

Recommendation

Spatial Planning and Natural Hazards

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Preface

Natural hazards such as avalanches, floods, and mass movements in Switzerland should be recognized, recorded, and presented spatially by unified criteria. For this purpose the federal government has published various recommendations and guidelines in recent years. In order to minimize existing risks, hazard maps are being prepared, and their implementation with spatial planning tools is our top priority at present and in the near future. This aspect is central to the current recommendation. It pursues the goal of pointing out the potential and limitations of spatial planning tools and presents sensible applications from the Confederation's vantage point. Our primary audience are experts involved in implementing principles within the domain of natural hazards.

Therefore, the recommendation is directed primarily toward a broad specialized public interested in spatial planning. It largely addresses specialists at the federal and cantonal levels. Secondly the recommendation should also be of use for specialists in communities, organisations, and insurance groups, because it supplements cantonal implementation tools and guidelines while serving planning and engineering offices. Since the various cantons employ widely differing implementation systems, the recommendation is confined to general information in regard to implementation.

Aspects that are particularly vital to federal agencies are summarised in basic ideas or principles. They have no binding character from a legal standpoint.

The recommendation emerged in close cooperation with a support group of cantonal representatives. The needs of other actors – organisations, insurance agencies, and communities – were expressed at a workshop in the form of a public hearing.

We thank all involved at this point for their valuable input and support. We hope that the recommendation provides a major contribution toward prevention and thus improved protection against natural hazards.

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Summary

The recommendation deals with serious natural hazards affecting a major area. These include floods, debris flow, landslides, rockfall, rockslides, avalanches, and ice slides. Hazardous processes do not just affect mountain areas. The potential for risk can also be very high in the midlands.

This recommendation treats the following issues:

- General principles for dealing with natural hazards and risks (Chapter 2);
- Necessary fundamentals for implementation (Chapter 3);
- Spatial planning tools and their use in combination (Chapter 4);
- Tasks and basic principles for directing cantonal structure planning (Chapter 5), land use planning (Chapter 6) and building-permit procedures (Chapter 7);
- Legal aspects, particularly for compensation and liability issues (Chapter 8).

Technical terminology is explained in the appendix.

General principles in dealing with natural hazards and risks

Recognizing and avoiding hazards, conscious dealing with risks, and safety reviews are important principles in coping with natural hazards. Spatial planning is a vital part of integrated risk management. It ensures proper use that takes the hazardous situation into account and contributes to reduction of risks and avoidance of new ones. Yet the promotion of the risk dialog and personal responsibility of those affected are also accorded high importance.

Necessary fundamentals for implementation

Protection from risks requires recognizing them first and then assessing them. Hazard index maps, hazard maps, and protection goals serve as vital principles in this regard.

The hazard index map provides a rough overview of the hazardous situation. It is based on model calculations and event calendars, but it cannot reconstruct the danger in any case. It helps when establishing a structure plan to recognise potential conflicts caused by use in endangered zones. Moreover, it serves to examine building applications out-

side building zones as well as to set the priorities in preparing hazard maps.

In contrast to hazard index maps, hazard maps provide a detailed overview of the hazardous situation. They contain endangered areas that form the basis for distinguishing hazard zones in land use planning. Attention to detail in the hazard map is correspondingly high.

The protection goals define the degree of safety sought for various spatial uses. Depending on the objects to be protected, the goal of protection is set higher or lower. Protection goals are graded by object categories and presented in a tabular goal matrix.

Implementation with spatial planning tools

Implementation by the cantons represents interplay between various tools. The following tools play an important role during the implementation phase:

- Hazard maps and hazard index maps are created at the cantonal level to complement federal law on the legal framework for implementing structural and land use planning as well as preparing the required legal foundation for it.
- The cantonal structural plan is the cantons' central spatial planning tool and also serves coordination and prevention purposes in particular. The following tasks face officials as binding strategic tools in protecting against natural hazards: laying down the principles and goals, organisation and coordination of the required basic jobs as well as assigning the binding mandates to canton agencies and communities.
- In land use planning, a community breaks the various use zones in its zone plan into precise parcels. The permissible land uses are laid down and bind landowners to the building and zoning rules contained in the regulations. A central task consists of implementing the hazard map that is based on scientific criteria in a legally binding manner.
- The canton and communities involved in the building-permit procedure ensure that a building application conforms to community regulations and higher laws. To protect against natural hazards, conditions can be formulated – e.g., flood-proofing measures – or building applications can be denied.

- Building insurance agencies can exercise an important steering function by setting conditions in applications for buildings and facilities within hazardous areas or in compensation cases. Insurance measures offer other technical possibilities.

Important tasks for land use planning and legal aspects

In principle, land use planning should grant no new building concessions to a zone with substantial hazards. In areas with moderate hazards, communities should carry out zoning with great caution. They should consider endangered areas with parcels already zoned. The proportionality and reasonableness of the protective steps to be taken – e.g., zoning prohibitions, flood-proofing measures, or use limitations – should be examined with special care. In any case, those affected should be informed promptly, and the measures to be taken should be introduced immediately.

Wherever the state averts protection by planning measures against hazards threatening human life and major property values – e.g., failure to zone or exclusionary zoning – there is no basis for compensation claims against the community. The community has only limited liability for defective zoning in hazardous areas. Hence a community is liable if officials recognize a hazard but fail to act on it at all within a reasonable period or act inadequately in other ways within the options open to them.

If a public official ignores the findings of a hazard map, the lapse is considered incorrect, and the official can be held liable.

1. What is at stake?

Spatial planning’s task is to assure purposeful and economic use of land and orderly settlement upon it. It should also consider natural hazards and risks.

Natural hazards have always threatened us. Serious natural hazards result from mass movement of water, snow, ice, earth, and rocks. During recent years, extreme events have led to great damages. In the course of climatic change, weather extremes can increase and raise risks and insecurity. Those affected by the processes of natural hazards are not only the mountain regions but the midlands as well. Yet, the increasing risk is not only a result of natural processes and global climate change. Rather it is linked primarily to the rise in potential damage from development of our settlements and their infrastructures.

In recent years the federal agencies have published various recommendations and guidelines on unifying recognition, recording, and spatial presentation of types of hazards (avalanches, floods, mass movements). As a result, numerous cantons have taken action on the related basic tasks.

Preparing hazard fundamentals and implementing them with spatial planning tools are priority tasks in the coming years to reduce risks. Therefore, our recommendation focuses on this aspect. It supplements federal recommendations and guidelines already existing and addresses responsible cantonal agencies handling spatial planning, river engineering, and forestry as well as interested communities and organisations including the private sector.

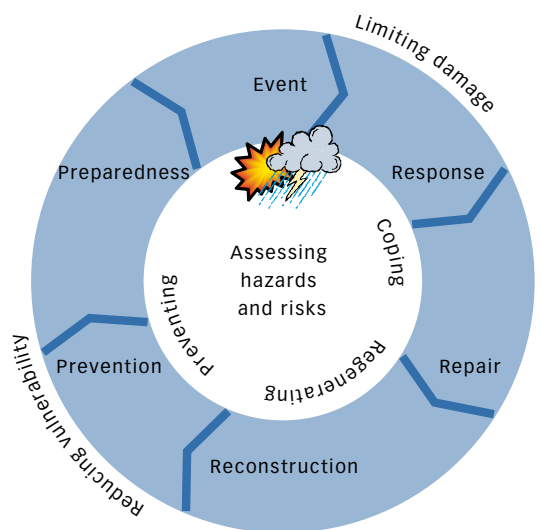
1.1 Spatial planning as a part of integrated risk management

All elements of integrated risk management (Fig. 2) – prevention, preparedness, response, repair, and reconstruction – are important and must act in complementary manner (e.g., working in harmony). Close cooperation between all actors is essential. This includes specialists from the sectors of natural hazards, spatial planning the insurance industry, warning services, and response forces (fire departments, police, first aid, civil defense, and the army). Yet it also requires the personal responsibility of those affected (Table 1).

Figure 1: Fully, Canton Valais (2000)



Figure 2: Integrated risk management



Spatial planning is part of integrated risk management and plays a key role in prevention. It assures appropriate use of endangered areas and helps reduce risks.

It pursues the following principles:

- Recognizing hazards
- Avoiding hazards
- Coping with risks.

1. What is at stake?

A premise for spatial planning measures is recognition of a hazardous situation. For this reason the cantons are preparing needed fundamentals to cope with hazards. When possible, no new buildings and facilities are built in endangered areas. The situation in areas already built up is more difficult. Here the goal is to reduce existing risks to an acceptable degree through a combination of planning, technical, and organisational measures.

1.2 Frameworks and tasks of spatial planning

Since 1979 federal law on spatial planning (RPG, SR 700) obligates the cantons to consider natural hazards in the fundamentals of establishing a structure plan. But only through amendment of federal laws on river engineering (WBG, SR 721.100) and forestry (WaG, SR 921.0) during the 1990s did this task become specific. Federally influenced spatial planning in Switzerland gives the cantons great flexibility in implementing principles contained in federal law. Important spatial planning decisions are made at the following levels:

- The legal framework is created at the cantonal level to supplement and implement federal law. This applies particularly to local planning, the building permit procedure, and preparing the necessary fundamentals (hazard index maps and hazard maps).
- Establishing the structural plan gives the cantons a tool for leadership and coordination. It can be used to set cantonal goals and carry out space-related tasks.
- The community is responsible for working out the zoning plan and building regulations (land use planning). Land use planning sets rules on use binding for property owners and detailed to each parcel.
- Cantons and communities assure that applications in the building-permit procedure contain community regulations and laws passed at a higher level. Conditions – e.g., flood-proofing measures – can be formulated, and building applications can be denied.
- The building insurance industry can exercise an important steering function by setting conditions for buildings and facilities governing building applications in hazardous areas or in compensation

cases. Technical measures affecting insurance offer other possibilities.

1.3 Sensitising and risk dialog

Sensitising officials and those affected is a vital premise for targeted application of spatial planning tools. Only when they recognize hazards and existing risks and can comprehend them, will the measures required receive the acceptance needed. Sensitising for frequent events is simpler than for rare extreme events when the link between the danger and measures to cope with it is not always obvious. Communicating new hazards – e.g., in connection with climatic change – represents an even more demanding task.

Therefore, risk dialog forms a central element in dealing with natural hazards. People in mountain cantons are particularly used to coping with natural hazards. They know that forecasts can never provide absolute safety or total accuracy. Sensitising people in the midlands to natural hazards is less developed. The fact that measures to protect against natural hazards must also be supported by the public demands that people become involved early as partners in the dialog and action plan. Regarding planning tasks, the spatial planning law also prescribes duties for information and joint participation.

1.4 Which natural hazards are relevant for spatial planning?

Spatial planning considers any relevant dangers for which spatial planning resources can influence the impact. Therefore, this recommendation focuses above all on serious hazards, since they indicate a high correlation with space. These hazards include floods, debris flow, landslides, rockfalls, rockslides, landslips, avalanches, and ice slides.

Spatial planning measures can also be suitable for defending against damages caused by hazards not treated in greater detail here. For example, sufficient distance from forests contributes to reducing damage from storms or forest fires. Hazards not handled specifically here may be found in the following specific documents:

1. What is at stake?

Table 1: Tasks and parties responsible within integrated risk management

	Prevention	Coping	Regeneration
Those affected	<ul style="list-style-type: none"> - orient oneself on risks - implement measures to protect objects - take steps for personal protection - prepare for emergencies - prepare emergency materials - drill for emergencies 	<ul style="list-style-type: none"> - guard against dangers - follow officials' instructions 	<ul style="list-style-type: none"> - implement use and building conditions
Agencies for natural hazards	<ul style="list-style-type: none"> - promote awareness of hazards - prepare concepts against natural hazards - create hazard map - assess risks - define protection goals - work out integrated protection concept - realise and maintain technical protection measures - cultivate protective forests - consider residual risks - promote communication on risks - set up early-warning systems - predict potential developments - issue warnings 	<ul style="list-style-type: none"> - ward off dangers - monitor hazards - advise emergency services 	<ul style="list-style-type: none"> - implement immediate measures for temporary regeneration of safety - review hazard maps - review protection concepts - realise technical protection measures
Agencies for spatial planning and building officials	<ul style="list-style-type: none"> - implement hazard maps in structural and land use planning - inform those affected - keep hazardous areas free from construction - set and monitor necessary use and building conditions (e.g., flood-proofing measures) 		<ul style="list-style-type: none"> - impose bans on building and create planning zones - review use - resettlement if necessary - adapt land use plan - enact required use and building conditions
Insurance industry	<ul style="list-style-type: none"> - advise on flood-proofing - formulate conditions for granting building permits - insure elementary damage 		<ul style="list-style-type: none"> - redeem insurance benefits - require flood-proofing measures - formulate building conditions
Emergency and rescue services (fire department, police, first aid, civil defense, technical services)	<ul style="list-style-type: none"> - prepare response resources - plan response - drill for emergencies 	<ul style="list-style-type: none"> - conscript emergency staff - issue alarms - evacuate - rescue - issue directives - prevent damage - inform 	<ul style="list-style-type: none"> - carry out evacuations - rebuild Infrastructure (e.g., electricity, water, roads) - support rebuilding tasks

1. What is at stake?

- Earthquakes: SIA Standard 260ff and guidelines on microzoning
- Hail storms: SIA Standard 261/1 and hail maps
- Storms: SIA Standard 261 (wind)

In assessing measures to protect against natural hazards, the specific properties of individual hazard types play a crucial role. Beside spatial ties, these include confinability, timing, predictability, intensity, probability, and susceptibility to influence.

1.5 Legal bases

In addition to spatial planning law, federal legislation on river engineering and forestry are of particular importance. The texts of current laws and ordinances can be found on the Internet (see Appendix). The following points should be given special emphasis:

- No general article on natural hazards is found in the federal constitution (BV, SR 101). Yet federal law has derived over the ages from regulations

in Article 75 BV (spatial planning), Article 76 BV (water), and Article 77 BV (forests). These compile certain rules for protection against natural hazards in the areas covered.

- The spatial planning law (RPG, SR 700) obligates the cantons to determine areas endangered by natural hazards. Areas threatened by natural hazards are only suitable for building under strict conditions, if at all.
- The rivers engineering and forestry laws (SR 721.00 and SR 921.00 respectively) contain the following points in particular:
 - Obligation to create natural hazard maps and to consider them in structural and land use planning as well as in all other activities affecting space;
 - Regulation of subsidies for setting standards;
 - Primacy of spatial-planning measures and maintenance of technical protection measures.

Earthquakes and spatial planning

A slight to moderate danger of earthquakes prevails in Switzerland. However, a serious earthquake – e.g., the 1356 quake in Basel – would cause immense damage today. Earthquakes occur over vast areas, and their impact is largely influenced by local surface and subsurface conditions.

Various cantons have conducted studies for microzoning that are comparable to hazard maps. Microzoning identifies areas where the earth’s surface would react unfavourably in an earthquake. New and remodeled structures would require special building codes in that case. A map of the subsoil classes (at a scale of 1:25,000) or – if available – a spectral seismic microzoning map as well represent the central base in regard to an earthquake’s natural hazards. The cantons’ structural plan should also address the topic of earthquakes beside other serious natural hazards (see Chapter 5).

Seismic microzoning in Switzerland does not lead to building bans. But it has a direct influence on zone plans and building regulations. Land use planning ought to give absolute priority to local impact zones proposed in the map of subsoil classes. Communities with endangered areas should set regulations on earthquake prevention – e.g., compliance with SIA standards – for those zones affected in the locality’s building and zoning regulation (community building regulation) that are binding on officials and the private sector (example: Appendix).

The Federal Office for Water and Geology (FOWG) is responsible for federal prevention of earthquakes. For this purpose it created the Federal Coordinating Agency for Earthquake Prevention (KSEV) in January 2001.

1. What is at stake?

The federal agencies have published various recommendations, directives, and guidelines (Appendix) for applying and implementing legal regulations and tasks. Previous recommendations and directives focus particularly on preparing the necessary foundations. They point out the need and requirements for the related inquiries and analyses, but they do not go into detail on how the fundamentals can be implemented with the tools of spatial planning. The National Platform on Natural Hazards (PLANAT) has conducted and published a special study (Lüthi, 2004) on legal aspects in connection with natural hazard maps.

2. Principles

Recognizing hazards and avoiding them, coping with risks consciously, and assessing safety represent central principles in dealing with natural hazards. Spatial planning has the tools necessary to promote risk-justified and sustainable development. It is an important component of integrated risk management. The personal responsibility of those affected also ranks high in significance.

On 20 August 2003 the Federal Council took note of the report «Safety in Case of Natural Hazards». This vision and strategy of the National Platform on Natural Hazards (PLANAT) contains general principles for dealing with natural hazards in Switzerland. The following principles fit into this strategy.

2.1 Recognise hazards

According to federal law, the cantons determine which areas are threatened by natural hazards or damaging impacts.

► P1 Clarify hazardous situations

Reporting hazards in event calendars, hazard index maps, and hazard maps allow risks and conflicts to be recognized and represented. The hazardous situation should be reviewed periodically. Known hazards ought to be considered in structure and land use planning. The hazardous situation must at least be known for settled areas.

► P2 Determine potential for damage

The risk in a certain area depends upon the potential hazard – i.e., the total possible impact of a hazard – and the possible damage in such an event. The risk to people and property can be determined by means of risk analyses.

► P3 Grant comparable level of safety

The supreme goal of safety efforts is to protect human beings and substantial property values from natural hazards. Safety of the living area is also the basic premise for a prospering society. Proper and comparable safety is the goal sought for the entire Swiss population.

2.2 Avoid hazards

In a densely settled and intensively used living and business area – such as Switzerland – avoiding hazards by means of spatial planning measures takes

high priority. Whenever possible, use should be adapted to the hazards.

► P4 Reduce risks

Spatial planning measures can contribute in the long term to prevent development of new risks in endangered areas. In areas already highly developed, they can prevent a rise in existing risks or even contribute to lower them. Spatial planning measures must be harmonised with other measures.

► P5 Spatial planning measures rank above technical measures

Spatial planning measures have priority and are in general preferable to technical measures. Technical measures should only be taken if a use – or a risk – already exists or if the use is absolutely necessary in an endangered area after weighing interests.

► P6 Identify and secure off-limits areas

Areas in which hazardous processes can be absorbed, retarded, or diverted should be off limits to buildings or facilities that can disturb the function of these areas. Among other areas, this applies to flood detention surfaces, sedimentation areas, runoff areas for avalanches, and flowing debris, discharge corridors, river courses, and the bank areas of flowing waters.

2.3 Cope with risks

At the same time, several factors increase the potential for damage in endangered areas. They include ever denser settlement, constant rises in property values, increasing traffic, and growing needs in professional life and leisure time. It also poses a demanding task for our society to reduce this potential for damage to an acceptable degree or at least to prevent it from growing. Therefore, it is important that the public is openly informed and involved in the sense of a dialog on risks during the phases of gathering basics and planning. Moreover, the status of natural hazards should be called to public attention over and over. This applies above

all when people unaware of local risks move into an endangered area or if the collective memory lapses during periods free of crises. Hence spatial planning also reflects itself in public awareness of natural hazards.

► **P7 Differentiate between protection goals**

Protection concepts are based on differentiation of protection goals: High property values are more important to protect than low values. According to this principle, uncultivated land and isolated unoccupied buildings usually need less protection than settlements, industrial facilities, or infrastructure sites. However, investigations of potential damage can result in different priorities in individual cases. Therefore, all measures must be assessed and reviewed for their proportionality (cost-benefit analyses).

► **P8 Act jointly and deal with residual risks**

Protection against natural hazards should be realised jointly by public agencies, insurance companies, and those affected. A definition of acceptable residual risks also emerges indirectly when determining protection goals. Emergency planning (warning, alarm, rescue, warding off damage) should rescue human beings and limit collateral damage above all else. Other damage can be reduced by proper behaviour in emergencies and – thanks to the options of damage prevention – even through action by those affected (preventive behaviour). An important premise for proper behaviour in case of major events is risk awareness. Only if the residual risks and possible countermeasures are clearly communicated to those affected they can react appropriately. This calls for a «risk culture» that allows risks and possible protective measures to be presented and assessed transparently.

► **P9 Risk-justified use**

Risk-justified use means that uses can even occur in hazardous areas. The following requirements must be fulfilled in such a case:

- no increase in risk potential;
- review of alternatives (advantages and disadvantages or other solutions and locations);
- proportionality of measures to protect against natural hazards
- comprehensive evaluation of interests regarding sustainability.

► **P10 Factor in needs of other sectors in protective planning**

Particularly when implementing technical measures it is vital for protective planning to consider other concerns and needs as well. This applies, for example, to the interests of the environment, nature, and landscape, those of farming and forestry, as well as water power and the concerns of the tourism and recreation sectors.

2.4 Review safety periodically

Various reasons can justify a reassessment of the hazard (and/or risk) situation. These include damage events, changes in use or public needs, aging of technical protection structures, or new scientific findings. Therefore, the principles, protective concepts, and measures must be reviewed periodically and adapted to needs.

► **P11 Review principles and protective concept**

Especially after severe events, unfavourable developments, or after the realisation of measures, the appropriateness of principles and the effectiveness of the protectiveness concept should be reviewed. Various aspects should be considered: i.e., estimation of hazard development and risk potential as well as possible changes in system vulnerability. Moreover, the effectiveness and efficiency of planning and structural measures must be reviewed periodically. The functioning of technical measures must be checked.

► **P12 Review safety of technical measures and assure their maintenance**

Construction safety (support security, serviceability) of protective structures should be maximised. The behaviour during events exceeding the design event must be assessed as well. Proper maintenance of protective structures and stream channels as well as care of protective forests are continuing tasks. These steps grant correct functioning of the «protection system», so that the available protective structures, protective forests, and stream channels as well as deposit and runoff options remain intact.

3. Fundamentals

If risks are to be avoided, they must be recognized first. Hazard index maps and hazard maps serve as important fundamentals toward this goal. Supplemented by intensity maps and other documentation, they form a basic premise for making the hazards and risks understandable to officials and those affected. Only in this way are they in a position to assess the risks, formulate the necessary protection goals, and take the steps required.

Figure 3: Procedure in preparing for natural hazards and risks as well as planning preventive measures

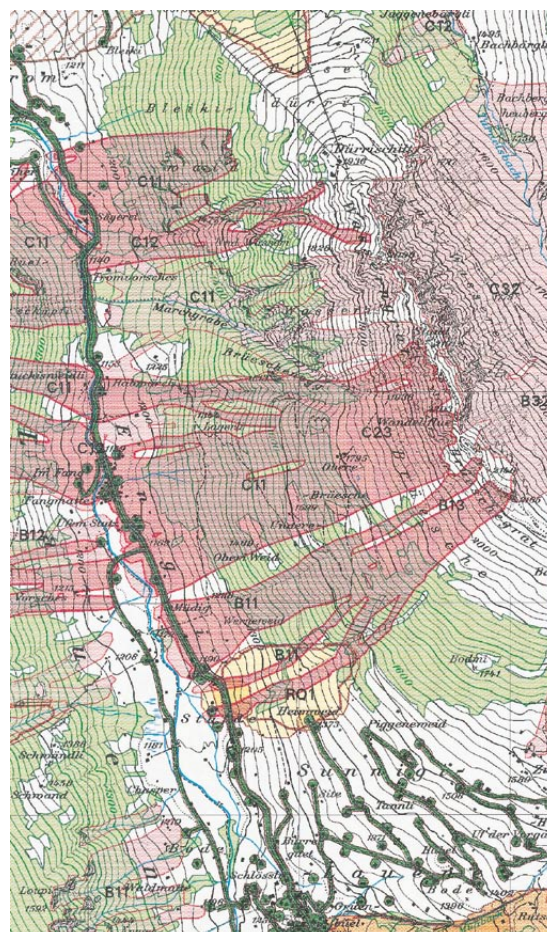
1. What can happen?	Risk analysis: <ul style="list-style-type: none"> – Hazard index map – Intensity map – Hazard map – Degree of damage
2. What may happen?	Risk assessment: <ul style="list-style-type: none"> – Protection goals – Risk acceptance
3. How can we protect ourselves?	Integrated risk management: <ul style="list-style-type: none"> – Spatial planning – Maintenance of rivers and cultivation of protective forests – Measures to protect single objects – Protective structures – Monitoring – Emergency planning – Insurance

The three most important fundamentals for reporting natural hazards and risks as well as planning preventive measures are described as follows:

3.1 Hazard index maps

The hazard index map provides a rough overview of the hazardous situation. It is based on model calculations and is made plausible by an event calendar. In regard to spatial limitation, it can contain vagueness and not reproduce the hazard in every case. In case of a flood hazard, for example, the extent of the inundated area is presented for an extremely high flow (EHQ).

Figure 4: Hazard index map: It provides a rough overview of the hazardous situation and serves for early recognition of possible conflicts between use and hazards.



The hazard index map covers large areas – usually a canton – comprehensively identifying where specific hazards must be expected. Yet it offers no data on the hazard level. Potential conflicts between hazard and use can be derived from it with little effort. On one hand, the hazard index map serves structural planning. On the other, it aids in examining building applications outside building zones

as well as in setting priorities when preparing the hazard map.

3.2 Hazard maps

The hazard map (Figure 5) provides a detailed overview of the hazardous situation at five threat levels:

- **red**: substantial threat
- **blue**: moderate threat
- **yellow**: little threat
- **yellow-white striped**: residual threat
- **white**: no or negligible threat

It represents hazardous areas and especially provides the fundamentals for distinguishing hazard zones in land use planning. Hazard maps and the technical reports related to them contain detailed data on causes, sequence of events, spatial expansion, intensity, and the probability of natural hazards occurring. Their level of detail is correspondingly high.

Figure 5: Hazard map: It provides a detailed overview of the hazard situation. Hence it serves as a basis for identifying hazardous zones and determining conditions for use.

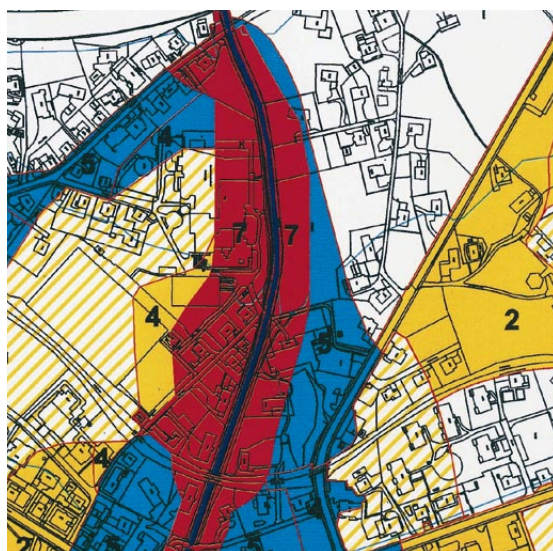
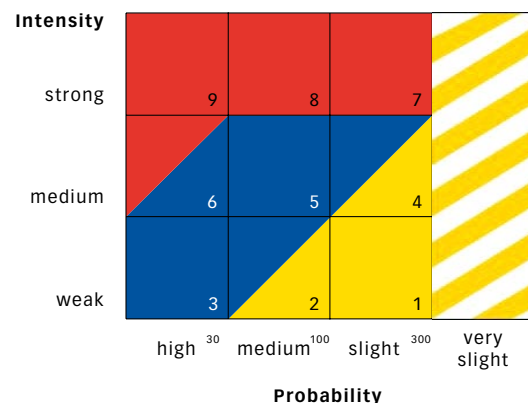


Figure 6: Hazard levels: Result of intensity and probability



An important interim product in preparing the hazard map is the intensity map (Figure 7). It shows the class of probability (high, medium, slight, very slight) and the expected intensities of the hazard processes. Examples are the depth of inundation and flow velocity in case of flood events. Such information can serve many uses. For instance, given the depth of water and velocity of flow in flood areas, the safety measures necessary for buildings and facilities – such as building conditions and flood-proofing measures – can be derived from it or the free space needed for runoff corridors can be determined. Intensity maps also form the basis for risk calculations as well as for planning and for emergency measures.

Hazard maps – or at least hazard index maps – are required for planning in hazardous areas. Integrated hazard maps include all types of hazards occurring in the area being considered. The plan to incorporate these documents is based on recommendations by the responsible federal agencies (FOWG, SAEFL, ARE, see Appendix). Where added information is available, the related cantonal recommendations and guidelines are also pivotal.

Hazard maps are obviously specialized technical bases prepared by the cantonal agencies responsible. The findings of hazard mapmaking must be communicated to the affected public. In the interest of broadranging awareness of the risk, information should cover the hazard and possible personal steps for prevention.

Hazard maps are obviously specialized technical bases prepared by the cantonal agencies responsible. The findings of hazard mapmaking must be communicated to the affected public. In the interest of broadranging awareness of the risk, information should cover the hazard and possible personal steps for prevention.

Figure 7: Intensity map: It shows the intensity for a selected recurrence period of 30, 100, or 300 years as well as for an extreme event. This information is of importance in assessing flood-proofing measures.



Table 2: Overview of characteristics of hazard index maps and hazard maps

	Hazard index maps	Hazard maps
Content	<ul style="list-style-type: none"> – Hazard existent/does not exist – Type of hazard 	<ul style="list-style-type: none"> – Precise location of endangered area – Type of hazard – 5 hazard levels (graded by intensity and probability)
Purpose	<ul style="list-style-type: none"> – Basis for structural planning – Recognition of conflict areas – Basis for assessing building applications outside building zone – Set priorities 	<ul style="list-style-type: none"> – Basis for identifying hazard zones in land use planning – Basis for formulating building conditions – Projecting protective measures – Emergency planning
Level of detail	low, rough overview, low precision in delimitation	high, detailed overview, high delimitation, precision (to the parcel)
Scale	1: 10,000–50,000	1: 2,000–10,000
Perimeter	canton (comprehensive)	region/community (not comprehensive)
Review	periodic, e.g., in framework of structural plan audit	periodic in framework of land use plan audit or if hazard situation changes greatly (e.g., following protective measures or event)
Products	map and technical report	map and technical report

3.3 Differentiating between protection goals

The degree of safety sought for various spatial uses is defined within the protection goals. Depending on flood-proofing, the goals will be set higher or lower. If people or substantial property values could be affected, the protection goal will be set higher than that set for objects of lower value with lesser damage potential.

Flood-proofing is represented in a tabular matrix according to its assessed protective goal category. Figure 8 shows an example of such a matrix for surface prevention as used in similar form by the cantons. These matrices with overriding protection goals can assure that comparable scales striving for common safety values are present throughout Switzerland.

Protection goals in accord with the matrix serve as the structural values that should be fulfilled in the ideal case. But no claim for attaining the goal can be derived from it!

In many cases it is possible to eliminate protection deficits by planning suitable preventive measures. In a few cases, however, this is not possible at justifiable cost. Project-related protection goals can deviate from the overriding protection goals. They are to be set in the framework of preventive measures planning after careful weighing of interests and consideration of business, social, and ecological aspects. Beside spatial use, the type of hazard is also to be considered here, e.g., intensity, early warning time, and possible influences. If protection deficits remain high – and thus still pose a substantial remaining risk – the use should be modified. The Swiss Association of Engineers and Architects (SIA) is preparing measurement perimeters for structures in hazard areas.

The most important categories of flood-proofing are as follows:

- Dense settlements:
As a rule, they should also be protected against rare events and often even against very rare events.
- Industry and commerce:
The same principles apply to these structures and facilities as for dense settlement areas. The









often very high potential for damage should be given special attention here. These facilities should usually also be protected against rare events.

- Infrastructure facilities:
Differences between facilities (streets, rail lines, etc.) of national, regional, or local importance are made here. Depending on their status and vulnerability, the protection goal will be set higher or lower.
- Special objects:
Particularly sensitive flood-proofing objects (schools, hospitals, etc.) must be judged individually, because their operational safety must also be guaranteed in case of a damaging event. Also applicable here: the greater the potential, the higher the protection goal.

If the pure defense against a hazard took priority in the past, one today seeks to base decisions on risks. Determining protection goals is primarily a political task and should be supported by quantitative risk considerations. Various interests are weighed when factoring in aspects of sustainability. The issue here is the level of protection we can afford and which remaining risks we want to take. Cost-benefit analyses are a tool to make such decisions. Spatial planning becomes influential in dividing use of space and should therefore also be involved in determining protection goals. On the other hand, the protection goals represent important framework conditions that should be given compulsory attention in land use planning.

Figure 8: Protection goals matrix for surface protection: Example of such a matrix as used in similar format in the cantons (according to SAEFL, 1999): Reading aid: For dense settlements (object category 3.2) one should strive for complete protection up to 100-year event level. Weak intensities are acceptable between the 100- and 300-year event levels. Medium intensities are tolerable for even rarer events.

Key

	= complete protection		= no intensity permitted	= 0
	= protection from medium and strong intensities		= weak intensity permitted	= 1
	= protection from strong intensities		= medium intensity permitted	= 2
	= lack of protection		= strong intensity permitted	= 3

Object category

Protection goals

No	Property value	Infrastructure facility	Nature value	Return period [years]			
				1-30 often	30-100 rare	100-300 very rare	>300 extreme- ly rare
1		Mountain and ski tour routes (according to SAC map)	Natural landscape	3	3	3	3
2.1		Commercial hiking paths and skiing trails, corridors, conduits of local importance		2	3	3	3
2.2	Unoccupied buildings (sheds, pasture stables, etc.)	Transport routes of local importance, conduits of cantonal importance	Forest with protective function, land useful for farming	2	2	3	3
2.3	Parttime or permanently occupied individual buildings and hamlets, stalls	Transport routes of cantonal or major community importance, conduits of national importance, mountain railways, zones for downhill skiing, and training grounds	Forest with protective function if it protects dense settlements	1	1	2	3
3.1		Transport routes of national or major cantonal importance, skilifts, cablecars		0	1	2	3
3.2	Dense settlements, commerce and industry, building zones, camping sites, leisure and sport facilities	Stations for various transport uses		0	0	1	2
3.3	Special risks or special vulnerability or secondary damage	Special risks or special vulnerability or secondary damage	Determination case by case				

4. Tools for implementing spatial planning

If the necessary fundamentals – such as hazard index maps and hazard maps – are available, the issue of implementing spatial planning emerges. Federal law obligates the cantons and communities to consider natural hazards affecting all spatially relevant activities. This applies especially in structural and land use planning. Effective implementation assumes clear regulations governing execution and responsibilities.

According to the laws on river engineering and forests, cantons and communities must consider the fundamentals prepared on natural hazards – such as hazard index maps, hazard maps, and other documents – for all activities affecting space. This applies especially in structural planning (Chapter 5), in land use planning (Chapter 6), and in granting building permits (Chapter 7). The actors entrusted with protection from natural events pursue the same goal: to prevent personal and property damage whenever possible. Therefore, coordinated implementation is required at all levels, and clarity on the process and responsibilities must prevail. The following tasks take priority at the cantonal level:

- Creating the necessary legal enactment (laws, decrees);
- Preparing a cantonal concept on natural hazards or a corresponding strategy;
- Compiling hazard index maps;
- Defining general protection goals.

The cantonal structural plan serves as a spatial coordination and leadership tool. Supported by these fundamentals, the canton or the communities prepare hazard maps. Afterwards implementation follows in land use planning (which falls to the communities in general) and finally the permit procedure. Table 3 gives an overview of the most important implementation tools with their responsibilities and functions.

Table 3: Responsibilities and functions of the various implementation tools

	Responsibility	Functions	Examples
Laws	Binding on all	The legal framework conditions in laws and decrees on preventing natural hazards and the responsibilities of cantonal, regional, and community agencies can generally be understood as binding on all parties.	<ul style="list-style-type: none"> – Building ban in endangered areas – Plans for identifying hazardous zones – Plans for uses in hazardous zones – Envision committees on hazards
Planning Structure plan	Binding on officials	The cantonal structure plan serves to recognize tasks relevant to space at the cantonal or regional level in the realm of natural hazards, to coordinate implementation, and to close gaps in implementation. Tasks that require a regulation to bind landowners cannot be dealt with in a cantonal structure plan.	<ul style="list-style-type: none"> – Represents the start-up situation and the need to act – Formulates important principles and goals – Defines tasks and measures for cantonal, regional, and community agencies
Land use plan	Binding on property owners	The land use plan sets binding regulations on landowners for effective use of land by considering the specific hazard situation parcel by parcel.	<ul style="list-style-type: none"> – Identifies hazard zones with corresponding regulations – Adapts uses to the hazardous situation
Guidelines	Binding on officials	Guidelines serve to assure unified and legally equitable implementation, especially in weighting factors.	<ul style="list-style-type: none"> – Define tasks of implementation authorities – Binding regulations of administrative flows and responsibilities – Define concepts and interpret them
Directives, instructions, etc.	Not binding	Directives, instructions, etc. are suitable for pointing out to various actors how to prevent natural hazards functionally. They fulfil an important task in informing and sensitising officials and the public.	<ul style="list-style-type: none"> – Point out implementation and the process based on case examples and patterns – Practical tips in dealing with natural hazards – Point out the possibilities for engineers, architects, and contractors
Building permits	Binding on addressee	The building permit procedure reviews if a specific building project contains the legal and planning standards. If needed, supplementary information (e.g., expert opinions) is demanded and conditions formulated.	<ul style="list-style-type: none"> – Conditions regarding flood-proofing measures – Gathering expert opinions on hazards (especially outside the building zone)

5. The cantons' structure planning

The cantonal structure plan is the canton's main tool for spatial planning. It particularly serves coordination and prevention. As a strategic tool that binds officials, it fulfils vital tasks in protection against natural hazards. Thus it also serves to maintain principles for organising and coordinating the necessary fundamental work and to divide binding tasks among cantonal agencies and communities. It is the task of land use planning to identify and implement hazardous areas binding on landowners.

In order to prepare their structure plans within the basic framework, the spatial planning law requires the cantons to identify which areas would be substantially endangered by natural hazards or damaging impact. The guideline to structure planning (BRP 1997, p. 44) requires the plan to point out «measures to protect against threatening natural hazards (e.g., use constraints) as well as to prevent potential damaging events or their aftermath (such as protective structures).» The following basic principles supplement and detail the elements of structure planning. Depending on the nature of the problem and the current status of work, the cantons set various priorities in treating the subject in their structure plan. But it is of major importance that all types of natural hazards existing in the canton are included. If this occurs in a single role or in several is secondary and depends on the form of structure plan.

5.1 Principles (minimum requirements)

► P5-1 Basic principles for protecting against natural hazards

The canton's structure plan maintains as a goal the canton's principle of guarding against natural hazards. With reference to the problem status – and supported by its legal bases, directives, etc. – the canton formulates the most important fundamentals and principles for protecting against natural hazards. The priority of spatial planning measures preventing damage over technical measures to defend against hazards shall be emphasized here. So should the basic principle of comprehensive protection from nature, which covers all types of critical natural hazards.

► P 5-2 Organisation and coordination of basic tasks and responsibilities

Starting from the status of previous work (status at onset) the canton formulates tasks in preparing hazard index maps and hazard maps, sets deadline

targets, and fixes responsibilities. In this case, one could require that an event calendar be compiled. This cannot be done for the structure plan. Based on an existing hazard index map, the jobs required – especially in large cantons – can be scheduled and staggered by priority. Depending on the canton, responsibility can lie with cantonal officials or the communities. Depending on the canton's planning system, delegation of work to regional planning is also conceivable.

► P5-3 Assigning implementation of hazard maps to communities in land use planning

The canton assigns the communities the task of implementing the hazard maps available in their land use plans. This task can generally be assigned to all communities at the beginning of work on hazard maps and serve as the milestone for completion. But it is also possible to address any targeted community that has not adapted its land use plan (closing gaps in implementation) once the hazard map exists. In implementing land use plans, the canton can draft guidelines in the structure plan or refer to related legal instructions, guidelines, and directives.

► P5-4 Review and updating

Periodically or after important changes, the canton may prefer to review and update the hazard fundamentals. A damaging event, construction of protective measures, or new scientific findings may lend impetus to this.

5.2 Supplementary content

Beside the minimum requirements formulated in Chapter 5.1, which the federal government sets when reviewing and approving cantonal structure plans, the cantons may provide further structure plan content in the domain of natural hazards.

Hence, various cantons impart a rough spatial overview of endangered areas. This usually occurs by means of a hazard index map in the form of a basic map within the structure plan text or even integrated in the structure plan map. It is also possible here to indicate conflict areas and to determine a further plan of action.

Larger and particularly transborder concepts for integrated protection – e.g., the Linth 2000 flood protection concept, the third Rhone correction, and similar plans – are also to be coordinated within the structure plan.

Additionally, the chapter on natural hazards often treats closely related topics («Safety Function of the Protective Forest» or «Safety of Streams' Spatial Needs») with related principles and assignments (see Chapter 6.8).

6. Land use planning

A community employs land use planning to identify the various use zones in the zone plan parcel by parcel. Moreover, it determines approved ground uses for landowners in the related provisions of the building and zoning regulations. A major task consists in legally binding implementation of hazard maps prepared according to scientific criteria.

Land use plans cover permissible use of land. They differentiate to begin with between building, agricultural, and protection zones (Art. 14 RPG). According to Art. 15 RPG, only land suitable for superstructures may be allocated as a building zone. Areas or parcels that are threatened by natural hazards only fulfil this basic assumption to a limited degree or not at all.

Besides the basic uses mentioned, cantonal law can allow further zones. This also includes hazard zones. While the expression «hazardous area» in the following always refers to the hazard map, the term «hazard zone» refers to implementation binding on landowners in land use planning.

6.1 Principles

► P6-1 Identifying hazard zones

All hazardous areas should be identified in the zone plan (red, blue, yellow, yellow-white, white). If a merely indicational presentation of the hazardous area occurs in the zone plan, a legal basis that largely bans building in endangered areas is especially vital at the cantonal level. Moreover, legal protection for those affected must be assured.

► P6-2 Taking over hazard areas

Hazard maps should be taken over in the zone plan with as few changes as possible. Minor deviations – e.g., rounding off or simplifications due to parcel structures – are possible in identifying zones. On the other hand, major alterations only come into question as exceptions resulting from interests weighed against risk factors.

► P6-3 Regulating hazard zones

Use rules on forbidden or conditional zones (or areas) are urgently needed in the building and zoning regulations. Within the indexed area any recommendations or regulations should be directed primarily toward risks. The regulations' goal is to minimize the risks at hand and to prevent new ones.

► P6-4 No building zones in highly endangered areas

Basically no areas with substantial hazards can be allocated to a zone for building use.

► P6-5 Restrained zoning policy in areas with moderate hazards

A zoning test is possible in areas with medium danger. However, conditions are the proof of an overriding interest and the lack of suitable alternative locations. If this is the case, the inside and outside safety of the planned building must be thoroughly checked. Hazards with little or no early-warning time pose a major problem in guaranteeing safety outside of buildings that must be resolved with proper measures.

► P6-6 Dealing with parcels already zoned

An especially thorough review is necessary if endangered areas overlap parcels already zoned. In such cases, the proportionality and reasonableness of the precautionary steps proposed – e.g., zoning bans, flood-proofing measures, or use restrictions – must be clarified precisely. Various factors in connection with interest balancing must be clarified and weighed against each other. This applies in particular for the potential hazard and risk, the public and private interest in an use, available alternatives, as well as the peculiarities of the location – e.g., in regard to the degree of superstructures and gaps in building. The planning zone tool (Art. 27 RPG) allows officials the time needed to evaluate and judge the suitability of protective arrangements in areas not yet developed or only partially developed. In any case, those affected must be informed promptly, and the necessary protective measures are to be introduced immediately.

► P6-7 Dealing with protective structures

Securing spaces with protective structures represents a demanding task. Financing, maintenance, and renewal of protective structures must be assured over the long term. However, when extreme events occur, the best protective structures offer no absolute safety. Therefore, protective structures

should be erected only with great reservations if they extend existing building zones or identify new building areas. This applies all the more if it concerns endangerment by natural hazards with little early-warning time and higher intensity or if the use is extended toward the source of the hazard. Protective structures in secured areas should be identified in the zone plan as potentially hazardous areas with residual dangers. Areas with very great potential for damage should call for effective flood-proofing measures. There are cases in which realisation of structural protection measures justify extending building zones or permitting new building areas. Depending on the situation, however, such an approach can also be highly problematical.

► **P6-8 Dealing with special uses**

In regard to potential risks, special uses (e.g., camping sites, hospitals, industrial and commercial areas) require an early and detailed clarification. The tool of the special land use plan is suitable to implement special structural, planning, or organisational measures.

► **P6-9 Dealing with lack of hazard maps**

Areas for which hazard maps are not yet available are to be treated as hazardous areas if it is assumed that natural hazards could occur due to hazard index maps or other documents. Zoning, rezoning, or extensions on use are to be waived here until the hazard map or an expert opinion create clarity on the danger.

6.2 Which tasks do planning officials face, and how does the planning process work?

Hazard maps (Chapter 3) are prepared according to objective scientific criteria. Their implementation in land use planning poses a demanding task for all involved. Besides communicating the complex specialized findings from hazard assessment, conflicts and use claims should be clarified in an initial step. Already at this stage important issues of principle can arise that demand detailed clarifications. If building zones lie in a hazardous area, the issue also emerges with which measures the existing risk can be reduced to an acceptable degree. Moreover, the extent must be clarified to which intervention in property rights can still be seen as proportional and

reasonable. Among other things, proportionality depends greatly on the degree of accessibility, development and particularly settlement (including property value). If it involves parcels already developed, officials usually check use restrictions and flood-proofing measures above all. Various factors play an important role in the judgment. Technical feasibility, cost, sustainability (including maintenance) potential risk reduction, and public interest all figure into this. If the hazardous area affects undeveloped parcels in the building zone, officials should usually take exclusionary zoning into consideration – if necessary in combination with a search for alternative locations. In urgent cases, the responsible officials can also employ the planning-zone tool and thus freeze planned development for up to five years or have it revised (Art. 27 RPG). If it involves structural gaps, the location (on the edge of a community or at its center), the degree of hazard (blue/red), and the potential for risk gain a higher status. The right to equal treatment cannot be applied if the danger was recognized at a later date.

In a follow-up step, planning officials must weigh interests. Their findings can be justified all the more and explained during the following involvement, depending on the greater caution of the authorities, who had carried out the planning process, reviewed alternatives, and provided detailed clarifications. Before one can finally present planning to the public, it must be reviewed and revised. After possible negotiations on objections, a decision needs to be made by the responsible community body (community council, community assembly, or plebiscite) before the cantonal officials can approve the plans and regulations. These will take effect if no appeals are lodged.

6.3 Which rules belong in a building and zoning regulation?

Rules for hazardous zones are enacted in a building and zoning regulation. Rules are indispensable for ban and conditional zones; they must be assessed for index zones based on the risks involved. Table 4 shows an overview with the consequences that can occur at various hazard levels in identifying zones and how they are integrated properly in the building and zoning regulation. Table 4 also lists references

to other importance sectors of integrated risk management.

The officials responsible must make the following decisions in particular regarding implementation of the hazard map:

- Where does danger to human beings pose an acute need for action, so that suitable protection measures should be taken within a reasonable period regardless of a specific building application (even of an organisational nature)?
- Where can measures wait until construction officials receive a specific building application?

In areas with moderate hazards, no sensible uses should be permitted that represent a high risk to people and property. Uses in case of low hazards and in residual hazard sectors – with related conditions governing safety – should only be tolerated if no alternatives are available.

Owners of property and possessions are personally responsible for implementing protective measures recommended in areas with minor hazards. Depending on the risk involved, officials should set conditions in case of sensitive uses for major developments.

6.4 Which basic implementation models exist?

Communities in most cantons identify hazard zones binding on landowners in the zone plan and issue related regulations. This implementation model is referred to hereafter as a «hazard zone model». A few cantons used another model: hazardous areas on the hazard map are entered here only as indices in the zone plan. Building and zoning regulations contain general rules on hazardous areas. This model is referred to hereafter as a «hazard index model».

The hazard zone model offers all options: from general rules in building and zoning regulations to very detailed articles with related zone representations. In practice to date, the hazard index model usually permits general rules that produce a direct link to the hazard map.

6.5 Advantages and disadvantages of both models

The hazard zone model can lead to greater transparency and legal safety for those affected. The more detailed building restrictions for hazard zones are formulated, the clearer they are for those affected in an early stage of the situation. Buyers and sellers, for instance, are informed of the consequences of hazardous situations when selling real estate. By contrast, the generalities formulated in rules of the hazard index model create transparency and legal safety for those affected at a relatively late stage. In order to establish which specific building restrictions apply for a piece of land in a hazardous area, those affected must lodge or present a specific building application. Therefore, the advantages of this model above all lie in the flexibility of making rapid changes in the hazard map and integrating them in the zone plan in a formless and transparent way. In order to assure uniform implementation, it is sensible in both models for the canton to enact a regulation on cantonal law that restricts building in hazardous areas. This at least informs those affected in a legally binding manner that they must reckon with major restrictions if their piece of property lies in a hazardous area. Furthermore, legal protection for those affected must also be assured in the hazard index model (e.g., by creating an option for raising objections (practice in Canton Fribourg).

6.6 How detailed should plans and rules be?

While rules have only been generally formulated in practice to date in the hazard index model, the hazard zones model also allows detailed formulations of detailed zone rules and representations. Hence, for example, identification can occur, not only of hazard levels but also types of hazard, protective measures, and other criteria. It is not necessary to adapt the zones to parcel structures. They can also follow the precise boundaries of hazardous areas marked in the hazard map.

Both legal safety and transparency as well as flexibility depend on the degree of detail found in rules and plans (see Figure. 9). A community with relatively few structural changes may profit from a solution with as much legal safety and transparency as possible. On the other hand, a community with

Table 4: Consequences of various hazard levels for identifying zones and the building and zoning regulation

Hazard zone	Zone identification	Building and zoning regulation	Other measures
Ban zone (major hazard, red)	<ul style="list-style-type: none"> – No identification of new building zones; – Preclude zoning for undeveloped building zones 	<ul style="list-style-type: none"> – No building or expansion of structures and facilities; – Decree necessary use restrictions for existing structures; – Rebuilding and functional changes only with conditions to reduce hazards; – Rebuilding of destroyed structures only as exceptions with conditions noted. 	<ul style="list-style-type: none"> – Prompt information to land and property owners about existing hazard and necessary preventive measures; – Note use restrictions in land register if applicable; – Rapid planning and implementation of necessary technical and organisational protective measures.
Conditional zone (moderate hazard, blue)	<ul style="list-style-type: none"> – Identify new building zones only with conditions and after reviewing alternatives and weighing interests . 	<ul style="list-style-type: none"> – No building of sensitive objects; – Building permit only with conditions; – Decree necessary use restrictions for existing structures; – Fix requirements for spatial arrangement, use, and design, possibly also development of accessibility to buildings and facilities; – Depending on type of hazard and intensity, detailed rules must take account of various protective measures. 	
Index zone (low hazard yellow/ residual hazard, yellow/white)	<ul style="list-style-type: none"> – Avoid zones in which facilities with high potential for damage could be built; – Reference to the hazard situation. 	<ul style="list-style-type: none"> – Recommendations for existing buildings; – Weigh conditions according to risk in case of sensitive uses or major developments. 	<ul style="list-style-type: none"> – Information for landowners on existing hazard; – Advice on measures to prevent potential damage in cooperation with insurance industry; – Special technical and organisational measures for sensitive objects with safety conditions.

ongoing structural development may be primarily interested in having as much flexibility as possible. But the choice of the degree of detail most suitable also depends on other factors – e.g., on the offer of expert advice in implementation.

6.7 What options do special land use plans offer?

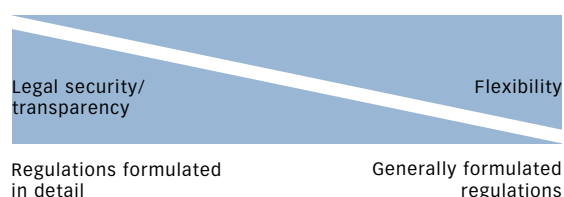
Various cantons know the tool of special land use plans (design plan, development plan, district plan, or similar terms). Special land use plans are part of land use planning. However, they can make commitments binding on landowners for a clearly defined spatial area that deviates from zone plan regulations or those of building and zone regulations. Important parts of the special land use plan's content might be designation of building lines or building fields – similar to rules on special building distances and structural protection measures or setting special-use restrictions. Therefore, special land use plans are suitable for finding planning solutions at the edge of hazardous areas involving major parcels or large developments that are adapted to special local conditions. Existing or planned uses can be harmonised better in this manner to fit specific hazard situations in terms of time and space. Various measures can thus contribute to reduce the hazard and risk. Examples might include building a dam, a special arrangement of buildings, location of a development facility, or coordination of runoff routes with flood-proofing measures. Moreover, the costs of such measures can be spread over the entire planning perimeter.

6.8 Spatial safety

According to Article 21 of the federal law on river engineering, the cantons are obligated to define the spatial needs for floods to run off and consider them in structural and land use planning. In connection with improving safety against flooding hazards, safety of spatial needs is a central concern. Expanding river space, securing runoff, and maintaining runoff corridors and detention areas can reduce the risk of flood damage. The need for space can be set by means of building lines, regulating distance from water courses, or zones. These tasks should preferably take place in close harmony with

identification of hazardous areas. In an individual case, combining of endangered areas and space for water courses should be tested.

Figure 9: Influence of level of detail in regulations and plans on legal security, transparency, and flexibility



7. Building permission

During the building permit procedure, the officials responsible check whether the required regulations have been incorporated in the building plan. This also includes measures on protection against natural hazards. In many cases the decision whether and to what extent measures to protect against natural hazards must be taken only occurs in the building permit procedure.

In many cantons laws forbid approval of building plans in hazardous areas or permit it only under certain conditions.

Granting a building permit represents a spatially effective activity. According to river engineering and forestry law, the cantons consider all spatially relevant activities on hazard maps. Before they grant a building permit, the officials responsible have to consult federal law affecting hazard maps and other documents. This duty applies regardless of whether or not the related fundamentals have already been implemented in a spatial planning sense.

Hazard maps concentrate in general on the building area. Therefore, officials frequently fall back on hazard index maps or event calendars at best rather than hazard maps for building plans outside building zones. Hence the approach differs, depending on whether a building plan's activity should take place within or outside the building zone (Chapters 7.2 and 7.3). It should also be noted that federal law requires a cantonal agency to check compliance of building plans outside the building zone or if a permit exception can be granted.

7.1 Principles

► P7-1 Clarifying the hazard situation

Compliance officials reviewing building permits check if a hazard exists. If it does, the agency ensures that the necessary fundamentals have been noted and considered.

► P7-2 Deciding on the building application

If the risks can be reduced to a justifiable degree by suitable measures, the conditions required are set in the building permit (Chapter 7.4). If a risk is shown to be too high, the permit should be denied.

► P7-3 Simultaneous implementing of conditions

The building permit should ensure that the conditions required are fulfilled at the same time within

the building plan. Implementation must be reviewed in case of building approval.

7.2 Construction guidelines within the building zone

Inside the building zone, the building permit agency primarily checks if the application corresponds to the zone plan and the building and zoning regulations related to it. If building zones are affected by natural hazards, the necessary permit conditions can usually be derived from the building and zoning ordinance regulations. Questions on details can be clarified in follow-up talks with specialists.

7.3 Construction guidelines outside the building zone

Outside the building zone, a first step should establish if the building plan is affected by natural hazards. This can be determined in many cantons on the basis of the hazard index map or an event calendar. If the object involved is located in a potentially hazardous area, more detailed clarifications by specialists will be necessary.

7.4 Setting conditions

If the risk can be reduced to a justifiable degree with suitable preventive measures, the related conditions in the building permit should be spelled out. In case of new construction, the room for flexibility is naturally greater than for rebuilding or an annex. Building insurance firms can also create added incentives for implementing protective measures. The following options exist for building permit officials:

Use restrictions

Certain uses of a building are restricted or forbidden entirely by such precautions. It is possible, for instance, to ban residential use in endangered parts of homes. However, use restrictions have a disad-

vantage: it is difficult to check compliance with a permit after it is granted. Moreover, it is not assured that the necessary information about the protective measures will be passed on in case of a rental or sale to another party. Therefore, it is sensible to enter a note on use restrictions in the property register.

Flood-proofing measures

These include furnishing and allocating buildings, strengthening walls, or specially designed doors and windows. The Association of Cantonal Fire Insurance Providers (VKF) published a «Guideline on protecting objects against grave natural hazards» in 2005 (Egli, 2005). It contains a collection of flood-proofing measures that is directed toward various types of hazards as well as practical tips for engineers, architects, and homeowners.

SIA standards

Swiss Institute of Engineers and Architects (SIA) standards 260, 261, and 261/1 set protective standards for new buildings against the impact of natural gravitational hazards as well as wind, hail, snow, and earthquakes. Among other things, the protective goals must be described in a use agreement based on a dialog between the client and project author. In the project's basic formulation, its author also explains hazardous situations observed as well as the requirements for load capacity, user friendliness, and sustainability. Moreover, he proves the measure envisioned to ensure protection goals – e.g., the protection concept.

Technical protective structures

This concerns structures such as dams and avalanche protection. Such structures not only protect solitary buildings but also entire building groups or infrastructure facilities. As a rule, they do not fall within the client's area of responsibility. Normally a building plan in such cases is only approved if the required protective structures are actually realized.

Recommendations

It can prove useful to call the building applicant's attention to voluntary protective measures in the index zone. It should be noted here that conditions should be weighed, depending on risks, in case of sensitive uses or major developments.

8. Legal aspects

Measures to protect against natural hazards can result in exclusionary zoning, bans on use, building precautions, or restrictions. Which demands for compensation can be lodged in such cases? And can officials be held responsible if they fail to act in a timely and appropriate manner? The explanations of legal expert Rolf Lüthi provide an overview of current legal practice.

8.1 Financial consequences of planning measures to protect against natural hazards

Fulfilling spatial-planning mandate demands separation of building areas from areas banning construction. Therefore, when creating a basic ordinance on spatial planning that relates to constitutional and legal requirements, allocation of land to a nonbuilding zone usually has to be accepted by the landowner without a right to indemnity. This is certainly the case if the area is declared a nonbuilding zone due to natural hazards. Due to the legal order, in the first place, no grounds for zoning exist on the basis of a legal ordinance. Furthermore, according to Art. 15 RPG, building zones only cover land suitable for development. Pieces of land that are threatened by natural hazards – depending on the type of threat – are allowed to be developed in either a very restricted manner or not at all. If a parcel is not at all suitable for construction, no damage results for the landowner from it not being zoned. Moreover, failure to zone can be explained by police arguments. Police restrictions are to be accepted without compensation. They do not fulfil the facts of a material expropriation case (see BGE, 122 II 20). The same applies for exclusionary zoning. In this case too, there are no claims for compensation. Exclusionary zoning due to a natural hazard occurs because it is later determined that the land is unsuitable for development. There can be two reasons for this: either the reason had not been recognized during zoning or the danger did not exist at the time. In such cases the landowner or possessor has no claim that his land should remain in a building zone if land use planning causes a revision. Here too the issue is not only one of spatial planning but also one involving police powers.

8.2 State liability in case of faulty zone identification in hazardous areas

The state's law on liability is governed differently from one canton to another. However, the premise

for liability is usually that illegal damage be present. This can occur from an action or neglect, but it only becomes illegal if there is a duty to act. A government agency acts improperly if it fails to recognize zone identification on a hazard map or does not allow a hazard map to be drawn up, though it has certain indications or knowledge of potential natural hazards in this area. On one hand, the agency is obligated to clarify the legal facts of the case raised. On the other, it is forced by the general clause on police aspects to intervene if life and limb could be endangered. Therefore, this sort of neglect in a zoning decision can lead to liability.

The situation looks different if an agency draws the wrong conclusion from the hazard map. If findings from the hazard assessment are considered during a zoning action but the conclusions are later shown to have been ill-advised, the community does not become liable. Liability only exists if the assessment made by the officials is not comprehensible in light of the facts. Thus a crucial error must be present if liability is awarded. Therefore, it is always better when considering the liability aspect if all facts are weighed to the best of one's knowledge and belief and to make a decision instead of denying the problem.

8.3 Implementation outside the building zone: legal status of expert opinions on hazards

The basic assumptions for liability are referred to in discussion on this issue (8.2). No hazard maps usually exist for areas outside building zones. Here building permit officials must seek further clarifications before their decision in a specific case, if they have indications that an area might be threatened by natural hazards. In the process permit applicants can either commission an expert opinion themselves or demand that building permit officials seek one. Regardless of the expert opinion's origin, building-permit officials must examine it and consider it based on their best knowledge and belief. They may

conclude that the opinion is misguided, though this seldom occurs. As a rule, building-permit officials can rely on an expert opinion. In this case, they do not become liable. This is only possible if the agency completely ignores the expert opinion or it obviously misinterprets it. This would be the case if officials made a decision based on the opinion's comments, yet it could not be implemented objectively on a factual basis.

8.4 Legal meaning of hazard maps if they are not implemented in spatial planning

In connection with issuing a decree – e.g., granting a building permit – officials are obligated to consider hazard map results in assessing the facts. This also applies if these results have not yet become part of structure and land use planning. If an agency fails to do this, it commits a mistake in that legally pertinent facts have not been properly established. But the findings from the hazard map should be considered even if the agency is not immediately occupied in issuing a decree (see Lüthi, 2004, page 40).

Appendix: Lists

Glossary

Most of the definitions – some slightly changed – are taken from the «*Wörterbuch Hochwasserschutz*» (Dictionary of Flood Protection) by Roberto Loat and Elmar Meier (2003).

<i>Damage</i>	Negative effect of an event or a process.
<i>Event calendar</i>	Systematic, structured, and interpretable list of past natural events.
<i>Flood-proofing</i>	Protection of a structure or facility through structural measures next to or near it.
<i>Hazard</i>	Potentially damaging event or phenomenon that may harm people or cause damage to the environment or to property.
<i>Hazard index map</i>	Map produced according to scientific criteria that indicate hazards without providing in-depth assessment.
<i>Hazard map</i>	Map, produced according to scientific criteria, which indicates hazards with information on their type, degree, and spatial extent.
<i>Hazard potential</i>	Sum of all potential dangers in an area.
<i>Intensity</i>	Physical dimension of a natural event.
<i>Land use plan</i>	Spatial planning tool that regulates the use of land with regard to purpose, location, and extent, and that is binding on every landowner.
<i>Land use planning</i>	Process of preparing the land use plan until it takes effect.
<i>Planning zone</i>	The planning zone (Art. 27 RPG) refers to an area in which land use plans are enacted or must be changed. The planning zone is enacted by an agency and takes immediate legal effect upon enactment. Nothing may be undertaken in an area designated as a planning zone that would prejudice (future) land use planning.
<i>Protection goal</i>	Degree of (existing) safety.
<i>Safety</i>	Condition where the residual risk is considered to be acceptable.
<i>Structure plan</i>	Plan binding on the administrative bodies that describes objectives and general measures for future land use and that specifies the activities necessary for that purpose.
<i>Structure planning</i>	Process of preparing the structure plan until it takes effect.
<i>Susceptability to damage</i>	Extent of the possible damage in a given hazard area.
<i>Threat</i>	Imminent hazard concerning a specific situation or threatening a particular object or community.

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