WSL MAGAZINE

DIAGONAL

FOCUS

Research for a sustainable future

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Swiss Federal Institute for Forest, Snow and Landscape Research WSL

EDITORIAL

Dear Reader
Our motto – 'research for people and the environment' – encapsulates our aims: to do cutting-edge research that addresses global challenges for society and to develop regionally adapted solutions. In pursuing these aims, we are contributing in many ways to the Sustainable Development Goals (SDGs). The SDGs, agreed on by the global community, are wide-ranging, with 17 major goals to ensure the future is sustainable for all of us. We all need to contribute, as best we can, to facilitating the realisation of these goals. In this DIAGONAL, we highlight some of WSL's contributions. Their breadth and scope is impressive. It makes me feel a little proud to know that we have been working in the spirit of the SDGs since long before they were even formulated.
You may have noticed that this issue has a special cover. It marks a small anniversary: today you are holding the twentieth issue of our magazine in your hands. We very much hope you will continue to be a loyal reader and follow our work in the future!

Beate Jessel
Director WSL

FOCUS

WSL and the SDGs

17 GOALS FOR A BETTER WORLD
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RESEARCH FOR PEOPLE AND THE ENVIRONMENT

The Sustainable Development Goals provide the global community with targets for working towards a sustainable future – in the broadest sense. Switzerland, research and WSL are all making significant contributions.

17 goals for a better world

The 17 Sustainable Development Goals at a glance

We want the world to have become a better place by 2030. The steps taken must be sustainable, i.e. they should not be at the expense of future generations. This is what the global community wants, and is why it agreed on the 17 Sustainable Development Goals (SDGs). In Switzerland, the aim is to implement these goals throughout the country and help to realise them worldwide.

The SDGs are very broad. They range from 'No Poverty' to 'Climate Action' and 'Partnerships for the Goals'. There is, however, no binding international agreement on their implementation and no Swiss 'SDG law'. Instead, the federal government has appealed to all non-state and state actors to work towards the goals in their activities. This call applies, of course, also to WSL. According to our Director, Beate Jessel, WSL research already relates to many SDGs: "Forests alone, for example, contribute to the goals of 'Good Health and Well-being', 'Affordable and Clean Energy', as well as 'Climate Action' and 'Life on Land'. We are researching the best ways for them to do this."

It is no coincidence that she chose the forest as an example: the term 'sustainability' comes from forestry. It once referred to a balanced form of forest management to ensure there would be enough firewood and timber in the long term. Today, it refers to a comprehensive and dynamic approach to future-oriented economic, social and ecological development – not only in forest management.

However, a forest that is intended to sequester as much carbon as possible looks different from one that is primarily geared to providing wood and habitats for plants and an-

imals in future climates, and is also managed differently. But these are all explicit sub-goals of the SDGs. This dilemma illustrates one of the problems with the SDGs: some of the goals and sub-goals partly contradict each other. Here, Beate sees WSL making an important contribution by exploring different scenarios, i.e. using scientifically based simulations to show what future awaits us if a particular political decision is taken. "This enables us to develop options for action and show what consequences they would have so that politicians can then make decisions with their eyes open." She says WSL is doing what the Federal Council expects of research when it describes it as a 'driver' for achieving the Sustainable Development Goals.

Moreover, conflicting goals can sometimes be resolved, as the multifunctionality of the forest demonstrates (see the Infographic on page 5). WSL research helps, for example, to reconcile wood use and nature conservation as much as possible. And thanks to social science studies, we know how to plan wind turbines so that they meet with more public acceptance.

The SDGs are listed in: *un.org/sustainabledevelopment*

Long before the SDGs were formulated, WSL research was already dealing with some of the topics they cover. The SDGs are now, however, also providing additional new impulses. Beate refers, for example, to the goal 'Sustainable Cities and Communities', which also includes their surrounding areas. Urban ecology and the importance of urban forests for health and recreation have long been research topics at WSL. In particular, health issues, as well as urban trees and urban forestry, are promising fields to explore in future forest research.

Practise what you preach

In addition, WSL is, as an environmental research institute, called upon to make sure its own business activities are sustainable. Beate thinks WSL is on the right track. For example, the grounds in Birmensdorf have long been maintained in accordance with the specifications of the 'Nature and Economy' Foundation (https://www.naturundwirtschaft.ch/). Wood chips are used for the heating there, whereas in Davos the heating is geothermal. But sometimes running the institute involves dealing with conflicting goals. For example, the SDGs call for and promote global cooperation, but the travelling required for international research activities is bad for the climate. "Of course, we have to weigh up critically every time whether a trip makes sense," says Beate. "When it does, we should go, but also compensate for the CO_2 emissions."

Implementing the 17 SDGs is therefore anything but easy for WSL, Switzerland and the world. If our planet is really to become a better place by 2030, the contributions from research and also from WSL will be indispensable.

(bio)

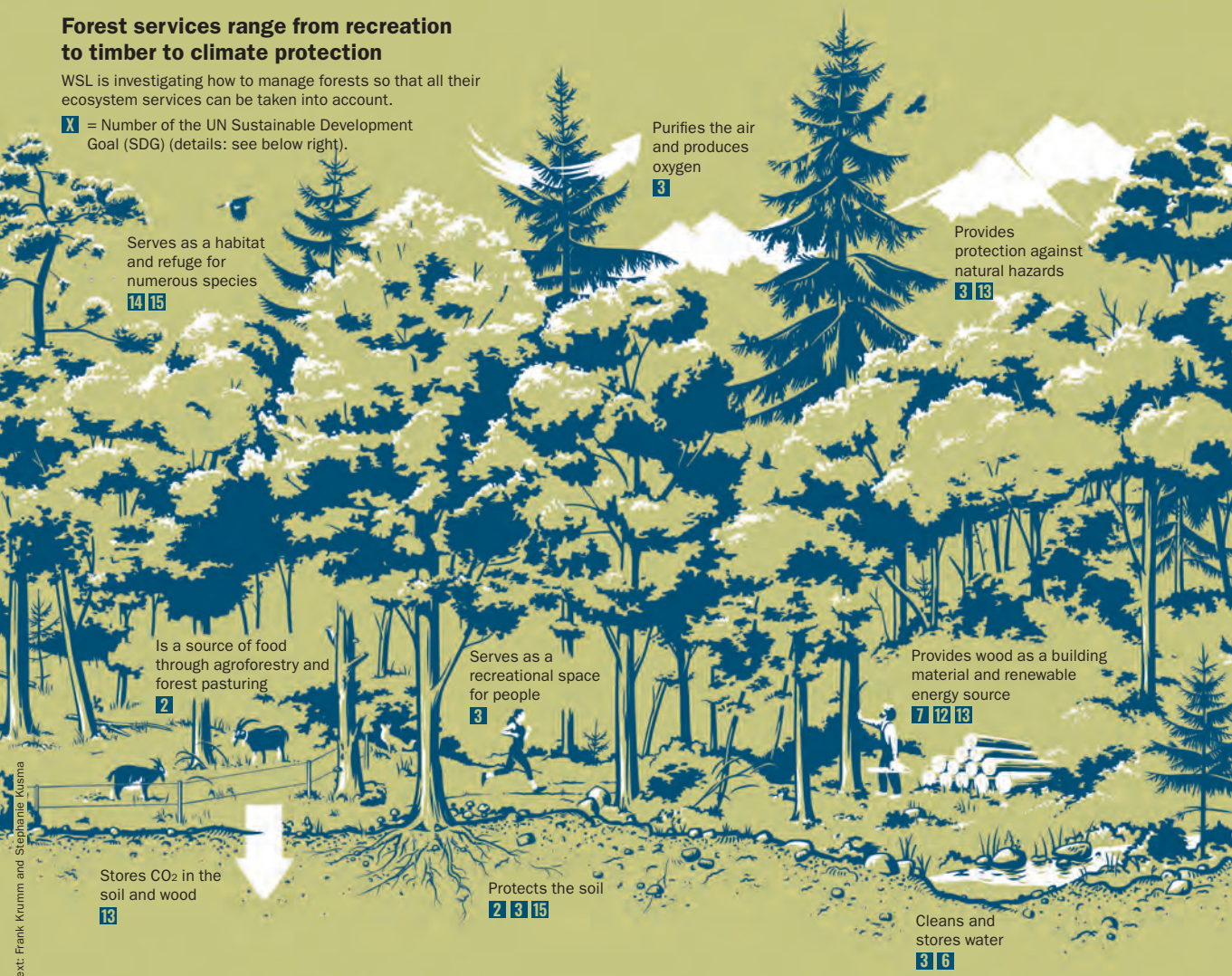
INFOGRAPHIC

What the forest contributes. Forests play a central role in realizing the Sustainable Development Goals (SDGs). This requires, as a basic prerequisite, ensuring that they are managed sustainably worldwide.

Forest services range from recreation to timber to climate protection

WSL is investigating how to manage forests so that all their ecosystem services can be taken into account.

X = Number of the UN Sustainable Development Goal (SDG) (details: see below right).



One third of the earth is forested

... and used. For example, 2.4 billion people worldwide use wood for heating and cooking, and 75 per cent of the earth's accessible drinking water comes from forested catchment areas.

The forest and the SDGs

Forest services relate to very different SDGs, ranging from food security to the protection and provision of aquatic and terrestrial habitats.

- 2 Zero hunger
- 3 Good health and well-being
- 6 Clean water and sanitation
- 7 Affordable and clean energy
- 12 Responsible consumption and production
- 13 Climate action
- 14 Life below water
- 15 Life on land

Infographic: Michael Stünzi and Daniel Röttele, infografik.ch; Data and text: Frank Krumm and Stephanie Kusma

LANDSCAPE USE

From wilderness to residential area: sustainability means reconciling different interests.

Landscapes are there for everyone. To ensure this remains so, fresh ideas in planning – from young people, for example – are needed.

"We are continually having to renegotiate what is important for us and what we can do without," says Silvia Tobias, the head of WSL's Landscape Centre. She is referring to regional planning. Careful weighing up is called for to ensure that landscapes can provide all the services required. These include having space not only for wildernesses and recreation, but also for mobility, industry and housing, and in some cases for the production of food and energy as well. And this must be done sustainably – in tune with the UN's Sustainable Development Goals.

Silvia uses transdisciplinary methods, among others, in regional planning and advocates involving the younger generation more. One of her recent research projects found that they tend to suggest different solutions from those of the older generation. She and her team worked with participants in workshops to develop visions for the future of the landscapes in Lucerne's Seetal valley. Such rural regions close to a city are confronted with a basic problem: the more people move there to live in the countryside, the more built-up such areas become. Commuter traffic also increases, congesting roads and village centres. Thus, much of what attracted people to the region in the first place – the recreational value of the landscape – is being destroyed. What changes then are necessary and how should they be made?

Here the younger participants were freer in their thinking than the older ones. For example, they envisaged putting large wind farms at suitable locations and green high-rise buildings in village centres to make them more vertically dense. Silvia thinks such ideas should be considered in planning: "They indicate which directions the *Zeitgeist* could take."

For more information about WSL's Landscape Centre, see: *wsl.ch/landscape-centre*

The effects of climate change – both those noticeable now and those likely in the future – should, Silvia says, also be taken into account in regional planning decisions. She and her team are, on the basis of climate scenarios, currently developing before-and-after images that show the current state of landscapes and what they could look like towards the end of the 21st century. Lakes, for example, could shrink drastically or soils that are fertile today might no longer be suitable for wheat cultivation. "The aim is to raise awareness of the issues among experts and the general public," says Silvia.

'Biocity' – a vision for the future

Cities are also part of the landscape and can perform a wide variety of functions at the same time. Nicole Bauer, an environmental psychologist at WSL, recently discussed ideas for 'biocities' at workshops with other European experts as part of an international project. "It's about making cities harmonise better with nature and thinking about how to do this in a completely new way,"

The young people participating in a WSL research project were very open-minded about wind farms.

she says. The researchers drew on the literature about future scenarios for urban centres to develop – in workshops – ten possible forms the biocity vision could take.

One possibility is the biocity as a forest. The basis of the idea is to consider the forest and the city not as separate, but instead to think of the city as integrated into the forest. As Nicole explains: "The goal of such a biocity is to have a city that absorbs and stores CO_2 rather than emitting it." For example, a network of avenues could purify the air, as well as cooling it and providing shade, which are important functions in the context of global warming.

"It remains to be seen whether all cities could, in all situations, become biocities," because cities face internationally different challenges. Countries in south-eastern Europe, for example, have major problems with air pollution, while increasing poverty is a problem in the UK and traffic congestion a problem in Switzerland. Ideally, says Nicole, research and politics will in future be inspired by these visions and adopt policies that bring back nature into cities and reduce CO_2 emissions.

"What we plan today will shape the living space of future generations," says Silvia. "And we have the opportunity to use the landscape more sustainably. That means not building everywhere, but instead promoting nature sometimes by doing without more infrastructure, or by dismantling it and building more densely somewhere else." *(sru)*

Illustration: Yvonne Rogenmoser; double page p. 8/9: Christoph Graf, WSL

With further climate change, debris flows, i.e. mudflows and debris avalanches, are likely to pose increasing problems worldwide, and will probably cause, for example, more damage. The UN's Sustainable Development Goals (SDGs) call for action to combat such consequences of climate change. This means, however, understanding them better. Findings from WSL research are a source of much valuable information.

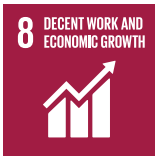
The measurement data on the speed, force and composition of the debris flows enable the researchers to understand them better and describe their flow behaviour. It is also contributing to the development of more effective warning systems and protective structures for, e.g. residential areas.

Debris flows are unusually frequent in the Illgraben due to its special geology. This is why WSL has been observing it closely for over twenty years using different measuring instruments. For example, the laser scanners (LiDAR) installed there measure the debris flows three-dimensionally.

The Illgraben near Leuk (VS)

INTERVIEW

"Keeping the economy within planetary boundaries." The earth's natural resources are running out and the climate crisis is changing the planet and our lives. One reason for this, according to the economist Irmi Seidl, is economic growth.



Irmi Seidl is an economist and head of the Economics and Social Sciences Research Unit at WSL. Her research areas include economic instruments and measures that have ecologically relevant effects.

Irmi Seidl, you are critical of economic growth. Why?

Because economic growth is one of the main reasons for the ecological crises we are facing today. With growth, the consumption of energy and resources increases, as does damage to the environment. Constant growth began in the 1950s and now exceeds the limits for our planet as we consume more resources than can be reproduced.

With the Sustainable Development Goals (SDGs), the UN is trying to shape the future in a sustainable way. What are your views on this?

These globally supported goals are welcome and can help to mitigate the environmental crises. But some of the goals have conflicting targets. For example, SDG 8 promotes "sustained and sustainable economic growth." Growth leads, however, to increasing environmental and resource consumption and cannot, therefore, be sustainable. SDG 7 aims to ensure "access to affordable, reliable, sustainable and modern energy for all." This suggests that our energy consumption in the West would also be possible on a global scale, whereas to comply with global environmental treaties such as the Paris Agreement, it should actually decrease. Our consumption must also respect planetary boundaries, i.e. remain within the limits of available resources. A prerequisite for this is ending our dependence on economic growth.

Can our economy and companies function without growth?

Many small and medium-sized enterprises manage well without growth. One of our doctoral students studied SMEs in the construction industry such as carpenters, electricians and painters. The results show that many of them are not at all interested in growing. Other companies do not aim to make profits and therefore do not need to grow. Take, for example, the Swiss water utilities or cooperatives.

Do we need more state intervention?

Not necessarily. Above all, we need the right kind of interventions. In recent decades, many interventions have been made to promote growth, including subsidies. In 2020, we identified over 160 subsidies and financial disincentives that harm biodiversity. The biodiversity crisis could be defused if only subsidies that did not harm biodiversity were granted or if at least some serious attempts were made to resolve

"Environmental resources need a price that takes into account their environmental costs."

Photo: Gottardo Pestalozzi, WSL

conflicting goals. The tax system also promotes economic growth, for example through tax rebates or deductions for interest on debts. But most urgently, the price for environmental resources such as fossil energy should reflect their ecological costs such as their impact on climate. Since the 1980s, economists have been working on concepts for an ecological financial reform where the external environmental costs are considered in setting prices.

Wouldn't that make a lot of things more expensive?

Some things would become more expensive. Up to now, many things have become cheaper – at the expense of the environment. In some cases, only a few benefit from this. For example, only 20 per cent of air passengers from Switzerland travel to another continent. They are the ones who benefit in particular from untaxed aviation fuel, especially as many of them are frequent flyers. If the climate impact of CO_2 emissions were reflected in the price, a flight to Bangkok would be 900 francs more expensive and one to London 100 francs. But other things could also become cheaper. If environmental resources were taxed more and employment income less heavily, we would have more in our pay packets and the services of, for example, a bicycle mechanic or a nurse could become cheaper.

What other approaches are possible?

Some incentives exist to encourage people to save things rather than waste them. France, for example, has introduced extended product warranties, encouraging people to repair rather than replace things.

According to a WSL study, some SMEs in the construction industry are not interested in growing.

And Austria pays people part of the repair costs if they have electrical appliances repaired. Such measures also help to promote sustainability.

That would then also be in the spirit of the SDGs, wouldn't it?

Of course. The diversity of the SDGs reflects the many areas in which changes in consumption and production are necessary in order for us to live, work and do business within planetary boundaries. *(sru)*

Photo: Keystone

CLIMATE CHANGE

Quo vadis, Flora? Climate change is altering habitats. How will the plant world respond? WSL researchers are using computer models to try to find out.

Will our children's children find themselves walking in winters in Switzerland under evergreen holm oaks or olive trees? It may sound bizarre, but average temperatures are rising, the summers are getting hotter, the winters wetter, dry periods longer and heavy precipitation more frequent. Habitats change with climate, opening up new opportunities for some plants to spread and putting others under pressure.

Researchers at WSL are working on understanding these processes and predicting the future responses of plants. They use computer programmes to model where, for example, alpine plants might grow in future, or how well trees are adapted genetically to the climate conditions that are forecasted. Such future projections make it possible to prepare forests for the future climates and to protect endangered plants. This is in line with the UN's Sustainable Development Goals (SDGs), which stipulate that, in addition to protecting terrestrial ecosystems and biodiversity, "urgent action must be taken to combat climate change and its impacts."

So what will grow where in future? To answer this question, reliable climate models are needed. Niklaus Zimmermann, a researcher at WSL, describes one simple comparative method like this: "If you know what kind of climate conditions can be expected for a particular region in a hundred years, you can look for places that already have such a climate." He continues: "You can then go there and analyse the plant communities that grow at these sites."

This was the approach taken a few years ago in the 'Forest and Climate Change' programme of WSL and the Federal Office for the Environment. The team was led by Peter Brang, a forest researcher at WSL, who died in July 2022. The researchers identified regions on the European mainland where the climate today corresponds roughly to that predicted for Geneva, Basel or Chiasso in a hundred years time. If a warming of 6 degrees takes place – which is the most extreme of the climate scenarios considered – comparable regions for Geneva would be the Maremma and central Italy; for Basel, southern France and the eastern Po Valley; and for Chiasso, along the Adriatic coast and in Tuscany. Forests there are often evergreen.

Slow movers

But that does not mean that a Mediterranean forest will, in future, grow on Switzerland's Central Plateau because there are obstacles like the Alps in the way. Moreover, trees migrate very slowly. Even the very fastest species, such as poplars or birches, which grow quickly and whose seeds are dispersed by wind, manage to travel without human intervention only one kilometre per year. "But the model gives foresters, for example, indications as to which tree species they could try planting for the forests of the future," says Niklaus.

He is using so-called habitat suitability analyses to address the question of where species are likely to find suitable habitats in future. "Putting it simply, you first examine the climate conditions under which a species thrives today," he explains. "And then you calculate where the same conditions will prevail in the future." Dynamic models, which are much more complex, also show the routes along which the distribution areas could shift and identify possible obstacles to migration.

However, if a simple model that relies on statistical methods indicates that the beech will no longer find a suitable climate on the Central Plateau in a hundred years, this does not mean that it will disappear everywhere in this area. If no dramatic and extreme events occur – such as several long periods of drought in a row – plants can still survive for centuries in habitats that are no longer suitable for them. "This is known as 'extinction debt'," says Niklaus.

In a joint study of WSL and the University of Vienna, researchers found that sixty per cent of the more than one hundred alpine plants they investigated were living with such an extinction debt. These species were growing at the lower edge of their actual ranges in habitats where, according to the models used, they should actually no longer occur. "So such models do not predict facts. They merely indicate what may potentially happen," Niklaus explains.

Genetically equipped for the future?

These modelling approaches may be overestimating extinction debts under climate change. For example, they often assume that only one habitat is optimal for an entire species. In reality, however, the levels of tolerance species have for

Photo: Christian Rellstab, WSL

According to species distribution models, the thermophilic and largely drought-resistant oaks are considered possible beneficiaries of climate change. However, populations may differ genetically and thus be adapted differently to future conditions.

the local site conditions may well vary from population to population. For example, their minimum water requirements may be different. Moreover, these models ignore the fact that – given enough time and sufficiently large genetic diversity – species can adapt over generations to changing conditions.

To address these issues, researchers are trying out new methods in which they model the ideal future composition of populations on the basis of genetic data and climate forecasts. "This involves first determining the current genetic composition of populations using many different sites in the genome," explains Christian Rellstab, a researcher at WSL. The geneticist was one of the first – in 2016 – to try out such a method on oak trees.

After characterising the genetic variation, the researchers then identify those sites that co-vary with climatic factors, for example those where the populations that grow in cool areas differ from those growing in warm locations. For their analyses, they therefore need genetic data from plants that grow in geographical regions or periods with different climates, such as from old trees that had germinated and established under different climatic conditions. This was also the approach taken in a recently published WSL study on Swiss stone pines. The team, led by Benjamin Dauphin, Christian Rellstab and Felix Gugerli, found that more than one hundred sites in the trees' genomes were related to the temperatures of the locations where they grew. And the number of genetic sites related to precipitation was even as high as several hundred.

Based on such data, the model then calculates which genetic composition would be suitable for a future climate. The further away the current genetic state of a population is from the optimal state in the climate future, the greater the risk of it not being adapted one day. Such information is helpful for protecting biodiversity: "If you want to save a species, you could, for example, give priority to protecting those existing populations that have the least risk of being poorly adapted and thus have the greatest chance of survival," says Christian.

The results are also relevant for forestry. For example, Christian's oak study, published in 2016, found that the Pedunculate oak was at most risk of being poorly adapted if the climate becomes drier and at least risk if it becomes warmer. This reflects the fact that the species already grows in warm and humid areas in Switzerland. The extent of the risk varied, however, from population to population. Foresters can use this information to select, for example, populations for seed production that are likely to be particularly robust in a future climate.

Valuable information

Like the habitat models, the genetic models do not take into account all the relevant factors. They are limited, for example, to present-day genetic variation. But populations can obtain new genetic variants that may be favourable through, for example, gene flow with other species or even crossing with closely related species.

The combination of these modelling approaches provides valuable data that will help to find the best ways to react to climate change and to protect the ecosystem services of forests (see graphic on page 5), as well as biodiversity, as required by the SDGs. Nevertheless, the researchers still cannot do with-

The yellow mountain saxifrage *(Saxifraga aizoides)* is one of the alpine plants that will have to move to higher altitudes to cope with climate warming.

out experiments in the laboratory and experimental gardens, or without test plantations. Such experiments are often time-consuming and expensive, but they provide important comparative data and 'reality checks' for the computer models. *(kus)*

Photo: Niklaus Zimmermann, WSL

ENERGY **Can Switzerland ever be 'renewable'?** Switzerland has abundant renewable energy resources: sun in the Alps, wind in the Jura and biomass in the forest and on farms. Researchers at WSL are investigating how the Swiss can – and want to – use them.

Photovoltaic systems in the mountains could significantly improve the electricity supply in winter.

Photo: Jérôme Dujardin, WSL

11 March 2011: The reactor disaster in Fukushima in Japan contaminates wide areas of air, soil and water and exposes people to radioactive radiation. The shock leads the Federal Council to decide to gradually phase out nuclear power. In 2017, the electorate approved the Energy Strategy 2050 with its three

pillars: to have no new nuclear power plants, to expand renewable energy and to reduce consumption through improved energy efficiency.

According to the Swiss Federal Office of Energy, the Swiss currently consume around 220 terawatt hours (TWh) of energy per year. Almost half of this comes from petroleum products and about a quarter is in the form of electricity, which is mainly produced from nuclear and hydroelectric power. Gas, coal and waste heat make up the rest. Is it possible to generate this quantity of energy and still ensure that it is in line with the UN's Sustainable Development Goals, i.e. clean and affordable? To find out, the federal government invested 250 million Swiss francs in Innosuisse's Energy Funding Programme. For the so-called 'energy transition', 1300 researchers and other experts explored technical, social and political solutions between 2014 and 2021.

The resources are there

WSL also participated in the Programme. For many years, WSL researchers have been collecting data on the development of forests, glaciers, snow and other environmental parameters. They use this data to develop simulation models to estimate the availability of natural sources of renewable energy, namely biomass, water, wind and sun.

Their findings show that one potentially quite large source of energy is stored in biomass, i.e. organic substances such as wood, cuttings and solid and liquid manure. "Biomass is a valuable substitute for fossil fuels. It is available everywhere and can be efficiently converted into energy," says Oliver Thees, a forest scientist and economist at WSL. His team explored the energy potential of woody and non-woody biomass as one part of the Energy Funding Programme and found it could contribute as much as 27 TWh of energy per year.

Wood in the form of forest and woodland wood, industrial residues and waste wood is already being used intensively, especially for heating. However, the researchers showed that about one third more, amounting to 13.9 TWh per year, could potentially be used sustainably.

Manure heaps and liquid manure pits have considerable energy potential, and could provide around 6.6 TWh. Much of this potential is currently unused according to a WSL study on biogas production from solid and liquid manure. A further bonus of using farmyard manure for energy is that less would be spread on fields and meadows, which would reduce not only greenhouse gas emissions, but also overfertilisation.

Filling the winter electricity gap

Hydropower will continue in future to supply a lion's share of the electricity in Switzerland. But winters present a problem. When water is bound up as snow and ice, the water levels in the reservoirs fall, and with them, the electricity production. Climate models predict that, in future, there will be less rain in summer and more in winter. "In this case, climate change would help the energy transition," says Michael Lehning, head of the Snow Processes Group at the WSL Institute for Snow and Avalanche Research SLF. But this would not be enough to close the so-called 'winter gap'.

Switzerland relies on electricity imports in winter. But what will happen if neighbouring countries no longer can or no longer want to supply it and if

nuclear power production one day stops? Huge storage facilities would be needed to store the electricity generated in summer. This would require, for example, constructing new and higher dams and additional pump storage power plants, which would be highly questionable from an ecological point of view.

A simulation study at SLF and ETH Lausanne explored how much potential renewable energy in Switzerland has to fill the winter gap. It showed that, if wind and solar energy were expanded considerably, they could, together with today's hydropower production, reduce the amount of energy Switzerland would have to import in winter without nuclear power by 80 per cent.

Solar power in the mountains is very promising. Solar plants on dam walls and avalanche barriers work much more efficiently, especially in winter, than those in the foggy lowlands, says Annelen Kahl. She is a solar researcher at SLF and co-managing director of the solar company SUNWELL. In the mountains sunny days are more frequent, the snow reflects the sunlight, and the solar panels can be optimally aligned with the winter sun, unlike on the roofs of buildings. According to the simulation, installing roughly 100 km^2 of new solar panels, with half in the Alps, would be realistic. The rest of the winter gap would have to be filled by about a thousand new wind turbines.

Together, these plants would produce around 25 TWh of electricity, which is considerably more than that produced today with solar (3 TWh) and wind power (0.15 TWh). "You would still need to have additional storage for summer electricity, but much less," says Michael Lehning. "So the energy transition in Switzerland would be feasible from a technical point of view."

Wind power as a stumbling block

Administrative hurdles such as building permits pose difficulties, while social acceptance is even more of a problem. In unspoilt areas with great wind potential, the public tend not to want energy plants, as WSL's Energyscape project showed. Several wind-farm projects remain blocked by local opposition even in well-populated regions. "It's not about the lack of technology, but the lack of communication and acceptance," says Boris Salak, a social scientist who participated in the project. Various studies have shown that the public tend to be more positive about energy plants if they are involved in the planning process at an early stage.

To encourage local participation, energy cooperatives could provide a role model. Around three hundred such cooperatives already exist in Switzerland. They mostly operate small, jointly financed photovoltaic or woodchip plants, especially in rural areas. A WSL survey in 2016 concluded that the advantages of cooperatives are their local roots, broadly based financial participation and close cooperation with the local communities. However, promoting this form of organisation would require a cost-covering purchase guarantee for the energy produced that lasts for the lifetime of the plants.

According to Boris Salak, the energy transition will only have a chance if the authorities and energy producers take socio-political aspects into account. These include social values such as people's attitudes towards 'their' landscape, as well as such ecological costs as a possible loss of biodiversity. "Selecting the sites for energy plants on the basis of technical-economic principles alone will not be sustainable." *(bki)*

Kerstin Treydte, Birmensdorf

“Music provides a wonderful counterbalance for research and stimulus for other facets of my personality. The regular master classes for recorder and early music in Arosa and chamber music courses like this one on Rheinau Island are always highlights of my year.”

TREE RINGS AS CLIMATE ARCHIVES

Kerstin Treydte is a tree-ring researcher. She analyses stable isotopes in wood to study past climates and to find out how ongoing climate change is affecting tree growth. Such data help to refine climate models and predictions about the future of forests. Currently, she is, together with an international team, reconstructing atmospheric dryness over the last 400 years in the European lowlands. “The discussions with other colleagues are very enjoyable.” *(bki)*

Photo: Bruno Augsburger, Zürich

Stormy times for our forest floors

Storm damage can sometimes have long-term effects on the soil.

The traces of storms that have caused damage aboveground in the forest, such as broken branches, bent stems and uprooted trees, often remain visible for a long time. Mathias Mayer, a soil scientist at WSL, is researching how such storm damage affects carbon storage and biodiversity in the soil.

Mathias and a team from WSL analysed the carbon contents in soil samples from 19 forest sites in Switzerland that had been devastated by storms either twenty years ago by Vivian or ten years ago by Lothar. The sites are located between 420 and 1550 metres above sea level. The researchers compared the samples with soil samples from neighbouring forests where no storm damage had occurred.

They analysed first the organic carbon stored in the samples and found that the humus layer – the uppermost, purely organic layer of the soil – generally stores more carbon in the mountains than on the Central Plateau. This is due to the temperature differences. In mountain regions, where it is colder and the warm periods are shorter, decomposition processes take place more slowly so that thicker humus layers form. In warmer soils, on the other hand, soil organisms are quick to almost completely decompose the new leaf and

Photo: Mathias Mayer, WSL

needle litter that accumulates during the year.

Fragile mountain forests

According to the study, thick layers of humus are, however, particularly sensitive to storm damage. The researchers found that soils in mountain regions still contained up to ninety percent less carbon in the humus layer at the time of sampling than before the storms. The reason for this is that, at sites without trees, which shed leaves or needles every year, the humus layer hardly receives any replenishment of organic material. At the same time, the soil becomes warmer and wetter because there are fewer trees to shade it and draw water from it. This accelerates the decomposition of the existing humus layer.

This process also takes place at lower altitudes. "But there the soil and the humus layer recover more quickly. The next generation of trees grow faster than in the mountains, and the subsequent litter inputs build up the underground carbon stock again more quickly," says Mathias. Moreover, after only ten years, virtually no effects of the storms could be detected in forest soils from lower-lying regions.

In a second step, the team modelled the possible losses of soil carbon due to storm damage for the entire Swiss forest. For this they relied on the WSL soil database, which contains data from over 1200 Swiss forest sites. They concluded that many Swiss mountain forests would lose large amounts of carbon from the humus layer after storm damage. The losses after windthrow correspond roughly to the amount of carbon that the forest incorporates in the biomass on an equal area in forty years. "If the carbon storage of several decades is cancelled out in this way, it has a negative impact on the climate," says Mathias.

Storm damage influences soil fungi

Changes in the carbon stock of mountain forests are not the only effects of storms Mathias found in forest soils. In cooperation with researchers from the University of Natural Resources and Applied Life Sciences Vienna, he was able to show that storm damage also greatly influences the soil fungi. According to Mathias: "Mycorrhizal fungi, in particular, which live in symbiosis with trees, are especially affected by the loss of the tree layer." But if the surviving trees and storm wood are not removed, the negative effects on this group of fungi can be buffered. However, from the point of view of forest management, it is, he explains, often advisable to clear away storm wood to prevent pest infestation. *(sru)*

The researchers compared soils from storm areas and undisturbed parts of the forest.

Photo: Daniele Haager

Storm damage poses challenges for forestry

A violent storm can devastate a forest – with drastic consequences for forestry and the ecosystem services the forest provides (see Infographic, p. 5). With large-scale events, the oversupply of timber leads to the collapse of prices on the international market and makes it difficult for sawmills to keep up with the work. What do forest owners do in such situations and how do sawmills react?

Wet storage enables forest owners to maintain the quality of the timber over longer storage periods.

To address these questions, a research team led by the forest scientist Janine Schweier studied seven major storm events, including the storm Lothar in 1999. This enabled them to identify the most common forestry practices in Switzerland and other European countries. They also asked sawmills how they cope with fluctuating timber volumes after extreme events.

The top priority, Janine says, is ensuring the safety of people in the forest. Loose branches and damaged trees are dangerous for foresters and people seeking recreation in the forest. Only when forest owners are sure it is safe, do they decide, individually, how much they will clean up and the extent to which they will sell the wood. Exactly what they do also depends on the mix of ecosystem services the forest should provide. Is the emphasis on wood as a sustainable raw material, recreation, habitats for animals and plants or protection against natural hazards, or a mixture of these?

If they can delay selling timber, this would bridge the periods when prices are low and reduce the burden on sawmills. However, the quality of timber diminishes during storage. "Wet storage offers a surprisingly simple solution, but it is still too rarely implemented," Janine says. Sprinkling the logs with water continuously helps to preserve their quality.

Janine is evaluating, as part of several interdisciplinary projects, the risks storms pose for forests so that forest enterprises can be better prepared. For example, they can adapt their management strategies and plant more robust species in endangered tree stands. Such strategies are becoming increasingly relevant because, with climate change, storms are likely to become more frequent and more intense in future. *(mlg)*

wsl.ch/ONEforest_en

Photo: Janine Schweier, WSL

Historical parks are more than green lungs

What do the Rieterpark in Zurich and the Eram Garden in Shiraz in Iran have in common? Both were once the private gardens of stately homes and are now important components of the cities' 'green infrastructure'. Such parks serve, with their historical garden architecture, not only as places for recreation, but also promote a so-called 'sense of place', i.e. an attachment to a place, especially among immigrants – as Mahsa Bazrafshan, a doctoral student at WSL, and Felix Kienast, her supervisor, discovered.

As part of their research, they showed people from Switzerland and Iran views of both parks in an audio-visual laboratory, and measured the electrical conductivity of their skin. This provides an indication of how tense or relaxed someone is. The participants in the study were asked about their impressions of the parks and what they thought about them. Their answers allowed conclusions to be drawn about their place attachment. "The stronger it was, the more relaxing the images of the park in question seemed," says Mahsa. And according to her measurements, people seemed most relaxed in the park associated with their own culture.

The experiment also made it possible to find out about when place attachment arises after migration: In her study the 'foreign' Rieterpark had a measurably greater relaxing effect on the participants from Iran, who had all lived in Switzerland for several years, than did the Eram Garden on the Swiss test subjects, who had never been there.

In another study Mahsa carried out in Iran, she found people from Afghanistan discovered elements and functions in the historical fabric of Persian gardens that they could link to their childhood memories. "Such links probably arise particularly frequently in historical parks," says Felix. "This means they should be maintained not only because of their cultural history, but also because of the role they can play in integration."

(kus)

Photo: Mahsa Bazrafshan, WSL

The Eram Garden in Iran is an example of a Persian Garden in a millennia-old tradition.

Do digital plans make spatial planning more democratic?

Almost all municipalities today post colourful plans on the Internet showing the building and development zones. An EU-wide project, in which the WSL researcher Anna Hersperger took part, explored the pros and cons of this kind of digitalisation.

Anna Hersperger, what is a digital plan?

AH: It refers to spatial planning data that is available in digital form. This could consist not just of a map, but also the results of a population survey or analyses of the population development in, for example, a particular neighbourhood. In Switzerland, we have the PLR-Cadastre, which lists all the public-law restrictions on landownership. These include restrictions on where, what and how you are allowed to build or to use land commercially, and indicate which areas are protected or contain contaminated sites. The local authorities, landowners and investors need this information for planning projects and land use.

Why do you need to research this?

Digital planning is developing quite rapidly at the moment. It is thus important to keep a critical eye on the developments to see which approaches are successful and what you need to pay particular attention to. Why, for example, did something not go so well? Our applied research helps users to develop such 'best practices'.

How did you proceed?

We conducted a rough survey in 15 countries and a more detailed survey in six countries to determine what plans they have available online and how extensive they are. Other questions were about the people involved and whether the plans are legally binding for concrete building projects. We also wanted to know how digital planning data influences planning practices.

What did you find out?

We found that digital plans vary tremendously, ranging from a simple scan of the land-use plan to a complete online register with geo-data. In general, digitalisation makes things more efficient. In the past, you had to go to look at the plan on a wall in the town hall, but today you can check the plans very quickly using GIS, the geographic information system.

Are there other advantages?

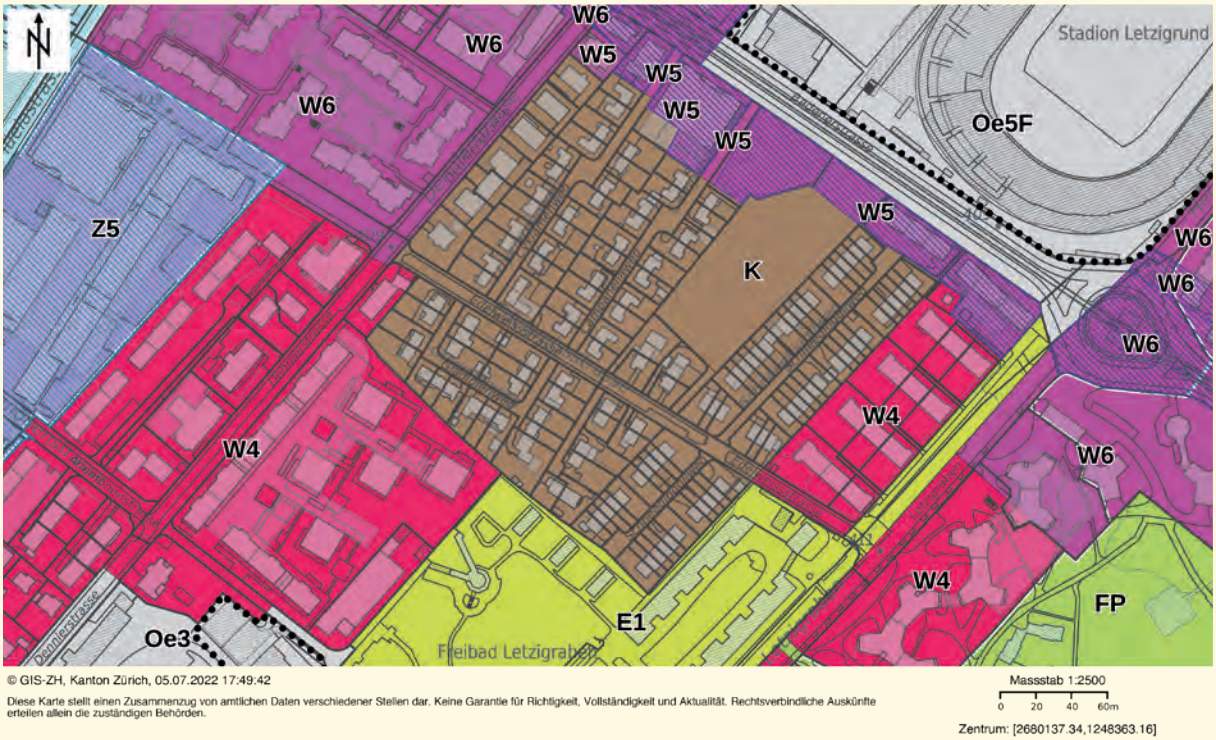
Digital data makes it easier to involve the construction sector, nature conservation, infrastructure and services more closely in the planning process. It contributes – at least to some extent – to better quality planning, as well as to more transparency.

What are some of the difficulties or disadvantages?

A big challenge is developing uniform standards, for example standardising the map symbols, colour schemes and data formats used. This would help us to address interesting questions for larger regions, such as whether a particular area has developed as originally planned.

Anna Hersperger is the Head of the 'Land Use Systems' Research Group and a member of the WSL Directorate.

Photo: Gottardo Pestalozzi, WSL



Everything online: The cadastre with the public-law restrictions on landownership (PLR-cadastre) contains all the information you need on how you may or may not use a plot of land.

You have formulated 25 recommendations for policy. Which do you consider the most important?

A longer-term strategy for digitalisation is certainly needed, and it should be made as user-friendly as possible. Digitalisation in rural areas should be promoted and planning should be thought about more in process chains. Currently, planning is carried out with each sphere considered separately: starting with building permits, then construction and finally monitoring. It would make more sense to approach all of these on the basis of the same standardised data.

Do more people use the plans when they are online?

Notary offices and real estate companies, for example, do indeed seem to use digital plans quite often. But we would have expected them to be used rather more by nature conservation and local organisations to keep up to date.

Do digital plans make spatial planning more democratic?

If you do it well, yes. Clearly, digital plans make it much easier for the public to obtain information and have more of a say. However, some people fear that spatial planning will then become too technocratic and thus non-transparent, and that political discussion and the creativity of individual spatial planners will take a back seat. I'd also like to stress that there is still room for improvement in terms of transparency – many supra-regional plans, such as programmes for agglomerations, have not yet been included in the digital plans. *(bki)*

espon.eu/digiplan

Image: GIS-ZH, Canton of Zurich

Trees on the move

It is impossible to imagine the tree line in the Alps without the Swiss stone pine, *Pinus cembra*.

As the queen of the Alps, the Swiss stone pine defies icy cold and intense sun. It thrives at the alpine tree line as well as in disjunct locations in the Carpathians. This was not always the case. The warmer and colder periods occurring during the ice ages repeatedly forced the species to migrate. Researchers at WSL have now reconstructed – for the first time – the paths it took and the places where it survived during colder and warmer periods. To do this, they relied on fossil finds and genetic data collected across its entire range.

The team, led by Felix Gugerli, analysed dated fossil records of Swiss stone pine that had been found in over a hundred sites. The oldest fossils were around twenty thousand years old. The researchers also determined the genetic diversity in almost one hundred and fifty Swiss stone pine stands. The fossil evidence enabled them to 'firmly pin' the species to certain regions and times, while the genetic data provides clues to events that can date back hundreds of thousands of years.

Two lineages identified

It seems that, more than 200,000 years ago, some of the Swiss stone pine must have been spatially separated from the rest for a long time: As a result, an 'eastern' and a 'western' lineage of the Swiss stone pine formed. "Hardly any genetic exchange takes place between individual stands if they are further apart than about five hundred kilometres," explains Felix. This is why the genetic pattern of the eastern lineage, which today occurs in the Eastern Alps and the Carpathians, differs from that of the Swiss stone pine in the Western Alps.

The data also indicates that the Swiss stone pine was not very widespread at that time. Even towards the end of the last cold period, when it was most widespread and when it col-

Photo: Felix Gugerli, WSL

onised the area between the Alps and the Carpathians up to the intermediate altitudes in the mountains, its populations were probably scattered.

"With increasing warming, Norway spruce moved in, spreading faster and growing more rapidly," Felix explains. The Swiss stone pine then 'retreated' to the higher altitudes. This kind of information about past migrations helps improve forecasts about the future of the tree species with climate change.

The researchers suspect that, if temperatures continue to warm, the Swiss stone pine could continue to move further up, but it will probably need human help to do so. The nutcracker, which disperses the pine's seeds, only occasionally hides them above the tree line. Should planting be necessary, genetic data will help to identify suitable provenances and sites. *(kus)*

wsl.ch/Swiss-stone-pine

BIODIVERSITY

How snow shapes nature

Snow cover greatly influences alpine and arctic ecosystems. In this interview, Christian Rixen, a researcher at SLF, explains why.

Christian Rixen, you are a plant ecologist and do research in very cold ecosystems in the Arctic and the Alps. Why, of all places, in areas where not much grows?

I find plants that are specialised for the cold fascinating. They grow in what we consider to be hostile environments, and their habitats are particularly affected by climate change. I wonder what kind of future these high alpine specialists will have. Where will they go when the climate gets warmer? The mountains here are relatively high, but the higher up the plants have to move, the smaller their habitat becomes.

But why the Arctic?

I tend to say: what happens in the Arctic does not stay in the Arctic. Huge amounts of carbon are stored in the permafrost, i.e. in the permanently frozen ground there. When this thaws, the carbon is released in the form of greenhouse gases. This can further fuel global warming, which – viewed pessimistically – cancels out our efforts to stop climate change. Plants can play an important role in both fixing and releasing carbon. Moreover, they are excellent indicators of the local environmental conditions and may also provide information about the carbon stocks in the soil.

Christian Rixen is a plant ecologist at the WSL Institute for Snow and Avalanche Research SLF

Photo: provided

What impact does snow have in such cold ecosystems?

The effects of snow are particularly evident there because it remains for much of the year. The

length of the snow-covered period determines how long or short the summer season is. And the exact timing of the snowmelt greatly influences which plant communities can develop there.

Does the snow cover in the Arctic differ from that in the Alps?

Much of the precipitation in the Alps is in the form of snow, which insulates the ground. When the snow cover is more than about half a metre thick, the temperature on the ground surface is zero degrees, and below the surface a few degrees warmer. In the high Arctic regions, on the other hand, it is often relatively dry, and less insulating snow accumulates. As a result, ground frosts are heavier and the ground cools down more, which also affects the permafrost.

What happens when the snow melts earlier? Do the plants benefit?

That's an interesting question. In a winter experiment in Davos, we shovelled away the snow on selected areas above the forest line every spring. Most plants did not benefit from this. For many alpine plants it is better if the snow remains longer because it protects them against ground frosts and the plants have more moisture in spring. The only exception in our experiment was the alpine azalea. It grows naturally on hilltops where the snow melts early, and benefited in our experiment from the longer growing season.

And what if the snow stays longer than normal?

This has also been investigated experimentally, with interesting results. Instead of shovelling away the snow, you can put up snow fences. A pile of snow then forms on the downwind side in places where it snows less and there is a prevailing wind direction. Researchers at the Abisko research station in northern Sweden found, in one such experiment, that the permafrost under a snow pile actually thaws more. The snow prevented the ground from cooling.

Has climate change affected the amount of snow?

In recent decades it has become warmer and the ground has, at the same time, remained covered with snow in most places for shorter periods. On the Weissfluhjoch in Davos, for example, the duration of the snow cover last winter was the shortest we've had in the eighty years since measurements began. What we don't know yet, however, is whether climate warming will lead to there being less snow everywhere. It is also possible that the higher temperatures will bring about more precipitation, resulting in more snow at higher altitudes in the high mountains or in the High Arctic. The relationship between climate warming and snow cover is not linear. *(bki)*

Eric Gehring, Cadenazzo

“I love looking at my surroundings through ever new eyes. It's like a timeless game where it seems as if I can expand my perception to infinity. And when I am in such beautiful natural surroundings, it feels almost magical.”

Photo: Bruno Augsburger, Zurich

ON THE TRACKS OF INVASIVE PLANTS

Eric Gehring works at the WSL site in Cadenazzo. As a member of the Insubric Ecosystems Group, he studies exotic plants such as the paulownia tree or the tree-of-heaven, which are proliferating rapidly in the forests of Ticino. He wants to find out what makes these woody plants so invasive and how best to deal with them. “Of course, these plants do cause problems, but I find their ability to survive even in hostile environments fascinating.” *(gpe)*

Evaluating the effects of deadwood on rockfall and avalanches better

Much of the Swiss forest protects residential areas and infrastructure against avalanches, rockfall and debris flow. But storms may topple trees over large areas of forest, which influences how protective these areas are. This is what some researchers at the WSL Institute for Snow and Avalanche Research SLF have been investigating.

"Torrents and debris flows are more dangerous if deadwood is lying around," says Peter Bebi, the researcher at SLF who is supervising the study. But removing it increases mudslides' potential to cause damage. "This is why deadwood is normally cleared in channels with a high risk of mudslides. For avalanches and rockfall, the situation is less clear," which is why the PhD students Natalie Brozová and Adrian Ringenbach have addressed this question.

In one of Adrian's tests, for example, artificial stones weighing 45 kilos overcame only slightly under four per cent of a zone with lying trees. In the standing forest or after clearing the area, it was over 70 per cent in each case. "It's is a question of probability," explains Peter. "If a stone rolls down the hill, the chances of it hitting a tree lying across the direction of fall are greater than that of it hitting a standing tree. Our models indicate that, even after ten years, lying deadwood still provides better protection against rockfall than a standing forest. In very steep terrain, however, loose stones behind decaying logs pose a residual risk because they can start rolling again."

Long-lasting protection

According to Natalie, deadwood also provides protection against avalanches for several years. After ten to fifteen years, however, the effectiveness of the protection reaches a low point with branches rotting or breaking off and the barrier of wood collapsing. A few years later, things start to look up as the forest begins to regrow and fulfil its protective function again. The same applies to rockfall.

The researchers also found ways to represent the 'roughness' of the soil, i.e. obstacles such as deadwood,

Standing (yellow/orange) and lying trees (white) influence the speed of the rolling stones (green in the image).

Image: Adrian Ringenbach, SLF

solitary trees or unevenness, better in risk analysis models and simulations. These models do not, according to Peter, take this factor sufficiently into account in. But with climate change storms, drought and bark beetle attacks are expected to result in more deadwood, which is why soil roughness is becoming increasingly relevant.

Natalie succeeded in finding an algorithm to take this into account for avalanches and in adapting it to the situation on a mountain. She also noticed that some remote sensing data is suitable for estimating roughness. Including it in models would allow hazard analyses to be carried out on a much larger-scale than is possible with surveys alone. Adrian's data has made it easier to integrate lying timber into rockfall models correctly.

"Now we need to gather empirical values with the adapted models," Peter says. "These would enable us to, for example, set threshold values above which deadwood provides protection on, say, a certain slope, and specify what the residual risks are. This would be useful for the forest services when they have to decide whether to clear wood or leave it." *(bki)*

wsl.ch/protectionforest

NATURAL HAZARDS

Unused potential: monitoring avalanches with fibre optic cables

Most avalanches that occur in the mountains are not observed. Knowing exactly where and when avalanches release is important, in particular for road safety, as it would enable the local authorities to clear the affected road more efficiently and minimize closure times. And the information would also help the avalanche warning system refine its forecasts.

One novel way to observe avalanches in the field involves using existing fibre optic cables from telecommunications to record vibrations in the ground with minimal deformation. By using a device that sends laser pulses into the cables, these vibrations can be measured, which means the cables can be used as seismic sensors. "The technology is not new, but this is the first time it has been applied to detect avalanches," says Alec van Herwijnen, an avalanche researcher at the WSL Institute for Snow and Avalanche Research SLF.

Tests on the Flüela Pass (GR) were very promising. A team led by Pascal Edme, a researcher from the Seismology and Wave Physics Group at ETH Zurich, identified several avalanches that released over or next to a cable. Identifying these signals in real-time, however, is not very easy. The problem is that the cable records all vibrations in the ground. "To monitor an entire area, we will need new methods, such as machine learning, to evaluate the enormous amounts of data produced," Alec says. He is nevertheless convinced that, in coming years, great steps forward in research on this will be made. *(lbo)*

Drones will, in future, be able to detect and map avalanches autonomously

Here a human is still controlling the drone, but in future drones should be able to fly and map avalanches fully autonomously.

Every day, aircraft-like drones take to the skies in the Swiss Alps. They fly over large areas and record the starting zones, tracks and deposition areas of all the avalanches that have come down. The information is transmitted immediately to the avalanche warning service at SLF and local safety officers. The data is also used by engineering offices that produce hazard maps and plan protective measures.

This is the vision of Yves Bühler, a remote sensing specialist at SLF, but it is still something for the future. "Today we have to piece together bits of information about when and where a particular avalanche occurred," he explains. "But this data is important for understanding why avalanches do – or do not – release under certain conditions."

Artificial intelligence and autonomous drones

There is still a lot to do before his vision can be realised. Up until now, it has always been necessary for people to identify avalanches in photos. One of Yves' doctoral students, Elisabeth Hafner, has, however, managed to train an artificial intelligence system using satellite images, which the computer can work with to map avalanches independently. She is now teaching it to do this with drone images as well. Moreover, if the drone takes photos of each avalanche from several angles, the computer can calculate its volume photogrammetrically.

The Autonomous Systems Lab at ETH Zurich is collaborating with SLF on developing the appropriate drone technology. The drone has not only to cope with frost, rock faces and gusty mountain winds, but also to stay in the air long enough to reach remote areas. In addition, it should be able to change its flight path independently from 'overview mapping' to 'detailed mapping' as soon as it discovers an avalanche somewhere. This means that the programme has to detect avalanches in real time and interact reliably with the drone's flight controls. But it will not be easy, as Yves knows: "The project may, of course, fail. But if it succeeds, it will be a huge step forward for avalanche protection!" *(bio)*

*wsl.ch/avalmapper_*en

Photo: Elisabeth Hafner, SLF

New method for measuring snowpacks worldwide

Sizeable parts of the Earth's surface are covered seasonally or all the year round with snow. They have considerable influence on the global climate. To estimate how much, we need to have more exact information about the snow cover. But it is precisely the large snow-covered areas in Antarctica, Greenland, northern Canada and Siberia that are particularly influential in terms of climate – and they are extremely remote. Measurements in the field of the quantities of snow in such places are therefore rare.

To obtain data on the snow for wide areas in these regions, satellite observations are used. However, evaluating this remote sensing data involves considerable uncertainties. Henning Löwe from the WSL Institute for Snow and Avalanche Research SLF has, together with researchers from France and Canada, now developed a method for this that enables more accurate measurements to be made.

Key to understanding

The satellites measure the microwaves emitted from the earth's surface. The signal that the satellite receives depends, in part, on whether and how much snow is on the ground. In addition, the radiation measured by the satellite is also influenced by the type of snow, i.e. by its microstructure. Researchers need to understand these interrelationships very well in order to be able to derive snow quantities from the remote sensing data.

Henning and his colleagues therefore analysed samples of different types of snow in a microtomograph in the SLF's cold laboratory. The analyses provided them with new insights into the microstructure of the snow. This enabled them to determine the influence of the snow type on the microwave radiation scattered in the snow cover and to confirm this with satellite measurements. By taking this improved understanding into account when evaluating remote sensing data, more precise information about the snow cover can be obtained, which Henning expects will contribute in future to making meteorological and climatological forecasts more accurate.
(mhe)

Microtomographic image of a snow sample from the Arctic. The microstructure must be taken into account when interpreting remote sensing data.

Photo: Henning Löwe, SLF

Marco Hofmänner, Davos

“In winter the bike and rope park here is very quiet as it’s closed. I only use my bike now to ride to work. As a passionate biker, I come here in summer to practise. I like the informal atmosphere here. It’s a popular place for people to meet in Davos.”

VARIETY AND FREEDOM IN THE KITCHEN

Marco Hofmänner is responsible for the physical well-being of the staff at the WSL Institute for Snow and Avalanche Research SLF in Davos. “I plan the menus, shop, cook, bake, clean and interact with lots of different people at the Institute – I really enjoy having such varied work.” The chef is also glad to have such pleasant working hours, which are unusual in his line of work. He wants his ‘guests’ to leave the cafeteria feeling satisfied and welcomes feedback! *(sni)*

Photo: Bruno Augsburger, Zurich

OUTLOOK DIAGONAL NO. 1, 2023

Boundaries are zones not only of separation, but also of encounter. They may be sharp or indistinct, incomplete or impregnable. In their work, WSL researchers repeatedly come across boundaries and investigate them. What, for example, takes place at the boundary between water and land? How does the forest boundary shift when it gets warmer? And how can invasive species be prevented from crossing our national boundaries? In the process, researchers often cross boundaries themselves, collaborating across research disciplines, institutions and continents.

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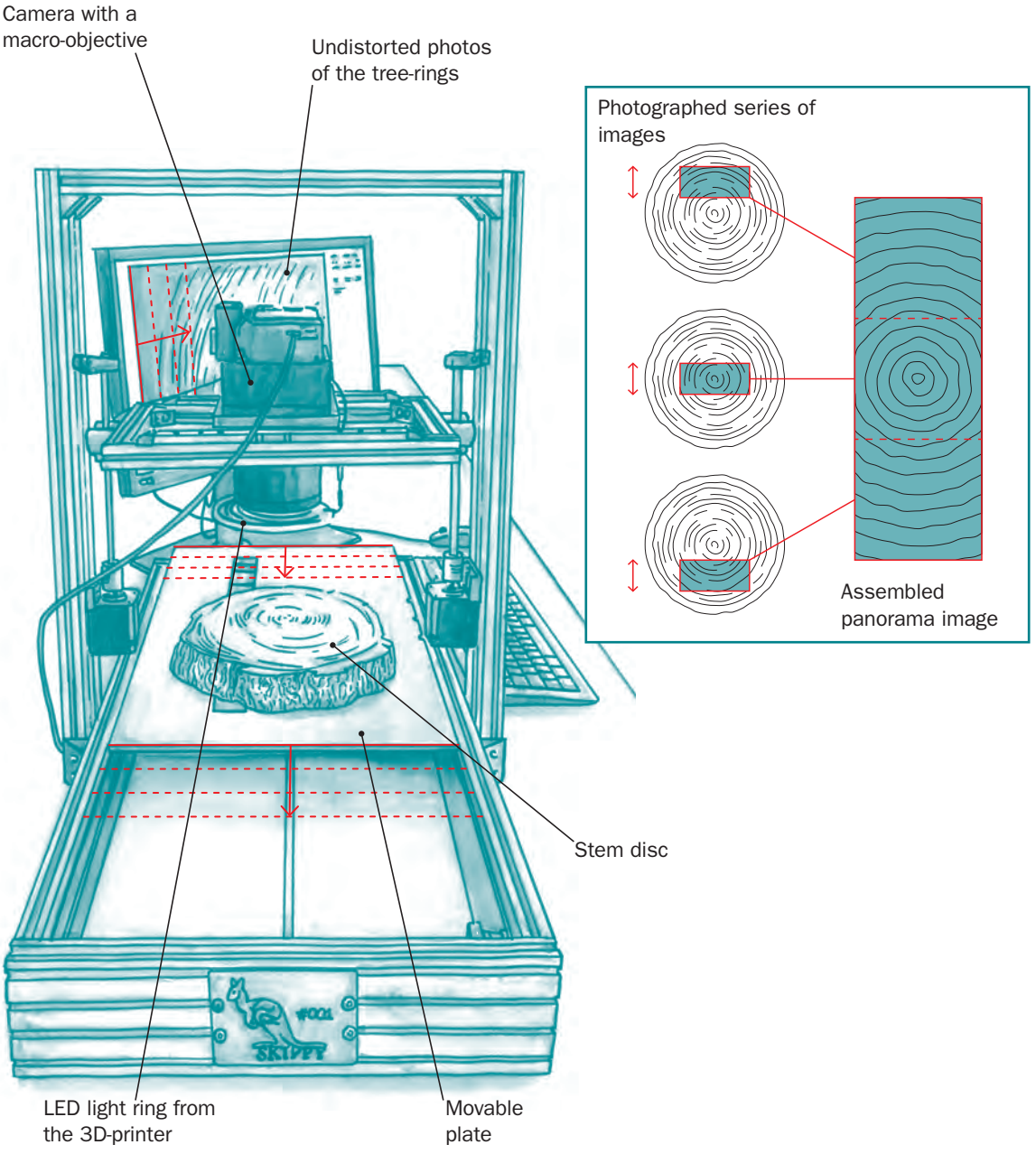
PEOPLE

The Diagonal editorial team, from left to right, top row: Stephanie Kusma, Beate Kittl; bottom row: Birgit Ottmer, Sandra Gurzeler, Claudia Hoffmann, Lisa Bose

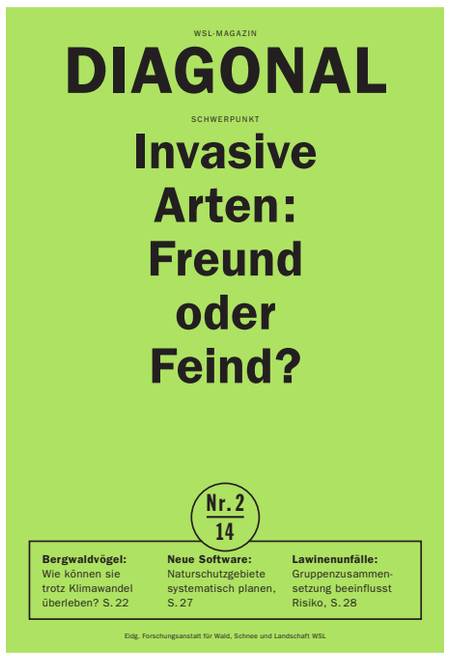
PHOTO-ROBOT ‘SKIPPY’

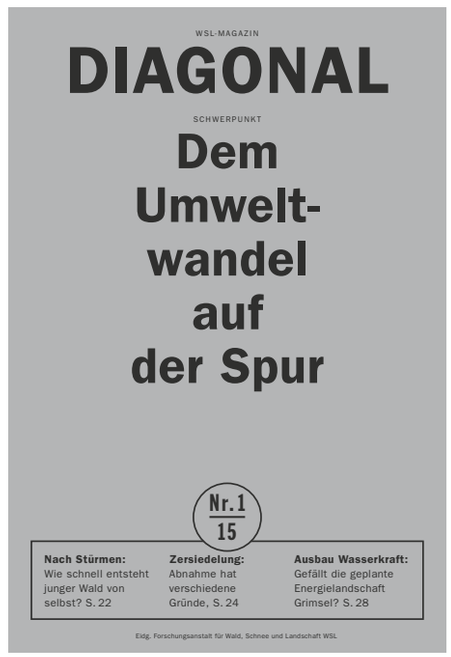


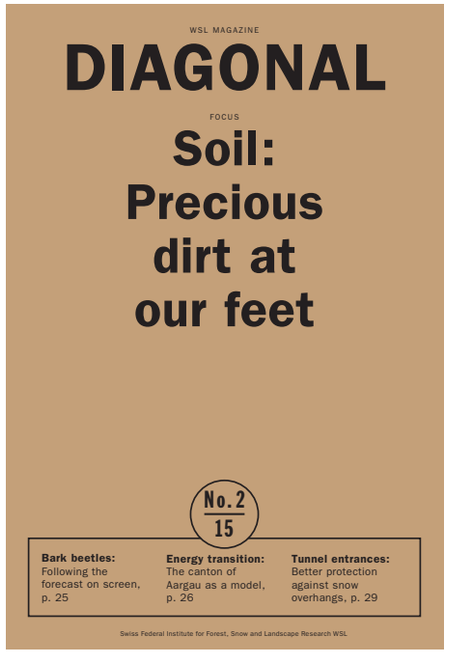
Tree rings provide us with important information about the climate of the past, which is why the dendro-researchers at WSL measure hundreds of thousands of them every year. Until now, they have had to do this ‘by hand’ with a click of the mouse on a ‘live’ image of an increment core or a stem disc. Recently, the photo robot known as ‘Skippy’ has made this work easier for them. The increment core or the stem disc is placed on the movable plate, which can be controlled by a computer and moved forward a few millimetres at a time. Each time it stops, a camera mounted on a bracket takes a photo. All the images are then stitched with the help of a computer programme. The resulting high-resolution panorama image is distortion free and each annual ring can then be measured very precisely. *(bki)*

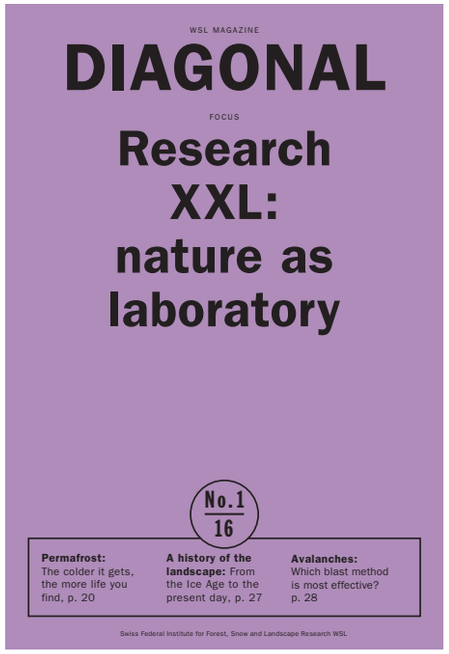
Video at:
www.wsl.ch/object

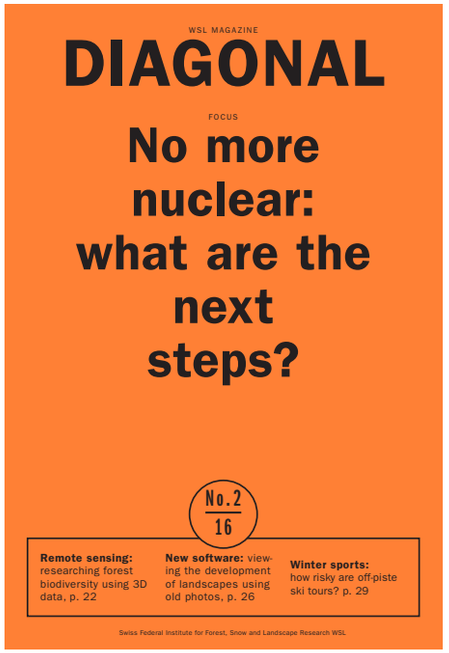
Illustration: Raffinerie



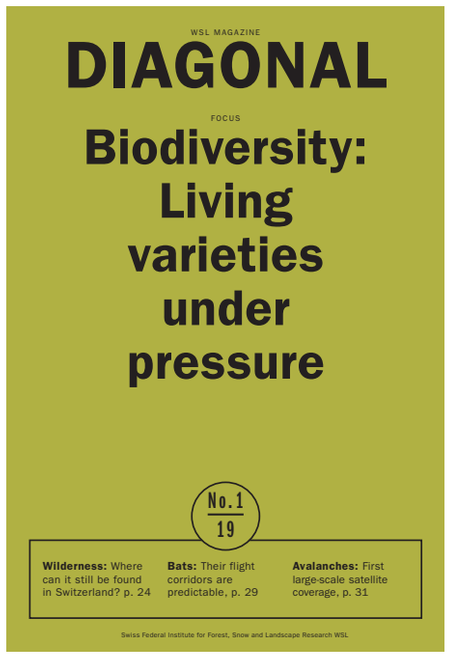


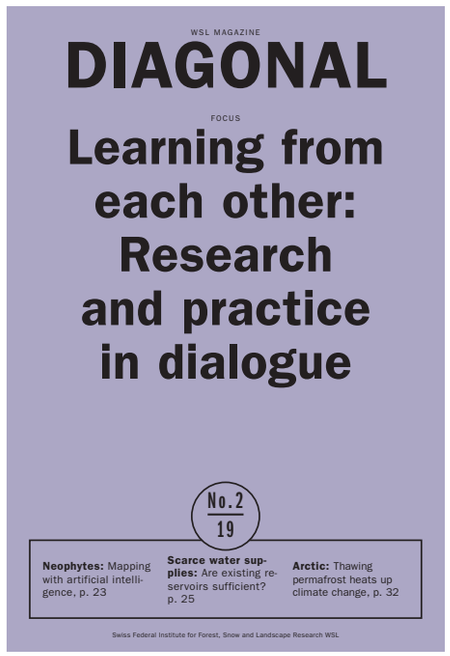


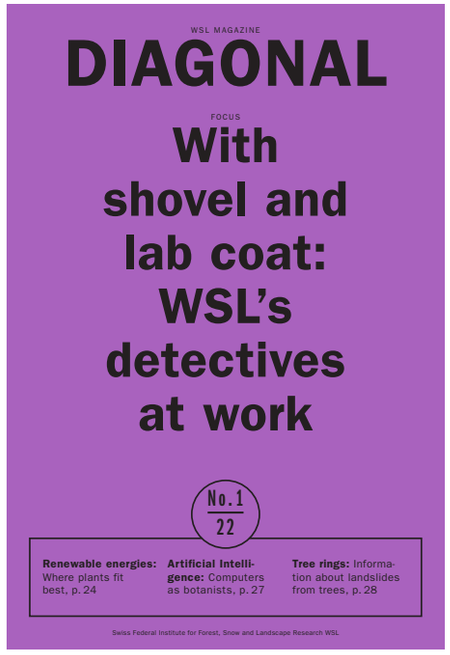




The cover pages of all Diagonal magazines published to date. Note: English translations of Diagonal were not produced until 2015







The cover pages of all Diagonal magazines published to date.

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