

AVALANCHE HAZARD ZONING AND SETTLEMENT DEVELOPMENT IN AUSTRIA

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ABSTRACT: Hazard zoning has a tradition of over 50 years in Austria and is an essential part of natural hazard management. Both the criteria for zoning and the zones themselves have changed over this time. The criteria have been adapted and changed following significant events, e.g. after the avalanche disaster in Galtür in 1999. The zone definitions are also dynamic. They can be expanded due to climate change and extreme events. On the other hand, they are withdrawn once technical protection measures have been completed. This approach has different effects on settlement development and risk potential. Climatic changes and rising land-use requirements also increase the need for action in planning. Special solutions such as temporary access restrictions may also be necessary.

The fact is that avalanche hazard areas are increasingly overlapping with settlement areas. Integral natural hazard management in which stakeholders from different disciplines work together is essential for future risk reduction.

This contribution will discuss the different effects and challenges in the context of avalanche hazards and settlement development in the Alpine region. Practical examples will be used to illustrate the (future) challenges as well as legal issues.

KEYWORDS: Spatial planning, hazard zoning, settlement development, risk reduction

1. NATURE PROVIDES THE DANGER AND HUMANS THE RISK!

Extraordinary natural events have been recorded since time immemorial. In recent years in particular, there has been a steady increase in the number of natural catastrophes worldwide. At the same time, the economic losses per catastrophe have increased enormously. (EM-DAT 2018) At first sight, this seems paradoxical, as knowledge of natural hazards (forecasts, effects, etc.) is constantly increasing, technical capabilities are improving, and more and more money is being invested in the protection of human habitats. This is due to increasing population density, land consumption, mechanization, the increasing value of material assets and the increasing vulnerability of systems. (Renn et al. 2006) The problem of avalanches in the Alps is not new either. Every year an increasing number of avalanches occur in winter. Most of them cause no damage and are therefore of little concern to the population. In recent years, however, the type and size of avalanches have changed. In connection with the current development of settlements, where building zones are expanding into the slopes, there are more and more interfaces between danger zones and settlement areas. This is due to the limited

space in the valleys. Building on slopes also creates new locational advantages for the tourism industry.

2. SITUATION IN AUSTRIA

About two thirds of Austria's territory, about half of its municipalities and about half of its population are located or live in the Alps. Due to the topography, however, only 25% of the Austrian Alpine region is suitable for permanent settlement, whereby the Alpine region according to this definition does not cover the entire national territory. (Dittrich all. 2022) Of the total area of Austria, which is just under 84,000 km², the permanent settlement area is about 39%. In the western federal states, this value is significantly lower. (Statistik Austria 2019)

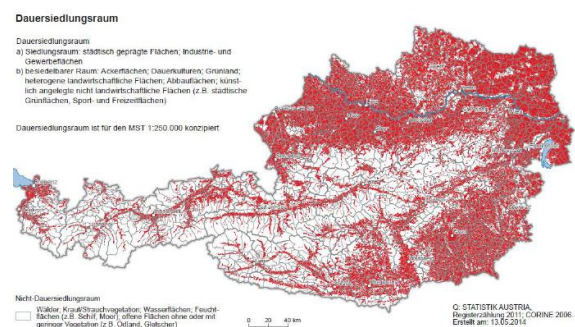


Figure 1: Permanent settlement area Austria shown in red (Statistik Austria 2019)

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In addition to the limited permanent settlement area, the Alpine region faces other challenges. At the bottom of the Alpine valleys, rivers bring the risk of flooding, and the catchment areas of torrents and avalanches extend along the slopes. There are therefore few alternative areas in exposed communities. Various measures are taken to reduce the risk of natural hazards and to provide settlement areas. Technical applications are most often used to protect against natural hazards. In alpine areas in particular, massive concrete structures are part of the landscape. Without such stabilization measures, settlement and tourism in some regions would come to a standstill.

2.1 *The federal state of Tyrol*

In contrast to the eastern Federal States of Austria, the land reserves in the Alpine regions are very limited due to the topography and the resulting high relief energy of the mountains. The permanent settlement area in Tyrol is only 12% of the total area. The few areas that would be suitable for settlement are often overlapped with hazard zones. There are about 2.700 avalanche areas in the province of Tyrol. However, many areas are affected by more than one natural hazard, which is described as a "multi-hazard problem".

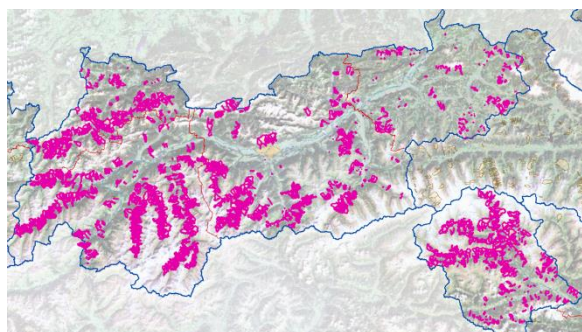


Figure 2: Avalanche catchment areas in the federal state of Tyrol (WLKWEB 2023)

At the same time, Tyrol is facing increasing settlement pressure. Tyrol is characterised by dynamic development and is experiencing continuous population growth. The number of buildings has more than doubled in the last 50 years and the number of people has increased by around 40% (state government of Tyrol 2018). It is not only the growing residential population in the Inn Valley, but also the increased desire for residential use and tourism in the side valleys that has led to an increase in the potential for damage. Particularly in the Tyrolean valleys that are highly frequented by tourists (e.g. the municipality of Ischgl), the number of people staying there multiplies enormously at peak times of the season.

This also increases the personal risk and exposure to damage.

3. PREVENTION BY PLANNING

The aim of prevention is to avoid the damaging event or at least to minimise its negative effects. In addition to structural, forestry and organisational precautions, protection against natural hazards also includes spatial planning measures. However, planning is not only concerned with the cartographic representation of hazard, but also with the avoidance or at least the long-term reduction of risks through planning measures. Due to its forward-looking character, spatial planning therefore plays an important role in hazard prevention. (Hemis 2012) *"Essentially, it is about nature's claim to space versus humans' claim to space"* (Hemis 2012: 44). Restrictions or bans on use in spatial planning can be used to keep vulnerable areas and areas in need of protection free and to achieve the associated risk reduction. (Hattenberger 2006; Rudolf-Miklau 2009)

4. THE HAZARD ZONE PLAN

The current hazard zone plan has existed in Austria since the mid-1970s. The decisive factor for the development of such a planning instrument were the floods and subsequent debris flows in 1965/66, which severely affected Carinthia and East Tyrol in particular. (Holub 2006). The enormous damage to the settlements and the economy caused by the successive events was to be reduced or, at best, avoided by the development of this instrument. Even if the reason for the creation of the hazard zone plan was the flood event at that time, the plans today represent several natural events in red and yellow zones.

4.1 *Lessons learnt from the avalanche winter of 1999*

The avalanche winter of 1998/99 is considered to be decisive for the planning of danger zones because of the devastating damage it caused. Numerous fatal avalanches occurred throughout the Alps during this winter. (Patek 2009) In January 1999, a north-westerly weather pattern dominated the weather in the Alps until 26 February. This resulted in three precipitation periods with large amounts of fresh snow. The interpolated snow amounts result in an annuality of about 300 for the Galtür area. The calculated values are therefore significantly higher than the 150-year design event for which the hard zone plan is calculated. The winter of 1999 was the snowiest winter of the 20th century in many regions of western Austria. (Patek 2009) In addition to the persistent snowfall, consistently low temperatures and north-westerly winds led to an unstable snow

cover, which was further exacerbated by a rise in temperature. (Edliner et al. 2003) Due to the peak season, high numbers of tourists were present at this time. Two avalanches (the *Weißer-Riefe avalanche* and the *Äussere Wasserleiter avalanche*) reached areas considered to be free of danger, including the village of Winkel, where settlement development had started in the 1970s. This area was especially hard hit. The avalanches killed 31 people in Galtür, injured another 22, completely destroyed six buildings and damaged many others.



Figure 3: Pictures of the destruction in Galtür (Tirol ORF 2024)

On the day after the avalanche in Galtür, a tragedy also took place in the hamlet of Valzur in the municipality of Ischgl. The slab avalanche destroyed Untervalzur. Several residential and farm buildings were destroyed or damaged by the masses of snow. The evacuation of Untervalzur was already in progress when the avalanche hit. Seven people died and three were seriously injured. (Patek 2009; Schindelegger 2019) After the event, the municipality, with the consent of the owners, decided to relocate them. To this purpose, the municipality selected a replacement site that was available for development in accordance with the Valzur settlement concept. The designated building land was converted into a mixed agricultural area to allow the previous agricultural use to continue at the new plot. The remaining areas in the red zone were rezoned from building land to green land in the zoning plan. The resettlement in Valzur was financed by the Austrian Disaster Relief Fund. (Schindelegger 2019) The 1999 winter event had long-term effects and led not only to new protection measures in Valzur and Galtür, but also to nationwide adjustments. The limit criteria for the red zone were adjusted from 25kN/m² to 10kN/m², resulting in the expansion of existing red zones and the creation of new ones. With the extension of the red zones, the associated building ban was also extended. This led to fierce criticism from the population, who feared that the value of land and property would fall as a result. (Schopf 2019; Patek 2009) It was also argued that the new adaptation regulations were

exaggerated, as there had not been such severe avalanche events in recent decades. To increase public acceptance, options were offered to abolish the red zones under certain conditions. In return, protection structures were adapted to cope with higher snow loads and ensure safety. In addition, a new regulation was introduced for the regular maintenance of protective structures.

4.2 Case Study

In 2019, Gschnitz, a municipality in Tyrol (Innsbruck Land district), has around 450 inhabitants on an area of around 5,900 km². The number of inhabitants has remained almost constant over the last forty years. The permanent settlement area in the municipality is 4.7%, of which 0.1%, or 4.21 ha, is designated as building land. (Statsik Austria 2019) On the valley ground of the municipality there are hardly any areas without hazard zones. Southwest of the Nennesbach is the hamlet of Stauden-Ost, which is situated in an avalanche hazard zone. Part of the settlement was built before 1970, i.e. before the implementation of spatial planning. In recent years there has been a tendency for people to move away from the municipality, especially young people. As a result, there is a risk that there will not be enough residents to maintain the infrastructure, especially kindergartens and primary schools. To address this, the city council wanted to designate new land for housing. As there is hardly any land in the municipality that does not overlap with the hazard zones and is also available, it was decided to expand the settlement in the hamlet of Stauden. The avalanche protection dam was extended and, as the entire new settlement is located in the yellow hazard zone, conditions were imposed to ensure that the construction was adapted to natural hazards. The new settlement (purely residential) is designed for a total of 29 building plots. On the one hand, an avalanche barrier has been built here to protect the existing buildings, but also with the intention of designating new building plots for the protection of these buildings.

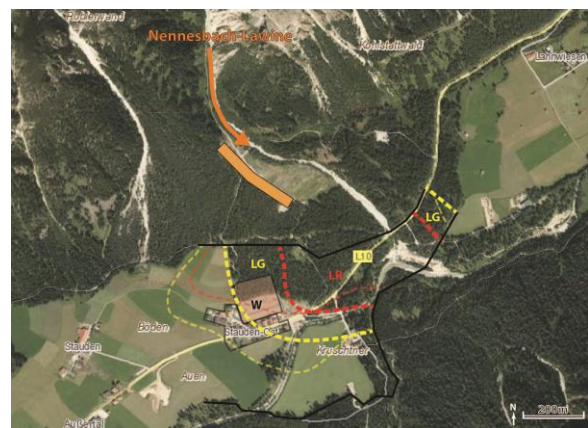


Figure 4: Case study Gschnitz (own illustration)

5. RISK VERSUS SPATIAL PLANNING OBJECTIVES

In terms of spatial planning objectives, there are also reasons for building in hazard areas. A compact settlement structure is an essential public interest, especially where permanent settlement space is scarce. From a spatial planning perspective, in addition to the risk of damage, the following objectives need to be considered:

- Economical use of land
 - Compact settlements and inward development
 - Economic infrastructure (development, supply and disposal, public transport links, etc.)
 - short distances
- (Kanonier and Schindelegger 2018)

Due to the lack of alternatives, in some cases it makes sense from a planning point of view to deliberately increase the density within the effective range of protective structures. In the knowledge that this will increase the risk. The following diagram illustrates the trade-offs. If the aim is not to increase the risk of damage, then the hazard should be avoided. However, this is not always possible in some regions of Austria. A compact settlement structure in the protected area can on the one hand avoid the disadvantages of urban sprawl, and on the other hand, fewer protective structures are needed because a smaller area has to be protected. This also has economic benefits. Therefore, when considering expansion areas, gaps between buildings in the protected area should be favored from a spatial planning perspective.

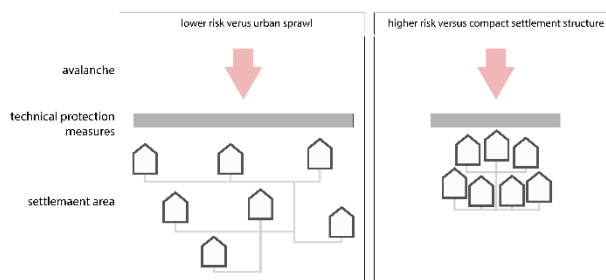


Figure 5: Risk versus spatial planning objectives (own illustration)

6. CURRENT CHALLENGES

Spatial planning in Austria faces the challenge of protecting the population from natural hazards while at the same time meeting the demand for settlement areas. The hazard zone plan is a key instrument for identifying and minimising risks. It is therefore important that the designation of building land is based on the defined hazard zones. The examples from Tyrol illustrate the

need for a careful balance between safety and efficient land use.

In addition to the hazard zone plan, land use planning also plays an important role. The risks are always weighed up, and densification can also take place in hazard zones if this appears sensible from the point of view of spatial planning and natural hazards. The designation of special areas and textual information on construction methods in the sense of risk-oriented spatial planning should also be applied more frequently. These enable the efficient use of settlement areas, which is of great importance in view of the limited permanent settlement area and urban sprawl. A shift from hazard-oriented to risk-oriented spatial planning is therefore desirable. In addition to minimising risk, this will also help to reduce the economic costs of damage caused by natural hazards in the long term. In order to ensure a standardised approach to planning, the concepts of residual risk and risk need to be defined at a national level and then incorporated into spatial planning legislation. Increased awareness and education of decision-makers and the public about the possibilities and benefits of preventive measures could also lead to greater acceptance and implementation.

Continuous adaptation of hazard zone plans to new scientific knowledge and changing environmental conditions is essential for the future. Climate change brings new challenges that require flexible and forward-looking spatial planning. The integration of expert knowledge should be further developed to enable informed planning decisions. All in all, protection against natural hazards requires close cooperation between municipalities, specialist authorities and the population in order to develop risk-minimising and sustainable solutions.

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