are sometimes disrupted – for example, if the activity of pollinators no longer coincides with the flowering period, or if there are temporal or spatial mismatches between predators and their prey.[19, 20]

In response to warmer temperatures in the mountains, many species are shifting towards higher altitudes.[21] As a result, over the last 100 years, plant species richness has increased on summits in the Central Alps – partly because existing specialist species are not immediately displaced.[22] However, if average global temperatures rise by 2.2 °C, the treeline elevation will shift upward by approx. 400 metres. Worldwide, around half of the alpine area is likely to become mountain forest,[23] and in the long term the extent of

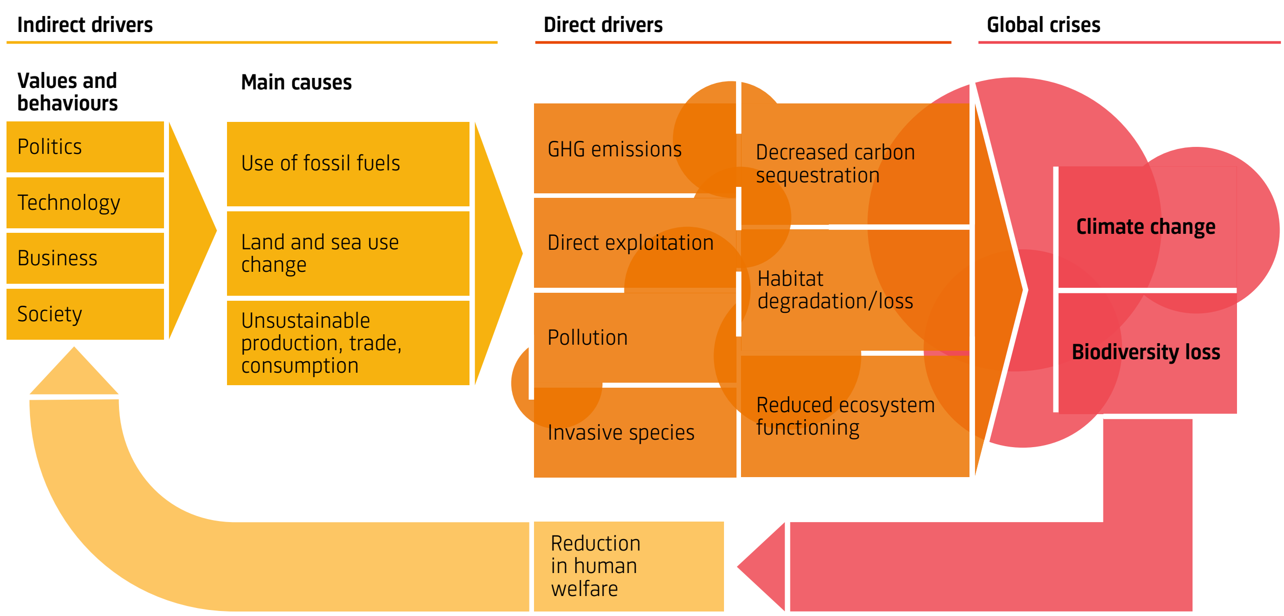
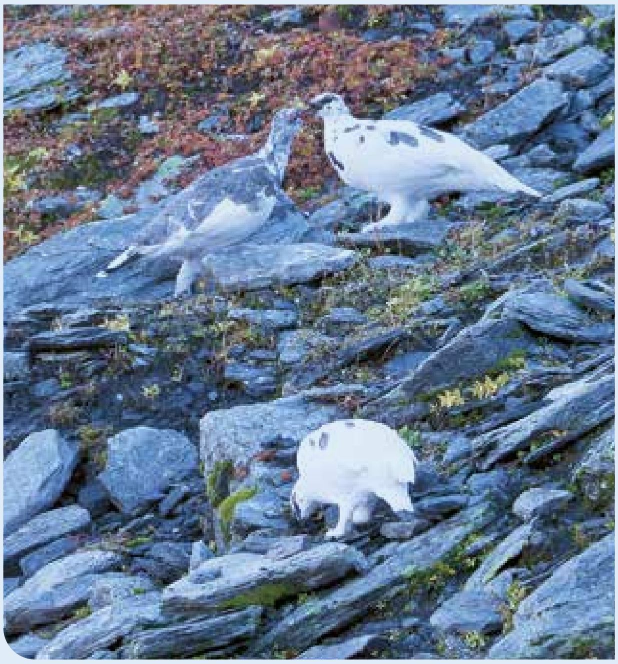


Figure 1: Currently prevailing societal values and behaviours lead to the unsustainable use of natural resources (indirect drivers). This overexploitation gives rise to the factors that impair the stability and functioning of the climate and ecosystems (direct drivers). These can reinforce each other, thus intensifying climate change and biodiversity loss. In turn, a changing climate and declining biodiversity adversely affect the direct drivers – a downward spiral. But the consequences of the global crises also have an impact on our way of life and hence on the underlying indirect drivers.

Box 1: Climate change undermines the rock ptarmigan's camouflage



Switzerland is home to around 40% of the global population of rock ptarmigan. Between 1990 and 2017, their numbers declined by about 30%.[33] The rock ptarmigan is now classified as near threatened[34] and is a national priority species.[35]

Climate change could put further pressure on this species. Climate models predict that its potential habitat in Switzerland could decrease by up to two thirds by 2070.[36] However, the problem does not arise merely from higher temperatures. The birds can survive in areas which would normally be too warm as long as sufficient shade is available.[37] It is rather indirect factors linked to climate change – such as earlier snowmelt – that contribute to their decline: if the snow disappears while the birds are still in their white winter plumage, then their camouflage is lost and they will be more easily detected by predators. The advance of climate change is thus increasing the pressure on a species already threatened by other factors such as winter sports and hunting.

Photo: Oliver Born

habitats lying above the treeline will consequently be markedly reduced.

Many species cannot keep up with the rapid pace of climate change.[20] The most vulnerable are those with low genetic variation, a low reproduction rate, poor dispersal capacity and narrow ecological niches.[24] They are displaced by (generally common) species with greater adaptive capacity, leading to ecosystem homogenisation.[25, 26, 27] With the current trajectory of global warming (average increase of 3.2 °C by 2100), around 49% of insect species, 44% of plant species and 26% of vertebrate species are projected to lose more than half of their geographical range.[28] In addition, native species are at greater risk, while invasive alien species are expected to benefit.[29, 30] Mires, forests, dry grasslands, springs, surface waters and rocks have a high proportion of species with narrow ecological niches and are therefore considered to be climate-sensitive habitats.[31, 32]

5 Biodiversity mitigates climate change and its impacts

The atmosphere and the biosphere interact closely. Terrestrial ecosystems and marine sediments are the largest carbon reservoirs and CO_2 sinks. Carbon is also dissolved in water. About half of the carbon released into the atmosphere as a result of fossil fuel burning and land-use changes is absorbed by vegetation and the oceans (Figure 2).[38]

Vast amounts of carbon are also stored by the biosphere in Switzerland. The largest reservoir is the forest, with 155 megatonnes of carbon stored in live and dead trees and around 175 megatonnes in forest soils.[39, 40] Non-forest soils represent the second-largest carbon reservoir, with approx. 122.6 megatonnes[41] stored in agricultural mineral soils and 30 megatonnes in peatland soils[42] (Box 2).

The preservation of intact and restoration of degraded ecosystems sequesters carbon and reduces CO_2 concentrations in the atmosphere. Such so-called nature-based solutions (NbS)[43] also include green spaces and waterbodies in cities or agricultural areas. As well as counteracting biodiversity loss, these approaches can help to reduce the effects of climate change (Box 2). For example, protection forests, river restoration or peatland rewetting can mitigate the impacts of droughts, storms and flooding. In urban areas, NbS can help to reduce the heat island effect and regulate the water cycle.

To what extent CO_2 can be removed from the atmosphere via NbS or engineering solutions is currently difficult to estimate. Measures of this kind should not blind us to the fact that – in addition to sustainable management of land and water resources – rapid replacement of fossil fuels by renewables remains indispensable.[44, 45, 46]

6 Strengthening synergies, minimising conflicts due to competing goals

Climate change is currently the third most important – and from 2050 is likely to be the leading – cause of the biodiversity crisis.[7] For this reason, in the long term, measures to combat climate change, such as the promotion of renewables, will also counter biodiversity loss. At present land-use changes which lead to the degradation and loss of ecosystems, are the main factors contributing to biodiversity loss.[7] As they impair ecosystems' capacity to store carbon and absorb CO_2, they also drive climate change. The mainte-

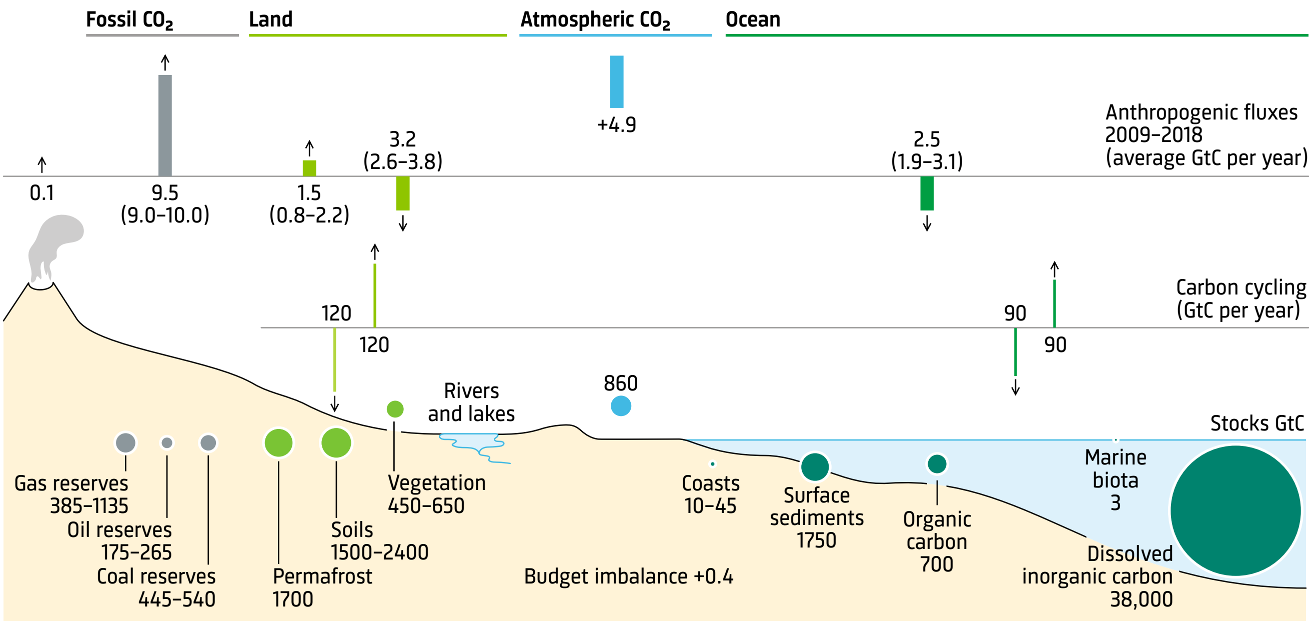


Figure 2: Anthropogenic perturbation of the global carbon cycle. In the natural cycle, carbon circulates between the atmosphere, land and oceans (thin bars). In the oceans, carbon is stored either dissolved in water or fixed in biomass. Human activities – especially the use of fossil fuels and changes in land use – lead to the release of additional carbon, only some of which is subsequently stored by vegetation and the oceans (thick bars). In this schematic representation adapted from Friedlingstein et al. 2019[38] the estimates are expressed as gigatonnes of carbon (GtC), averaged globally for the period 2009–2018. A conversion factor of 3.664 is applied to convert the amount of carbon to CO_2 emissions.

nance of intact and the restoration of degraded ecosystems are therefore key measures to combat both of these crises. However, measures to protect the climate and biodiversity may not only generate synergies, but also adversely affect the achievement of the other (competing) protection goal (Box 3).

This is illustrated by a qualitative assessment of the effects of eight selected measures in the areas of energy, ecosystems, behaviour and economic policy (Figure 3). With optimal implementation, all these measures have the potential to contribute to synergistic management of both crises. To this end, conflicts arising from competing goals need to be minimised, with measures being coordinated and synergies strengthened. Negative effects of measures are frequently attributable to land-use conflicts between conservation, decarbonisation and food production. However, unwanted changes in behaviour may also nullify desired effects, e.g. if, when resources are used more efficiently, the resultant savings lead to an increase in consumption (rebound effect). If insufficient attention is paid to minimising negative effects in the other area when measures are implemented, the climate or biodiversity crisis may even be further intensified.

The effects of virtually any measure thus depend on the overall framework and the type of implementation. Systemic thinking and action are needed to identify intended and unintended effects, and to minimise conflicts arising from competing goals. Even if individual measures are particularly important, multiple coordinated approaches are required to address the two crises.[57, 58] In order to develop sustainable solutions, transdisciplinary sustainability research should increasingly be promoted in addition to disciplinary approaches, taking all relevant perspectives into account.[59]

7 Need for transformation of society

Climate change and biodiversity loss are increasingly causing economic damage and unpredictable changes in society.[60, 61] Among the top global risks identified by the World Economic Forum are climate action failure, infectious diseases, environmental degradation, biodiversity loss and extreme weather events.[62]

In view of the predicted impacts, business as usual is not an option. The Intergovernmental Panel on Climate Change and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services agree that, as well as numerous individual measures, there is a need for a fundamental change in our way of life.[7, 57] This is the only way in which production and consumption can be brought to a level that respects planetary boundaries.

Per capita, both at home and abroad, the Swiss population is a higher-than-average contributor to GHG emissions[2] and to biodiversity loss.[63] At the same time, biodiversity is at particular risk in Switzerland,[11] and climate warming is above the global average.[2] Not least because of the country's topography, this gives rise to considerable environmental risks. Thus, urban areas, as well as agriculture and forestry, are increasingly threatened by storms, landslides and flooding, and winter tourism is affected by the rising temperatures.

As well as having a major international responsibility, therefore, it is very much in Switzerland's own interests to play a pioneering role in efforts to protect the climate and biodiversity.

Box 2: Peatlands are important for agriculture – but also for the climate and biodiversity

Peatlands only cover around 3% of the world's land area,[47] but they store approx. 21% of global soil carbon,[48] which explains the importance of protecting those peatlands which remain intact. Worldwide, the rewetting of peatlands could reduce GHG emissions by 1.91 (0.31–3.38) gigatonnes of CO_2 equivalents per year – more than twice as much as was emitted by global aviation in 2019.[49]
In Switzerland, most peatlands have been drained for agricultural use. But as soil oxygen levels rise, organic carbon is broken down, producing CO_2 and nitrous oxide (N_2O), which are released into the atmosphere as GHG. Switzerland's agriculturally used peatlands emit 0.77 megatonnes of CO_2 equivalents per year, representing around 14% of total annual emissions from agriculture.[40] Intact peatlands are also becoming increasingly dry as a result of artificial drainage[50] and are turning into GHG sources.
Protected mires (raised bogs and fens) occupy just 0.5% of the total area of Switzerland, but they harbour around 25% of its threatened plant species.[51] In addition, intact peatlands mitigate the impacts of climate change: given their capacity to store water, they can reduce local flood peaks and release water to adjacent areas during dry periods.

Box 3: Prioritising renewable energy production at existing sites

The transition to renewable energy supplies requires large areas and is thus in competition with land use for conservation or agricultural purposes. If priority is accorded to areas already under some form of land use as sites for electricity production, such conflicts can be effectively managed and synergies exploited. For example, solar power systems can be installed on existing buildings and infrastructure or combined with the cultivation of certain crops (agrophotovoltaics).[52] As the expansion of renewable energy requires vast amounts of raw materials – often from sensitive ecosystems – there is also a need for a shift towards sustainable mining.[53, 54]
In Switzerland, small-scale hydropower plants make up the largest proportion of hydroelectric plants, but only account for 10% of total hydropower output.[55] They are often harmful to river ecosystems.[56] Relative to the electricity generated, the numerous small-scale plants probably have a greater impact on biodiversity than a small number of large plants. In addition, ecological compensation measures are more readily justifiable economically in the case of large plants.[56] Small-scale hydropower plants should therefore only be maintained or expanded on river sections which are already severely degraded, and – in terms of additional damage to ecosystems – the expansion of existing large plants would appear to be more efficient.

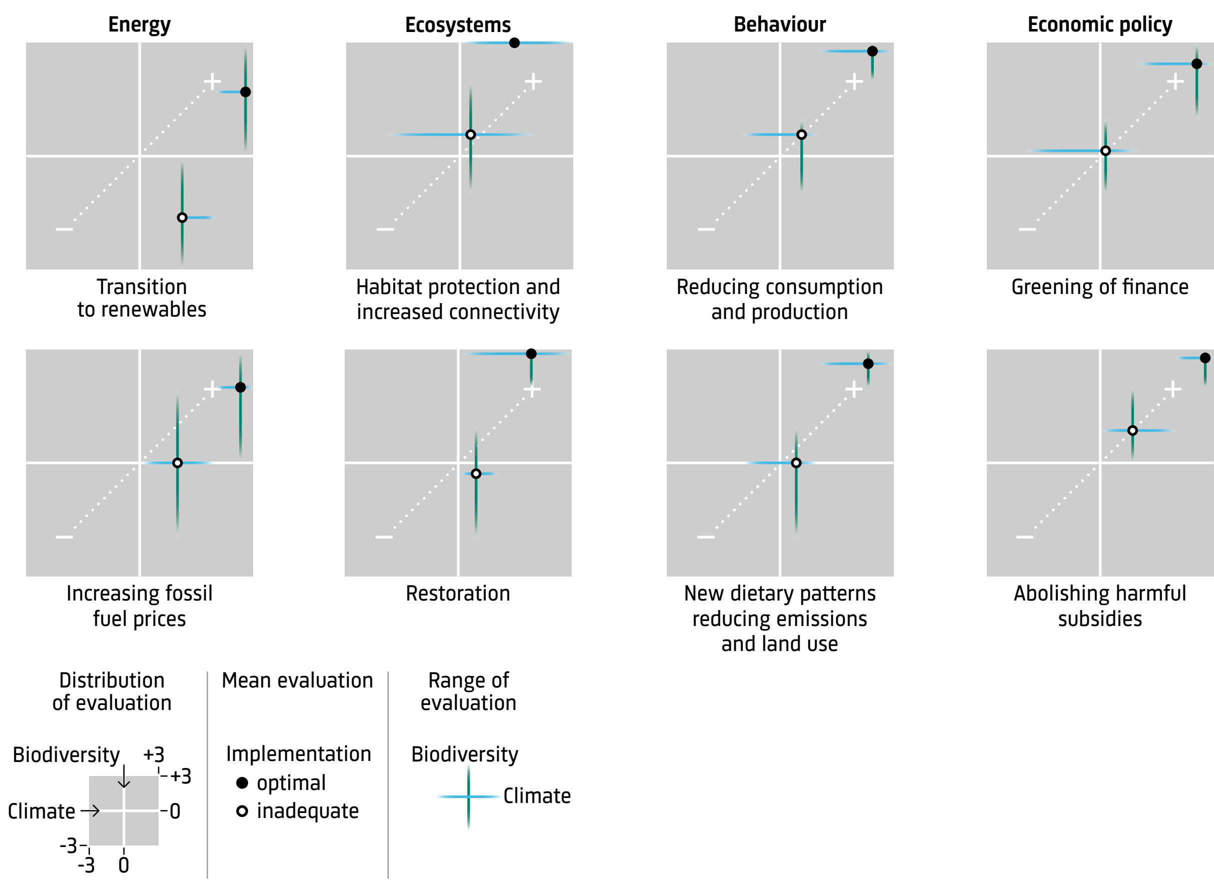


Figure 3: Qualitative evaluation of selected measures to protect the climate and biodiversity. The authors estimated the effects for the climate and biodiversity using a 7-point scale (–3 = strongly negative, –2 = negative, –1 = somewhat negative, 0 = neutral, +1 = somewhat positive, +2 = positive, +3 = strongly positive). In each case, they evaluated an optimal implementation, where unintended negative effects are minimised, and an inadequate implementation, where negative effects in the other area are accepted. With optimal implementation, all the measures considered show positive to strongly positive effects on protection of the climate and biodiversity. By contrast, with inadequate implementation, various measures may intensify the crises.

In seeking to curb climate change and biodiversity loss, the following steps are important:

→ **Transformative change to a sustainable economic system:** The economic development of countries and companies must also be measured by their management of natural resources. One recent approach calls for the inclusion of environmental and biodiversity assets in national and corporate accounting systems.[64] This could help to take negative externalities into account in the setting of prices. Still more comprehensive is the concept of ‘doughnut economics’, in which development is to take place both within the environmental planetary boundaries and with minimum social standards being met.[65] Accordingly, this also encompasses goals for the GHG and biodiversity footprint.

→ **No subsidies harmful to the climate and biodiversity:** Switzerland and other countries around the world spend much more on environmentally harmful subsidies than on measures to protect the climate and biodiversity.[66, 67] To avoid conflicts with environmental goals, national subsidies need to be reformed.

→ **Radical reduction of GHG emissions:** Only rapid decarbonisation can curb climate change.[1] Agricultural GHG emissions (including methane and nitrous oxide) from land-use change in Switzerland and abroad are also to be minimised.

→ **Overcoming land-use conflicts:** The use of land for buildings, transport, food production, climate protection and biodiversity conservation needs to be coordinated.[58, 68] With its National Soil Strategy, Switzerland has defined the ambitious goal of achieving ‘no net soil loss’ by 2050.[69]

→ **Environmental regulations for the financial sector:** The financial sector has a major influence on economic activities which are harmful to biodiversity and the climate. This is also true for Switzerland, where finance is the third largest sector.[70] Switzerland is supporting education and training measures[71] and the ENCORE tool, which highlights the impact of environmental change on the economy.[72] Binding environmental regulations could make the Swiss financial sector an international pioneer in the rapidly growing market for sustainable financial products.

→ **Reduced consumption of meat and dairy products:** Natural ecosystems must no longer be converted to plantations, arable land or livestock farms. The agricultural, forestry and fishing sectors must sustainably manage those areas already in use. This also requires changes in dietary habits.

→ **More funding for conservation:** To achieve conservation goals, Switzerland and other countries around the world need to invest many times the amount that is currently expended.[73, 74, 75] Measures such as protected areas, restoration or increased connectivity, as well as the promotion of biodiversity in all sectors including forestry and agriculture and urban development, scarcely involve any conflicts with the goal of climate protection – on the contrary, they often have a significant potential to prevent GHG emissions arising from ecosystem degradation[57] or to mitigate the impacts of climate change.

SDGs: The UN's International Sustainable Development Goals

With this publication, the Swiss Academy of Sciences contributes to SDGs 13, 14 and 15
‘Take urgent action to combat climate change and its impacts’, ‘Conserve and sustainably use the oceans, seas and marine resources for sustainable development’, and ‘Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.’

> sustainabledevelopment.un.org
> eda.admin.ch/agenda2030/en/home/agenda-2030/die-17-ziele-fuer-eine-nachhaltige-entwicklung.html

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