5.2 Protection against natural hazards

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> *According to the National Forest Inventory, 42 per cent of the forests in Switzerland provide protection against natural hazards. In mountainous regions, the proportion is considerably higher.*
> *A forest can reduce several hazards at the same time. The majority of protection forests avert natural hazards that involve flowing water.*
> *The silvicultural treatment of a protection forest ensures it is effective. This is why around half of the protection forests in Switzerland were treated between 1993 and 2013.*
> *During the same period the protection forest has become denser, and the proportion of pure conifer forest has dropped. This has improved the protective effect.*
> *Lack of natural regeneration and increasing wild ungulate browsing of important tree species threaten the long-term effectiveness of the protection forest.*

Protection forest

Avalanches, rockfall, debris flow, landslides and floods are natural hazards for people and their infrastructure. In Switzerland, 26 per cent of the railway network and 24 per cent of the first- and second-class roads, for example, are threatened by natural hazards (Losey und Wehrli 2013). In mountainous regions, the proportion of infrastructure at risk is often much larger. A forest can help to reduce the risk of damage from natural hazards so long as it has a particular composition.

Fig. 5.2.1 *Protection forest near Adelboden (BE). The protective effect of the forest was reinforced with steel-snow bridges (top right) and steel nets (bottom left). Photo: Peter Brang*

This is why the protection forest is an important element in integral risk management to provide protection against natural hazards. The protection forest can be supplemented with technical measures, such as avalanche barriers. It is inexpensive, and protects large areas often against several hazards at the same time. Technical measures, on the other hand, are expensive and are therefore used in unforested areas or in places where the protective effect of the forest is insufficient (Fig. 5.2.1).

The cantons designate, as part of their forest planning, which forests are protection forests according to objective criteria developed by the federal government together with the cantons (Losey und Wehrli 2013). The cantons are responsible for managing their protection forests, but receive support from the federal government set out in programme agreements.

The following information about protection forests is based, unless otherwise specified, on the National Forest Inventory NFI surveys (Brändli et al. 2015).

Natural hazard processes

The Swiss forest provides protection against natural hazards on 42 per cent of its area according to the NFI 2009/13 (section 1.1), with the most protection forests in the Alps and on the Southern slopes of the Alps (Fig. 5.2.2). Much of the protection forest – namely 85 per cent of the area – diverts so-called 'channel processes'. These include all processes that take place in connection with flowing water (channels), such as debris flows, overbank sedimentations and bank erosion. The trees help to prevent them by stabilising the soil with their roots. As a result, when a land-slide, hillslope debris

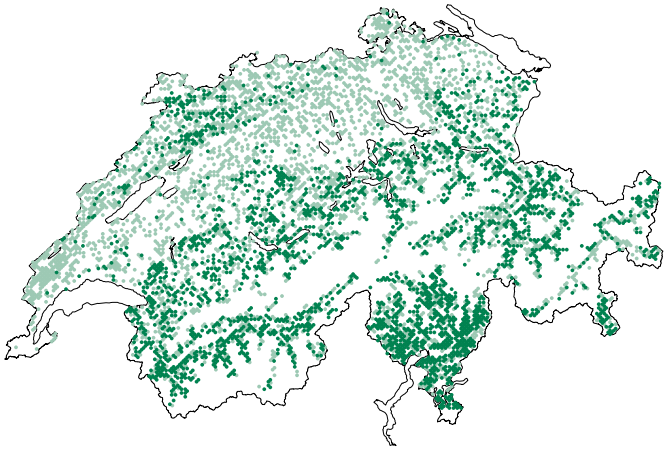

Fig. 5.2.2 *Distribution of protection forest and other forest. Source: NFI 2009/13*

flow, avalanche or rockfall occurs, less material reaches the channel. Thus less of the material that can lead to sediment deposits forming downstream is released if there is flooding.

The forest does not only provide protection against natural hazards involving flowing water. 24 per cent of the area of protection forest keeps people, buildings and facilities safe from hillslope debris flows and landslides. This flowing or sliding of soil material down a slope may be fast or slow. It is triggered by heavy precipitation, long periods of rain or intensive melting of snow. Avalanche protection forests make up 19 per cent of the protection forest area. They prevent the build up of an unstable snow pack, thereby reducing the risk of snow movements that could lead to an avalanche forming. 8 per cent of the protection forest provides protection against falling rocks and boulders as the tree roots stabilise the ground and thus prevent rockfall occurring. Furthermore, contact with trees can break the fall of tumbling and rolling stones, or even bring them to a standstill. If all the sections of protection forest are added together, the result is over 100 per cent because about a quarter of the protection forest area is effective against several natural hazard processes at the same time.

Managing protection forests

The effectiveness of a protection forest can only be maintained permanently if it is regularly tended, as stand structures form during the natural development of a forest that over decades do not provide sufficient protection, particularly during the forest's early and late development phases. Silvicultural treatments help to prevent the occurrence of such phases so that the forest can have a long-lasting protective function. For example, cutting out gaps promotes the occurrence and development of natural regeneration, and felling individual trees gives their neighbours more room, enabling them to develop better and thus become more stable. Such interventions are the tasks of the forest owners. The Forest Act specifies that at least some management of the protection forest is mandatory. The owner is then reimbursed by the federal government, the cantons and other beneficiaries (including the municipalities and infrastructure operators). Stakeholders can find information on this in the guidelines on "Sustainability and monitoring in protection forests", which set standards for minimum tending according to standardised criteria (Frehner et al. 2005).

Since 1995 1.9 million cubic metres of timber have been removed from Swiss protection forests each year. This corresponds to 26 per cent of the annual harvest yield. Between 1993 and 2013 nearly half of the protection forests were treated (Table 5.2.1). The favourable climate of the Swiss Plateau, the Jura and the Pre-Alps means that the forest there develops faster than in the Alps, and silvicultural treatments are performed at shorter intervals. On the Southern slopes of the Alps, the intervals between treatments are much longer than in the other regions. The reasons for this difference are that the proportions of broadleaf and coppice forests are greater, and the terrain is very steep (90 % of the slopes have an inclination of over 40 %). Moreover, the access network is much less dense. Timber from more than half of the sites is transported by helicopter, which is, in comparison with other forms of haulage, relatively expensive. In the Alps, the amount of steep terrain is proportionally roughly the same, but access to the protection forest via forest roads is better. On almost half the areas there, timber can be hauled with cable cranes, on around 21 per cent with forestry tractors and on about 29 per cent by helicopter.

Table 5.2.1

Proportion of protection forest areas in per cent according to the time of the last intervention. Source: NFI 2009/13

Production region	Time of last interventions		
	Up to 20 years ago	21–40 years ago	More than 40 years ago
Jura	70	14	15
Swiss Plateau	74	16	10
Pre-Alps	68	16	15
Alps	44	22	34
Southern slopes of the Alps	17	14	68
Switzerland	**46**	**18**	**35**

Tree species mixture and stand density

For the protective effect to be long-lasting, the tree composition must be suitable for the site as this reduces the risk that the protective effect will be diminished as a consequence of, e.g windthrow or an infestation of bark beetles. Around 47 per cent of the protection forests are pure conifer forests and about 25 per cent pure broadleaf forests, with the rest mixed. Pure conifer forests grow mostly in the upper montane and subalpine vegetation belts, while broadleaf forests occur mostly at lower altitudes (section 1.1). The proportion of pure conifer forests fell between 1995 and 2013 by 2 per cent, whereas that of mixed and broadleaf forests rose. At lower altitudes, conifers, which used to be planted and are not well adapted to the local site conditions, are today increasingly being replaced by broadleaf trees, which are better suited (section 4.3).

To provide protection against rockfall, the density of a stand is crucial because only in sufficiently dense stands will frequent contact with the trees break the fall of descending stones and eventually bring them to a standstill. Experts measure the density of a stand on the basis of the so-called 'basal area'. If this is at least 25 square metres per hectare (m^2/ha), the protective effect of a forest is sufficient (Volkwein et al. 2011). Between 1995 and 2013, the proportion of protection forests that had at least this density increased by 5 per cent to 64 per cent. Today 19 per cent of the protection forests with a basal area of under 15 m^2/ha are still insufficiently stocked. A further 17 per cent of the protection forest areas have a basal area of between 15 and 25 m^2/ha, so that their protective effect is at a critical level.

For protection against avalanches, hillslope debris flows and landslides to be optimal, the ground must be covered with living trees with as few gaps as possible. In the NFI, the degree of cover is determined with the help of aerial photos. This involves measuring how much of the forest area has canopy cover. Experts call this proportion the degree of canopy cover. In a protection forest it should amount to at least 40 per cent (Frehner et al. 2005). This requirement is met by most of the protection forests, and on 48 per cent of the protection forest area the degree of cover is even twice as high. Only on 6 per cent of the protection forest is this minimum value not reached.

Risks for the protection forest

Disturbances like windthrow, snow break and bark beetle infestations are part and parcel of the forest ecosystem. They may, however, endanger the protective effect of a forest by causing extensive tree mortality or even ripping large holes in the protection forest. The protective effect of the stands affected is therefore reduced or may even be lost altogether.

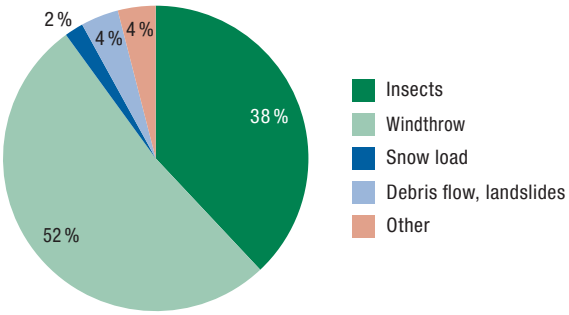

Fig. 5.2.3 *Main reasons for salvage logging between 1995 and 2006. Source: NFI 2004/06*

Protection forests should, therefore, be as resistant to disturbances as possible. According to NFI 2009/13, the protection forest has become more stable since 1995. The proportion of the forest area with critical or diminished stability has sunk by 4 per cent and today is 53 per cent.

Since 1995, disturbances have resulted in an average of 509,000 cubic metres of timber per year having to be cut without prior planning. This so-called 'salvage logging' corresponds to around a quarter of the total annual use. Such disturbances occur, however, irregularly and with differing magnitudes. The amount of salvage logging during the period from 1995 to 2006 was exceptionally high, particularly as a consequence of the storm 'Lothar', which created large areas of windthrow (Fig. 5.2.3). The Jura, Swiss Plateau and Pre-Alps were especially badly affected. Between 2006 and 2013 the amount of salvage logging was less, and roughly half of it was due to insect pests like the bark beetle.

Forest regeneration is a prerequisite if the forest is to have a long-lasting protective effect. It ensures that the next tree generation can perform the function of the trees that today provide protection after these older trees die. If young trees grow on less than 10 per cent of the stand area in a protection forest, the regeneration is considered to be critical or even insufficient (Brang and Duc 2002). The regeneration situation in protection forests deteriorated between 1995 and 2013, as the proportion of the protection forest area with critical to insufficient regeneration rose from 36 to 41 per cent.

The composition of tree species is also important for regeneration, as only tree species adapted to the site can ensure that the stands are stable in the long term. Wild ungulates can influence the tree species composition because the animals prefer to browse on certain species like silver fir, maple and rowan and thus affect their growth. Silver fir is particularly sensitive as a browsing intensity of 9 per cent is already critical (section 4.2, Eiberle und Nigg 1987). If this

value is far exceeded, the silver fir saplings cannot usually grow to maturity and will therefore not reach the upper layer. Since 1995, the browsing intensity on silver fir has increased from 14 to over 20 per cent. Protection measures like fences or individual plant protection (section 4.2) are expensive or even infeasible in protection forests because of the steep terrain and deep snow. The recruitment of silver fir is therefore severely endangered. This tree species is, however, particularly important in protection forests for the development of stable stands. It can regenerate in shade and its roots penetrate deep into the ground, thereby contributing to the layered structure of the forest and to stabilising and draining the ground.

Altogether, the protection forest has developed in different ways over the past few years: while the tree species composition and the forest structure have improved, the regeneration situation has deteriorated. The regeneration is often too sparse and the occurrence of ecologically important tree species is threatened by browsing ungulates. To ensure an adequate protective effect in the long term, great efforts will need to be made in the coming decades to manage the protection forest and ungulate populations appropriately.