IMPROVING THE MANAGEMENT OF PROTECTION FORESTS IN SWITZERLAND

THE PROJECT SILVAPROTECT-CH

VERBESSERUNG DES SCHUTZWALDMANAGEMENTS IN DER SCHWEIZ

DAS PROJEKT SILVAPROTECT-CH

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ZUSAMMENFASSUNG

Um dauerhaft eine hohe Schutzwirkung erbringen zu können, werden Schutzwälder häufig gemäß speziellen Richtlinien gepflegt. Dies generiert zusätzliche Kosten und macht so den Einsatz von öffentlichen Mitteln nötig. Diese Mittel sind beschränkt und müssen daher so effizient als möglich eingesetzt werden. Dazu braucht es eine Schutzwaldausscheidung, welche auf nationalem Niveau möglichst einheitlich ist. In der Schweiz ist dies momentan nicht der Fall. Aus diesem Grund hat das BAFU das Projekt SilvaProtect-CH gestartet.
SilvaProtect-CH soll die Grundlagen für zwei Ziele bereitstellen: (1) Für einen objektiven Zuteilschlüssel der Bundesmittel auf die Kantone und (2) für eine vereinheitliche Schutzwaldausscheidung in der Schweiz. Das Projekt baut auf fünf Modulen auf. In den Modulen 1 und 2 wurden die Waldfläche und das Schadenpotenzial über die ganze Schweiz bereitgestellt. In Modul 3 wurden verschiedene Naturgefahren modelliert. Die Resultate der Module 1-3 wurden schließlich in zwei GIS-spezifischen Modulen miteinander verschnitten und analysiert.
SilvaProtect-CH lieferte die für den Zuteilschlüssel nötigen Daten Mitte 2006. Die Kriterien zur einheitlichen Schutzwaldausscheidung werden momentan entwickelt und sollten bis Ende 2007 verabschiedet sein.

Keywords: Schutzwald, Naturgefahrensimulation, Subventionswesen

ABSTRACT

To provide an effective protection from natural hazards, protection forests are mostly managed following specific management rules. This often generates additional expenses which are supported by public funds. For an efficient application of these funds, the

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delineation of protection forests needs to be comparable on a national level. Since this is not the case in Switzerland, the FOEN has launched the project SilvaProtect-CH.
SilvaProtect-CH has two major aims: (1) to provide an objective distribution frame for the public funds and (2) to supply basics for a standardized delineation of protection forests in Switzerland. It is organized in five modules. In module 1 and 2, the forested area and the damage potential were acquired over whole Switzerland. In module 3, different natural hazards were modelled. The results of modules 1-3 were finally intersected and analyzed in two GIS-specific modules.
SilvaProtect-CH provided the necessary data for the distribution frame by mid 2006. The criteria's for a standardized delineation of protection forests are currently developed and will be passed by the end of 2007.

Keywords: protection forests, process modelling, management of public funds

BACKGROUND

According to the Swiss Federal Law on Forests of 1991, the cantons are obliged to delineate protection forests (Art. 18, Federal Ordinance on Forests). The former Swiss Agency for the Environment, Forests and Landscape (SAEFL) defined the criteria to be used in the delineation of the special protective function; only general information was provided on the delineation of the protective function. SAEFL was not involved in the concrete planning subsequently undertaken by the cantons. This process resulted in significant differences in the delineation of protection forests.

Since 2003 certain federal subsidies were restricted to the area of the protection forest perimeter. Moreover, the cantons have long been demanding for a distribution of federal resources on the basis of objective criteria. For this reason, the varying cantonal delineations of the protection forests are no longer adequate. At a conference of the Confederation and cantons in 2003, agreement was reached on the implementation of protection forest delineation on the basis of harmonized objective criteria to ensure that the quality of delineation would be consistent throughout Switzerland in future. It was also decided that the differentiation between the "protective function" and "special protective function," which is difficult to pinpoint, would be abandoned and, in future, reference would only be made to the protection forest.

PROJECT PHASE I

Introduction

The Federal Office for the Environment (FOEN) launched the SilvaProtect-CH project in 2004. The aim of Project Phase I is the formulation of a protection forest index which is required for the allocation of federal funding to the cantons for protection forest maintenance (as a basis for an objective allocation code). Based on the results of Project Phase I, it is intended to define uniform criteria on cantonal protection forest delineation in a follow-up project (Project Phase II).

With SilvaProtect-CH, FOEN aims to develop a uniform solution for all of Switzerland that is designed on the basis of objective criteria. The following conditions were defined for the basic data:

- the input data used must be available for all of Switzerland, consistent in quality, regularly updated and recorded;
- the system used must allow dynamic data management so that different scenarios can be developed and data that quickly becomes obsolete (e.g. on damage potential) can be updated at any time;
- the minimum aim is to create an 80/20% solution.

The project was closely supported by a group of experts comprising representatives of the Cantons, representatives of the High schools and FOEN. The support team's tasks are:

- to provide advice and support to the project management on specialist issues,
- to forward the information to the cantons,
- to discuss the pilot findings and incorporate the views of the cantons,
- to discuss the final results and assist in their implementation in the cantons.

The Five Modules of SilvaProtect-CH Phase I

Project phase I of SilvaProtect-CH is based on five modules (Fig. 1):

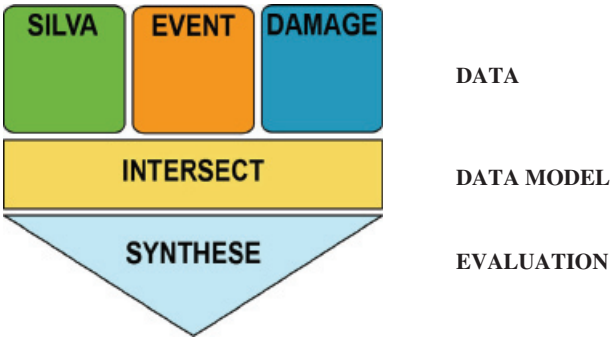

Abb. 1: modularer Aufbau der Projektphase I
Fig. 1: modular design of project phase I

SILVA

The SILVA module yields Switzerland's forest area.

EVENT

In this module, different hazard perimeters were modelled on a process-specific base.

DAMAGE

The relevant damage potential was defined and developed in this module.

INTERSECT

In this module, first, the data records from the other modules are represented in a data model and managed in the Geographical Information system and, second, the hazard perimeters are linked with the damage potential.

SYNTHESE

The end results of Project Phase I are processed in the module called „Synthese": the damage-relevant process areas in the forest.

SILVA

The relevant forest areas were extracted from the 1:25,000 digitized map (i.e. forest and open forest). The digital data records of the areas damaged by Storms Vivian (1990) and Lothar (1999) were added to these areas.

EVENT

Snow avalanche
Model and simulation were developed respectively done by the Swiss Federal Institute for Forest, Snow and Landscape Research and the Swiss Federal Institute for Snow and Avalanche Research.
Potential avalanche release areas were identified on the basis of an analysis of the digital terrain model with a distinction being made according to whether the avalanche releases arise in the forest or outside it. For the calculations, the thickness d_0^* of an avalanche with a 300-year return period was determined for each sub-area based on the extreme-value statistical analysis of monitoring data from long-standing stations. The two-dimensional Voellmy-Salm model, AVAL-2D, was used for the calculations (Gruber 1998). In order to ensure that the runout zone of each avalanche can be traced back to the corresponding release area, the release areas were divided in such a way that the avalanche tracks of adjacent release areas do not overlap.
Given that, in extreme situations, adjacent release areas can also be triggered together, resulting in the flow of a correspondingly larger mass down to the valley, there is a risk that the avalanche threat in individual areas is underestimated. This circumstance was taken into account to a certain extent in that a slightly lower coefficient of friction was selected than that used in the previous individual calculations of avalanche paths which were carried out manually.
Switzerland was divided into 30 operational areas with a maximum size of 1500 km2. A total of approximately 10,000 simulations were carried out.

Rockfall
Model and simulation were developed respectively done by the consortium GEOTEST AG / Geo7 AG / Oeko-B AG (Liener et al. 2008).
The Geotest/Zinggeler rockfall model (Liniger 2000) calculates the paths of rocks and boulders in digital three-dimensional terrain models (DEM). Starting points are generated in a specified density within defined detachment zones. Based on these points, the fall of a block is modelled as a sequence of contact reactions of the block with the substrate or the forest, as flight parabola and a rolling motion.
The information density of the input parameters is based, first, on the size of the test area and, second, on the specified test objective. Standardized values were used for SilvaProtect-CH which should enable the calculation of the maximum possible realistic coverage. The program calculates thousands of rockfall paths, whose envelope defines the rockfall process space.

Slope-type debris flow / shallow landslides
Model and simulation were developed respectively done by the consortium GEOTEST AG / Geo7 AG / Oeko-B AG (Liener 2000, Liener et al. 2008).
The modelling of the process of slope-type debris flow is divided into two parts. First, the release areas are modelled using the SliDisp model and then the transit and runout areas are calculated using the SlideSim model.
SliDisp: The SliDisp model determines the slope stability for each 10*10 m grid cell with the help of the 'Infinite-Slope-Analysis' stability calculation method.

SlideSim: Based on the topography and gradient and taking the spread parameters into account (i.e. spread factor, persistence factor, limit gradient), the runout paths of slope-type debris flows are simulated using a random walk approach. The range of slope-type debris flows is determined using a simple analytical approach, i.e. the Voellmy approach.

Debris flow
Model and simulation were developed respectively done by the consortium GEOTEST AG / Geo7 AG / Oeko-B AG (Liener et al. 2008).
The debris flow trajectories were simulated using the *MGSIM* program (Gamma 2000) which consists of four components:

- relief analysis (catchment area size per pixel, slope gradient, exposure, flow paths)
- estimation of available bedload and analysis of sediment yield (debris production, matrix, permeability)
- Identification of debris flow release areas
- Identification of debris flow range and runout of debris flows on the cone.

The available bedload is calculated for each point in the channel based on the analysis of the relief and other basic data. The possible debris flow releases are determined on the basis of the available bedload and the size of the catchment area. The spread and ranges for all debris flow releases are calculated using the dfwalk program (Gamma 2000) and archived as trajectories.

Driftwood
Model and simulation were developed respectively done by the Ingenieure Bart AG St.-Gallen.
A driftwood movement track is calculated from each point in the terrain that is not higher than 2000 m asl and fulfils the necessary conditions either until the maximum specified transport distance is reached or until a channel with debris flow potential or a flood buffer with a hydrological watershed area of at least 0.2 km^2 is reached.

Hydrologically effective areas
Model and simulation were developed respectively done by the Ingenieure Bart AG St.-Gallen.
The basic information as to whether a forest has an effect on flood water run-off is taken from the guide "Nachhaltigkeit im Schutzwald - NaiS" (Frehner et al. 2005) which specifies the extent to which the water retention capacity of the soil in every forest community can be influenced through silvicultural intervention. Thus the aim of the modelling is not the flood protection effect in itself, but the definition of the forest communities.
What is involved here is the identification of the most likely vegetation communities from a (limited) number of input data (based on Kienast et al. 1994, 1998). In addition to the actual plant species, the different forest communities mainly differ in terms of their regional distribution, altitudes, exposure, slope, climate and soil properties. These parameters were defined in a GIS and linked with each other.

DAMAGE

The damage potential was defined together with the support group and the relevant objects extracted from the input data as damage potential. Afterward, the line and point objects were buffered.
The following categories were included:

- road network with access function
- railway network with mandatory timetable and industrial railway

- residential building (permanently and temporarily occupied)
- industrial and commercial buildings and industrial zones
- public buildings
- installations
- tourism installations

INTERSECT

In this module, first, the data records from the other modules are depicted in a data model and managed in the Geographical Information System, and, second, the hazard perimeters are linked to the damage potential (Fig. 2):

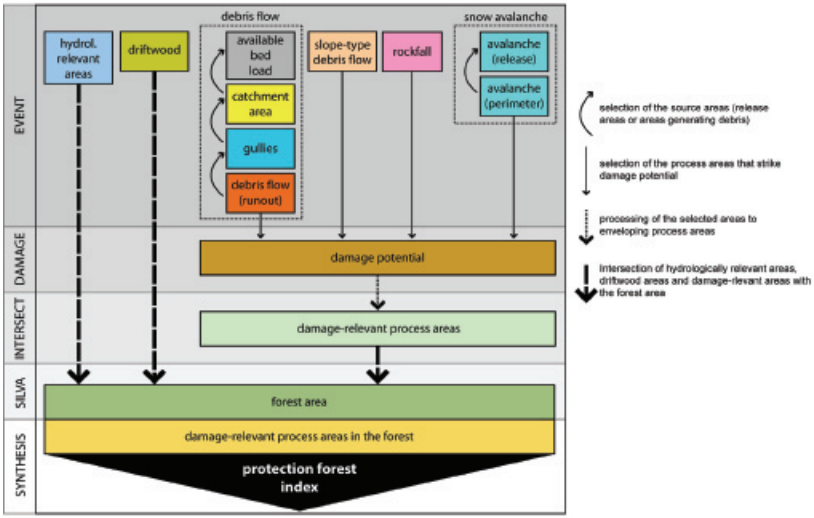

Abb. 2: Schematische Darstellung zu Datenverknüpfung und –bearbeitung im Modul INTERSECT
Fig. 2: Schematic representation of data linking and processing in Module INTERSECT

Based on the data in the EVENT and DAMAGE modules, the damage relevance of the modelled trajectories and areas is verified (blending with the damage potential, Fig. 3), buffered in part (rockfall, slope-type debris flow) and then summarized in one damage-relevant process area (Fig. 4).

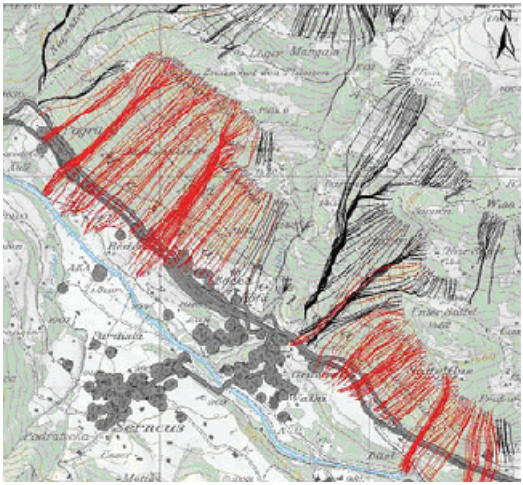

Abb. 3: Sturztrajektorien (rot), welche auf ein Schadenpotenzial (grau) treffen. Schwarz: übrige Sturztrajektorien
Fig. 3: Rockfall paths (in red) striking a damage potential. In black: remaining rockfall paths

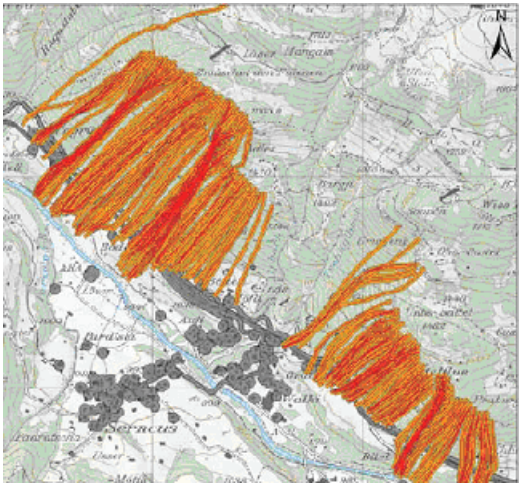

Abb. 4: schadenrelevante Sturztrajektorien (rot), und deren Umhüllende (orange)
Fig. 3: damage-relevant rockfall paths (in red) and their envelope (in orange)

SYNTHESE

The results from the INTERSECT module and the areas that generate driftwood as well as the hydrologically effective areas from the EVENT module are individually intersected with the forest area (SILVA module) to obtain the damage-relevant areas in the forest (*srPW*) per

process type (Fig. 5-6). These are then weighted for the calculation of the protection forest index with the overlaps of the individual areas being adjusted in advance.

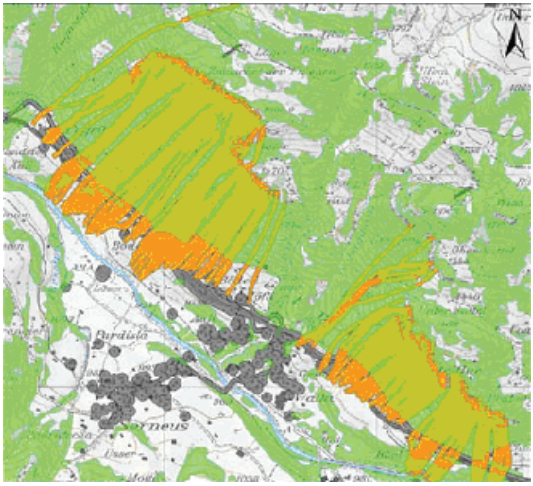

Abb. 5: Umhüllende der schadenrelevanten Sturztrajektorien (orange), überlagert mit der Waldfläche (grün)
Fig. 5: envelope of the damage-relevant rockfall paths (in orange) overlaid by the forest area (in green)

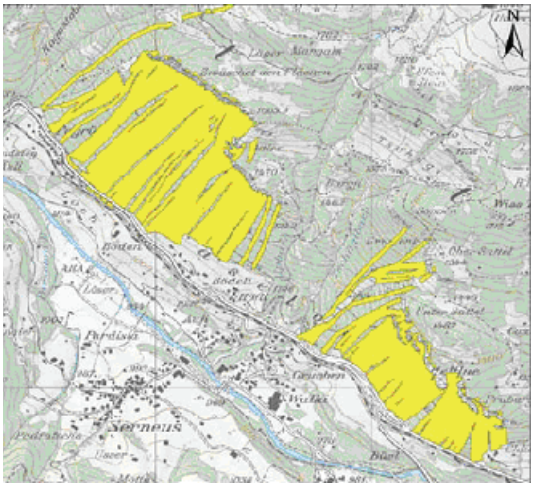

Abb. 6: schadenrelevante Sturzflächen im Wald *srPW*
Fig. 6: damage-relevant rockfall areas in the forest area *srPW*

Protection forest index *SWI*

The protection forest index is defined as the proportion of the damage-relevant process areas in the forest per canton derived from the project SilvaProtect-CH on the basis of the total damage-relevant process areas in the forest calculated for Switzerland (percentage).
The individual processes here are weighted in accordance with the following criteria:

- the variety of the protective functions must be represented;
- well-represented processes are more strongly evaluated;
- processes must be represented as simply and transparently as possible;
- overlapping areas are not calculated twice - the area with the higher weighting counts.

The support group defined the following weighting system:

Process	Weighting
Snow avalanche	1
Rockfall	1
Debris flow	0.8
Slope-type debris flow	0.5
Driftwood	0.5
Hydrologically relevant areas	0.2

PROJECT PHASE II

In Phase II, harmonized criteria were developed for the cantonal delineation of protection forests based on the results of the first phase of the project. These are to be implemented in the cantons. The aim of Phase II is to define a delineated protection forest perimeter for each canton which is enshrined in the forestry planning. The "Protection forest in accordance with federal criteria" (*SW-B*, see definition below), which corresponds to the harmonized criteria for protection forest delineation, covers the main part of this cantonal protection forest perimeter or even the entire cantonal protection forest perimeter.
The aim of Phase II will be achieved over a number of stages. During the first stage the bases for the development of the harmonized criteria were compiled in the context of presentation visits to all cantons. As part of this process, the damage-relevant process areas in the forest (*srPW*) modelled in Phase I were compared with the current protection forest delineation using sample perimeters. The feedback from the cantons on the visits was very positive and in many cases there was relatively good level of agreement between the *srPW* and the cantonal protection forest delineations. However, numerous deviations also arose which demonstrated where the focus should be placed within the process of the development of harmonized criteria for protection forest delineation: i.e. on (1) the definition of the protection forest; (2) the delimitation of the protection forest in accordance with the Federal criteria (hazard and damage potential, consolidation); and (3) the implementation of the harmonized criteria in the cantons.
A very important insight from the presentation visits was that the development and definition of harmonized criteria for protection forest delineation must be approached as far as possible separately from the issue of the future protection forest index *SWI* (for the allocation of resources): whereas the priority in the case of the *SWI* is maximum objectivity, which can only be achieved with bases that are available on the same level for all of Switzerland, the requirements of the *SW-B* are rather more differentiated. What is required here are real forest areas, in which from the second new fiscal equalization (NFA) period, federal resources can only be used for the NFA Protection Forest Programme. It is clear here that the criteria for the *SW-B* (e.g. for consolidation) cannot be applied with such a high level of selectivity. Through the separation of *SW-B* and *SWI*, the debate surrounding the harmonized criteria (e.g. in relation to consolidation or cantonal basis for hazard or damage potential) can thus be approached in a more relaxed way.

In the second stage of Phase II, a support group comprising federal and cantonal representatives was developing a proposal for the harmonized criteria for protection forest delineation based on the above-mentioned focal points. This proposal was presented to the cantons for consultation should finally be adopted by the Board of FOEN by end of 2007. The cornerstones of this proposal are outlined in brief below:

Definition of protection forest and its denomination

The term "protection forest" has hitherto been construed in different ways in the cantons, ranging from very broad interpretations ("protection forest is forest that has some kind of protective function", e.g. biodiversity, natural hazards, drinking-water protection) to very restrictive ones ("protection forest is only protection forest with special protective function against natural hazards"). The definition and use of the term protection forest is central to the further success of Phase II of SilvaProtect-CH. For this reason, the support group has formulated the following definition which should make the protection forest more tangible as a concept.

1. A *protection forest* is a forest which can protect the damage potential from an existing natural hazard or reduce the associated risks.
2. A *protection forest according to federal criteria* (*SW-B*) is a forest which can protect the damage potential acknowledged by the Confederation from an existing natural hazard or reduce the associated risks

The different protection forest categories can be described as follows: the total forest contains the protection forest. Most of this perimeter is also part of the *SW-B*: as demonstrated by the results of the presentation visits in the cantons, the cantonal protection forest perimeters already overlap relatively extensively with the "damage-relevant process areas in the forest" modelled in SilvaProtect-CH, but do not generally coincide with them 100 percent.
The *SW-B* is the perimeter within which the federal funding for the protection forest programme may only be used from the second new fiscal equalization (NFA) period.

Criteria for the delimitation of the *SW-B* (hazard potential, damage potential, consolidation)

In order to delineate the *SW-B* in relation to hazard potential, it is first necessary to define the processes that must be taken into account. Only the following processes alone were included in the support group's proposal: (1) avalanche; (2) rockfall (including ice fall [falling or rolling ice, in particular on rock faces]); (3) slope-type debris flow/landslide; and (4) channel borne processes.
The basis for the ***criteria on hazard potential*** is constituted primarily by the results from Phase I of SilvaProtect-CH (in particular the damage-relevant process areas in the forest (*srPW*)). These *srPW* require supplements in some cases, which must be based on objective information on the hazard potential. The link between the natural hazard to be demonstrated and an acknowledged damage potential (in accordance with the SilvaProtect-CH damage potential list or complementary damage potential criteria) is assumed, i.e. the natural hazard must affect a relevant damage potential. The minimum requirement for such information is the demonstration of the hazard potential at indication level by means of hazard indication maps or hazard maps in accordance with enforcement aids or by the event register. In other words: if a hazard potential is not duly covered by SilvaProtect-CH but is indicated on the

local hazard indication map, for example, the proof is provided and accepted as hazard potential for the *SW-B*.
The starting point for the processes debris flow, mobilization of driftwood and hydrologically effective areas (summarized as "channel-borne" processes) modelled in SilvaProtect-CH is somewhat different. Because with these processes, the differences between the *srPW* and the actual protection forest delineations considerably outnumber the coincidences, the *srPW* are revised in advance in SilvaProtect-CH using a new approach. This new approach should take the specified deficits into account and will also have impacts on the protection forest index (*SWI*). The re-calculation of the *srPW* for the channel-borne processes commenced in summer 2007.
The ***definition of the damage potential*** accepted by the Confederation was already the content of the first phase of SilvaProtect-CH. For the damage potential list compiled in this first phase, only input data can be used that are available at a consistent quality level for all of Switzerland, are regularly updated and recorded. This was necessary to obtain the most objective basis possible for the calculation of the *SWI*, but resulted, for example, in the fact that the entire third-class road network could not be taken into account as data is not available on it for all of Switzerland, which would enable a differentiation between "less important" and "more important" roads (with access function). Thus, while the damage potential list from Phase I is sufficient for the calculation an objective overview of the distribution of the protection forests throughout Switzerland and can be used for the *SWI*, the list does not fully reflect the actual protection requirements. For this reason, the support team proposed some additions to this damage potential list for the definition of the *SW-B*, in particular for the roads with access function. The following objects are explicitly not recognized as additional damage potential for the *SW-B*: (1) tourism infrastructure; (2) agricultural areas and infrastructure; (3) undeveloped construction zones.
As part of the calculation of the *SWI* in SilvaProtect-CH Phase I, the question regarding ***consolidation*** was explicitly excluded to avoid overloading the objective allocation key unnecessarily. Thus, in many areas the modelled *srPW* based on SilvaProtect-CH form a mosaic with "normal" forest (leopard skin) which is sufficient for the calculation of an index. However, consolidation is unavoidable for the management of protection forest in practice. Thus, as part of the harmonization of the criteria for cantonal protection forest delineation, the support group also developed a proposal on this point and, moreover, on the necessary additions to the forest perimeter as exists in the Silva module of SilvaProtect-CH. As opposed to this, the support group does not deem the discussion of the minimum area for individual *SW-B* perimeters as necessary; this should continue to be a matter for the cantons.

Implementation in the cantons

In the third stage of Phase II, the harmonized criteria will finally be implemented in the cantonal protection forest delineation. An essential objective by the second NFA period is that each canton has carried out protection forest delineation and forwarded it to FOEN for comment (for the purpose of verification with the *SW-B* criteria). In its response, FOEN will note whether the harmonized criteria have been complied with. Otherwise a reservation will be added in the programme agreement for the second NFA period. Ideally, this protection forest perimeter is already enshrined up to a certain point in time in the forestry planning. The (eventually revised) protection forest delineation must, however, be enshrined in the forestry planning by the next update of the latter. Where possible the implementation of the harmonized criteria should pass without major additional cost for the cantons.

OUTLOOK

The database developed in the first project phase offers a unique opportunity to carry out evaluations and scenarios on the topic of protection forest and natural hazards at national level. In the event of changes in the individual modules (change in the damage potential, new process modelling etc.), the protection forest index and the different scenarios can be re-calculated at a relatively low cost. In addition, the data are available to the cantons for their own evaluations.

With the proposed criteria from Phase II, over 90 percent of the currently delineated protection forest should already be covered, or come within the *SW-B*. Additional clarification will be required for some protection forests (e.g. in the sense of the proof of hazard potential, see above), however this can generally be provided by the canton without incurring significant additional cost. A few perimeters will ultimately not be accommodated in the *SW-B*, but can be managed as cantonal protection forest (without the financial support of the state for their maintenance).

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