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The genesis and implementation of the new criteria for border setting in avalanche hazard zones planning in Austria

A Master Thesis submitted as partial fulfillment
of the requirements for the degrees
"Diplomingenieur" and
"Master of Natural Resources Management and Ecological Engineering"

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Master's programme: Natural Resources Management and Ecological Engineering
Matr.Nr.: 0740508

Vienna, November 2013

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Abstract German

Gefahrenzonenpläne werden von dem Forsttechnischen Dienst für Wildbach- und Lawinenverbauug (‚WLV') erstellt und von Gemeinden verwendet um verbindliche Raumordnungsmaßnahmen zu erstellen (Flächenwidmungspläne, Verbauungspläne). Die WLV zeigt mit Hilfe von roten und gelben Zonen die Gefahr planerisch dar; in der roten Zone wird angenommen, dass Gebäude dem Lawinendruck nicht standhalten. Deshalb ist die Zone nicht für Besiedelung geeignet. Bis zu der Grenze von gelb zu rot sind neue Baumaßnahmen möglich. Diese Grenzlegungskriterien waren vor 1994 von den WLV-Sektionen individuell und nicht formell bei 2,5 t/m² (Druck einer 150-jährigen Lawine) festgelegt. 1994 führte das Ministerium für Land- und Forstwirtschaft strengere, bundesweit einheitliche Kriterien ein: 1,0 t/m², als 'vorläufige Leitlinie'. Dies führte zu Widerstand aus der Sektion Vorarlberg: Es sei unmöglich noch strengere Grenzlegungskriterien einzuführen, da der Siedlungsdruck schon sehr hoch wäre. Schlussendlich wurden die neuen Kriterien bundesweit zurückgezogen. 1999 schaffte das Unglück von Galtür ein öffentliches Bewusstsein für die Notwendigkeit des Katastrophenschutzes, das es dem Ministerium ermöglichte, die bundesweite Richtlinie von 1994 bindend zu erlassen.

Diese Arbeit untersucht den Implementierungsprozess der neuen Grenzlegungskriterien, welche Gemeinden, Privatpersonen sowie die WLV betreffen. Erkenntnisse über Prozesse und Verhalten der Akteure wurden durch die Studie von gefahrenzonen- und raumordnungsplanungsrelevanten Gesetzen und Dokumenten gewonnen, zwei Gemeinden in unterschiedlichen Bundesländern bzw. Sektionen der WLV dienen als Fallstudien. Diese Arbeit stellt überdies den Widerstand und Argumente Betroffener gegenüber der Richtlinie von 1994 dar, sowie die Gründe für die Widerrufung und die neuerliche Auflage der Richtlinie von 1999.

Eine Auswirkung der neuen Grenzlegungskriterien von 1994/99 war die Vergrößerung der roten Zonen, die daraufhin zusätzliche Gebäude enthielten. Zur Reduktion des Risikos dieser Gebäude wird üblicherweise eine Lawinenverbauung durchgeführt. Nach deren Bau und einer Revision des Gefahrenzonenplans können rote und gelbe Zonen wieder zurück verschoben werden. Die Wirkungen der neuen Grenzlegungskriterien sowie der Lawinenverbauungen heben sich daher tendenziell auf.

Tirol verzichtet auf die Besiedelung gefährdeterer Bereiche, während Vorarlberg diese Entwicklung erlaubt. Diese zwei Strategien der Raumordnung im Umgang mit Naturgefahren können als Paradigma des begrenzten Wachstums in Tirol und Paradigma des umfangreichen Wachstums in Vorarlberg bezeichnet werden.

Abstract English

Austria's Avalanche and Torrent Control Service (Wildbach- und Lawinenverbauung, 'WLV') creates hazard zones plans. Hazard zones are used by municipalities, which undertake spatial planning measures to decrease the risk caused by avalanches (by site planning, prohibition of building measures). The WLV incorporates the degree of risk in the red and yellow zones. In a red zone, houses are expected not to withstand the pressure of an avalanche and new settlement is not safe according to a planning event of 150 years. In the last decades the border setting value between the red and yellow zone (up to which settlement is possible) was defined informally and individually by each provincial unit of the WLV at mostly 2.5 ton/m^2 of pressure caused by an avalanche. In 1994, a regulation introduced a nation-wide and stricter, more careful border setting of 1 t/m^2 on a tentative basis. Within the provincial unit of Vorarlberg resistance arose, based on the fact that settlement pressure had already been too high and stricter border setting therefore would not be possible. In consequence, the regulation of 1994 was withdrawn.

In 1999, the disaster of Galtür with human casualties happened, causing public awareness of the necessity for risk reduction. This enabled the ministry in charge (Ministry of Life) to irrevocably re-enact the regulation of 1994.

This thesis scrutinizes the genesis of the new criteria for border setting in avalanches hazard zones planning and the implementation of the corresponding regulation by the ministry. Interviews with relevant actors (WLV, spatial planning, municipalities) and the selection of two case studies (municipalities) were chosen as methodology.

The new regulation has resulted in a spatial increase of every red zone and also includes buildings and building projects not any more considered safe into the red zone. Normally, the WLV increases safety of these new areas by construction of avalanche barriers. After construction of barriers and following new assessment of the hazard zoning, the red zone can often be scaled down to the former level, before the new border setting value was implemented. If no new settlements occur in endangered area, the overall safety is increased.

The reason for the resistance in Vorarlberg can be explained by two paradigms of spatial planning that are incorporated and followed by the WLV. Whereas Tyrolean spatial planning law restricts development into more risky areas (paradigm of restricted development), Vorarlberg's spatial planning law does allow it, given that protective measures are possible (resulting in the paradigm of extensive land use). Therefore, the new border setting has harsher effects on Vorarlberg as there is smaller or no 'buffer' area for this stricter border setting situation.

IV

Remarks

The author's master's programme, Natural Resources Management and Ecological Engineering, is a collaboration between Lincoln University in New Zealand and BOKU in Austria.
Therefore, the language of this thesis is English.

Chapter 7 is a glossary which aims to clarify expressions used.

For any questions, contact is possible via http://winfriedhoke.at
(e.g. for a high-quality pdf of this thesis, or an epub version).

Acknowledgements

I would like to offer my special thanks to the members of the Torrent and Avalanche Control (WLV), the members of the municipalities and the provincial government who helped me to realise this thesis.
You were very helpful and cooperative!

I am particularly grateful for the supervision given by Gerhard Weiss, Karl Hogl and Roy Montgomery! Gerhard Weiss spent a lot of time to provide helpful comments and to assist me.

I really like to thank Alex and Martin, my dear colleagues who supported me, just by being in touch. It's good to have you, both for bureaucratic madness, just having fun, or anything in between (e.g. a one way trip to Oslo or meeting accidentally in London).

Of course, the creation of this thesis would have been so much harder without the motivation given by family and friends. Thank you, guys! Thank you, dad, for proof-reading and sending me comments. Thank you, mum, for hours and hours and hours of help, thank you for everything...

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1. Introduction and research questions

The Republic of Austria is a country within the European Union, landlocked by eight other countries and with a total area of approx. 84.000 sq km. The Alps, a massive mountain range, is situated in seven countries of Europe: Austria, Slovenia, Switzerland, Liechtenstein, Germany, France, Italy and Monaco. Most of Austria's area is covered by the Alps; 32 percent have an elevation of less than 500 m. (CIA, 2012 and Compare Infobase, 2012) In the Tyrol, for example, there is just 12 percent of the whole area suitable to be settled, as two thirds of the area consists of alpine landscape. This circumstance allows a high tourist activity in Austria. The combination of limited settlement in alpine regions and the hazard of avalanches lead to the necessity of scrutiny for threats by torrents and avalanches.

1.1. Problem situation

The first publication concerning catastrophes by natural hazards in the alpine area was written in 1779 at the University of Innsbruck, containing a systematic overview over possible construction measures. Extreme flood water events in 1882 led to the implementation of unified measures for torrent control, bound to the newly founded "Forsttechnischer Dienst für Wildbachverbauung" (torrent control by forest-relevant institutions) in 1884. Evaluations and investigation of hazards were increased, by merging and unifying organisations and services dealing with natural hazards. Before 1975 no specific law establishing avalanche control existed. The Forest Act of 1975 brought the torrent and avalanche organisation to life (**WLV** - 'Forsttechnischer Dienst für Wildbach- und Lawinenverbauung') (ZAR, 2006) because of floods in 1965 and 1966. The WLV started to create maps and plans (hazard zones) for a better monitoring of immanent threats by torrents or avalanches in affected municipalities. (Lebensministerium, S.A.)

The winter season of 1998/1999 was disastrous in terms of damages by avalanches. The example of the municipality of Galtür/Tyrol demonstrates the importance of laying scrutiny on the potential effects of the hazard avalanches: The disasters of 23 and 24 Feb-

ruary 1999 caused 31 human casualties in Galtür and 7 in Ischgl. (Drössler, 2002) The economic loss in Galtür did amount to an estimated sum of 10 to 60 million Euro from 1950 to 2000 due to following limited land use and restricted building measures. (Fuchs & Keiler, 2008) The consequence of this tragic winter season were changes concerning the hazard zones plans.

Chapter 3 will show relevant laws and regulations, as well as their continuous changes.

A decreasing trend in number of natural events as avalanches and torrents can be observed. (Interv. Fuchs, 2012) However, risk and damages are increasing, mainly because of intensified development into more risk-prone areas. (Kanonier, 2006:124) Alpine municipalities and regions have developed from an agricultural background towards "a service industry- and leisure-oriented society" (Holub & Fuchs, 2009:527) and increased socio-economic development, including more settlement, industry and recreation.

Hence, the number of elements at risk (i.e. buildings) is increasing, thus leading to increased potential loss. (Fuchs & Keiler, 2008) This is strongly influenced by the number of people present in hazard prone areas (i.e. citizens and tourists), which strongly determines the development of further infrastructural assets.

In winter sport regions the number of people at risk may be enormous during day and night. (Keiler et al., 2005) In terms of statistics, a tourist overnight stay is defined as a one night spent at a given place by an Austrian or non-Austrian person. Since 1990, the overall stays have increased from 130.000 visits to 240.000 in Austria per year. High-frequented winter sports places have a constant or increasing visitor numbers. (Statistik Austria, 2012:448)

Winter sport tourists are to be found both within the buildings of the municipality and on e.g. the skiing slopes. This thesis deals with the danger within settlement area. Other dangers and accidents are put aside, e.g. the accident of the Dutch prince in Lech in 2012. (Spiegel, 2012)

Due to these facts and the expectable further trends, a risk management in areas prone to avalanches is necessary and a holistic view should therefore be achieved.

1.2. Research questions and hypotheses

Principal issue:

» How did the genesis of the new criteria for border setting in avalanche hazard zones planning of Austria occur and how are they being implemented?

Secondary issues:

» Which factors influence the implementation and which are the roles of main actors involved?

» How has it been possible to enforce stricter regulation?

Laws governing and regulating the ways in which the hazard avalanche is being dealt with do exist in Austria. The respective ministry issues binding regulations (administrative orders) and is the head of the organisation dealing with the assessment of the risks of the hazards ('Torrent and Avalanche Control Service'; 'Forsttechnischer Dienst für Wildbach- und Lawinenverbauung', abbreviated: **WLV**.) Three regulations were issued in the years 1998 to 2001. This thesis determines the effects of those changed regulations within the municipalities, foremost the regulation changing the border setting criteria for hazard zones planning will be taken under scrutiny. Entities concerned with hazard zones planning and land use and also other relevant stakeholders of the municipalities (e.g. economic interests) will be identified and analysed. In other words: what are the effects of the changed regulations within the process of creating a new hazard zones plan and what is the role and behaviour of the actors? Further on, two other aspects will be analysed: what specific role does the Torrent and Avalanche Control Service (WLV) have within this process? Citizens and municipalities formed resistance against the regulation of the border setting: How was it possible to overcome these problems and implement the border setting regulations?

Along with the research questions, **hypotheses** were formulated. They are supposed to help framing the research questions and aims of the thesis.

An interview with WLV staff (IN0.5) led to the hypothesis that planners of the hazard zones plan (**HZP**) were aware of the upcoming new regulation and were already taking precautionary measures to reduce its effects on a smoother transition towards the new regulation. They anticipated the stricter border setting and took it as basis for the design of the HZP on the basis of the current regulation, which was less strict. (As a hypothetical avalanche exerts different levels of pressure on the ground, the border setting criteria determine until which value of kg per m^2 settlement is possible and buildings can withstand the pressure. The change from 2.5 to 1 ton/m^2 represents taking back settlement.)

This led to the first hypothesis: **Zoning was (at least partly) conducted more carefully than required so that the zones remained at the same location: the 1 t-border being the same as the 'overcautious' 2.5 t-border.** This will be discussed on page 81 in chapter 5.3.2.

The new 1 t/m^2 regulation of border setting for hazard zones enlarges the red hazard zone. To increase safety for the objects where zoning has changed, avalanche barrier constructions are striven for and realised. After finished barrier construction works and a new HZP including them, the zoning is readjusted; it is assumed that the zoning before the regulation and after the construction works are comparable. It is also aimed to answer if it is possible for the hazard zones to shrink after the implementation of the regulation. This led to the second hypothesis: **The stricter guideline and consequently the avalanche barrier construction counterbalance each other.** This will be discussed on page 84 in chapter 5.4.

Data sources of planning are on the one hand avalanche simulations and on the other hand the 'historic method' (silent witnesses, interviews with locals, history of the avalanche and the municipality). As simulations provide a concrete line of the hazard zone borders and are therefore not easily alterable, the hypothesis is that the historic method will be able to deliver a more flexible outcome for a more careful zoning. This led to the third hypothesis: **Silent witnesses, questioning of locals, study of records etc. is more frequently used than calculations, probabilities and simulations.** This will be discussed on page 81 in chapter 5.3.2.

1.3. Theoretical approach

In this chapter, a short literature review and state of the art from a scientific point of view is provided, focusing on risk management and social behaviour and the potential of actors involved (political, structural and social properties). This overview allows the understanding of social and environmental processes in the following chapters.

The classical definition of risk by natural hazards involves the dangerous processes in terms of the potential damage as well as how to cope with the risk and the elements exposed (people and human settlements in the range of natural processes).

> » Risk is a "measure for the hazard"; it combines the actual natural process with the extent of possible damage, including values at risk and vulnerability of the anthroposphere and probability of occurrence. "Risk (R) is defined as the function of the probability of occurrence (p) of a specific process and the height of the related damage potential (S). R = f(p,S)" (Keiler, 2004)

Hence, social systems must be understood to be able to grasp risk-related processes. A full protection from disasters and undesirable effects is not possible, as the overall costs

would mostly be too high. (Gamper, 2008:233) Therefore, a certain level of risk has to be accepted and managed.

1.3.1. Risk management

» "Human beings, not nature, are the cause of disaster losses that stem from choices about where and how human development will proceed. Nor is there a final solution to natural hazards, since technology cannot make the world safe from forces of nature." (Mileti, 1999a:5)

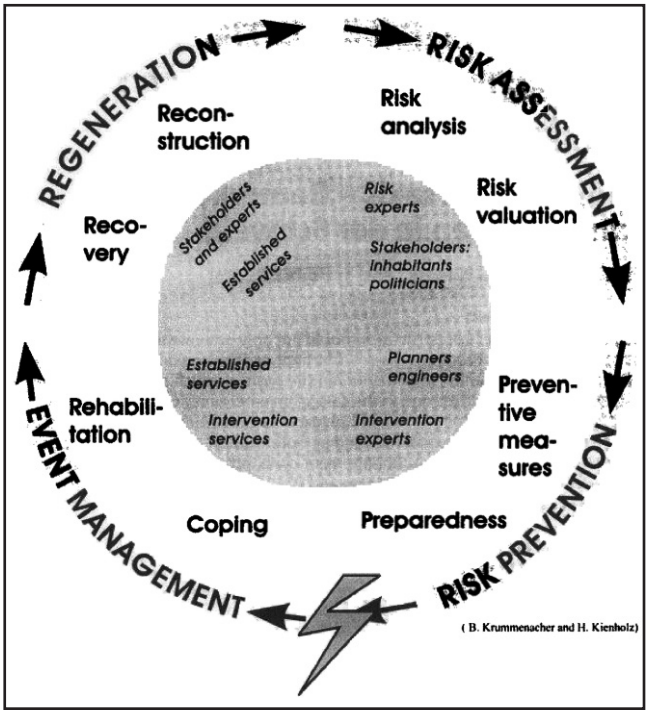

Illustration 1: Risk Management Cycle (Kienholz et al., 2004)

Hence, natural processes and human behaviour are in interaction, resulting in the creation of risk, which has to be managed to be reduced.

To describe the proceedings of risks and disasters, literature often cites Kienholz (et al. 2004) and their concept of **integral risk management** and its **risk management cycle**, consisting of four phases, see illustration 1. Its goal is to answer: 'What security at what price?' To deal with the missing certainty of risk, Kienholz suggests a '**risk culture**' which helps to accept risk as part of normal life and as something that is manageable.

1. Risk assessment: **Risk analysis** considers the qualitative and quantitative assets at risk as well as natural processes' physical understanding (hazard analysis), "What could happen?" **Risk valuation** scrutinises opinions of politics and society: "what loss is acceptable; what could be permitted to happen?" (ibid:44)
2. The **risk prevention** phase utilises the knowledge of the first phase to prepare for the actual event through prevention and preparedness. To allow **risk preparedness**, focus has to be laid on the concrete potential danger instead of the hazard, e.g. preparation of resources, training of staff, establishment of early warning systems and mobilising staff for requests of the media in case of an event.
3. The event management or **disaster management** deals with the real disaster (= event). Warning, coping and rehabilitation are the keywords of this phase. Consequences should be limited depending on the intensity and duration of the event. The transition from this **coping** phase towards the **rehabilitation** phase is mostly overlapping;

life-supporting structures are erected provisionally, following costs of those should also be taken into account. It is important to care for documentation, e.g. rocks may be cleaned away quickly from the roads; those silent witnesses may be lost forever.

4. The phase of regeneration differs from the last one by long-term instead of temporary solutions. The **revision** of risk and hazard assessment, but also of mitigation and prevention concepts is intended; e.g. hazard zones, direct protection measures and event management. Also, new implementation of concepts, measures and actions, as well as other investments "may involve changes in regulations (laws, regulations, professional rules, etc.)" (IBID:49), but together with education of people and staff, improved prevention and preparedness follows.

If those four phases are exerted optimally, the municipality can achieve higher levels of overall safety with every turn of the cycle, resulting in the so-called **risk management spiral**: constant improvements in risk assessment, risk management and of risk culture. (KIENHOLZ ET AL., 2004)

Within these four phases, stakeholders should "accept responsibility for hazards and disasters". (MILETI, 1999A:5) This situation is improved if the beneficiaries and the money sources are the same persons. Currently, in Austria, the municipality and not the affected persons contribute to the funding.

1.3.2. Actors involved and their relationship

Gamper (2008:238F) gives an overview of actors involved in the hazard zones planning, consisting of politicians, experts, the commission who confirms the HZPs, voters and finally interest groups.

1. **Politicians** seek to stay in power and be popular, also through media coverage. They "might seek some ex ante control on the one hand, and on the other some form of increasing the representation of preferences of their voters in the final decision". (IBID:238)

   The **mayor** has a special role, he/she has much power but also responsibilities within the municipality, as he/she is the person responsible for the safety of every citizen. The mayor has power to increase security, i.e. by deciding on site-plans or the initiation of an avalanche barrier construction process etc. On the other hand, he/she is legally responsible as is shown below. Although the mayor is rarely accused and sued for failure, responsibilities make him/her take adequate, pre-emptive counter-measures. (INO.2)

- The mayor is **criminally** liable ('strafrechtlich') for the legal cause of involuntary homicide ('Fahrlässige Tötung'), e.g. if someone dies in a disaster due to imprecise zoning or if the avalanche commission did not work efficiently.
- He/she is liable under **administrative law** ('verwaltungsrechtlich'), if he/she has impinged against building laws.
- He/she is liable under **civil law** ('zivilrechtlich'), if e.g. a house outside the hazard zone is damaged and should therefore be unaffected by the event.

2. **Experts** are mentioned as 'agents' as they are to implement the preferences of the principals/politicians. They are also called 'bureaucrats' because they deal with the issue concerned on an institutional level. Experts of the WLV firstly create the hazard zones plans and secondly develop and install protection measures. This first duty may be problematic, as it experts may find themselves in unpopular situations, seen from the locals' point of view; thus they may also strive for public acceptance, which is easier in the second task (protection measures, i.e. avalanche barrier constructions, are advantageous for locals).
3. The **WLV-commission** consists "of one ministerial delegate, the regional planner as well as the regional head of section and one representative of the municipality for which the plan has been designed (usually this is the mayor)", (IBID:239) sometimes also others (e.g. a geologist in Vorarlberg). In many cases, the mayor is the person opposing the decision as he/she has other criteria (re-election etc.) than the others. For this reason some experts criticise the involvement of local governmental representatives. The experts and planners respectively have the possibility to include local people's attitudes and preferences in the hazard zones plans. They and the mayor respectively may strive to include public opinion to avert negative consequences.
4. Usually around 40% of the avalanche prevention measures is funded by the taxpayers or **citizens** of the municipality under scrutiny (the rest is funded by public funds of state level), therefore the taxpayers (and beneficiaries of the measures) should have the possibility to have a say. For four weeks, the hazard zones plan (HZP) is on public view in the municipality and everyone with a justifiable interest in the case can make statements that have to be considered in the process by the commission. In practice, only affected people and parties make use of this instrument to avoid negative personal consequences and "negative impacts on their utility from hazard zones maps (e.g. devaluation of their properties), hence they might plea for extending hazardous zones expecting future protection measures being installed (thus re-gaining economic values) or otherwise state against the extension of such zones." (IBID:239)
5. **Interest groups** may for example be "the tourism industry (e.g. hotel owners, lift operators etc.), environmentalists, the construction industry or farmers. As a group, they might come together to enhance their lobbying power and thus their rent-seeking

benefits." (IBID:239) Their involvement leads to the question how they take part in the process, and also if the planner and expert respectively is able to withstand the pressure of interest towards a neutral and an unbiased final result of planning.

Gamper (2008:234) explains the function of the relationship between **principals and agents**: A principal (e.g. politicians) assigns a task (e.g. of environmental kind) to an agent (e.g. bureaucrats or agencies). The principal delegates and supervises, whereas the agent has the know-how of scientific background and the social factors involved. Following this, the principal could be the ministry; the agent could be the WLV and its provincial and district units. As the principal (politicians) determines the distribution of funds and thus priorities, this so-called principal-agent-problem states that

» "[t]he work of [the agents] is economically argued to be a source of inefficiencies resulting in organisational slack and oversupply of the respective public good." (IBID:234)

To work towards a more efficient and applied process, Gamper argues that funds should be limited. Moreover, information should be symmetric, well distributed between principles and agents, this helps to increase efficiencies. As low-costs projects do not result in wide public feedback, not much effort is put into these, so Gamper. On the other side, high-cost projects generate far higher motivation to work thoroughly to evade negative consequences for the agents by facing the danger of being rejected or not accepted. This shows that public participation may be a relevant means of meliorating the projects' outcome. It is also suggested to add a public ex-ante control "to focus on reducing asymmetric information". (GAMPER, 2008:236)

Citizens and stakeholders should

» "determine the amount and kind of damage that those who experience disasters can bear. These plans would enable policy makers, businesses, and residents to understand the limitations of their region and work together to address them. Full consensus may never be reached, but the process is a key element because it can generate ideas and foster the sense of 'community' required to mitigate hazards." (MILETI, 1999A:11)

Applying this for hazard zones planning, this could mean that affected citizens should (at least partly) be responsible for their behaviour regarding risk management. In Austria, the WLV's duty is to determine the policy of risk management (according to the law), but integration of public opinion could possibly increase the efficiency of risk management.

1.3.3. Paradoxes of social behaviour

> » "Research has shown people are typically unaware of all the risks and choices they face. They plan only for the immediate future, overestimate their ability to cope when disaster strikes, and rely heavily on emergency relief when disasters occur." (Mileti, 1999a:4)

Dealing with risk is often understood as a linear process: "Study the problem, implement one solution, and move on to the next problem", but these problems as well as the recovery after the event cannot be solved in isolation and with a high degree of short-sightedness. (Mileti, 1999a:2+10) In other terms, applied for this study, hazard zones planning cannot be completely "solved" by the construction of avalanche barriers.

Specialities in the context of natural hazards and social behaviour will be discussed in this chapter.

Burby (2006) discovered two paradoxes about developmental and governmental practices in hazard management within the USA. They demonstrate the necessity of a good system of risk management. Between 1978 and 2000, nearly every year occurred a flooding of relevance for settlements in New Orleans, USA. During this time, 1/5 of federal development funds was used to protect existing assets and municipalities, 4/5 was used for development of new area and to create new 'productive land' and settlements by levees. By means of residual risk covered by low-cost loans, tax deductions for uninsured losses, subsidised flood insurance incentives were set for further development into these new areas.

Hurricane Katrina in 2005 was followed by massive floodings. "Ironically, [...] the entire area of urban growth the city had been promoting and the Corps protecting for forty years was entirely under water." (ibid:176) The 2005 disaster proved that the supposedly safe development was in fact unsafe, due to limitations of protection work (levees being overtopped, design flaws) or errors within mapping.

The protection work is useless if its reduction of damage is less than the new risk created by further settlement someplace else. This demonstrates the **Safe Development Paradox**. "The paradox is that in trying to make the most hazardous parts of New Orleans safe for urban expansion, it had the unintended effect of contributing directly to the devastation of Hurricane Katrina." (ibid:176)

Only less than 15 percent of property owners took private measures to improve the resilience of their houses. Budget constraints or the missing readiness to invest may be crucial factors. Also, little information and communication about risks and hazards was provided. (Burby, 2006)

In essence, the Safe Development Paradox proves that development by state and private entities into less safe areas is common.

Unrelated to the 2005 disaster, Mileti (1999a:3) argues that not only natural events are responsible for disasters but mostly human decisions and choices of settlement. Similar observations are reported about natural hazards management policy in Austria. (Weiss, 1998) A 'spiral of risk' (literal translation of the German 'Risikospirale') is often caused by risk management measures: the reduction of risks results in the creation of new uncertainties, again leading to new measures for coping with the risk.

> "Es kann sich eine 'Risikospirale' öffnen, bei welcher bei der Verringerung bestimmter Risiken neue Formen von Unsicherheiten entstehen, die ihrerseits weitere (riskante) Bewältigungsstrategien provozieren." (Weiss 1998:43)

An illustrating example in terms of avalanche hazard zoning is the following: a hazard zones plan depicts the zoning of threats. Ensuing, avalanche barrier constructions are being built. Then, the hazard zones plan is changed according to the measures taken, later new buildings are constructed as the area appears safe. This can result in worse destructions of lives and buildings due to unusual or unexpected avalanche events, imperfect barrier constructions or avalanches with a higher impact than the standard event for which the construction was designed for. Theoretically, the risk is hereby increased by adapting the hazard zones plan; first by the new buildings closer to the hazard and secondly by the residual risk (risk in case of failure of the barrier construction). As a result, new damages occur and new barrier constructions are demanded and realised as a reaction. The spiral of risk is continued when the still remaining risks are ignored and the hazard zones plan is adapted again.

Local Government Paradox: People at risk are often neither covered by sufficient insurance policy nor "covered by federal disaster relief", according to Mileti. (1999a:66) As they are voters it could be assumed that the avoidance of losses (e.g. through stringent building law) counts as high priority for local officials, but this is often not the case. (Burby, 2006:178) The reason for this could be that risk management is seen less important than unemployment figures, housing problems etc. Also, costs of risk measures are immediate whereas their benefits stay uncertain. (Mileti, 1999b:160 cited in Burby, 2006:180) Another point in need of improvement is the lack of participation of the citizens involved. (May, 1991 cited in Burby, 2006:180)

> "The local government paradox is that while their citizens bear the brunt of human suffering and financial loss in disasters, local officials pay insufficient attention to policies to limit vulnerability." (ibid:171)

> "By strengthening incentives for states and localities to do what they should already be doing on their own initiative — paying systematic attention through existing local planning mechanisms to finding ways to reduce hazards vulnerability — they promise to halt and possibly reverse the trend in increasingly serious natural catastrophes." (Burby, 2006:187)

The awareness of the necessity for avalanche barrier constructions should be high for their beneficiaries, the citizens of the municipalities whose security has highly increased. The funding for the construction, however, is public, by the state as well as the municipality, but not directly by the citizens. Hence, they have decreased influence and understanding of measures undertaken. To reduce lack of information about natural processes, their consequences and inter-relationships, Rappold suggests to introduce participatory tools that help to create a sense of responsibility. Citizens affected by natural processes should be able to understand which measures are necessary; they should be in a position to participate in the planning procedure. For hazard zones planning, the large part of the creation process is not done by the citizens of the municipality, but by the WLV. Nevertheless, official authorities would have the potential to implement more participatory elements in their administration, to be more conceptive for sensitive issues and adapt to priorities of public interests. (Rappold, 2001:3-11)

Clientelism: Organisations, which deliver services to the public, are in consequence close to their clients. For the WLV, these are the municipalities and affected citizens.

» 'The modus operandi of administrative bodies is oriented by its clients; '**compatible**' and easily enforceable solution strategies are developed. This bargaining procedure is supposed to increase the implementation, but implies the danger that the WLV is captured by the interest of powerful clients.'

» „Die Normierungslogik der Verwaltung orientiert sich an der Klientel: es werden „verträgliche", d.h. leicht durchsetzbare Lösungsstrategien entwickelt. Die Aushandlung der Lösungsmaßnahmen (bargaining) soll die Durchsetzungschancen erhöhen, doch birgt diese Vorgangsweise die Gefahr mit sich, daß die Verwaltung von einer mächtigen Klientel vereinnahmt wird." (Weiss, 1998:46)

Within the WLV, the provincial units have considerable autonomous power in terms of decision-making and working closely together with the municipalities. In consequence, the possibility of a biased behaviour of WLV officials is given and informal interest may be dominating. On the example of Austria, this is shown to be relevant in hazard zones planning and measures against natural hazards such as avalanches.

2. Methodology

The procedures concerning hazard zones planning are based in different laws which are described in this chapter. Also, theoretical knowledge of policy processes and analysis is illustrated. This thesis gains its new insights by study of literature and documents as well as from case studies and interviews.

2.1. Methodical approach

This chapter describes the theoretical background of data collection (scientific literature) and also reveals important aspects relevant for the methods applied (expert interviews and qualitative data analysis). The following paragraphs will explain the background of the approach and the strategy for expert interviews.

Empirical-social studies aim to assess social conditions, human affairs and behaviour but also their creations (objects etc.). This ideally happens within a systematic context, respecting preconditions, with planning, replicability and a theoretical backup. Atteslander (2010) supplied a scientific background for this topic. This paper focuses on qualitative investigation. In this social and dialectical study of society it is not possible to measure or observe, contrary to quantitative studies or empirical-analytical research.
Social research may be biased towards the agenda of the interviewing party; e.g. in commercial contexts, where the results of the survey brings use to the interviewer just in one way of the outcome (e.g. positive attitude to a product). Also an incomplete survey, e.g. through an incomplete questionnaire, leads to inaccurate results. This has to be kept in mind during data collection and interpretation.

The following exemplary procedure of data collection is followed in this thesis.

1. The problem under scrutiny has to be identified and defined; hypotheses have to be formed. The scope and aim of this study is discussed in introducing chapters, resulting in the formulation of hypotheses (chapter 1.2.).

2. What is the research issue? What has to be found out? What are the proceedings? The scope of this thesis results in the need for case studies and study of documents. The aim is to analyse the implementation of the new regulation in municipalities, the roles of actors and various consequences. Chapter 2.3. discusses how case studies and other sources are used to obtain this information.
3. In the execution phase, a method is chosen: basically, for scientific research, this should be objective and aiming for the truth. The findings of the backgrounds, motivations and relationships between the actors, stakeholders and decision makers is being aimed for, free of biasing pressures etc., in a truthful manner (chapter 3).
4. Analysis and evaluation of the retrieved data and information. In chapter 4. and 5., the results of the interviews are inspected, compared and put into perspective. This is done by argumentation and combination of different sources.
5. Application, deployment and the use of the acquired knowledge and information. The aim of the study is to scrutinise the implementation of laws and regulations. It is not the aim of the study to suggest proposals for modification.

The comprehensibility and replicability are of high importance to allow control (e.g. by peer-review). So concepts and instruments are documented. Atteslander (2008:77) suggests to document all kinds of happenings and objects which normally are attached to little importance. This allows a more complete analysis. The researcher's use of instruments and the interpretation of results should be logical and replicable but also representative. In this thesis, representative results are not feasible, but the maximum of roles of actors and details of implementation, within a logical and replicable scope is presented.

According to the interpretative paradigm by Wilson (Atteslander, 2008:77), objects and assets are perceived individually by actors and therefore have different attributes defining their value and purpose. The roles of those objects do not obey stringent rules, they act flexibly. With help of interpretation of the social situations, it can be possible to derive the actual value from the value perceived by the actors.
A too high complexity of research questions hinders open-mindedness during data collection and therefore has to give way to an open approach.

The interviews for this thesis are based on an interview guideline (see appendix), its questions are accorded with the research questions; the interview is partially structured, so basically enabling a free conversation, where just short questions, keywords and topics motivate the interviewee to talk freely. Potential bias of the interviewee, as well as indicated problems, coherences, relationships and linguistic attributes are brought into focus.

In interviews, certain limitations of what can be asked and discussed may be given. Sieber and Stanley (1988:49, cited in Dickson-Swift et al., 2008:1) provide a definition of 'socially sensitive' research:

> » "studies in which there are potential consequences or implications, either directly for the participants in the research or for the class of individuals represented by the research"

Sensitive interviews or research is accompanied by the danger of infiltration of someone's private sphere or personal environment or experience, enacting or manipulating social control, or "impinge [...] on the vested interests of powerful persons or the exercise of coercion or domination". (Lee & Renzetti, 1993:6 cited by Dickson-Swift et al., 2008:2f) Atteslander (2008:77) agrees that it is possible that the interviewee is not willing to expose all information that would be useful for a study.

The WLV (torrent and avalanche organisation, 'Forsttechnischer Dienst für Wildbach- und Lawinenverbauung') is an organisation dealing with manifold actors and interest of different political, economic and media-related power. It is not possible to directly ask sensitive questions, as they may not be official business of the WLV. In order not to "scare" the interviewees by inconvenient questions and risk a limitation in the ensuing conversation, it is firstly made clear that this study is merely for academic reasons and not for other purposes (e.g. report for the ministry) and secondly, interview questions are asked in a relatively open way which allows free and spontaneous answers about what is personally important. If statements regarding mentioned powers are made, the questions is asked again and later compared to other sources.

This paper's methodology aims for interviews with approximately ten persons of different institutions. Dickson-Swift (et al., 2008:8ff) shows that one-off interviews (just one interview, not repeated) are prone to convey less information from interviewees to interviewer than repeated interviews would do, due to familiarity and trust. Even if this method was not possible in the scope of this thesis, the nine interviews are essential. Hence, the one-off interviews were conducted carefully. The comparison between data of several interviewees is used to create a more complete impression.

2.2. Case studies

In order to develop a reasonable and adequate scope and coverage of this thesis, documents (laws, regulations, literature) as well as explorative interviews were conducted. To research in depth case studies also led to the exploration and analysis of documents (HZPs, regulations, etc.) and expert interviews.

The aim of this study is to illustrate the implementation of the changed regulations regarding the creation of the hazard zones plans. HZPs are always created within the boundaries of a municipality. Its citizens and other stakeholders (e.g. mayor) have influence on the development of the HZPs, but the WLV is the acting agency (including WLV's hierarchic levels: provincial units and district units). Municipalities having changed their HZP according to the new regulations are of relevance for this study to be able to compare their state before and after the change of regulations.

Due to limited resources, **no complete analysis** of all municipalities with hazard zones plans in Austria can be provided. As a result of limitations in time and of travel expenses, the scope was minimised to **two case studies**. In each of them, interviews demonstrate the processes and roles of actors. Two provincial units of the WLV ('Sektionen') were chosen with one municipality each (so two case studies = two municipalities). This allows to understand similarities between municipalities but also to perceive possible differences between various units of the WLV.

The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (the 'ministry') is the institution in control of the WLV. Its original German name is 'Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft' or short 'Lebensministerium'. The ministry issues regulations, which are passed on to the WLV. For an exploratory interview, WLV staff is ideal to reveal general information about the WLV and its subdivisions. The WLV has seven subordinated provincial units (PU, 'Sektionen'), two of which will be chosen for case studies where avalanches are an important source of natural hazards. The selection of provincial units was made on the basis of an interview and was backed up by document analysis. The research within the two provincial units (case studies) was also based on document analysis as well as on interviews with the WLV and spatial planning authorities. All interviews were led as semi-structured, qualitative expert interviews.

The first mostly exploratory interview with experts of the WLV revealed among other background information, which two provincial units are best suited for case studies illustrating the highest potential of effects of the changed hazard zones border setting. Most avalanches are to be found in Salzburg, Vorarlberg and the Tyrol. Salzburg was named to have more space for settlement and less pressure for settlement due to their topographical circumstances and the related increased activity of the WLV with avalanches and HZPs, the Tyrol and Vorarlberg were named to be 'experts' concerning avalanches and the handling of them because they are dealing with the combination of scarce settling space and alpine dangers for many years and therefore have a vast experience and many possible

case studies. Also, avalanches directly threaten 91% of the Tyrol and Vorarlberg's municipalities, which is the highest percentage of Austria. (Lebensministerium, 2011b)

Therefore, the Tyrol and Vorarlberg are chosen as the two provincial units for the case studies.

For the purpose of finding and selecting municipalities as case studies, contact to provincial units (PUs, 'Sektion') of the WLV was sought. Each PU is superior to the district units (DUs, 'Gebietsbauleitung') and has a supervising role in the proceedings of these district units and therefore an understanding of the current situation.

Interviews with heads (or their deputies) of the PUs led to municipalities which, according to the interviewees, show a multitude of factors that are typical for the processes of the implementation of the new regulation. These municipalities are therefore chosen as case studies.

- For the Tyrol, the municipality of **Telfs** was recommended by WLV-staff of the PU for the Tyrol because it shows the clearest and most concrete consequences compared with all other municipalities in the PU (one single significantly enlarged red and yellow zone). The area affected by the changed zoning is large, many buildings of different kinds are affected through zoning. Also, the single ample avalanche barrier construction shows the consequences of simulation and construction building.
- For Vorarlberg, the municipality of **Lech** was recommended by two experts of the PU Vorarlberg because, firstly, it is at high elevation which is connected with high touristic activity for winter sports and leads to a more diverse range of stakeholders (fewer citizens, more tourist related activity), secondly, because the high amount of relevant avalanches (50+) already forced the municipality to exert risk management and the construction of avalanche barriers in the past.

These two case studies are used in the next chapters to illustrate consequences of the changed border setting criteria and inter-relationships between politics and actors, natural processes and different interests.

These two municipalities are within the competence of a DU each, and interview partners of the DU were interviewed. As a completing measure, interview partners within the municipality were sought: this could be the mayor or a delegate, responsible municipality staff for hazard zones plans, or also for spatial planning or natural hazards.

As the two provinces under scrutiny have different spatial planning laws, contact with staff of the provincial spatial planning agencies was sought as well.

2.3. Data collection methods

2.3.1. Interviews

The most important methodology to obtain data are expert interviews. The selection of interviewees was discussed in chapter 2.2. (e.g. stakeholders of the WLV or other officials). Two kinds of interviews were conducted.

- Interviews to gain general information about structures, interrelations, dependencies between the actors and institutions of relevance, as well as historical and overview background, e.g. of the HZP-development of the last years. Exploratory interviews are necessary to obtain a good overview. (Atteslander, 2010)
- More specific interviews consisting of precise questions about the procedures, processes, problems and opportunities, dealing with the specific context of the implementation of changed hazard zones regulations for avalanches and the hazard zones plan within the case studies.

Both kinds of interviews are led on a semi-structured basis and with qualitative expert results. The interview guideline is based on the research questions of chapter 1.2. and aims to answer hypotheses of chapter 1.2. Its questions are designed to gain insight into following issues: processes within the WLV and its divisions; properties, effects and importance of regulations; their effects on municipalities and the hazard zones; roles and motivations of actors involved. Generic interview guidelines were designed and adapted to the specific interviewee/expert. The interview guideline can be found in the appendix on page 106.

Experts are members of organisations involved in political processes and potential conflicts. To ensure that interviewed experts are not made vulnerable because of their statements in this thesis, they are anonymised (randomised Interview-numbers, in the text as INo.1-9). Statements cannot be linked to the identity of these experts.

2.3.2. Document analyses

The collection and analyses of documents, such as legal texts (law and regulations), land and area use plans and hazard zones plans and maps drawn at different points of time (specially before and after the implementation of the new regulations) are crucial. As well, the relationship between hazard zones planners, the WLV and citizens is taken into scrutiny for a better understanding. One of the most important types of document analysis is in this thesis to search for differences in HZPs before and after the implementation of the regulation, e.g. the numbers and types of buildings and constructions in hazard zones.

The results of this study (chapter 4) are subdivided into the consequences of the new regulation on a larger scale and the case studies.

- To understand the background and the process of the regulations, the regulations and laws are the primary source of information, but letters and instructions within the WLV and the ministry, correspondences from and to the WLV by mayors or provincial government also are of essential importance.
- To understand the case studies hazard zones plans, reports of WLV, experts or lawyers, statements of citizens affected by the hazard zones plan, letters and media articles were analysed.

The documents were supplied by the WLV itself; legislative and regulative texts were accessible online or offered by the WLV. The ministry's website is a rich source of relevant information.

3. Hazard zones planning in Austria

Human behaviour, e.g. increased settlement and intensified building measures have increased the risks in alpine regions, in addition to consequences of climate change. Spatial planning on all levels (European Union, state, provinces and municipalities) may enhance an appropriate use of land and reduce risks through a legal framework. (Kanonier, 2006:124) Land use plans are a good instrument to attenuate natural hazards, they work best if they are based on single nationwide laws based on 'Nationwide Hazard and Risk Assessment' and are responding to the national geographic situation. (Mileti, 1999a:8) A multitude of laws and regulations exist in Austria: from the continental level of the European Union (EU), from the Republic of Austria, its provinces and the municipalities themselves. They are determining certain aspects for spatial planning, but Austria's tangible spatial planning law concerning hazard zones planning etc. is enacted by each provincial government only. Some of these laws are not relevant for this study and are therefore not covered (i.e. EU-laws).

This chapter first aims to outline the legal situation given and then provides information on instruments and regulations concerning spatial planning and natural hazards planning.

3.1. Present legal situation

This chapter 3.1. illustrates the legal situation in Austria, firstly with regard to **spatial planning**, secondly to aspects **dealing with natural hazards**.

In Austria, laws can be issued on state level or by provincial governments. This chapter is limited to those legal texts. Regulations and other administrative decrees will be discussed in chapter 3.2.

Spatial planning is a matter of the provinces. Therefore, there are no spatial planning laws on state level, but there exist programmes for certain aspects of nation-wide spatial planning; the Austrian spatial development concept ('Österreichisches Raumentwicklungs-

konzept', ÖREK) determines a common idea of essential ideas and aims, but is not bound to the law. Nation-wide, governmental programs such as main traffic, train route planning or energy structures (not spatial planning programmes) are enabled by multiple federal sectoral programs. These have to be respected within the provincial spatial planning. The ForstG (Forest Act) is another example of state programmes that primarily focuses on forestry issues, and prescribes among others the creation of hazard zones plans. Those are not binding for authorities but are to be used as expert reports for spatial planning. Therefore, the ForstG indirectly influences spatial planning.

Nation-wide as well as provincial agencies and programs are setting limitations, opportunities or have other influence on municipal programs (i.e. development program, area zoning programs, building site plans, etc.). (Kärntner Landesreg., 2012) This shows that the diverse Austrian situation with federal as well as provincial laws and municipal activities is leading to complex situation due to a high number of laws, regulations etc.

3.1.1. Spatial planning laws

All power, which is not given to the state by constitution, stays with the nine provinces ('Bundesländer', federal states). (B-VG Art 15, Abs 1, as amended in 1929; Weber, 2006) In Austria, **spatial planning laws are provincial matter**.

State laws with respect to special programmes (forestry, rail works etc.) however entail regulations or instruments within this matter (e.g. forestry) and therefore influence spatial planning of the nine provinces. For example: the hazard zones plan, initiated by a state agency (WLV: the torrent and avalanche organisation) under the jurisdiction of forestry assesses the risk of avalanches and thus has effects on the spatial planning on provincial level.

Each provincial government is responsible for its spatial planning law. The case studies of this thesis are located in two different provinces (the Tyrol and Vorarlberg), their legal situation is described in chapters 3.1.1.1. and 3.1.1.2.

Austrian municipalities execute laws, regulations and programs by the provincial spatial planning laws and also have to obey state laws concerning natural hazards. Therefore, they have to create various concepts and plans. (See chapter 3.2.)

The aims of the nine different provincial laws are identical with the main understanding of regional planning: to make the 'best possible use and (enable) safeguard of living space and environment' with headline goals defining the optimum state of the area and it structures, creating equal treatment of all citizens and equip them with same rights and opportunities. Following examples illustrate overall aims. (Weber, 2006:25ff)

- Preservation and development of immanent sources for life
- Protection from natural hazards and pollution by passive measures (e.g. not building/ using areas near landslides, rockfalls, debris flows, floods, avalanches, earthquakes or e.g. building schools near emitting zones)
- Provision of dwellings, work places, infrastructure
- Sustainment of agriculture and forestry
- Sustainment of industry and businesses
- Sustainment of recreational areas and competitiveness of tourism, e.g. its spatial accessibility

Therefore, it is aimed for to follow principles, e.g.

- Economise land and property reasonably, don't 'waste land', organise urban sprawl
- Efficient use of natural resources, energy and taking into account natural assets and their protection
- The public interest should always weigh more than interests of individuals

Planning authorities have various influencing factors and priorities, nevertheless, should they aim for a neutral and balanced planning. The aims above are giving a general direction and idea of the intentions of the law and 'more clear pre-requisition for denial of site-planning within site-planning'. (Weber, 2006:129) Literature shows that the general aims of these laws are interpreted differently while dealing with hazard-prone areas, potentially leading to a bias of priorities and therefore to other problems.

» 'The practical application of the goals of spatial planning allows a wide interpretation, especially when deciding on site-plans in hazardous areas.'

» "Die praktische Anwendung der Raumordnungsziele zeigt vor allem bei Widmungsentscheidungen in Gefährdungsbereichen eine erhebliche Auslegungsbreite" (Kanonier, 2006:129)

According to Weber (2006:61), a differentiation between spatial planning on a larger than municipality level ('überörtlich') and municipality-level (planning by and for within the municipality; 'örtlich') is made. It is referred to which administrative level is conducting the planning measures. The implementation and concrete measures are taken by municipalities, but spatial planning authorities above municipal level can create plans and maps that have to be included in the municipalities' planning processes.

The state law (i.e. ForstG) enables the creation of hazard zones plans. In provincial laws, the hazard zones plans are used for spatial planning procedures that deal with risk attenuation for municipalities. Apart from that, provincial authorities do not supply specific and detailed plans and programmes concerning natural hazards. (Kanonier, 2006:133)

As many different laws and regulations restrict development in endangered zones, officials have to set limitations and restrictions for the use of land and building objects. As official decision makers are not perfectly impartial, conflicts between officials of administrative and regulating bodies tend to be unavoidable. Notwithstanding, informal and consensus-based solutions are a possibility to provide cooperation of involved authorities and actors. (Rappold, 2001:1 and Kanonier, 2006:125)

» 'The long-term and hardened right to use plots and space are facing hazard zones which are variable in time and intensity.'

» "[L]angfristig rechtsverbindlich und generelle Nutzungsrechte treffen auf unbeständige und bezüglich Intensität und Häufigkeit veränderliche Gefahrenbereiche" (Kanonier, 2006:132)

In chapter 3.2.2.2. will be shown that the border setting criteria were changed in 1994 and 1999 due to a changed approach and understanding of risk.

3.1.1.1. The Tyrol

The Tyrol is a province highly prone to risk from different natural hazards, including avalanches. The catastrophe of Galtür in 1999 caused 38 human casualties. Also other avalanches before were the cause for harm, e.g. a tourist was killed in a phone booth in the disaster of Ischgl by an avalanche in 1984. It was estimated that in the last 600 years, 150 people were killed just within the Paznaun-valley in the Tyrol. (Mausshardt, 1999)

Disasters had consequences for the Tyrolean Spatial Planning Act ('Tiroler Raumordnungs-Gesetz' or 'TROG') (see chapter 4), as well as for other hazard zones planning regulations (e.g. nation-wide border setting). The incident of 1984 indirectly lead to, or at least contributed to following new regulation in the provincial law (LGBL-TI, 2011, §37 Abs.2): New development (settlement) that is only suitable if buildings are in the appropriate condition and configuration - is only allowed if the **new development areas**, firstly, are within or adjacent to an existing settlement zone and secondly, the **settlement area is not expanded towards an area with an essentially higher level of hazard**.

» "Grundflächen, deren Eignung als Bauland wegen einer Gefährdung durch Lawinen [...] nur unter [...] bestimmten Anordnung oder baulichen Beschaffenheit von Gebäuden [...] gegeben ist, dürfen nur dann als Bauland gewidmet werden, wenn diese innerhalb eines bebauten Bereiches oder unmittelbar im Anschluss daran gelegen sind [und] das Bauland dadurch nicht in Bereiche mit erheblich höheren Gefährdungspotentialen erweitert wird."

As space is scarce, human behaviour tends to use all existing area for development, especially in touristic regions. Hence, the aim of this amendment of the TROG steers to pilot development and settlement in a safer direction, no additional buildings and elements should be put at risk.

The word 'essential' ("wesentlich") in the law allows the possible variability in interpretation of the law. Also, the Tyrolean law makes new development possible in areas adjacent to existing settlement, this is different to other provincial laws where a more strict limitation is exerted, barely the filling of gaps is allowed ('Lückenschluss' in Vorarlberg). (These restrictions and allowings are referring to developments within the yellow hazards zone, see chapter 3.1.2.1.)

From 1999 on (TROG, 2011) it was settled by the law that dangers had to be assessed and represented with help of existing hazard zones plans (HZPs), as far as possible.

» "Die Gefahrensituation ist so weit wie möglich auf Grund bestehender Gefahrenzonenpläne zu erheben." (TROG, §28, Abs. 2)

Differing to all other provincial laws, the Tyrolean law is directly referring to the red hazard zones (zone not safe for settlement) and prohibits building measures there. Analogous to other provincial spatial planning laws, the yellow zone (zone safe for settlement under restrictions) can be used for constructions if safety measures are possible, according to each law. Another noteworthy feature of the law determines that site-planning can be limited in time if this is increasing the overall safety of the vicinity. (Kanonier, 2006:132+146)

The law also states that the municipal spatial development concept ('Örtliches Raumordnungskonzept'), site-planning and building site plan have to be created by each municipality (LGBL-TI, 2000, §108 Abs.1 & §29 Abs.3). The municipal spatial development concept has to be submitted to the provincial government of the Tyrol, which has to confirm it, as it is the inspecting authority. Both the creating party and the confirming party have to follow regulations and laws concerning natural hazards; e.g. site-plannings are including the restrictions of HZPs.

3.1.1.2. Vorarlberg

The provincial government of Vorarlberg issued a spatial planning law in 2006. (LGBL-V, 2012, §18) In its introductory chapter 'Aims of spatial planning', it is stated that open spaces ('Freiräume') necessary for protection from hazards should be kept free and that no settlement into the area outside of settlements should occur for the purpose of the public interest for protection from avalanches.

» "Die zum Schutz vor Naturgefahren notwendigen Freiräume sollen erhalten bleiben." (ibid:§2, Abs.3 d)

» "Die äußeren Siedlungsränder sollen nicht weiter ausgedehnt werden." (ibid:§2, Abs.3 g)

In case of danger from the natural environment, e.g. avalanches, site-planning for building measures is not possible. If measures averting the natural threats exist or can be constructed within technical and economical reason, building measures are possible.

All provincial spatial planning laws prohibit settlement in red hazard zones, but they differ in the understanding of the yellow hazard zone. (For red and yellow zoning, see chapter 3.1.2.1.) The Vorarlberg spatial planning law allows building (i.e. construction of buildings, hotels, etc.) if protective measures are possible. Other provincial spatial planning laws have a more cautious understanding of the yellow zone and do not allow it.

» "Als Bauflächen dürfen nicht gewidmet werden Flächen, die sich wegen der natürlichen Verhältnisse ([...zB.] Lawinen [...]) für eine zweckmäßige Bebauung nicht eignen, es sei denn, dass Maßnahmen zur Abwendung solcher Gefahren technisch möglich und wirtschaftlich vertretbar sind". (VLBG RPG, 2006, §13, ABS.2)

The law determines proceedings on municipal level. Every municipality has to create a spatial planning concept ('Räumliches Entwicklungskonzept'), indicating position and status of the municipality, development of the area (settlements, traffic systems...) and free spaces for protection against hazards. (IBID:§11)

The site-plan ('Flächenwidmungsplan') is consisting of plots and their planned use (e.g. development (possible building), open space, traffic space, reservation zones, referenced zones). The plan has to be in accordance with other federal concepts. (IBID:§12) Every five years it has to be reassessed, whether the site-planning is still up-to-date; if necessary it has to be renewed. (IBID:§24)

Concerning compensation: If a site (lot, parcel) is set for building but cannot be built on because the site-planning is being changed by the municipality, the owner may request a compensation payment.

» "Die Gemeinde hat dem betroffenen Grundeigentümer auf Antrag eine Entschädigung zu leisten, wenn ein als Baufläche gewidmetes Grundstück oder ein als Sondergebiet gewidmetes Grundstück anders gewidmet wird und dadurch die Bebauung verhindert wird." (IBID:§27, Z.1)

3.1.2. Laws concerning natural hazards

3.1.2.1. Forest Act (ForstG)

In the second half of the 19th century, development in valleys of the Alps was enhanced, resulting in increased sensibility and susceptibility towards alpine hazards. Hence, an authority regulating torrents ('Wildbachverbauung') was founded by law in 1884. (ZAR, 2006) To care for safeguarding of hazards (i.e. torrents and avalanches) and its protective measures, a law was issued in 1884 ("Gesetz vom 30. Juni 1884, betreffend Vorkehrungen zur unschädlichen Ableitung von Gebirgswässern[...]", RGBl., 117/1884). It imposes onto the authority 'Wildbachverbauung' to supervise the correct realisation of avalanche barrier constructions.

This organisation, the WLV, was relaunched as a torrent and avalanche control service by the Forest Act (**ForstG**) of 1975 as 'Forsttechnischer Dienst für Wildbach- und Lawinenverbauung' (WLV, 'Wildbach- und Lawinenverbauung'). (Chapter 3.2.2.1.)

The ForstG states that the WLV shall be an agency of the ministry (Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, 'Lebensministerium') responsible for a diverse range of duties: Organisation and elaboration of hazard zones plans and implementation of related construction measures, monitoring, representation of the public interest, etc. (see below). There are slightly different duties for different agencies (subdivisions PUs and DUs) of the WLV, details can be found in the directive. (BGBl., 507/1979, Verordnung "Aufgabenbereich der Dienststellen")

Austrian law obliges subordinated institutions to assess the possible threats from natural hazards. For alpine hazards, the WLV is set to create hazard zones plans. Austrian law does not oblige to evaluate economic assets at risk. In other words: only physical risks have to be assessed, not the economic/social/monetary risks. (Risk is defined as the sum of the physical consequences of a hazard and the affected assets' susceptibility to risk; only the hazard is regarded. Interv. Fuchs, 2012) This is of importance for the following chapters because financial and social factors have influence in the understanding and interpretation of (physical) hazards. The WLV however does include the assessment of human development and threats to it, e.g. while planning and setting priorities for new avalanche barrier constructions. Also, during the creation of the HZPs, values (houses, social factors) are assessed.

Following the ForstG, the three eastern provinces (federal states) with the least share of the Alps are put together as one **provincial unit** (PU, 'Sektion'), every other province corresponds to one provincial unit; altogether there are seven units for nine provinces, as agencies of and for the WLV (BGBl, 72/1978)

Those seven PUs are subdivided into 27 **district units** (DUs, 'Gebietsbauleitungen', agencies of the WLV for a certain area) responsible for administration on a smaller spatial scale, from two to six per provincial unit (PU). (BGBl, 72/1978) PUs and DUs are called 'Dienststellen' or agencies of the WLV. They are subordinated to the ministry and its departments, which are also subordinated to the minister.

According to the ForstG, the WLV has six categories of duties and responsibilities: Counselling and providing information and reports, hazard zones planning, construction and maintenance of protective barriers and financial management. (Lebensministerium, 2013a, see chapter 3.2.2.1. for details.)

Before the Forest Act of 1975, there was no legal basis for hazard zones planning in Austria. §11 states:

> 'In the hazard zones plan have to be depicted: areas endangered by torrents and avalanches and the degree of danger, which require special regulations, land use or which have to be kept free for later measures of protection.'

> „Im Gefahrenzonenplan sind die wildbach- und lawinengefährdeten Bereiche und deren Gefährdungsgrad sowie jene Bereiche darzustellen, für die eine besondere Art der Bewirtschaftung oder deren Freihaltung für spätere Schutzmaßnahmen erforderlich ist." (ForstG, 1975)

> "Hazard zones planning is an important basis for future spatial planning [...], so that new areas are only released for development projects in less hazardous zones, or alternatively released conditioned upon the instalment of private protection measures." (Gamper, 2008:237)

The Forest Act (§11 ForstG, i.d.g.F) states that it is the duty of the WLV to create hazard zones plans (HZP) for municipalities, where necessary. Areas threatened by torrents or avalanches have to be depicted either by red or yellow zoning according to the degree of hazard. This happens through the concept of pressure applied by an avalanche expected to occur every 150 years (design event of 150 years). Buildings are expected to withstand a certain value of pressure which is measured in kN/m^2 or ton/m^2 (t/m^2). The hazard zones plan primarily depicts the red zone, where the expected pressure is too high for development (more than 25 or 10 t/m^2, resp. before and after the changed regulation, see chapter 3.2.2.2.; and the yellow zone where development is restricted but possible (more than 0.1 t/m^2), see below. Depending of the expected and calculated distribution of pressures within the area, the hazard zones plan is created, also referring to areas requiring special protective measures or cultivation.

The Forest Act (ForstG) also states that the draft of the hazard zones plan has to be given to the mayor of the municipality. He/she has to put it on public display for four weeks, so that legitimately affected and interested citizens can post statements or objections. After evaluation by a commission of the WLV and the confirmation of the ministry, it turns into a valid hazard zones plan. (See chapter 3.1.2.3. for the complete process.)

§102 ForstG (Forest Act, 1975, i.d.g.F) specifies the organisation of the WLV within Austria. Since 1975 there have been 15 changes within the total of the ForstG, but just two of them have some impact on the WLV, but not for hazard zones planning. They are therefore not dealt with in this thesis. (BGBl, 576/1987 and 59/2002)

3.1.2.2. Hazard zones planning regulation

One year after the ForstG (Forest Act, state law), a regulation ('Verordnung', a ministerial decree) was issued, regulating the hazard zones planning ('**GZP-VO**', BGBl. 436/1976).
The primary aim of the HZP is to enable and evaluate projects implementing and enforcing technical and planning measures to protect assets in affected areas. Also, the staff of the WLV is to serve as official expert in this field. In principle, a HZP is to be the basis for land use planning, construction planning and security planning (e.g. evacuation plans etc.). A HZP has to include all relevant criteria concerning the catchment area of a municipality, either on areas with or without forest. Even after a completed HZP, changes of criteria have to be taken into consideration: Altered land use, completed protection measures, immanent threat of malfunction of protection measures, change of findings of natural assets or other factors (e.g. climate change). All of these should be considered while creating the next HZP. (Lebensministerium, 2011b)
The Forest Act and the GZP-VO constitute the legal framework of the WLV and the HZP on state level. The ministry issues regulations directly for the WLV. Both laws and regulations are applicable nation-wide. On the other hand, spatial planning authorities in Austria are on provincial level; provincial parliaments issue laws and regulations. Again, spatial planning measures of municipalities have to comply with them. So, HZP is based on state law but used by provincial spatial planning laws.
For the creation of a HZP, the WLV has to determine the sources of hazards regarding geological, hydro-geological, hydrological, meteorological, climatic, biological, anthropological and cultural conditions. Additionally, it has to monitor and evaluate the statistical occurrence of natural processes and consequences.

The GZP-VO-regulation states that hazard zones plans consist of a cartographic and a textual part. The cartographic part defines different zones:

- Hazard zones (German: Gefahrenzonen) are catchment zones of torrents or avalanches, constituting a hazard to the municipality, based on an event calculated to occur every 150 years (design event). These are either depicted in red or yellow; see below. (Lebensministerium, 2011a)
- Reservation zones ('Vorbehaltsbereiche') depict areas which should be kept clear for subsequent planning measures. In the context of spatial planning (Weber, 2006) these are areas which may belong to private parties but are planned to become areas for public use (e.g. school). As this can be an invasive measure, it is not often applied.
- Reference zones ('Hinweisbereiche') may be affected by hazard zones but are not directly in the catchment area, they may be sensitive to cultivation and management.

The cartographic part of the HZP primarily has to depict hazard zones and blue reservation zones. Several colours depict different zones:

- The **red hazards zones** cover the directly affected areas by torrents or avalanches, restricting the permanent use for settlement or transportation.
- The **yellow hazards zones** cover the remaining affected areas where risk is still given, but danger is limited and constructions must be equipped with additional protective measures to withstand the potential danger of the hazard.
- The blue reservation zones have to remain unused or need special protective cultivation (i.e. biological or technical measures).
- The brown zones present different threats or hazards than related to WLV.
- The violet zones depict need for cultivation to function as a protection.

The textual part describes and discusses the cartographic part and its evaluation. (Further information on cartographic and textual part can be found in BGBl., 436/1976.)

Hazard zones can be red or yellow (see illustration 2: Red zone in the middle and a part of the yellow zone on the left side), and refer to the potentially affected areas by natural process, e.g. area threatened by an avalanche or a torrent. In this thesis, focus is laid only on avalanches. The differentiation between the red and yellow zone can be broken down to differences in pressure that an avalanche can apply to the ground and objects. For the last decades, the amount of pressure 25 kilo-Newton per square

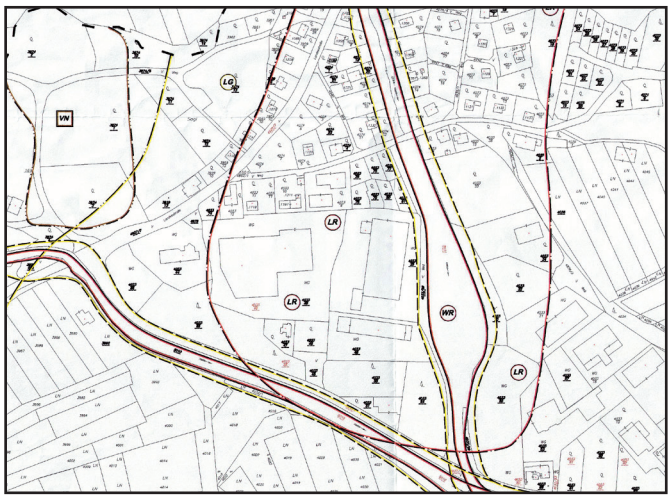

Illustration 2: current hazard zones plan, municipality of Telfs. (Telfs, 2013c)

metre (25 kN/m²), equivalent to 2.5 tons per square metre (2.5 t/m²) was used as a threshold value between the more endangered red zone and the less endangered yellow zone. Thus, constructions in the yellow zone had to withstand between 2.5 t/m² and 0.1 t/m².

» 'The red hazard zone comprises areas which are threatened by avalanches or torrents in a degree that makes permanent settlement impossible. Avalanche barrier constructions enabling permanent housing and withstanding the possible pressure of more than 2.5 t/m² would be disproportionately enormous and expensive. Therefore, most building measures are not possible.'

» Die "Rote Gefahrenzone umfasst jene Flächen, die durch Wildbäche oder Lawinen derart gefährdet sind, dass ihre ständige Benützung für Siedlungs- und Verkehrszwecke wegen der voraussichtlichen Schadenswirkungen des Bemessungsereignisses oder der Häufigkeit der Gefährdung nicht oder nur mit unverhältnismäßig hohem Aufwand möglich ist." (BGBl. Nr. 436/1976., §6a (GZP-VO))

The 2.5 t/m² border setting, which was valid for many years, was changed by two regulations in 1994 and 1999 to 1.0 t/m². This will be discussed in detail in the next chapters.

To give a better understanding of the red zone and dangers of an avalanche: the limiting value between the yellow zone and the red zone is 2.5 or 1 t/m² (resp., before and after the changed regulation). This value represents what amount of pressure an average building is expected to withstand. The maximum pressure exerted by avalanches can be up to 100 t/m². (WSL, 2011)

The yellow zone, representing a less endangered zone, has had a constant border setting value for the side averted to the source of danger: 1 kN/m² (0.1 t/m²) as border to the 'normal' zone with a risk that is not being taken into consideration, it is accepted to be reasonably safe (design event of 150 years, see chapter 4.1.1.). 25 resp. 10 kN/m² (2.5 resp. 1 t/m²) is the border setting at the side facing the red zone and the avalanche. (BMLFUW, 2011)

The wording 'disproportionately enormous and expensive' ("nur mit unverhältnismäßig hohem Aufwand") of the GZP-VO referred to avalanche barrier constructions that would be too costly and are therefore not possible. Vorarlberg's and the Tyrol's spatial planning laws determine the possible site-planning in areas affected by avalanches. The Tyrolean spatial planning law **prohibits** building in areas where hazard zones plans defines settlement not safe. The Vorarlberg spatial planning law **allows** building if protective measures are technologically and economically possible and justifiable.

» „Von der Widmung als Bauland sind insbesondere ausgeschlossen [...] Grundflächen, soweit sie unter Bedachtnahme auf Gefahrenzonenpläne wegen einer Gefährdung durch Lawinen [...] für eine widmungsgemäße Bebauung nicht geeignet sind." (TROG, 2011, §37, Abs.1a)

» „Als Bauflächen dürfen nicht gewidmet werden Flächen, [...] die sich wegen der natürlichen Verhältnisse ([...] Lawinen[...]gefahr [...]) für eine zweckmäßige Bebauung nicht eignen, es sei denn, dass Maßnahmen zur Abwendung solcher Gefahren technisch möglich und wirtschaftlich vertretbar sind." (VLBG RPG, 1996, §13, ABS.2A)

For both provinces, avalanche barrier constructions have to be feasible and provide a change of risk and zoning, but the different wording is illustrating a fundamental difference between Vorarlberg and the Tyrol.

The main issue of this thesis is to discuss the regulations changing the border setting from 2.5 t/m² to 1.0 t/m². The abbreviation **1TBS** ('1 ton border setting') will be used in this thesis.

3.1.2.3. Creation of hazard zones plans

For the creation of hazard zones plans, district units of the WLV assign a planner (e.g. a graduate from BOKU university) who collects data in the field (silent witnesses, archives, history of the avalanche and the surrounding municipality and interviews with experienced citizens). The staff unit 'Snow and Avalanches' (SSL), an agency of the WLV, creates different hazard zones simulations which are combined with other data. The planner writes a report, which is discussed with other DU agents. This version of the report is brought to the GZP-Referee of the provincial unit, who may need further data or proof. This report is then made public within the municipality for a minimum of four weeks. Citizens who can prove that they are affected by the changes of the HZP may file an objection. Finally, the commission convenes, consisting of:

- One deputy of the **ministry**,
- One deputy of the **WLV** (which mostly is the head of the provincial unit or the head of the district unit),
- One deputy of the **province** and
- One deputy of the municipality (this is mostly the **mayor**.)

This commission conducts a technical discussion about the plan in general and especially about possible objections of concerning citizens. The document is verified and finally validified by majority of confirming votes; in case of equal vote, the deputy of the ministry decides. It is possible that each opinion has two members (e.g. an additional expert), but their vote count as one. Finally, the hazard zones plan is confirmed by the vote of the deputy of the ministry. The commissional verification has to be approved by the ministry and this validates the document and it has to be treated like a regulation. (FORSTG, 1975, §11, ABS.6)

3.2. Measures and instruments

3.2.1. Spatial planning instruments

3.2.1.1. Spatial planning instruments on above-municipal and municipal level

Austria's spatial planning is divided in larger than municipality level spatial planning and in municipality-level spatial planning. (See chapter 3.1.1.)

On municipal level, measures and plans are created for within the border of the municipality. The larger than municipality level on provincial level is interacting with the municipality, both by imposing and controlling it. Both Vorarlberg and the Tyrol are required by law to confirm several municipal plans, especially the site-planning ('Flächenwidmungsplan') is relevant for the context of settlement projects and natural hazards. By these means, there exists the possibility for the provincial spatial planning agencies to influence the municipal plans, and to supervise the proceedings of the complete area of the province.

Regional spatial planning programs and plans are issued by the provincial government and address certain aspects of spatial planning (e.g. defining area for free space or locations for shopping centres.) Provincial concepts, e.g. determining areas as ski resorts, use the results of HZP for planning. (INo.1)

A representative of the province has to be in the commission of the WLV, voting for the finished HZP. The province can choose who is to attend, this could be a geologist, but mostly a representative of provincial spatial planning is chosen. (INos.1+2)

It is the task of the federal state to assess a topographic mapping of Austria. The Tyrol initiated own data collections to enable an increased level of safety due to more precise maps. This data can be used for different purposes, e.g. creation of the HZP. (INo.1)

Spatial planning instruments on municipal level

Provincial governments' laws state that different spatial plans and concepts have to be created on municipality level (municipal spatial development concept ('Örtliches Raumordnungskonzept'), site-planning and building site plan). All of these have to be in accordance with other plans on provincial or state level. (See chapter 3.1.1.)

The following chapters describe the different plans and concepts and their relevance for protection against natural hazards. It will be shown that the municipalities have to consider areas under risk. For this purpose, they mostly rely on external data (most commonly the hazard zones plans provided by the WLV) instead of assessing this data on their own. (Kanonier, 2006:131)

3.2.1.2. Spatial development concept

The municipal spatial development concept or concept of municipal development is called 'Örtliches Raumordnungskonzept' in the Tyrol (TROG, 2011, §31) and 'Räumliches Entwicklungskonzept' in Vorarlberg (Vlbg RPG, 1996, §11).

The concept should include the current status, weaknesses and strengths of the municipality, orientation and scope of action, and hence plans of development for approx. 10 years, in terms of e.g. public space, environment, population and settlements. Age, gender and economic status of the citizens should be known to the municipality as well as the movement in terms of migration (push- and pull-factors), commuting and, if existing, tourism activities and movement. The technical infrastructure is crucial for transport of humans and material; road networks, car parks and public transport may be taken into scrutiny on all levels (local and regional). The aims of traffic planning may be to decrease motor use (e.g. more public transport, car sharing), diminish emissions or increasing safety on the road. (TROG, 2011, §31 and Kanonier, 2006:138)

The Tyrolean spatial planning law (TROG, 2011, §31) defines the municipal spatial development concept as way to implement the general aims named by the law, it does not add additional obligations.

In the Vorarlberg law, more precise instructions are given referring to natural hazards. As a basis to both the site-planning ('Flächenwidmungsplan') and the building site plan ('Bebauungsplan'), the municipality has to create a municipal spatial development concept. This concept has to make general statements and determine aims, e.g. open spaces that have to be kept free from building measures to avert risks from natural hazards. (Vlbg RPG, 1996, §11 Abs.1e)

> » "Die Gemeindevertretung soll als Grundlage für die Flächenwidmungs- und die Bebauungsplanung [...] ein räumliches Entwicklungskonzept für die Gemeinde erstellen. Dieses soll insbesondere grundsätzliche Aussagen enthalten über [...] die zu sichernden Freiräume zum Schutz vor Naturgefahren"

The municipal spatial development concept as well as site-planning are relying on the information from hazard zones plans. When a hazard zones plan is changed, the municipality has to adapt its spatial planning concepts and plans to the new state of the art; development and other conditions of the municipality may be altered. Therefore, the spatial planning authority and the WLV (the organisation creating the HZPs) discuss if the status quo of the concept is still up-to-date, has changed or will change and which possible future developments should be intended for the next 10 years. The most important decision is the direction and extent of the development area. This has naturally to be outside of red hazard zones, and just to a limited degree in the yellow zone. (Ino.4)

An external planner is assigned by the municipality to create the municipal spatial development concept. Citizens wishing for a changed site-planning or new settlement directions can include those in a list within the concept, which then is brought to the provincial government ('Landesregierung'), the inspecting agency. Then, the WLV comments if the concept is possible with respect to hazard zones and the planner may make adaptations. Finally, the building authority ('Baubehörde') of the municipality issues the concept. (Ino.4)

3.2.1.3. Site-planning (Flächenwidmungsplan)

Site-planning ('Flächenwidmungsplan') is a plan, created by municipalities and sets a specified planned kind of utilisation to each site (plot). To accomplish the mentioned aims of spatial planning (chapter 3.1.2.), the site-planning is used to plan the development of municipal land use. Borders between sites (plots) as well as borders between infrastructural measures and areas of special relevance have to be clearly marked in the plan.

The site-planning is limiting the possibilities of use for the owner, but this is justified as the overall public benefits from it (e.g. by increased safety or maintained aesthetic values).

Plots used for settlement must be suitable for being used as building land, especially in areas prone to natural hazards (floods, avalanches, mud flows, rockfall) or areas with difficult exposition or steep slope, except if measures allow protection. The aesthetic and ecological properties of landscape have to be taken into consideration, e.g. limited height or choice of areas for buildings, also areas which are already developed should be considered to influence further settlement and constructions. (Weber, 2006)

Both in Vorarlberg and the Tyrol, only following kinds of utilisation are allowed in site-planning: use of the site (plot) for building, open/free space and traffic areas (and some other), other uses are forbidden. (Vlbg RPG, 2006, §13, Abs.2 and TROG, 2011, §37) There are minor differences between the laws (e.g. different names of kind of utilisations) but the common aims are identical.

The actual site-planning comprises a legal document, a plan and a textual document explaining the decisions made within the process of its creation (e.g. involvement of public opinions). (Weber, 2006) In consequence of the law, the municipalities must not set other actions contradicting to it and, within its planning activity, take action according to the plan. (Vlbg RPG, 2006, §12, Abs.3 and TROG, 2011, §36, 1c)

Two principles are dealing with the change of site-planning of private property.

The principle **protection of stock** ('Prinzip des Bestandsschutzes' or also 'Objektschutz') warrants the usage of a site (plot) by its residents and thus disregards changing plans and

zones (e.g. site-planning or new hazard zones plans). This principle is applicable **as long as the site and use stay unaltered**.

If the owner or resident is altering the use of the buildings or its physical structure, this has to happen according to the currently valid plan: **principle of compliance with the plan** ('Prinzip der Plankonformität'), the principle protection of stock gets obsolete. When a hazard zones plan is changed, only new building constructions and altered constructions are faced with legal consequences, unaltered buildings are not affected. (Weber, 2006)

In practice, these principles are causing a change and control of development of settlements. Despite it being slow, its effects are evident. (Kanonier, 2006)

Because every municipality does have to create site-planning on a precise site (plot) level, this instrument is mentioned to have the highest potential for reduction of risk on a supra-municipal or state level. Practically, it can however not be used for such large-scale purposes of risk assessment and reduction because of a lacking completeness of the plans - not every province enforces the inclusion of the hazard zones plan and assessment of risks, and also because of different provincial laws. (Kanonier, 2006:140) Hence, risks have to be reduced separately; within each municipality.

Nevertheless, site-planning is the standard instrument to **influence and limit development**. The safest way of dealing with a risk is to obstruct development in the area close to the hazard - if it is not built on yet. If an area is already planned as zone for development and it is already built on, officials are in difficult position, as they cannot ask to reverse building measures. In consequence, they may have to limit themselves to ineffectual solutions in order to establish maximum security, as far as possible, e.g. by introducing defensive avalanche barrier constructions. Thereby, the necessity to obstruct development is evaded through changed site-planning.

This shows that buildings, when erected or planned, may have stronger influence on further planning than planning measures of site-planning. This problem will be taken up again in following chapters.

There exist legal ways to revert site-planning for plots planned for development in areas that have become endangered. According to Kanonier, the site-planning is mostly not reverted as it would involve compensation payment from official side (municipality) but also due to the fact that the board of control (provincial government) has confirmed the site-planning and would have to admit that they were wrong with their previous allowance of site-planning. (Kanonier, 2006:150)

3.2.1.4. Building site plan

The building site plan ('Bebauungsplan') is subordinated to the site-planning and asserts its intentions on smaller spatial level, the most concise mean of spatial planning. The building site plan determines on a site (plot) scale the amount, kind, height and position of allowed buildings. The building site plan has to be accorded with other plans of the province and protection measures concerning natural hazards. (Vlbg-RPG, 2006, §28, Abs.2d and TROG, 2011, §2)

Information and interaction of the public have to be included into the professional creation of the plan (by e.g. architects, spatial planners). Then, next procedural steps are a confirming statement of the provincial government and the formal decision by the municipality. The building site plan consists of a legal act, a plan and a textual document explaining decisions as well as communal concepts, e.g. for traffic, free space or protection of the aesthetics of the municipality; those are normally not binding to the law. (Weber, 2006) Also, the plan has to be in accordance with superior plans; i.e. municipal spatial development concept and site-planning. (TROG, 2011, §54, Abs.1)

3.2.2. Instruments concerning natural hazards

3.2.2.1. The Austrian Service for Torrent and Avalanche Control (WLV)

The 'Austrian Service for Torrent and Avalanche Control' will in this thesis be abbreviated by 'WLV' ('Forsttechnischer Dienst für **W**ildbach- und **L**awinenverbauung', literal translation: forest-technical service responsible for barrier constructions for avalanches and torrents). The WLV addresses natural hazards of alpine origin. As was discussed in chapter 3.1.2.1., its six duties and responsibilities are determined by the forest law (ForstG). (Lebensministerium, 2013a and INo.2)

1. Counselling and providing information about natural hazards and processes ('Naturgefahreninformation')
2. The WLV provides surveys and reports as a group of authorised experts ('Sachverständigentätigkeit')
3. Hazard zones planning ('Gefahrenzonenplanung')
4. Creation and planning of measures against natural processes (e.g. avalanche barriers; 'Maßnahmenplanung')
5. The realisation and maintenance of building measures (i.e. avalanche barrier constructions; 'Maßnahmensetzung')
6. Financial management: Each head of the provincial unit is provided with an amount of money he/she can use for the duties of the WLV which he/she can distribute in-

dependently (monitored by the ministry), additionally he/she can request further means. ('Förderungsmanagement')

The ministry is superior to the WLV. As national authority, the ministry issues new regulations or decrees for the seven provincial units (PUs), taking influence in the procedure of the six tasks. The competences of the WLV are hence clearly set. These nation-wide regulations are equally valid in areas without avalanches and in areas with little free space or settlement possibilities. As all laws are valid everywhere, not all citizens and subsidiary organisations are equally pleased by regulations. The Forest Act determines the segmentation of WLV into provincial units which form widely independent bodies. Hence, nation-wide laws and regulations have the potential to be perceived differently by each PU.
The district units are responsible for the creation of hazard zones and the regulations. Provincial units supervise and monitor. PUs and DUs cooperate closely, as they are often located in the same building (e.g. PU Vorarlberg and DU Mittleres Inntal, the DU in charge of Telfs). Austria's WLV often meet and calibrates issues and details, sometimes guided by the ministry. (IN0.4)

Additionally, there are three agencies of the WLV on state-level, directly subordinated to the ministry. They are responsible for an exchange of information between all PUs and DUs ('Dienststellen') concerning **geographic information** (in Vienna), **geology** (in Innsbruck/Tyrol, founded 1980) and **snow and avalanches** (in Schwaz/Tyrol, abbreviated SSL, founded 2000). (ZAR, 2006 and Lebensministerium, 2012)
Another nation-wide entity is responsible for the establishment of technical and formal standards and procedures, know-how and collaboration across sub-units, professional training as well as evaluation of HZPs: **Group G** ('Gruppe G'), consisting of academic members of each PU and a leading representative of the ministry. (Lebensministerium, 2011a)

Hazard zones plans are being created every 10 to 20 years, depending on capacities of the WLV and priorities to revise them. New HZPs before the end of this time are possible only if influencing factors and natural processes and their potential effects have changed. Instead of the creation of a new HZP, expert reports are created if they are needed, e.g. for building projects ('Einzelgutachten'). They include the actual state of art and other new factors (e.g. progress of the avalanche barrier, changed land use). (IN0.4)

The creation and planning of measures against natural processes is of mayor importance for this thesis. Avalanche barrier constructions are erected to protect settlement in municipalities.
All constructions cannot be built immediately due to financial resources and limitation in time; therefore the WLV has to prioritise the projects. Within each PU, this happens

according to a list, where every project can get a maximum of 12 points. These are distributed according to their necessity: 'Where are most objects in danger areas? Where is the highest frequency of hazards, etc.?' This list is kept up-to-date. (IN0.4)

When a construction project is initiated, the WLV runs a cost-benefit-analysis according to the plans provided by a planning engineer assigned by the WLV. The provincial unit is in charge of financing the project. Until a certain threshold cost value (e.g. 10 Mio Euro in the Tyrol, IN0.4), the head of the PU can autonomously authorise the project, above this value, the ministry has to do so.

Avalanche barrier construction projects are carried out in alpine areas and are therefore possible just in summer within a limited time. Before and after, climatic reasons prohibit building measures. Building projects may take many years (5-15 years) and cost several million Euro.

3.2.2.2. Changed regulations since 1975

The first regulation concerning hazard zones planning was issued in 1973 and demanded a provisional creation of HZPs, before it was set into federal law in 1975 by the ForstG. (IN0.5)

Hereafter are listed changes in regulation, which are relevant for this thesis and hazard zones planning for avalanches.

1980: 'Guidelines for operating and handling withdrawal of state funds concerning avalanches or torrents', which will here be called **regulation for revocation**, deal with duties of the municipalities tied to construction works for avalanche barriers.

"**Richtlinien betreffend die Handhabung von Hinderungsgründen für den Einsatz von Förderungsmitteln des Bundes im Zusammenhang mit Wildbächen und Lawinen**, im folgenden kurz 'Richtlinien Hinderungsgründe' genannt." (BMLF, 1980)

The regulation states: The protection of human lives has a higher priority than the protection of objects, and the protection of existing material assets has a higher priority than the protection of future assets. The subsidies of all other state funding programmes have to be balanced against the protection against torrents and avalanches.

» „Beim Einsatz von Förderungsmitteln des Bundes für den Forsttechnischen Dienst für Wildbach- und Lawinenverbauung ist höherwertigem Schutzbedarf Vorrang einzuräumen. Als höherwertig ist insbesondere der Schutz von Personen gegenüber dem von Sachwerten sowie bestehender Schutzbedarf gegenüber neu entstehendem anzusehen."

» „Bei der Beurteilung der Förderungswürdigkeit anderer Förderungen des Bundes sind deren Förderungsziele gegen den Schutzbedarf im Zusammenhang mit Wildbächen und Lawinen abzuwägen."

The principal aim of this document is to make the municipalities comply with the requirements of the WLV. If municipalities do not comply, a revocation exists and public funds are no longer available.

When a protective avalanche barrier construction should be designed and constructed, it is a prerequisite that in the municipality exists no impediment (revocation) according to this regulation. For the revocation exist certain criteria, thus, it is not allowed to increase the hazard potential (new buildings or enlargements) in the red zone while building measures of avalanche barriers are still in progress. However, the municipality is encouraged to allow building measures increasing the safety.

Should this list be neglected, the WLV immediately **stops the funding** for the protective building measures and the free **consulting service** of the WLV until the actions neglecting the criteria are undone by the municipality. (IN0.3)

1994: Before the regulation of 1994, the ministry did not issue formal decrees or guidelines setting borders. The amount of pressure 25 kilo-Newton per square metre (25 kN/m^2), equivalent to 2.5 tons per square metre (2.5 t/m^2) was used as a threshold value between the more endangered red zone and the less endangered yellow zone for avalanches. This was the unofficial agreement for most members of the WLV. The regulation states that the frequently used method ('historical method') describes the sum of possibilities that are likely to occur within red/yellow zones without involving mathematical modelling or calculations.

This regulation **introduces the 1 t/m^2 (10 kN/m^2) border** determining the red hazard zone for avalanches, between 1 and 10 kN/m^2 the yellow zone (1TBS). It is a **provisional** policy for the time being. (As a hypothetical avalanche exerts different levels of pressure on the ground, the border setting criteria determine until which value of kg per m^2 settlement is possible and buildings can withstand the pressure. The change from 2.5 to 1 t/m^2 represents taking back settlement.)

Next to the 10 kN/m^2 regulation, there are additional definitions to establish a more common understanding of terms like 'disproportional' or 'relevant' or the blue, violet and brown zones. (BMLF, 1994A and IN0.5)

1999: After the regulation of 1994 was fought against and withdrawn, the regulation of 1999 **re-enacts the regulation of 1994** making the boundary of HZPs to **10 kN/m^2 immediately effective**. Already existing HZPs are to be renewed or newly created as soon as possible. (BMLF, 2009A and IN0.5) This regulation is essential and a major break, as real change is following in hazard zones planning. (IN0.4)

2001: The regulation of 2001 states that the criteria and border-setting for the not frequent design events are set for the frequent ones as well, resulting in the elimination of the differentiation between frequent and not frequent design events. (BMLFUW, 2001 and BMLFUW, 52.240/07-VC6A/2001) This regulation is not being applied with relevant consequences for hazard zones planning and is here therefore not dealt with explicitly. However, the regulation has a simplifying effect on hazard zones planning through the elimination of this differentiation.

Shortly after the regulation of 1999 enforcing 10 kN/m² as border, structural changes within the ministry were carried out, as for example the foundation of the agency of the WLV 'Snow and Avalanches' (SSL) in 2000. Other regulations were of no relevance to avalanche matters (rules of other aspects of HZP). (ZAR, 2006)

2011: As mentioned above, between 1973 and 2001 18 regulations were issued in form of formal letters from the ministry to the WLV. In 2011 a **comprehensive guideline** was issued for the first time („Die.wildbach - Richtlinie für die Gefahrenzonenplanung", LEBENSMINISTERIUM, 2011A and BMLFUW: LE.3.3.3/0185-IV/5/2007). This document consisting of 46 pages summarises all relevant legal principles and formal rules issued by the ministry. The old letters and regulations are nullified as they became redundant (see last pages of the document). It was created by Group G in collaboration with the heads of the provincial units. After the issuing of the guideline, few new regulations, not relevant for this thesis, followed. (INO.5) The guideline is available online. (BMLFUW, 2011)

The 2011 guideline introduces the **voluntary** change in the fundamental approach to hazard zones planning. Commonly, hazard zones are being planned based on their catchment areas, e.g. one HZP with one avalanche catchment area. It is also possible (and common) that a municipality has several avalanche areas which are condensed into one physical hazard zones plan, resulting in several overlapping avalanche zones and hazard zones. With the introduction of digital data processing, it is possible to establish separate HZPs for each (independent) avalanche area instead of affected area, meaning one avalanche area for one HZP. The advantage of this is a more flexible and faster revision of the HZP. (BMLFUW, 2011:9+23, INOS.4+9)

3.2.2.3. Digitalisation of hazard zones plans

Every hazard zones plan includes maps and texts. Austria's PUs strive towards the digitalisation of all HZPs, old and new. E.g. in Vorarlberg, the digitalisation of the HZPs was completed in 1997. (V-LREG, 1997) Not only are concerned municipalities interested in

available hazard zones plans for their own planning, but also is the WLV on state level obliged to collect data and statistics to supply and inform the ministry (e.g. number of HZPs, size of catchment areas, etc.). (INo.9) Mileti (1999a:12) confirms that a nationwide collection of data, accessible to the public, increases the success of planning e.g. by means of a more transparent cost-benefit analysis.

Among the provincial units, only the Tyrol has passed a law making it compulsory to assess some physical properties of the provincial area, e.g. by laser scanning or ortho-photos (but not risk assessment). A nation-wide system of risk assessment, i.e. acquisition of hazard zones, does not exist. The site-planning could potentially provide data, but the incorporation of the HZP into the site-planning is not within the law in all provinces. (Kanonier 2006:131+140 and INo.1)

The agency of the WLV for geographic information (SGI - 'Stabstelle Geoinformation') is responsible for information technology (IT) and data processing, but also for the establishment of GIS (geo-information-systems). Maps, ortho-photos, hazard zones, plots, catchment areas, reports, relevant data for the WLV are collected in the computing centre, the WLK ('Wildbach- und Lawinenkataster'). The WLV organises and uses this complete geographic information system that will be further developed and completed in the next few years.

Advantages of the WLK are the centralisation of data about avalanches, torrents and its HZPs, expert reports, construction projects. In the future also development of HZPs (hence possible comparison of actual and desired state of the HZP), all in one central place, are planned in WLK. (INo.9)

3.2.2.4. Instruments concerning natural hazards on municipal level

Mayors are responsible for the security of their citizens. Ex officio, the mayor applies at the WLV for avalanche barrier constructions. After their construction, the hazard zones of the municipality are altered.

The avalanche commissions ('Lawinenkommission') are strictly speaking no spatial planning entities bound to law by provincial governments' laws. Only in the Tyrol exists a provincial law determining the responsibilities of avalanche commissions (T-LGBl., 1991). In other provinces, communities determine the commission's duties by themselves.

The WLV is responsible for the hazard zones planning and the construction of avalanche barrier constructions, but the mayor is responsible for emergency processes, e.g. evacuation of threatened houses, and also for monitoring and control of areas outside of areas of the HZP. He/she obliges a group of officials or private people to fulfil this task.

As an example, the avalanche commission of Telfs is consisting of a forester (chairman), mountain rescue staff, experienced citizens of Telfs and the head of the building authority.

The task of the avalanche commission is to monitor and look after the settlement area, to assess buildings and their potential degree of protection from an avalanche and areas of risk. In case of emergency (concrete danger of an avalanche), they initiate evacuations of concerned houses. (This happened once, in 2000, when the Breitlehner avalanche catchment area was not visible during a bad weather condition and therefore it was unclear how acute the danger was.) The commission is also responsible for area outside of the settlement area, e.g. skiing area. The commission has to make plans how to react in case of danger. Further on, if a building should be constructed outside regular settlement area (e.g. power plant or mountain shelter) the commission has to determine under which prerequisites this is possible. (IN0.7 and Telfs, 2013b) Hierarchically, the commission is advising the mayor who is commanding the emergency service of the municipality. (Telfs, 2013b)

3.2.2.5. Current state of hazard zones planning

In 2011, the WLV was in charge of 12.237 torrent catchment areas and 6.039 avalanche catchment areas, adding up to two thirds of Austria's total area. 80% of the municipalities within these areas are directly threatened by torrents or avalanches, the Tyrol and Vorarlberg even by 91%. (Lebensministerium, 2011b) Among the 2.357 municipalities concerned with those hazards, 1.614 are in need of a HZP because a hazard is affecting the municipality, 1.286 of them (approx. 80%) already have a HZP approved by the ministry. (Lebensministerium, 2010) Different disasters and extreme events create an awareness of the importance and the necessity of hazards zones plans among politics, officials and the public opinion. Illustration 3 shows the number of municipalities in need of and with completed hazard zones plans. Within a few years, the percentage of municipalities with hazard zones plan will have reached nearly 100. HZPs in less risky areas (very small risk due to a relatively safe geographical situation) are created much later than HZPs in e.g. avalanche-prone areas.

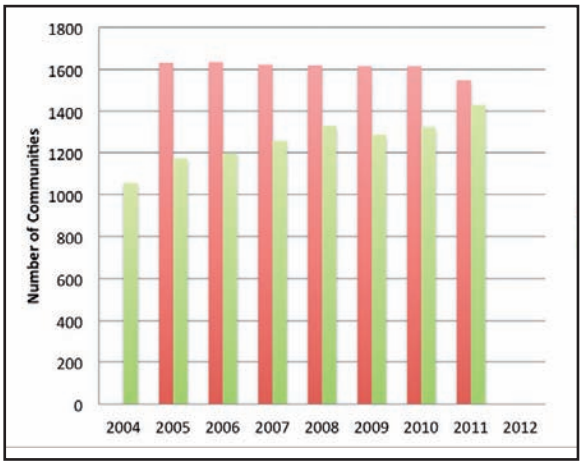

Illustration 3: Municipalities in need of (red) and with completed (green) hazard zones plans (Lebensministerium, 2011b)

The total expenses for protection measures (avalanche control structures) have remained approximately on the same level, at around 120 million Euro per year, for the last decade. The federal government contributes around 60% of the total cost by using funds designated for catastrophes ('Katastrophenfonds'). (See illustration 4.)

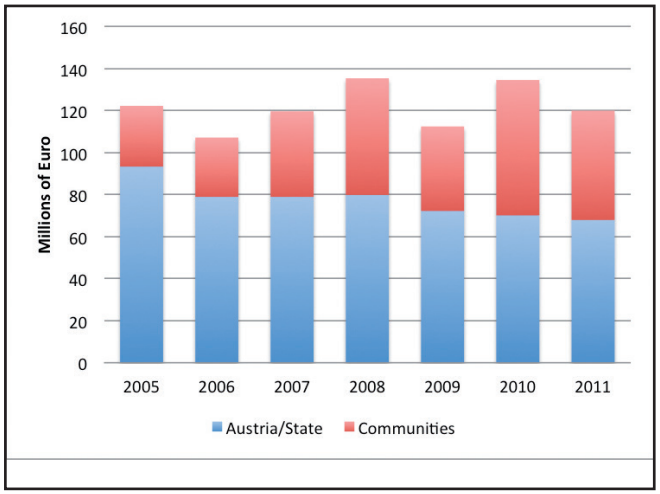

Illustration 4: Expenses of the Republic of Austria and municipalities for protection measures of the WLV (Lebensministerium, 2011b)

Technical solutions for protection measures (e.g. deflection and retention walls, torrential barriers) are the conventional way of dealing with natural hazards. However, they are cost-intensive and some types of barrier constructions are prone to physical degradation and have to be maintained. Various possible instruments of improvement are possible: Integral risk management (see chapter 1.3.1., a holistic approach of risk analysis, prevention, management and revision), structural precautionary measures or technical improvements (e.g. clinker-brick/reinforced concrete constructions). (Holub & Fuchs, 2009:524)

Holub and Fuchs (2009:524 citing Fuchs, 2009) say that Austrian "planning and implementation of local structural measures to reduce vulnerability [...] are neither highly sophisticated nor very innovative". They mention three fundamental problems regarding Austria's system of dealing with natural hazards:

- The legal differentiation between state and the province level is complicating the legal situation.
- Risk reduction measures are diverse, not centrally coordinated and not setting "incentives for individuals to prevent losses". (ibid:524)
- Limited information for the population of Austria is the reason for missing risk awareness.

The law enforces the establishment of hazard zones, but other existing plans are not necessarily enforced or taken into consideration by administrative bodies. Additionally, guidelines and directives of leading bodies are difficult to trace and analyse, and local bodies also have "different horizon[s] of spatial planning activities (5–10 years on the local level, 30–50 years on the regional level) and the hazard zoning process (10–20 years)". (Holub & Fuchs, 2009:526) However, those are being partly harmonised by an EU-program enforcing the mapping of hazard concerning water bodies (the Flood Risk Directive) by ensuring a 6-year-updating interval and an area-wide flood risk map. (Holub & Fuchs, 2009)

To actively reduce risk, either an avoiding strategy can be used (avoiding development into areas threatened; open spaces), or structural measures for existing objects and assets (avalanche barrier constructions). Building bans are rarely implemented (except in red hazard zones), so "the legal [...] prescription of protection in areas less endangered by natural processes also seems to be not very successful in practice". (IBID:527) Additionally, regional development plans can deliver a top-down approach setting requirements for a new construction or similar. The law restricts short-term modifications of objects to a high extent, which leads to conflicts of different interests within the municipality and the hazard management. (HOLUB & FUCHS, 2009)

4. Results

Chapter 3 showed how case studies were selected. In chapter 4.1. is shown how the regulation was perceived and responded to by different shareholders. In chapters 4.2. and 4.3., the practical impact and outcome of the new regulation are shown within two case studies.

4.1. Genesis and implementation of the new criteria for border setting

New regulations passed by the ministry (chapter 3.2.2.2.) influenced the proceedings and activities concerning the hazard zones plans in many ways. This chapter describes their process of creation and implementation.

The regulations of 1994 and 1999 are considered to be most important as they deal with the degree of safety striven for in hazard zones planning.

4.1.1. Provisional 1-ton border setting (1994)

In 1975, the use of hazard zones plans has been bound to law. One year later, border setting criteria were established in a conference in Flachau/Salzburg, namely 2.5 t/m² on a provisional basis. (PU-V, 1994A) These criteria remained valid until 1994. (As a hypothetical avalanche exerts different levels of pressure on the ground, the border setting criteria determine until which value of kg per m² settlement is possible and buildings can withstand the pressure. The change from 2.5 to 1 t/m² represents taking back settlement.)

For the initial border setting, experts were taking inspiration from Switzerland (3.0 t/m² for a design event of 300 years), but adapted it for Austria to 2.5 t/m² for a design event of 150 years. (BH-BLUDENZ, 1999 and INO.2)

Nation-wide border setting criteria did not exist before 1994. Each PU of the WLV had own criteria, mostly approx. 2.5 t/m², but on an informal basis. The ministry intended the

aim of common and formally bound border setting criteria. This would eliminate different approaches and autonomy of decisions of the individual PUs.

In March 1993, the first draft of the 1TBS was first mentioned in a letter from the district commissioner of Bludenz ("Bezirkshauptmann") to the WLV. (PU-V, 1993)

The ministry issued the regulation of 1994 to implement the criteria of 1 t/m² (changing the border setting from 25 kN/m² to 10 kN/m² or 1 t/m², abbreviated '**1TBS**') on a formal basis, as it was discussed and agreed on within the WLV's higher organisational levels in the ministry.

Further information, background as well as discussion can be found in chapter 5.1.

All of Austria's HZP-referees and the heads of all provincial units met and expressed their vote regarding the new regulation (1TBS). Vorarlberg's and the Tyrol's deputies voted against it, arguing that the new regulation would cause loss of credibility for the WLV in society and also because the additional safety would be insignificant ('geringfügig'). (PU-V, 1994A)

The PUs' authority over their border setting was given to the ministry who also changed the criteria to a more strict value. Therefore, the regulation was made tentative to give time for adaptation, e.g. of hazard zones plans. The regulation was legally issued on 24.02.1994.

» 'To be able to continue the task of hazard zones planning, this tentative regulation may be provided for the experts creating the HZPs. They may implement and use the regulation accordingly.'

» „Um die Tätigkeit der Gefahrenzonenplanung [...] zügig fortsetzen zu können, ergeht die Einladung, dieses vorläufige Exemplar allen GZP-Verfassern [...] zur Verfügung zu stellen und die Richtlinien bis zu deren Genehmigung vorerst sinngemäß anzuwenden" (BMLF, 1994A)

» 'In most cases there will be hardly any substantial changes for the existing hazard zones in short- and mid-term, because of the historical method (taking silent witnesses, interviews of locals and chronicles into account) which is still professionally justified.'

» "Eine wesentliche Änderung der derzeit ausgewiesenen Gefahrenzonen wird sich [...] in wechselndem, zumeist aber eher geringem Ausmaß ergeben, da die Gefahrenzonenabgrenzung der ‚historischen Methode' (Beachtung Stummer Zeugen, Anrainerbefragungen, und Chronikaufzeichnungen etc.) auch weiterhin ihre fachliche Berechtigung behält."

According to the wording of the regulation, the reason that the ministry assumes minimal changes due to the regulation may be the continual technical acceptance of the 'historical method', which is next to simulations the main reason for the border setting and the summation line.

» ‘Hazard zones created in such a manner (see above) are expert reports depicting the summation line, which represents the maximal possibility of risk within the limitation of the design event. This line has to be justified descriptively by the expert, as it used to be. Within the verification process, the plan may not seem to be justified from a mathematical point of view, nevertheless the correctness is backed by a thorough report by the planner.’

» “Die so ermittelten und dargestellten Gefahrenzonen stellen eine gutachtliche Feststellung der Summenlinie aller Möglichkeiten im Falle eines Bemessungsereignisses dar. Diese Summenlinie wird durch den Planverfasser so wie bisher auch descriptiv zu begründen sein. Durch Verifizierung dieser Begründungen im strengen Überprüfungsverfahren eines GZP erscheint die Gültigkeit dieser Aussagen - auch wenn sie nicht immer exakt mathematisch nachvollziehbar erscheinen - ausreichend gesichert. [sic]”

Those texts indicate that the regulation aims not to put pressure on the planners and the WLV but create a rather smooth transition towards the new border setting regulation following this tentative regulation a few years later.

On the 07. and 08.06.1995, a meeting (WLV-staff and other affected parties) by concerned municipalities took place in Gaschurn/St. Gallenkirch and Lech after travelling to various parts of the DU Bludenz, Vorarlberg to discuss the current state of hazard zones planning. (BH-Bludenz, 1995) The district unit Bludenz (DU-Bludenz, 1994b) argued that to ensure continuity, especially in the municipalities of Lech and St. Gallenkirch, the 1TBS has adverse effects. On 25.08.1995, however, a high-level ministry official of the ministry wrote to the district commission (‘Bezirkshauptmannschaft’) of Bludenz/Vorarlberg to announce the consequences of the meeting of 07. and 08.06.1995: (BMLF, 1995a)

» ‘In the meeting it was agreed that new reports for hazard zones planning will *neglect* the current state of official approval (see above, 1 t/m^2) and furthermore use the existing criteria of 2.5 t/m^2 for the setting of the red hazard zone of revised hazard zones plans. For new hazard zones plans, it is possible to use 1 t/m^2 as border setting between red and yellow zones taking the necessity of increased safety into account.’

» “[Es] wurde festgehalten, daß alle Gefahrenzonengutachten ohne Rücksicht auf den Stand des Genehmigungsverfahrens weiterhin unter Anwendung der bisher geltenden Kriterien für ‘Lawinenrot’ (Druckkräfte von 2,5 t/m^2) auszuarbeiten und zu revidieren sein werden. Für gänzlich neue Gefahrenzonen könnte in Anerkennung der Notwendigkeit der höheren Sicherheit die vorgeschlagene Grenze zwischen Lawinenrot und Lawinengelb von 1,0 t/m^2 gelten.”

Normally, finished avalanche barrier constructions work enable the option to reduce the red zoning, which possibly leads to new settlement (as it is then a yellow zone); but fur-

ther on the regulation says that the municipality does not have an 'a priori' right to make use of the newly created area.

» 'The border setting between the red and yellow zone should happen according to the existing criteria of 2.5 t/m², for all kinds of reports. To assist the already responsible building and spatial planning authorities, an agreement has to be introduced: After the finished construction of an avalanche barrier, an automatic assumption that plots whose zoning have changed from the red to yellow can be built on based on the fact that it is now a yellow zone is *not* legitimate.'

» "Die Abgrenzung der Roten Lawinengefahrenzonen gegen die Gelbe Gefahrenzonen soll nach den bisher verwendeten Druckkriterien von 2,5 t/m² generell für alle Arten von GZP - Gutachten erfolgen. Zur Unterstützung der schon bisher sehr verantwortungsbewußten Tätigkeit der Baubehörden und der Raumplanungsstellen wird [...] ein Passus aufzunehmen sein, [...] daß speziell nach erfolgter Verbauung und dadurch möglicher Rücknahme von Roten Gefahrenzonen die Gefahrensituation behördlicherseits neu zu beurteilen sein wird und nicht a priori ein Recht auf Nutzung einer vormals Roten und nunmehr Gelben Zone für Siedlungszwecke abgeleitet werden kann." (BH-Bludenz, 1995)

It can be assumed that the district commissioner aims to reconcile the aims of the ministry and Vorarlberg's PU: the ministry aims for the 1TBS, Vorarlberg cannot accept to change existing HZP, because they are, among other reasons, already short of land and cannot accept further limitations. (See chapter 4.3.) Hence it is suggested to introduce the following solution for Vorarlberg on a long-term basis:

Firstly, to use the 1TBS just for new settlements projects and their incorporation in a HZP.

Avalanche barriers are constructed to enable the safety of existing buildings according to the new border setting criteria. Formerly red hazard zones turn to yellow as the avalanche barrier increases the overall safety. This induced increase in safety should not be understood as legitimation to have new settlement, as this would again increase the danger. Therefore, secondly, it has to be resigned from development projects only enabled by avalanche barrier constructions.

The district commissioner ('Bezirkshauptmann') of Bludenz/Vorarlberg seems to be often in contact with the WLV, as he is the author of documents and for instance, announcing a written, official information on the effects of the meeting of 07. and 08.06.1995. This information and update was again issued by the ministry (BMLF, 1995b) and sent to all provincial units in late November: The ministry stated that the regulation of 24.02.1994, issuing the 1TBS, was mostly positively accepted, but was facing problems in Vorarlberg. Even so, to establish a nation-wide border setting, the **2.5 t/m² should be used henceforth**, everywhere in Austria. So, the regulation of the 1TBS was **withdrawn**.

As the new border setting of 1 t/m² was no more enforced by the regulation, the 2.5 t/m² border setting was used again by the WLV. To limit losses in safety, which the implemented zoning had already yielded, and to continue limitation of development towards risk areas in yellow zones, the paragraph described above (restricting the land use of new yellow zones, BH-Bludenz, 1995) was integrated into the document issued by the ministry (reinstating the 2.5 t/m²). There, it is also referred to the Tyrolean spatial planning law where it is not allowed to develop settlement towards a zone with a higher potential of hazard. (LGBL-TI, 2001, §37 Abs.2, chapter 3.1.1.1.)

The ministry offered individual help, including the offer of extended exceptions for the regulation for revocation to smooth this 'difficult situation'. (BH-Bludenz, 1995)

It can be followed that due to these strong protests within Vorarlberg, the ministry was not able to establish a nation-wide border setting regulation which was stricter than the old border setting.

4.1.2. Final 1-ton border setting (1999)

The winter season of 1998/1999 brought devastating avalanches, causing 38 human casualties (avalanches of Galtür and Ischgl, chapter 1.1.). Worldwide mainstream media reported about the disasters. (BBC 1999a+b and CNN 2001)

After the disaster, experts analysed the pressures of the avalanche applied on the buildings in Galtür by combining them with the data of the damage. Statically, they concluded that average houses withstood pressures from 1.2 to 1.7 t/m². This result was used as a basis for the technical figure of the 1TBS. (IN0.4) If the 1TBS had already been implemented in Galtür, it is possible that the damage would have been dramatically less, but this is not certain to say because the disaster in Galtür was based on exceptional conditions and should not be generalised. (IN0.5)

The disaster of Galtür drew public attention to the weak border-setting of the hazard zones, affected parties and officials pressed for an increase in safety. In consequence, the ministry issued a regulation already a couple of months afterwards, on 01.07.1999, without any room for discussion or alteration within the WLV. (IN0s.4+5 and Mausshardt, 1999) This regulation put the **regulation of 1994 immediately into effect**.

> 'The ministry orders that the formerly tentative guideline for the border setting of hazard zones has to be implemented immediately.'

> „Vom Bundesministerium [...] werden die [...] vorerst probeweise eingeführten Richtlinien für die Erstellung von Gefahrenzonenplänen nunmehr bindend und ab sofort zur Anwendung angewiesen." (BMLF, 1999a)

» ‘Existing and approved hazard zones plans have to be reassessed and revised as soon as possible.’

» „Bisher erstellte und genehmigte Gefahrenzonenpläne sind ehestmöglich [...] zu überprüfen und [...] der Revision zuzuführen“ (BMLF, 1999a)

The notes of a meeting (several representatives of the provincial government Vorarlberg and WLV, December 1999; BH-Bludenz, 1999) included that avalanche barriers as well as the hazard zones (with 2.5 t/m^2 border setting) in Vorarlberg have proved to be useful and warrant safety within the 1999 winter season; but a readjustment (‘Nachjustierung’) of the hazard zones border setting may be necessary, as well as an improvement of early-warning systems and further intensification and inspection of avalanche barrier constructions.

» „Der Lawinenwinter 1999 habe gezeigt, dass sich die Lawinenverbauungen insgesamt bewährt hätten. Dies gelte weitgehend auch für die Festlegung der Roten Lawinenzonen; teilweise sei jedoch eine ‚Nachjustierung‘ der Zonenabgrenzung notwendig.“ (BH-Bludenz, 1999)

Further on, the text refers to the 1TBS-regulation of 1999 by commenting that ‘most certainly no major ramifications will follow’ (“sicherlich keine großen Folgen”) because the avalanche barriers that had been built the years before provide safety. Only over 20 years old HZPs would have to be revised; just ‘a few’ buildings (“einzelne Gebäude”) would be affected by an enlarged red zone, in 10 municipalities in Vorarlberg and 20 in the Tyrol. In the following two years, modifications should be considered and planned. (BH-Bludenz, 1999)

In the following months, early 2000, it became clear that the vast amount of hazard zones to be revised would cause increased costs. Additional staff and means were requested from the ministry (e.g. cars, staff). (PU-V, 2000)

At the beginning of the process of the revision of the HZPs, media (e.g. newspaper) reported that red zones would become bigger and thus causing loss in property value. The WLV made public statements and elucidated the situation: In most cases the consequences would not be major and in some cases the zoning for buildings would not remain yellow but change to red; in this case, avalanche barrier constructions would revert the zoning within the following few years.

The district commissioner (‘Bezirkshauptmann’) of Bludenz/Vorarlberg wrote (BH-Bludenz, 2000) to his provincial government in Vorarlberg that he cannot guarantee full implementation of the wording from 25.08.1995 (BMLF, 1995a; see above, ‘After the finished construction of an avalanche barrier, an automatic assumption that plots whose zoning have changed from the red to yellow can be built on based on the fact that it is now a yellow zone is *not* legitimate.’)

This shows, that the enforcement of the 1TBS has been facing problems in implementation.

One and a half year after the regulation of 1999, an interest-group of the mayors of 21 tourist municipalities, under the leadership of the mayor of Lech, sent a letter to the minister. (ERFA-Gruppe, 2000) The group claimed that they had always strictly followed the 2.5 t/m^2 border setting and no harm had been done in the existing yellow hazard zones as they were being planned carefully. By appropriate protective construction, it would be easy to adapt to pressures to up to 3.0 t/m^2. This would have the same effect of safety than the 1 t/m^2 border setting. Thus the group intriguingly asked the minister to depart from the 1TBS. They also argued that negative financial results (banks, mortgages, insurances and disadvantages for the economy) would follow and that the regulative would be 'arbitrary' ("willkürlich"). No direct response of the ministry is known of.

The complexity of the matter can be shown in a case which the chamber of labour tried to win in precedence (AK, 2007): A person had bought a real estate without knowing that it was situated in the yellow hazard zone. The chamber of labour, representing the new owner, tried to establish this as a defect ("Mangel") of the real estate, but the Austrian High Court decided that the acquisition of the house was legal.

4.2. Case study 1 - Telfs/Tyrol

Telfs is the third biggest municipality of the Tyrol, with 15.000 inhabitants. (Telfs, 2013a) In the 19th and 20th century, especially after World War II, increasing settlement happened without any building restraints ('Bauauflagen').

In this municipality, the new border setting criteria changed the zoning of an over-average great number of residential buildings into red. Therefore, it was chosen as a case study.

4.2.1. Chronicle of Telfs

Eleven hazard areas exist in Telfs: a couple of torrents (red and yellow zones), one surface water-runoff area (purple zone), and one single avalanche catchment area, the **Breitlehner avalanche** with red and yellow zones in the settlement area. This avalanche is of relevance for this case study. It is situated in the north of the municipality on up to 2600 metres elevation (2000 metres above the municipality) where overhanging snow may be accumulated by winds. This snow, when dropping off the cliff, drops down a 1500 m, almost vertical slope. The following area of discharge ('Auslaufgebiet') has only 1000 m in length. Hence, the biggest threats for the municipality below are not wet snow/slab avalanches but powder snow avalanches, which can gain speed up to 300 km/h and develop high pressures, according to WLV experts.

The history of the Breitlehner avalanche: Between 1890 till 1900, and in 1914, 1915, 1916, 1917, 1956, 1960, 1970 and 1986 a total number of nine avalanches occurred. None of them caused human casualties but approximately half of them entailed minor damage on houses. Also, 4-10 ha of the forest was being damaged. Avalanches reached houses causing minor structural damage and discomfort to the inhabitants. (One owner of the Brandhof-building wrote down, he had 'a feeling, as if the world would collapse'.) (INo.3)

After 1975, the initial version of the hazard zone was nearly comparable to the current yellow zone. (The old equivalent for the yellow zone was 'indirectly endangered area', "mittelbarer Gefahrenbereich", there existed no red zone as it does today.) After the criterion for the red hazard zone was changed from 2.5 to 1.0 t/m^2 in 1999 (1TBS), the ministry on 17.04.**2001** officially confirmed the now valid hazard zones plan. (INo.3, document Zl. 52.246/06-VC6a/01) The HZP was developed both by an expert of the WLV and an external planner who was assigned by the WLV.

The HZP before the current HZP was based on the 2.5 t/m^2 border setting. Its yellow zone comprised around 100 sites (plots) within the district called Sagl ('Ortsteil Sagl').

The new HZP caused a massive increase in size of both the yellow and the red hazard zones because of the stricter border setting criteria (from 2.5 to 1 t/m^2). Sagl lies almost completely in the new red zone, where it was yellow zone before. The new yellow zone covers areas beyond the borders of the municipality and beyond the river Inn and into the municipality of Oberhofen im Inntal. (INo.7) (See illustration 2 on the next page.)

The municipality applied for an avalanche barrier construction work decades ago. Construction was started in 2005 and is still in progress (until 2013 or 2014, see next chapters).

4.2.2. Reactions during the process of the HZP revision

If the hazard zoning is changed to red, site-planning for building measures is forbidden ("Bauverbot"). Aggrieved habitants of the area first reacted with unease and fear (INo.7) and questioned the purpose of the new hazard zone as there had not been a devastating disaster for 500 years. Others seconded the measure as safety would increase. (Inh.Telfs, 2013) Though, there was no big outcry compared to other municipalities (see chapter 4.3.). Since the new zoning was introduced, the excitement about the topic has eased. As for 2013, it does not cause attention anymore and is generally accepted, according to a WLV expert and pedestrians in the area. (INo.4 and Inh.Telfs, 2013)

The WLV aims at a good relationship and trust with the municipalities as there is a close collaboration between them. (INo.7) The fact that planning for avalanche barrier construction work in Telfs started long time before the new hazard zone was implemented (2001) influenced the behaviour of the WLV during the implementation of the 1TBS: the

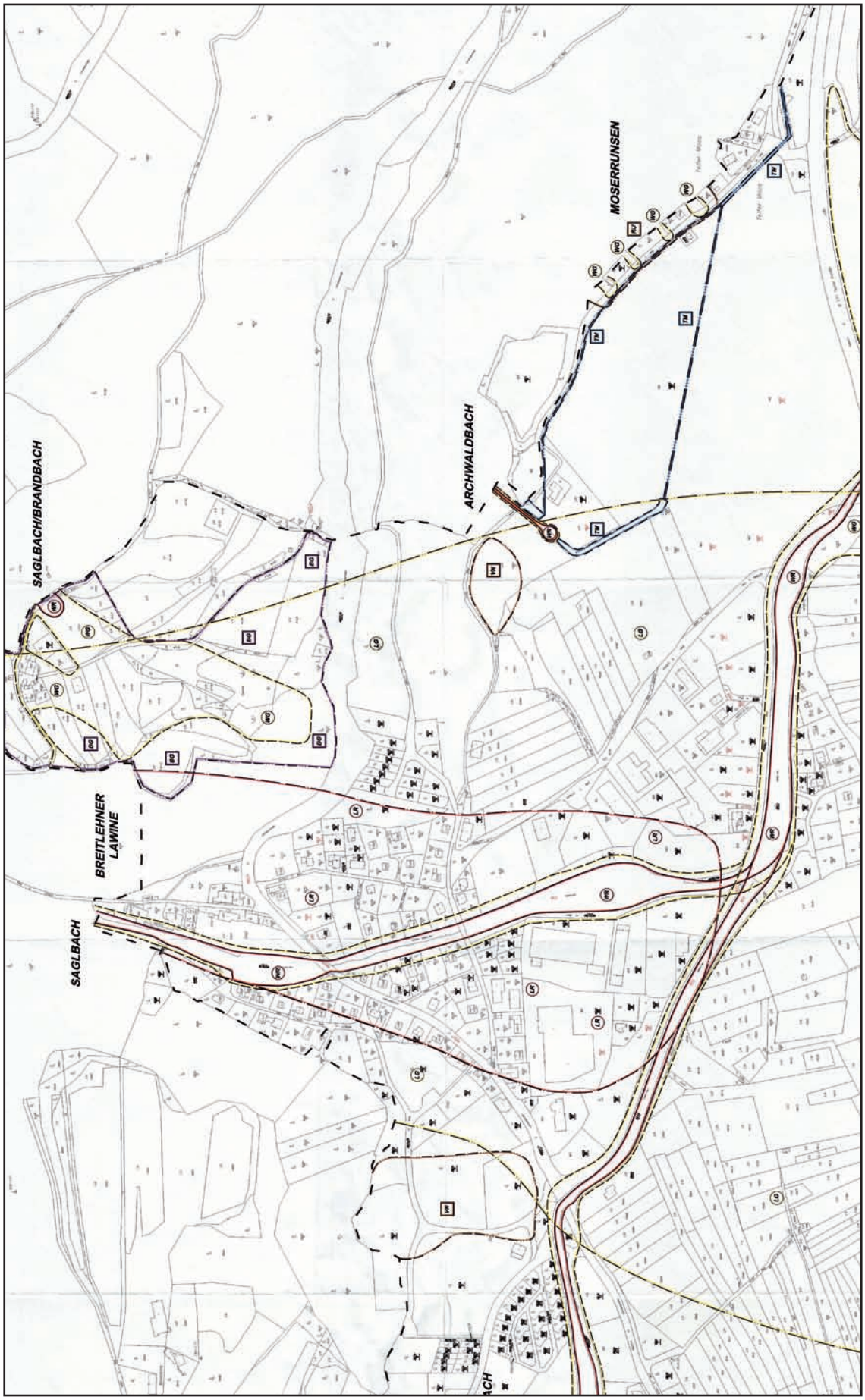

Illustration 2: current hazard zones plan, municipality of Telfs. (Telfs, 2013c)

WLV and the municipality were prepared for objections concerning loss of value or permission to build. The WLV was able to respond that 'in ten years' time, **everything would be as it was before**'. ("'In zehn Jahren bist du wieder draußen.'") The mayor who accepted the new hazard zones plan dealt with other objections personally. The close collaboration building authority and mayor helped to find solutions for objections. (IN0.7)

There are not only private houses in the red zone but also blocks of flats and businesses. The RISA-area may be taken as an example: a business large in terms of surface area with many exposed workers. According to the leader of the building authority, businesses are the most affected by the new zoning, as they may have to be shut down due to the extra effort of required consultation by the WLV and the labour safety inspector for every single measure and activity within the business. For the RISA-area, the property owner was not able and willing to deal with this effort and is now renting the estate to different smaller businesses.

4.2.3. Objections by expert's reports ('Gutachten')

It is forbidden to build new objects in the red zone (by overruling the possible site-planning as building space in the site-planning). Measures increasing safety are possible regarding certain perimeters. In Telfs, a number of plots in the red zone are owned by businesses, e.g. by a bank. These plots in the red zone embody a clear financial loss for them until the red zoning is changed back again by the next HZP. This is possible after finished avalanche construction works. (IN0.7) The principle 'protection of stock' ('Objektschutz', chapter 3.2.1.3.) describes that existing objects have the right to be used and can disregard the zoning, as long as they are unchanged. This principle allows a wide range of possibilities of what can be done within the legal terms and the cooperation with the WLV. An expert of the WLV said, 'Many citizens are mature people, they don't just accept what the WLV forces them to do, but respond with criticism and opposing opinions'. As there are also often many specialised engineering firms in municipalities, they can be hired to create adequate expert reports. (IN0.4) This demonstrates that the WLV's task is to provide hazard zones plans, it is not the WLV's task to directly benefit the citizens; if they have problems with the HZP they have to 'talk up' and make justified objections.

Some citizens would get an allowance to build in the yellow zone or expand buildings in the red zone, if they would fulfil special requirements ensuring safety. Nevertheless, they decide not to due to limited financial resources. After the avalanche building measures will be done and the zoning will have become yellow again through a revision of the HZP and building restraints will have vanished, it will be drastically easier and cheaper to realise building projects. (IN0.3)

If an owner wants to start the enlargement of his/her existing building in the red zone, the WLV offers a service to create surveys and expert reports ('Gutachten') for individual buildings/plots. Just if the municipality follows both the regulation for revocation (chapter 3.2.2.2.) and the spatial planning regulations (chapter 3.1.1., no settlement in more endangered regions etc.), the WLV states, if the building project is possible and under which requirements. In the red zone the new construction of a building is generally not allowed. (INo.3)

Not only the WLV but also private firms may be assigned by citizens/owners to create an expert report. This is a mostly very detailed document, containing precise information about each part of the project, e.g. different pressures on the avalanche-oriented side, left and right side and probably no pressure on the leeward side. If this report complies with the legal limitations, the WLV approves it. (INo.3+7)

For building projects within the yellow zone in Telfs, the WLV did not make any special differences in requirements of construction work before the introduction of the 1TBS but required 1.0 t/m^2 in general. With this measure where all projects were treated the same, no individual assessments were necessary. Also, with this value, building constructions were already relatively safe. (INo.3)

Now, the degree of risk varies with the 1TBS regulation: directly next to the red zone a pressure of 1 ton is defined and at the other end 0.1 ton (the border between the yellow zone and the 'normal' zone). In the areas lying in-between the pressure is interpolated by the WLV. The construction planners then design according to the pressures for the very position of the specific building site. (BMLFUW, 2011 and INo.3)

For building projects within the red zone, new buildings are not permitted to be built, just reinforcing or expanding building projects are allowed under certain conditions (regulation for revocation, chapter 3.2.2.2.). (INo.3)

According to the WLV, citizens are not well aware of the red zones and their purpose and the enlargement of the zones due to the 1TBS. Nevertheless, after clarification, they show understanding of for the necessity of the restrictions. They are cooperative towards the WLV, which they trust. (INo.3)

4.2.4. Role of avalanche barrier construction

The municipality is interested in the construction of an avalanche barrier but the WLV permits, manages and supervises the whole construction process. The municipality does not have direct influence on the procedures.

Already decades ago, the municipality of Telfs and its council requested an avalanche barrier construction. (INo.2+3) Generally, the mayor as the person responsible for the

safety of the citizens sets the initiative. The willingness of the mayor to apply for a construction also depends on citizens' actual awareness about hazards which may decrease after a few years of no incidence. Further influences towards application for constructions may be economic reasons (higher level of safety for businesses). (INo.4)

Prior to the construction process for the Breitlehner avalanche, a cost-benefit-analysis was conducted, the costs being a maximum of 13 million Euro and the benefit for the duration of 15 years 40 million Euro. The construction started in 2005. Now, in 2013, the building measures are almost completed and will most likely be finished in summer 2013 or 2014. (INo.3)

The construction is situated in highly alpine area and consists of two parts:

Illustration 5: current avalanche barrier constructions in Telfs (Sauermoser, n.d.)

- Measure 1: 2.2 km of reinforcing structures with nets retaining snow ('Stützverbauungen mittels Schneenetzen', see illustration 5) keep the snow from accumulating and forming an avalanche.
- Measure 2: In the North-West, the main wind direction, another control structure called 'snow-drift fence' keeps back wind and snow, which hence does not find its way to the avalanche-forming area ('Treibschneeverbauung' or 'Verwehungszaun').

The latter is mentioned by an expert of the WLV to be a successful measure, because the fence (measure 1) strongly increases the effect of depositing the snow out of the release-zone of the avalanche. The high elevation of the building site (2300-2600 m), limitation in access (only access by helicopter) and short working seasons (3 months per year in summers) have caused a relatively long building time (in 2003 it was estimated: 10 to 15 years). Workers and material always have to be secured (as the soil may still be frozen etc.) (INo.3)

The snowpach stabilising construction avoids the release of the avalanche in the starting zone on positions constructed in the Breitlehner avalanche as snow-net and not as snow-bridges of steel. One meter of the net construction work costs approx. 1300 Euro. During the building seasons in 2013 and 2014, 300 to 400 more meters of the reinforcing net structure will be constructed. After that, sufficient construction will have been erected, having cost 6 million Euro. (INo.3)

The funding is split among the state (funds for catastrophes, 'Katastrophenfonds') (60%), the province of the Tyrol (18%), the municipality of Telfs (20%) and the provincial agency responsible for street works, as they also benefit from the construction (2%).

Nearly after every building season, a simulation is conducted and shows how the red zone has moved. This information is also used for expert reports for building projects within the hazard zones. Thus, after every building season, the *effective* red zone of Sagl is moved. During summer 2013 the red zone still encloses a couple of houses. But after the final building season in 2014 the red zone will be outside the settlement area, leaving Sagl in the yellow zone as it was before the revision. An *official* revision of the hazard zones plan will follow when the WLV has capacities for the creation of a new HZP. This will officially move the red zone outside of settlement areas, enabling building measures. (IN0.3)

After all, hazard zoning and avalanche protection measures do not provide 100% certain protection from natural hazards, there will always be a residual risk that has to be accepted. (IN0.3)

Importance of avalanche simulations and zoning

Simulations of avalanches are 3- or 2-dimensional computerised models which help to understand processes, possible magnitude and distance of avalanches. For the last decade, they have always been used for the creation of provisional hazard zones and for the assessment of effective states of avalanche constructions. Simulations and their technology are not perfectly accurate, but computer models and programs are correlated and calibrated with real avalanches, which makes them increasingly accurate - these natural processes are too complex to be fully reproduced by simulations. (IN0s.3+4)

Interest-driven alterations of a scientific simulation are said to be impossible, as the initial parameters for simulations (e.g. maximum of 3-day-snowfall, additional snow brought by wind, coefficient of friction) are mainly collected in the field by individuals and the following simulations are studied in detail by many other experts and so abnormalities would be noticed. (IN0.4)

The SSL is an agency of the WLV responsible for the knowledge and simulation of snow and avalanches. The WLV assigns them for simulations during hazard zones planning. The SSL creates varieties of simulations with variations of the initial parameters. WLV experts of DU level then discuss those variations. After a number of iterations a final simulation is developed. The 1TBS is incorporated in this complete process. (IN0.4)

The simulation is a crucial part of the creation of the hazard zones plan, but also other factors are of importance: history of the area, silent witnesses and interviews of older citizens of the area all document an avalanche's last years and what has happened in a certain area. These factors are not connected with the 1TBS. The output of these factors and the finished simulations are combined. Both are used as argumentative statements in the process of the hazard zones planning. (IN0.4)

4.3. Case study 2 - Lech/Vorarlberg

Lech is a municipality with approx. 1500 citizens, but with several thousands of tourists during winter season. Accordingly, many hotels and winter sport facilities can be found. Lech was chosen as a case study because of many objections in the course of the hazard zones planning process and the multitude of reactions and processes ensuing the implementation of the HZP. (INo.6)

Chapter 4.3.1. first gives an overview of natural hazards in the municipality and their history. In the following chapters, the reactions to the new border setting, before, during, and after the creation of the new hazard zones plan is shown. Finally, the importance of simulations and avalanche barrier constructions is discussed.
The main source of this case studies are expert interviews and analysis of documents.

The municipality of Lech has an area of 90 km^2 and the elevation of settlement is between 1450m (Lech) and 1720m (Zürs). The municipality has a total of approx. 1500 inhabitants, but a maximum of 12.000 people during winter season (tourists plus locals), it labels itself as the largest tourist centre of winter sports in Vorarlberg (in the season 2004/2005: 881.079 overnight stays). As tourism is the most important source of income, the security of settlement area (many hotels) is crucial. (PU-V, 2008B:9 and INo.6; the new HZP of Lech provided this data.)
The municipality area contains 32 torrent and 103 avalanches catchment areas in total. 48 avalanches are of relevance ('raumrelevant') for settlement. Powder snow avalanches cause the main threat. (PU-V, 2008B:11FF)

4.3.1. Hazard chronicle of Lech

In 1979, the border setting of 2.5 t/m^2 was applied in Lech, four years after the legal introduction of the hazard zones plans in 1975. Lech's first hazard zones plan was created in 1979, the border setting between the red and yellow zone was determined as 3 t/m^2.[1] (PU-V, 2008B) This HZP was used as a reference and source for the following HZPs, additionally to simulations, interviews and silent witnesses. In 1999, the 1TBS was enforced. In the same year, the WLV assessed the situation created by the 1TBS and developed a new zoning (no official HZP) to determine the need of control structures. From 2000 until 2007, the municipality applied for construction of different avalanche barriers (a total of

1 It is not known to the author why 30 kN/m^2 were chosen for this HZP whereas the 25 kN/m^2 were the prevailing standard. However, the effects of the 25 and 30 kN/m^2 border setting are comparable. As the reason for this differentiation cannot be explained and their consequences in zoning are very alike, future references in this thesis about Lech will only address the 25 kN/m^2 value.

103 avalanche catchment areas in this area (see illustration 6 on the right) of which 48 are relevant avalanches). In 2000, a report was published by an external expert from Salzburg, where the technical basis (simulation etc.) for a (non official) HZP including the 1TBS was designed. From 2000 to 2008 this report was used for individual building or building enlargement measures, as no valid HZP existed at that time. (IN0.6)

The process for the revision of the hazard zones planning started in 2006. In 2007, the draft of the HZP was put on public display for four weeks. Also a conference with the citizens of the municipality was held to give information and the possibility to file objections. In 2008, the HZP commission scheduled two weeks in Lech, visiting all objecting parties in Lech (see chapter 4.3.3.). Shortly afterwards, the HZP was confirmed by the ministry.

Now, in 2013, the construction of most avalanche barriers is completed. The next revision of the HZP is scheduled for around 2030. (IN0.6)

The small spatial possibilities of settlement and the intense touristic activity explain why the 1TBS and the HZP-revision have such big potential influence. Many buildings (mostly hotels) were in the yellow zone where building measures were possible. Their zoning was then changed to red, resulting in a stop of these building or building enlargement permissions. Therefore, the general interest of the municipality and concerned citizens to build avalanche barrier constructions can be understood. Most of the necessary avalanche constructions are finished (Weiss, 1999:213), but they are based on the 2.5 t/m^2 border setting. New constructions as well as the completion of the old constructions have to be built according to the 1TBS. (IN0.2+6)

Before the 1TBS, people in Lech were used to avalanches and the necessity to manage risk. For specific reports (building measures within the yellow zone), the WLV adapted the expectable risk for specific cases within the zone, from 2.5 t next to the red zone to several 100 kg next to the 'normal' zone (by interpolation). (IN0.6) If a site (plot) was in the yellow zoning, building measures were possible and were realised, mostly for touristic purposes (hotels etc.).

By the implementation of the 1TBS in the HZP, the red zone was enlarged and will be kept until the avalanche barrier constructions suited for the 1TBS have been finished and then enable the zoning to be changed back to yellow. This will happen by means of a new HZP. (IN0.3)

The HZP of 2008 implementing the 1TBS changed the zoning of large areas within the municipality from yellow to red. This red zone comprises buildings and houses. Their property owners however need to adapt to touristic demands and change their assets and services by building measures that cannot be conducted while the zoning is red.

Illustration 6: Avalanche catchment areas in Lech (DU-V, n.d.)

The basis for the **creation of the HZP** is formed by a combination of the consultation of the local history of avalanches, silent witnesses (formation of trees, lack of vegetation indicating last years' events) and interviews of locals who are familiar with the chronicle of the area and natural hazards. This information about the chronicle and proof of events are combined with simulations. Simulations have become commonly used since 1999. (Simulation program: AVAL1D, from 2007 also ELBA and SAMOS.) (INo.6) Lech's simulations covered 48 avalanches, most of which with the SAMOS99-method. (SSL, 2007)

It is often the case that a red zone border cuts through a building as the zoning has to neglect buildings or other obstacles. During the HZP-process, citizens have the possibility to object this, should an expert report provide valid arguments for a less compromising zoning. (INo.6)

The following two chapters describe the reactions and responses directly to the 1TBS and other measures (around 1999), followed by a description of the reactions to the official process of the hazard zones plan revision in 2008.

4.3.2. Reactions to the new 1-ton border setting regulation

The location and the history of the setting of a municipality have large influence on the behaviour and bearing of its citizens. As an example, the municipality of Bludenz (Vorarlberg) has a single relevant potential avalanche within settlement area. Therefore the development of settlement can occur in the averted direction and also border setting can be stricter because other settlement area is available. Lech, on the other hand, is surrounded by avalanches and does not have sufficient settlement area. Therefore the idea of nation-wide border setting has to be questioned, according to an expert of the WLV in Vorarlberg. (INo.2) It can be gathered that this demonstration of the role of safe and available settling space gives a better perspective and understanding of the alpine situation and the way of dealing with the risk in Lech.

A **provisional HZP** was the basis for a stop of building measures from 2000 (introduction of 1TBS) until 2008 (new valid HZP with the 1TBS). This was done to prevent illegal building measures according to the 1TBS which however was yet to be published officially. Citizens were told that 'nothing is possible' until the new HZP is official in order to 'calm down' citizens. Then, exact calculation and re-evaluations would establish a solid basis for the HZP, and following potential building measures and objections. According an expert of the WLV in Vorarlberg, many citizens who first were badly informed accepted this and only asked when this new HZP would be implemented. (INo.6) As mentioned, the generally accepted aim was the retraction of the red zones as they used to be before. (INo.2)

To be able to achieve this aim, avalanche construction measures were envisaged by the municipality already in 1999 and planned/applied for beginning in 2000. This was also necessary to 'calm people down', to 'take the wind out of their sails' and to reduce the reasons for their protest against the 1TBS as they could be told that steps towards the reduction of the red zones were actively taken.

It must also be mentioned that the altered zoning brings an increase of security in the long run. This seems to have little importance to the citizens whose zoning is accompanied with personal adverse effects. (IN0.6)

Tourism organisations understood the zoning as a large threat. Public opinion and publicity, so they argued, would be harmed if media and therefore the public would get knowledge about the expanded zoning and the red zoning of hotels. Also, insurances, banks and mortgages institutes would cause trouble if they learned about it. (IN0.2)

After the 1TBS became known to the public, many people were surprised and confused by this and felt uninformed, the reason for and aim of the 1TBS and the red and yellow zone were not clear. For many citizens the red zone posed mainly the threat of a construction ban, hence they hoped for the zone to disappear for this very reason. (IN0.2)

4.3.3. Reactions during the process of the HZP revision

The following list illustrates the reasons, why the new hazard zones plan was created. (PU-V, 2007)

- The regulation changing the border setting criteria (1TBS) caused the enlargement of the red and yellow zones, the new HZP had to include the new zoning for official land use planning.
- The last HZP originated in 1979 and was due to be renewed and revised.
- The construction of 8 km of avalanche barriers had to be included into the HZP.
- Settlement areas were enlarged and population increased, without adaptation in former HZPs.
- The 1TBS led to an increased necessity for security measures and increase in population leading to enlargement of the HZP.

For the creation of the new hazard zones plan of 2007 different sources were used: the former hazard zones plan (HZP from 12.10.1979), data collection in the field, historical background and numerous avalanche simulations. (PU-V, 2008B:3) On 04.11.2008 the valid HZP was confirmed by the ministry and handed to the municipality of Lech by the WLV, with the advice to obey the regulation for revocation (chapter 3.2.2.2.). (PU-V, 2008C)

The primary assessment establishing the technical basis for the HZP (simulations, etc.) took place from 2005 until 2006. This was followed by the public display of the HZP, enabling citizens to make objections (four weeks in May and June 2007). (PU-V, 2008B:18)

The group of staff responsible for the procedure (the local expert, the DU and other members of the WLV) first wanted to publish the HZP on public display in the summer of 2006. But due to a case of illness in the group it would have had to be postponed to autumn. This was not accepted by the group because of the potential awareness of the media concerning the upcoming winter-sports season. Hence, it was postponed again to the next summer where attention of the media for winter activities and tourism is normally low. Until then, 'things could settle down again' ("... dass sich die Sache beruhigen kann"). (INo.6)

After two thirds of the time of the public display, a public conference was held to introduce the HZP within Lech. According to the responsible expert of the WLV it was an agitated event with many interjections and much dissent, most of which were not down to the point as no substantial arguments concerning 1TBS or other topics were uttered, according to the WLV. (INo.6)

The next step was the official review and ratification of the HZP by the commission of the WLV in 2008. In Vorarlberg and other PUs it is common that the commission visits all objecting parties at their properties and explains and discusses the issues. This itinerary is being scheduled beforehand to ease travel efforts. For this HZP the visitations took place during nine days of June 2008. (PU-V, 2008A)

4.3.3.1. Objections of the citizens to the hazard zones plan

During the public viewing time of the HZP, citizens who could prove their interest in the HZP were able to post an objection.

The number of objections within this HZP-procedure in Lech was extraordinary: more than 200. To put into proportion: Lech's HZP of 1979 had 120 objections, other hazard zones plans have approximately 50 or fewer objections, but they are from different years, so are not directly comparable.[2] (Weiss, 1999:211)

An expert of the WLV (INo.6) referred in an interview to the general approach in Vorarlberg, he stated that only one third of all objections were accepted and that Vorarlberg's WLV acts rather cautiously. If a statical report about a building project verifies that a building measure or intention is safe, it is accepted as safe by the WLV. If there is doubt,

2 The exact number differs slightly in different official documents because one objection filed by several people can be counted differently and also the date of the filing may be considered differently. The hazard zones plan, which is at hand, lists all objections. In the HZP (PU-V, 2008B:18) it is stated that 167 were filed, but the list of the HZP comprises 174. (PU-V, 2008B:19-60). Most of the objections posted were already within the time of public viewing, the rest was handed in later, even after the deadline.

the WLV refuses the building licence. Of those approx. 200 objections, 21% were accepted, 31% were accepted partially and 48% were declined. Due to the imprecise figures and different point of views, it can be estimated that approximately one third has been accepted. (Study of PU-V, 2008B:19-60)

Objecting parties have to argue and prove that they are in the red or yellow zone without justification. They can prove this by assigning an external expert to create an expert report. They can also do this by themselves, if they are qualified. This shows that border setting is also a matter of discussion and argumentation. (IN0.6)

For every objection within the document of the HZP the four members of the commission (ministry, WLV, provincial government, mayor) either accept or refuse the objection by common consent. (PU-V, 2008B:19-60)

The author's further analysis of the objections listed in the HZP showed that many people concerned do not understand why this measure is necessary, as there has never been a disaster (16%), many called the new border setting despotic and arbitrary ("komplett willkürlich") (9%). There were also partially offensive comments (e.g. 'simulations made by incompetent officials'). 5% of the objections were filed directly by tourism-related firms. Many of the other statements dealt with touristic facilities (hotels), but the precise number is not evident from the listing, as they are not listed as hotel owners but as private persons. 1% (two persons) did not object against a zone but pleaded for more protection. It occurred once, that a person asked for the reduction of a zone (what most objections are about) but the committee's review on site revealed that the zone should be even expanded. (PU-V, 2008B:19-60)

There exist two possibilities for property owners to influence the legitimate red zoning on their plot:

- The municipality requests avalanche barrier constructions to enhance protection for parts of the municipality. Also individuals have a similar possibility: Should the municipality see some benefit in this measure and should the cost-benefit-analysis be positive, public and individual funds may be used for **small scale barrier construction**. Consequently, the zoning may be influenced, and therefore the building allowance becomes possible. So, it is possible to build barriers for private protection, if size of property and funds are available. (IN0.6)
- **Special approval of site-planning**, German 'Sonderwidmung', allows buildings in the red hazard zone, which are not prone to the risk of avalanches. This can be below ground: a reinforced garage, spa area or dining room, or above ground: balconies which can be argued to not be endangered because of their height. (IN0.2)

In a letter of the WLV-agency 'Snow and Avalanches' (SSL), verifying and commenting on the simulations for the HZP, following lines were directed towards the commission and the local experts of the WLV.

» 'Due to the considerable number of objections, it makes sense to focus on the use of the simulation and the initial values and prepare those in a consistent manner. Hence, the validity of the simulations is pellucid and can objectively rectify any accusation of arbitrary interpretations and initial values.'

» "Angesichts der zahlreichen Einsprüche ist es besonders sinnvoll genauer auf die Verwendung der Simulationen und der Ausgangswerte Bezug zu nehmen und diese in konsistenter Weise aufzubereiten. Dadurch kann die Aussagekraft der Simulationen dargelegt werden und einer vermeintlich willkürlichen Wahl der Parameter entgegengetreten werden" (SSL, 2007:3)

That implies an awareness of the importance to take citizens' objections serious and that a profound argumentation has to be prepared to prove the accuracy of the simulation and hence the zoning.

4.3.3.2. Role of individual reports and external expert reports

In the documentation of the WLV (PU-V, 2008B:19-60) several reports, assessments of external or internal experts and letters can be found. External expert reports, requested from private parties in affected areas, have a major role as they are capable to disagree with the reports and planning of the HZP and deliver counter-arguments. The law states that the state of the art has to be followed in planning matters. (BGBl. Nr. 436/1976) The WLV accepts the flaws in its own plans or reports if the arguments of the external report are submitting valid arguments and the WLV sees no decrease in safety or additional risk.

Following instances show that well-argued reports can have influence on the hazard zones planning process. (PU-V, 2008B:19-60)

- Special approval measures of site-planning (see above) were applied for already before the 1TBS, e.g. an underground garage within the red zone was allowed by the WLV in 2006.
- A couple of examples from objections from the new HZP of 2008:
  - One objection argued that the 1TBS was illegitimate because of missing legal reason (not granted),
  - One objection asked for the creation of a private avalanche barrier construction and/or a meeting with the planners of the hazard zones to discuss the matter (granted),

  - One objection stated that the border setting was not according to the review and discussion with the commission on site (not granted),
  - A skiing lift firm aimed for an avalanche barrier construction for mostly private protection and the WLV confirmed that 40% of funding could possibly be contributed by public (granted).
- A request for a special approval of site-planning from a hotel owner for an underground dining room shows that the hotel owners may not be afraid of the avalanche but of the zone itself. Another special approval of site-planning, a pumping station in the red zone, was allowed by the WLV.

Next to the WLV, the municipality and the media, also **lawyers** and counsellors have a major role. They often represent hotel owner's interest and also rely on external experts. The fact that the WLV often faced not citizens but their lawyers had hardly any effect on the proceedings of the WLV. According to an expert within the DU Bludenz, also the municipality of Lech was very sturdy and able to withstand these pressures. So-called 'important people', prominent people with political or social influence, (INo.6) tried to have effect on proceedings by contacting the head of the WLV in the ministry and the head of the provincial government. Both personally came to Lech to discuss these matters, resulting in mutual agreement of involved parties and accepting the rules.

In this case study it became apparent that the WLV aimed for cooperation and **solutions agreed on by everybody**. For Lech, it can be said that almost every party filing an objection was eventually convinced by the WLV, understanding and accepting the state of the HZP, especially with the knowledge that avalanche constructions would eventually remove their red zoning. (Two people remained unwavering; they could not be satisfied by discussions with the WLV.) (INo.6)

4.3.3.3. Role of the media and the mayor

Newspapers issued articles and illustrations, focusing ton the red zone which was described as prevailing and dominant and led to problems for all citizens and hotel owners. An expert of the WLV even mentioned in this context that the red zone was called 'zone of death' ("Todeszone"). The newspaper articles refrained from reporting about areas where little change in zoning had happened. (INo.6) This can be highlighted by a newspaper article at hand which shows clippings of the hazard zones plan where the red colour is dominant (see illustration 7 on the next page). It was suggested by the WLV to use hachured instead of coloured hazard zone illustration for maps made public, aiming to have a less dramatic effect on the public through use by the media, especially, because newspaper articles are often not fact-bound. (INo.6) In a newspaper article the WLV and the minis-

try were said to neglect Lech's successful efforts to prevent avalanche disasters (avalanche blastings, barrier constructions and Lech's own risk management program); moreover, it was said that the WLV would not sufficiently allow public access to the hazard zones plan or just show limited areas to individual persons. (VD, N.D.) This newspaper article included an interview where the head of the PU responded to this accusation that technological premises for general access are not yet possible. The accusation of not including existing risk-reducing measures was contradicted by the head of the PU: a meeting of high-level WLV officials, including the head of the WLV had agreed on considering the possibility to include avalanche blastings in the HZP. (The comments of the HZP, oppositely, mention that they cannot be included because they are temporary measures.)

» "Hauptkritikpunkt[...]: Weder die in den vergangenen Jahren getätigten Lawinenverbauungen noch die Lawinensprengungen und schon gar nicht das laufende Projekt der Lawinenbeurteilung [...] wurden berücksichtigt." (VN, N.D.)

» "Der gesamte Plan bleibt der Öffentlichkeit vorenthalten: 'Wir sind elektronisch noch nicht so weit', sagte [der] Sektionschef". (VN, N.D.)

Influenced by media, citizens have been more afraid of the zoning than of the avalanche; the media could harm values of tourism by showing and referring to the red zone. (INO.2)

The mayor has the legal responsibility for the safety of the municipality (see chapter 1.3.2.) and has to undertake measures to do so. The mayor takes the role of applying for avalanche barrier constructions in the WLV in order to increase safety. He/she is responsible for a functioning avalanche commission (chapter 3.2.2.4.). Within the installation process of a new HZP, he/she is one of the four representatives who decide if the new HZP should be accepted. This shows that the mayor is in a central position and has a certain amount of power. Mayors have on one side the aim to increase safety through limiting

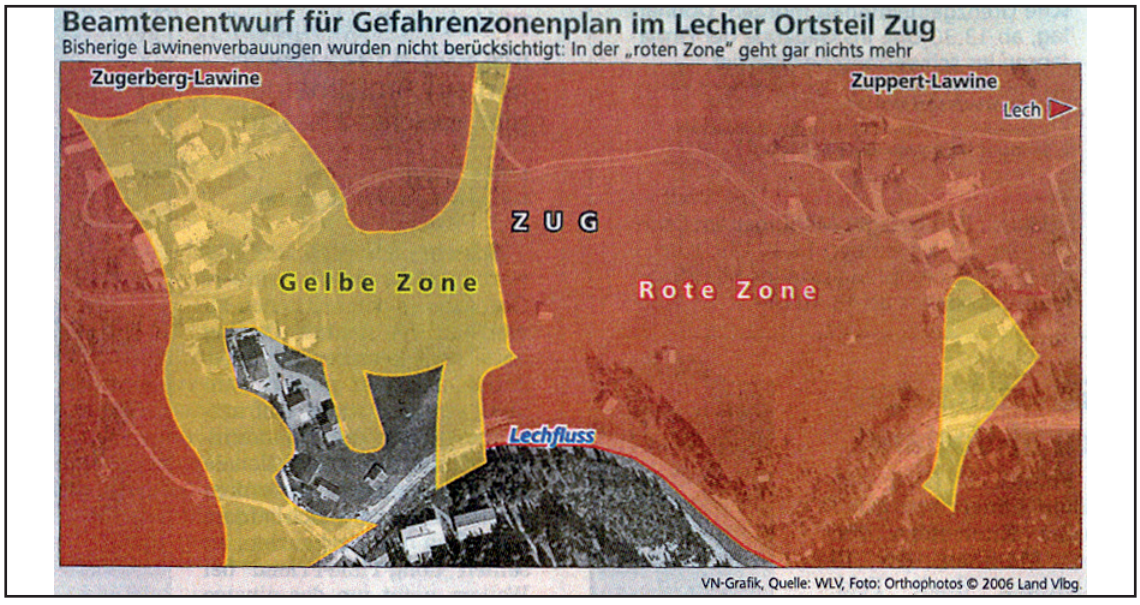

Illustration 7: Presentation of the hazard zones plan in a provincial-level newspaper (VN, N.D.)

new building constructions. On the other side, these measures may be faced by discontent by affected citizens who try to evade it e.g. with help of expert reports during the process of the HZP-revision. In Lech, according to an expert of the WLV, the mayor did not take part on the one or other side and stuck to the facts. (IN0.6) Typically, the mayor has a close cooperation with the WLV. (IN0.7)

It is possible that the mayor accepts the necessity of a new HZP but also does not want to be seen as antagonising to his/her citizens. As the commission of the HZP can ratify with single majority, the mayor may not sign. (IN0.2) In Lech's HZP, the mayor did sign.

4.3.3.4. Lack of information

Many objections make clear that citizens had not been informed sufficiently. (PU-V, 2008B:19-60) They did not know why and how the 1TBS was being introduced or who was in charge. (In the objections section of the HZP, complaints about lacking information were answered by referring to the Forest Act (ForstG) as it is the legal basis for the 1TBS.)

Other objections requested a publicly available GIS (geographic information system) showing all hazard zones plans to the public. This request was declined by the WLV, as it would not be in the interest of the municipality and the province, but access by and through the municipality has always been possible. (PU-V, 2008B:19-60) Having easy access to hazard zones plans appeared to be a major public issue and was also mentioned in newspaper articles. (VN, 2007)

The HZP also mentions that non-professionals may have difficulties to understand the abundance of information in the map of the HZP (depictions of zones for avalanche, torrents, etc.). It was suggested to add thematic maps (e.g. just avalanche related information) for a better understanding. (PU-V, 2008B:19) No consequences of this are known.

A letter from the WLV's DU to the municipality of Lech (DU-Bludenz, 1994A) asked the municipality to communicate to those who were planning to take building measures, that the red zone represented a zone of building ban and building projects involve the decrease of safety. This also shows that citizens often are not informed about HZPs and their effects, or that they ignore the decreased level of safety.

Three objections in the HZP criticised the method and hence the lawfulness of the public-viewing process (because, so it was argued, the property owner was on holiday). Also, three other objections criticised that the planning was not complete and e.g. avalanche blastings were neglected. The WLV answered, that short-term measures could not be included in the HZP. (PU-V, 2008B:19-60) This shows, that some people were not informed about the proceedings of the WLV, or they did not agree with them.

4.3.4. Role of avalanche barrier constructions

The basis assessment for the creation of hazard zones plans are simulations and other sources of data (history, silent witnesses, interviews). (INo.6) From a geological point of view, it would be possible to build avalanche constructions for approx. 80 avalanches out of 103 catchment areas in Lech. 48 of them are relevant and threaten infrastructure, especially in condensed settlement area. (INo.6)

Avalanche barrier constructions were conceptualised in 1999, construction plans were submitted beginning in 1999/2000. In Lech, construction work is still in progress, parts are already finished, but some projects (worth 5 million Euro) will take another couple of years. Then, avalanche barrier constructions will enable the shift of zones by means of the following HZP, i.e. most houses should be out of the red zone. After each year's building period, simulations determine the current danger and thus potentially enable further building measures due to adapted risk (depending on spatial planning) (INo.6)

The municipality has a list setting priorities for the most urgent avalanche barrier construction projects. The district units of the WLV develop and prepare the building projects for the provincial unit which finally confirm funds. Above a certain threshold, the ministry has to confirm the funding. Normally, the state (catastrophe fund) distributes 60%, the province 20%, the municipality and/or the beneficiaries (e.g. lift companies) contribute the remaining sum. (INo.6)

The economic efficiency ('Wirtschaftlichkeit') of avalanche barrier constructions is being raised by the new stricter hazard zones. As there is less space available for settlement, the areas in the enlarged red zone have an increased economic benefit. In consequence, the barrier constructions too are becoming more valuable. (INo.6)

5. Discussion

5.1. Introduction of the 1-ton border setting

5.1.1. Different opinions to the deployment of the new nation-wide regulation

Until approximately 1990 (the precise time is not known), it was not intended to establish a common, nation-wide, legally fixed border setting for Austria. There existed no official or legal border setting criteria. An unofficial and informal agreement on 2.5 t/m² was prevalent, but this was different for each provincial unit of the WLV (Austrian Service for Torrent and Avalanche Control). Hence, no nation-wide criteria existed. In 1991, the ministry strove to establish the nation-wide 1 t/m² border setting ('1TBS') according to interviews with the PU of Vorarlberg and a letter from a district commissioner. (PU-V, 1993 and BH-Bludenz, 1999a) (As a hypothetical avalanche exerts different levels of pressure on the ground, the border setting criteria determine until which value of kg per m² settlement is possible and buildings can withstand the pressure. The change from 2.5 to 1 t/m² represents taking back settlement.)

In 1994, the ministry issued the regulation deploying the 1TBS. This regulation implementing a nation-wide stricter border setting was not accepted by all provincial units.

Nation-wide regulations are useful concerning judicial and legal aspects, but natural assets are not uniform within the area of whole Austria. The PU of Bludenz argued that it is therefore not reasonable to limit development unrelated to the natural environment: in alpine areas, a stringent border setting may result in extremely enlarged red zones which are not necessary and put a halt to further development.

> » „Es wäre in einem großräumigen Gebiet nicht sinnvoll, eine Planung bis an das Limit mit bundesweiten Richtlinien heranzuführen, nur weil dies in den engen Alpentälern erforderlich ist. [...Es ist mit] extrem ausgeweiteten Roten Zonen in den Gebirgstälern zu rechnen, die entgegen der Notwendigkeiten jede Entwicklung stoppen." (PU-V, 1992:1)

This shows that discussions about this topic were led already before the first regulation of 1994. Most opposition against the compulsory regulation implementing the 1TBS came continuously from within the province of Vorarlberg. (INo.5) This is documented by different sources, e.g. a letter from the district commission ('Bezirkshauptmannschaft') of Bludenz/Vorarlberg: (BH-Bludenz, 1993)

Firstly, it is argued that in case of implementation of the 1TBS, all affected municipalities would have to adapt their site-planning ('Flächenwidmungsplan') to the hazard zones planning. As the red zone would be enlarged, zoning of lots within the new red zone would be changed and building measures would be illegal. In consequence, the municipalities would directly be confronted with citizens' claims for re-compensations (e.g. LGBL-V, 2012 in Vorarlberg). Municipalities should not be burdened with this, so was argued in the letter.

Secondly, it is referred to the Forest Act: 'In case of changed conditions concerning hazard zones or their assessment, the hazard zones have to be adapted.'

> » "Im Falle der Änderung der Grundlagen oder ihrer Bewertung ist der Gefahrenzonenplan an die geänderten Verhältnisse anzupassen" (ForstG, §11, Abs.9)

It is argued that changed conditions exist if causes, frequency or amplitude of events or natural processes are changed. The new criteria (1TBS) are not justified by this law as they are 'arbitrary' and not based on real changed conditions. Also, because these changed conditions do not exist, the new zoning criteria are not justifiable.

Summarising these first reactions to the draft of the 1TBS in 1994: The ministry aimed for the implementation of common criteria for border setting for hazard zones and issued a corresponding regulation. In Vorarlberg, the provincial unit as well as WLV-external institutions, foremost the district commissioner of Bludenz wanted to keep the existing border setting criteria (2.5 t/m^2) and did not want to accept the new one. The solidarity and collaboration of Vorarlberg's municipalities contributed to a stronger hence concrete resistance against the ministry. One the other hand, according to Vorarlberg's PU, the WLV and district commissioners of the Tyrol did not come to an united opinion against the 1TBS, concretely, it was said that members of the PU of the Tyrol were continuously arguing what paradigm would suit them the best, whereas voices from Vorarlberg were appearing with a single opinion, rejecting the 1TBS. (INo.2)

The PU of the Tyrol, as well as other PUs in Austria, did not oppose as fiercely as Vorarlberg.

In the regulation of 1994 it was argued that there would not be many effects (in terms of affected houses and properties) because of avalanche barriers that had been built the years before. Without them, many more houses would have been in the red zone. It was also argued that 'not many' objects would be affected by the changed border setting. In practice,

as shown by case studies and general interviews, there emerged more affected houses than the regulation would suggest.

This argument was aiming to downplay negative consequences and reduce uproar. Now, after this new regulation was being applied, it can be concluded that its argument was proven to be inaccurate.

During the discussion and implementation of the 1TBS, officials (e.g. member of PU Vorarlberg, a district commissioner) were aiming to prevent its implementation by referring to the differences of the provinces (i.e. varying geographical situation, hence also different settlement and development premises). It was argued that it is not possible to use nation-wide criteria for different land-use backgrounds.

Spatial planning programs should integrate HZPs created by the WLV. Hence, it could be assumed that the WLV's argumentation is independent from spatial planning. But, as shown, arguments above are clearly based on spatial planning thoughts (differences of provinces, municipal development). It can be concluded, that the WLV is using these arguments to prove that the 1TBS would have negative consequences not for the zoning, but to the reaction of citizens to the zoning. By using these arguments, the WLV goes beyond its standard tasks (creating hazard zones plan purely on scientific basis) and takes initiative in spatial planning matters (e.g. land use planning, social/economic factors) which again influence procedures of the WLV.

5.1.2. Provincial differences and paradigms in hazard zones planning

Despite the ministry's and WLV's intention to establish a nation-wide border setting, the provincial units had different approaches to hazard zones planning. E.g., Vorarlberg had elaborated a slightly own way to operate: a work-flow with spatial planning institutions as well as an electronic work environment (IT environment) were initiated quickly compared to other PUs. (IN0.9)

Yet, the ministry and the WLV kept the intention for a nation-wide border setting. Four months after the disaster of Galtür, the ministry enforced the 1TBS. The disaster had facilitated putting pressure and firmness to compel the whole of the WLV to obey to the new rules to increase safety. (IN0.5 and Mausshardt, 1999) According to an expert of the WLV (IN0.5) effects of the disasters would not have been devastating to such an extent if the 1TBS would already have been in place. Another expert (IN0.3) disagreed; it is possible but cannot be directly assumed as special conditions were prevailing and no generalisations are possible in this case.

Also, it was stated: while facing the disaster, the negative public opinion concerning 'inconvenient' changes in zoning was changing into a claim towards more protection. This

was intensified by media coverage. Already before the disaster, the ministry and politicians wanted to take all possible steps to stop endangerment of citizens and tourists, but these former unpopular measures were possible just now. In the regulation implementing the 1TBS (BMLF, 1994a), it is argued that increased awareness and sensibility of population (especially in tourism regions) towards this processes led to the necessity to create a nation-wide conformity of hazard zones and the border-setting.

Chapter 3.2.2.2. showed that legal and administrative conditions and the framework for hazard zones planning change with time. In Austria, the nation-wide border setting criteria was not officially introduced until 1994. Before then, each PU evolved its proceedings and criteria, adjusted to the local and regional premises (e.g. place for settlement, degree of danger from alpine areas). After much struggle, the commonly used criteria in the PUs were 2.5 t/m^2. In this stage, all PUs had adequate and adapted HZPs which were accepted by municipalities. The new criteria of the 1TBS in 1994 upset these accepted proceedings and hence caused disapproval, especially in PUs with little room for alteration in the HZPs. (IN0.4) Analogous, occurrence, frequency and amplitude of natural processes and hazards are not bound to precise laws but are a dynamic entity that can be adopted to but not be fully understood and integrated. (IN0.9)

In the years before, the ministry itself had to agree and settle on its targets and intentions. From approx. 1990 on, the ministry/WLV aimed at the creation of nation-wide border setting. (PU-V, 1993) The first documented proof of a concrete intention was in January 1994 (PU-V, 1994a), where high-level WLV staff (head of the provincial units and a task force, presumably Group G) expressed their vote regarding the first enactment of the 1TBS, Tirol and Vorarlberg voted against it. This settled the aim of the ministry but yet the powers of self-assertion were lacking. Only the disaster of Galtür made possible the intervening of politics/ministry towards a safer - but more uncomfortable - understanding of safety.

The PU in Vorarlberg initiated resistance against the ministry and the implementation of the 1TBS, which was successful as it led to the withdrawal of the regulation of 1994 (until 1999). This shows that PUs have a certain amount of power and influence on their behalf.

The WLV is divided in the ministerial department (in charge of regulations), the PUs and the DUs. The latter two can be seen as the **people of practice** as they know about local conditions and 'how it works'. This is expanding possibilities of the PUs and thus their potential influence in proceedings of the WLV.

The district commissioner of Bludenz, the WLV and municipalities of Vorarlberg were confronted by the same problems resulting from the 1TBS (e.g. limitation in settlement and restricted land-use). Documents prove connectivity and affinity between the WLV and the district commissioner. These **connections to politics** were another means to ap-

ply pressure for the departure from the 1TBS. (IN0.5) The PU of Vorarlberg therefore opposed to the ministry, whereas it is not known from resistance of other PUs in Austria.

The WLV is an organisation subordinated to the ministry and its subdivisions are therefore supposed to act according to the ministry's aims. The PU of Vorarlberg however proved that PUs (so, the WLV) are **not independent from objectives and programs of local and regional policies**. Vorarlberg's spatial planning paradigm (and law; see next paragraph) allows extensive land use. Vorarlberg has big settlement pressure and is depending on this paradigm to sustain necessary development. The WLV is therefore accepting this objective of spatial planning and sets its actions according to it. This fact was also perceivable through the PU's resistance against the 1TBS.

Another interpretation of this behaviour is that the PUs are subordinated to the WLV on state level, but work more closely together with provincial level spatial planning and are influenced by them more than by the state level WLV.

To understand the relevance of the following **Tyrolean** speciality, the paradox of social behaviour concerning development (chapter 1.3.3.) is referred to. Due to limited safe settlement area, citizens as well as other stakeholders tend to build houses into areas that are at risk. In the **Tyrol**, the **spatial planning** law (TROG) restricts development into more endangered areas by making it illegal. The existence of this law on the one hand proves that this social paradox of settlement exists. On the other hand, the law can be used by the Tyrolean WLV as an argument for the enforcement of a stricter border setting criteria; it is supporting the claim for more security within the municipalities.

No such concrete law to ban development in risk-areas exists in **Vorarlberg**; it is only vaguely stated in the general aims of the law that development should be safe and averted to risk.

Both the Tyrolean and Vorarlberg spatial planning law determine that no building is safe in unprotected area, but the wording is fundamentally different (chapter 3.1.2.2.). The Tyrolean spatial planning law **prohibits** building in areas where hazard zones plans defines settlement not safe. The Vorarlberg spatial planning law **allows** building if protective measures are technologically and economically possible and justifiable. This underlies the postulation of following two different paradigms.

The spatial planning laws of the provinces are determining the development within hazard zones:

- The Tyrolean TROG is restricting development towards a higher degree of risk, even within the yellow zone. The WLV follows this approach and therefore acts according to this **paradigm of restricted development**. As settlement is possibly elsewhere, at least to a certain extent, this paradigm is practicable.

It can be concluded that the Tyrol did not have as heavy arguments against the 1TBS (as had Vorarlberg) because of this paradigm of the WLV which was rather compatible with the 1TBS.

- In Vorarlberg, the spatial planning law does not explicitly prohibit development into more endangered zones (providing that protective measures are possible). Due to limited settlement area, the general paradigm in the province and the PU is to maximise land use and therefore exploit all possibilities of settlement, which was exerted by the WLV because no spatial planning law prohibited it.

  This **paradigm of extensive land use** was adapted to the old border setting of 2.5 t/m^2 and was satisfactory to all involved actors in the PU and the municipalities. The 1TBS introduced a massive change in land use and made impossible the existing paradigm of extensive land use. Therefore, it was fought against by the WLV in Vorarlberg with arguments that modus operandi and procedures would be disrupted (e.g. complete stop of development (BMLF, 1995B))

Those two paradigms are based on case studies and interviews. They underlay and confirm the way of thinking in those two PUs.

According to the case studies, these approaches and paradigms did not change during the implementation of the 1TBS, they were the same before and after it.

In chapter 1.3.1. was illustrated to what extent the four phases of risk management are a way to establish a risk culture by minimising risk within the four phases of the 'risk management cycle' (risk assessment, risk prevention, disaster management and regeneration). The 1TBS could be interpreted as an element within the iterative process towards a safer risk management, at least on a limited dimension. During the phases of risk assessment and risk prevention, the 1TBS provides a safer understanding of risk analysis and valuation by means of a higher estimation of risk. Also, a better preparedness in terms of resilience can be assumed. Effective risk management in the municipalities is not noticeably influenced by the 1TBS as the avalanche commissions' processes appear to remain unchanged.

The ministry puts orders and limitations onto the WLV. The WLV has many duties which are specified for the provincial unit, the district units and the municipalities. For the context of the 1TBS, there exists an imbalance between the ministry and the WLV. The first initiating steps for the regulation came from staff of the WLV on different levels. This was backed and influenced by members of the WLV. The official regulation was issued and enforced by the ministry who neglected information about possible problems. This illustrates imbalance of information which leads consequently to conflicts while managing the risk (change in processes and zones resulting in protests). Those conflicts are theoretically

avoidable. Though, in effect, the 1TBS is increasing the overall long-term safety and therefore the problems during the implementation can be argued to be worth the effort.

The ministry is on the highest hierarchic level of the WLV and is competent to issue official regulations which are supposed to be followed by all subordinated agencies of the WLV, with or without their consent. As was shown, this is not fully the case as Vorarlberg was in a position to revoke the regulation.

Formally, the WLV is an organisation subordinated to Austria's ministry and acting in its name. National funds ('Katastrophenfonds') are used for the financing of constructions of avalanche barriers. In a fair and official priority listing for constructions, the most risk-prone avalanches or torrents would be and normally are constructed first. (Weiss, 1998:294) Though, it is not impossible that the WLV aims for the national funding for a construction project that does not have the highest priority according to the list. The disaster of Galtür showed that a concrete event with actual damage can be a trigger for actions of the state, ministry and the WLV. Also, municipalities harmed by an event are more likely to receive funding, while public awareness exists.

Municipalities and interested citizens both want to further development and settlement in new areas, which results in more overall risk for local premises. This was already discussed in theory (see chapter 1.3.3., 'risk spiral' and 'Local Government Paradox'). It can be concluded that new and **stricter regulations** for border setting usually **do not originate from within the municipality**, as the municipality is focused on further development. (PU-V, 1992) The ministry is in the position to initiate, issue and impose nation-wide regulations on the WLV and the municipalities. As mentioned above, to a certain extent, the WLV has possibilities to resist them. Thus, there existed two clashing points of view: the ministry pleaded for safer border setting criteria, the WLV in Vorarlberg was opposing because of resulting problems. Vorarlberg's WLV prevailed against the ministry, by means of communication and argumentation. Consequently, the 1TBS was dropped (until the 1999 disaster in Galtür happened).

5.2. Effects of the 1-ton border setting and reactions by different stakeholders

5.2.1. Reactions of citizens to the 1-ton border setting

Both case studies of this thesis were selected with the aim to find as many and strong effects as possible during the change in zoning. Cases were chosen with a typical effect of the 1TBS: the enlargement of the red zone. This approach leads to a maximum of possible reactions of citizens and other stakeholder to the regulation implementing the 1TBS.

Lech is representing a tourism-related municipality with many strong economic interests (hotels, winter sport) and also very scarce settling area and big settlement pressure.

Telfs is representing a municipality with just one avalanche but a large part of the settlement area affected.

These two examples as well as interviews confirm that the 1TBS was implemented within relatively short time and hazard zones were expanded shortly after, putting many properties into the red zone with all its consequences. Most of these properties have to be protected by avalanche barrier constructions. This was used as argument by the WLV to eliminate frictions between citizens and the WLV: it was reasoned that consequences of the 1TBS (limited development) are **just temporary** until the barrier constructions cause the zones to be moved back again and the properties are out of the red zone as they were before.

As it was discussed in chapters 4.2. and 4.3., the reactions to the new border setting were manifold: citizens, municipalities and PUs were either supporting, accepting or declining the 1TBS with different intensity. Future changes by the 1TBS (creation of a new HZP) could be anticipated and, not being formally necessary, were commonly complied with by the municipality. The most common cause for problems were newly planned or additional buildings whose site-planning and building permit were hindered because of this pre-emptive planning for the 1TBS or, later, due to the official hazard zones plan officially implementing the 1TBS.

For affected or not affected citizens similarly, the most common reaction to the 1TBS was a lack of understanding. The use of this new guideline was not comprehensible: 'Prior big avalanches were not resulting in any harm, why should the next do so? Why changing something that has worked until now?' (PU-V, 2008B:19-60)

In the case study Lech, the municipal risk management and the avalanche blastings were not included into the hazard zones planning. This was criticised, but the WLV argued that just lasting measures of the WLV can be included.

In consequence, many citizens responded to the 1TBS with opposition and agitation.

The WLV allows those affected citizens to post well-reasoned objections that potentially could move their property out of the red or yellow zone. The case study Lech showed that this is an instrument of public participation able to both reduce the negative effects of the new zoning and to improve the hazard zones plan itself. Opinions and reports of citizens lead to more accurate zones and may help to reduce danger.

5.2.2. WLV's handling of affected citizens and stakeholders

It was mentioned repeatedly that the WLV has a good collaboration with spatial planning agencies and the municipalities for the creation of site-planning. E.g. the spatial planning office backs up the decisions of the WLV, which, generally speaking, cannot always be taken for granted. The WLV also backs up spatial planning decisions. The WLV also aims to have a **good relationship** with affected parties (i.e. citizens). The WLV illustrates them possibilities to upgrade and improve their situation by providing free information, e.g. about legal possibilities. Therefore, property owners are mostly cooperative ("kulant"). On the other hand, the WLV is bound to its regulations and the law and cannot deviate. It expects citizens to be autonomous and self-responsible and to initiate legal means if necessary and possible. (INo.4)

According to the ForstG, the WLV has to take into consideration objections of citizens and affected persons. ("Stellungnahmen [...] sind hiebei in Erwägung zu ziehen." ForstG, §11, Abs. 5) The way and kind of dealing with objections is therefore not specifically determined. Voluntarily, the WLV applies additional time and effort to minimise problems with individuals. The commission of the WLV visits every objecting party on their property and discusses the matter with them. According to the PU Vorarlberg, this additional commitment and expenditure of time (up to several days of time) is worth the effort because the character and type of communication is crucial, as well as the way of conveying the commission's decision to the property owner. Conflicts can be minimised by aiming for a consensual solution while being on site and in personal contact. (INo.2)

In chapter 1.3.2. was shown that **participation** is a reasonable measure of improvement; citizens have the possibility to learn about and then contribute to the process. For the implementation of the 1TBS, this procedure of contact with citizens eases the process on the long term as conflicts are cleared away, where possible.

The objections of the case study Lech (chapter 4.3.) show that the WLV is rejecting and accepting claims based on arguments concerning the aims of the hazard zones plan. If a citizen objects that his property's condition is safe, e.g. by means of an expert report, the WLV has to accept this certified argumentation for the benefit of the citizen, if it is in accordance with aims of the WLV. If the report or argumentation is not flawless, the WLV puts scrutiny on the issue and (at least partly) rejects the objection. It is also possible that the

new detailed inquiry leads to a situation even more unfavourable by the citizen (who expected a betterment of his situation by his objection). (PU-V, 2008B:19-60, OBJECTION 74)

In can be concluded that the WLV adheres to the law by taking into account well-argued objections with scientific accuracy.

> 'A commission has to examine the professional validity of the draft of the hazard zones plan. If it is necessary, it has to be adapted. Objections submitted in time have to be included in this process.'

> „Der Entwurf des Gefahrenzonenplanes ist durch eine Kommission [...] auf seine fachliche Richtigkeit zu überprüfen und erforderlichenfalls abzuändern; rechtzeitig abgegebene Stellungnahmen [...] sind hiebei in Erwägung zu ziehen." (FORSTG, §11 ABS. 5)

The case study Lech demonstrates that there exists a dependency between economic interests, the differing degree of acceptance for the new border setting and HZP, and finally the construction of avalanche barriers. Public opinions opposing the 1TBS as well as influential economic citizens are depending on avalanche barrier constructions to stay on the same level of safety. Nevertheless, decisions of the WLV are not alterable by these factors, but they have influence and are considered in the proceedings of the WLV.

Knowledge for this thesis originated from research and interviews within the WLV, this and also documents and WLV-external staff confirmed following impression: The district units of the WLV are most notably responsible for the hazard zoning and creation of expert reviews of individual building constructions; they obey the rules of the ministry and 'do their job', trying to cooperate and give satisfaction to anybody concerned. While doing so, they can create a positive relationship with other actors by helping them and allowing them to counteract.

E.g.: Cooperation between WLV and citizens is possible by informing about the legal situation and possibilities: If a house owner wants to have a building measure done, the WLV (PU or DU) would try to show goodwill and show steps possible to reach the aim, if possible. The WLV cannot and does not help if the building project is not possible due to evident opposing legal terms (e.g. in red zone).

Concluding, the WLV aims to have a good relationship with citizens and to be transparent, careful and helping but on the other hand firm and obliging to their objectives and laws.

5.2.3. WLV's handling of media and public opinion

Newspapers and other media showed a 'dramatic' version of the changed zoning, they were said to use cuttings of hazard zones plans with an above-average colouring of red, where the context is not apparent and it appears that the zoning of almost the whole municipality has changed to red. Over-regional media was illustrating the situation of the hazard zones planning and its economic effects on the citizens (ban of new building, very constrained building measures). This had the potential to discomfort readers and citizens and give them a biased understanding of the risk and HZP situation. Following the argumentation of the newspaper articles, the hazard zones planning is not important for the reduction of overall risk because necessary precautionary measures are already taken. Though, in the case of a harmful avalanche event, media would potentially cover the missing safety measures. Hence, it can be concluded that the media did not cover all aspects but took a biased approach on these issues which was more appealing to the readers/citizens and their private interest as citizens.

The WLV aimed to actively **alter public interpretation** and perception of hazard zones in the case study of Lech to minimise conflicts. They discussed the possibility to replace the colours red and yellow by different forms of hatching, as those would not appear as dangerous to the public. (INo.6) It is not known if concrete effects followed to this intention.

This indicates also a major phenomenon of the different perception of hazard zones:

- According to the WLV, citizens do not perceive the threat of the avalanche as the primary issue but the enlarged hazard zone. 'People were more frightened for the zone than for the avalanche, because the media could report that many hotels are in a red zone'. (INo.6) For citizens, the red zone represents obscure consequences. This may be justified by lacking information about the procedures and purposes of hazard zones planning, an unknown, potentially limited future concerning building measures.
- According to data received from case studies, the issue of real danger is not of primary concern as there was partly no awareness of risk. ('There was no disaster for the last 500 years, why the new regulation now?') The perceived problem for citizens was the changed zoning and its consequences in building activities. A third of Lech's objections explicitly argued that there never had been a disaster, further 10% criticised the HZP as 'arbitrary'. (PU-V, 2008B) Avalanche barrier constructions were used as argument to stall their building plans, in almost all cases the WLV could achieve a consensual dispute settlement.
- According to the law (GZP-VO, BGBL. 436/1976), the hazard zones plan is a resource to increase safety by means of spatial planning. The HZP has several effects (i.e. hindering development in endangered zones or construction/financing of ava-

> lanche construction barriers) but it should not be conceptualised as a harming entity of the WLV but as a tool for increasing safety. (INos.2+6)

These three approaches towards hazard zones demonstrate that hazard zones increase the safety of municipalities. Nevertheless, citizens primarily perceive the disadvantages of the HZP and eventually accept the benefit of the HZP subordinately, or the never accept it.

In the process of creating hazard zones plans, the WLV takes into account different factors and parties involved. The case study Lech demonstrated that public opinion and media have a direct influence on the behaviour of the WLV. Changes in Lech's situation as a winter sport area are easily perceived in media, especially in the winter half year. Hence, the WLV tried to **avoid conflicts** by postponing the press conference issuing the implementation of the new HZP in the winter time. The conference was held later, in summer. Therefore, (biased) effects by media on public opinion were minimised and the issue was made less dominant than it would have been in winter.

5.3. Creation of hazard zones plans

5.3.1. Simulation and border setting

Simulation is a relatively new resource for the border setting and the creation of hazard zones. Before simulations were used to determine borders of hazard zones, it was common to use silent witnesses in the field (rocks, vegetation), history of the area and avalanches, and interviews of locals ('historic method', 'historische Methode'). Since the simulation by computer is possible, the different possibilities for simulation were added, but did not replace the classic approaches but replenish them; both together, for the same amount, account for the border setting of hazard zones. According to interviews and mentioned documents, simulations and the classic approach are equipollent and used with the same priority.

In the documents instituting the 1TBS (regulation of 1994) it is argued that there would not follow many effective changes in the border setting of HZPs, as the historic method would lead to a border setting similar to the one from the 1TBS simulation. The implementation of the 1TBS in the HZPs proved this to be untrue, at least for both case studies Telfs and Lech. In these case studies, the zoning before the 1TBS was conducted with help of the historic method and respecting all legal standards. Nevertheless, the 1TBS considerably increased the red zone.

If simulations or the classic approaches do not deliver the same border lines for the hazard zones, the larger of them, hence the more careful of them are chosen. This principle ('summation line') aims to provide an additional level of safety.

» Silent witnesses, questioning of locals, study of records etc. is more frequently used than calculations, probabilities and simulations

This hypothesis (chapter 1.2) has therefore to be negated as these approaches are used with the same frequency and importance.

During the process of the creation of hazard zones plans, attention has to be put on transparency and credibility of arguments, documents and reports. The mentioned historic method is relying on a subjective consideration of the data, e.g. historical data and silent witnesses can be interpreted variably. Lines of argumentations are reassessed and supervised by all readers of the HZP under scrutiny, foremost the HZP-commission. Simulations are resulting in concise maps, their process of creation has also to be argued and documented to be understandable and replicable. It therefore seems to be impossible to make alterations based on individual's interest. In Vorarlberg, it was also mentioned that if buildings and humans are at stake, the WLV tends to be especially careful and examines two to three times if all data is correct. (INo.4)

In the process of creating border lines for the HZP, no attention is paid on the current land use of the area. In consequence, borders between zones may pass through houses.

Property owners who intend to build or alter a house that lies within the yellow zone have to include the prerequisites determined by the zoning into the new building process, e.g. fortification measures. If the zoning border cuts across the house, fortification measures are still necessary according to the precise boarder.

Property owners who want to expand the building or want to be out of the red zone may accept that they cannot change the building or the zoning. If they cannot accept it, they have to prove during the HZP process that their plots are not in the red zone, if it is possible.

During the scoping of this thesis (chapter 1.2.) formed the hypothesis

» Zoning was (at least partly) conducted more carefully than required so that the zones remained at the same location: the 1 t-border being the same as the 'overcautious' 2.5 t-border.

In Telfs as well as in Lech, there exist two hazard zones plans, one before 1994 (before the 1TBS) and one after 1999 including the 1TBS. For both, the former HZP was not equivalent to the new HZP. The red zone was corresponding to the 2.5 t/m^2 border setting, and not to the 1TBS. This was proved by the existence of changes to the new border setting, i.e. zoning becoming bigger and taking in more houses. The former HZP did not substantially differ from the 2.5 t/m^2 border setting. Also, expert interviews (INos.4+6) indicate, that the collective of planner and HZP-committee of the old and the new HZP did **not** aim for a more stringent HZP by e.g. taking precautionary alleviating measures for the next HZP.

The hypothesis was envisaged to confirm that at least in some cases a more than necessary (a more careful) border setting was introduced. The hypothesis cannot be affirmed. The regular and typical process of the HZP happens according to legal documents and the law, the WLV does not deviate from their tasks. One reason for this could be that planners barely 'do their job' as they do not want to get criticised for so-to-say unlawful behaviour of implementing a stricter border setting at will.

It has happened a few times that the HZP became smaller than the legal requirements would have demanded: the planner for the HZP was suggesting a more stringent zoning than the HZP-commission was agreeing on. This is the only possibility for the HZP to become smaller. Only in case of a disaster, this conjuncture has consequences, but for the planner as he/she becomes ousted from responsibility by the decision of the commission. These cases were not related to the implementation of the 1TBS and were therefore not investigated. (IN0.2)

Another subset of the hypothesis above dealt with the question if hazard zones always get bigger during the implementation of the 1TBS. The regulation states that the pressure threshold value is decreased from 2.5 to 1 t/m^2. Hence, the red zoning **cannot become smaller** by means of definition of this new border setting; they logically have to get bigger.

Hazard zones plans focus on one region of a municipality regardless of the number of avalanches under scrutiny. Alterations in the guideline of 2011 (BMLFUW, 2011:9+23) describe a new approach of the hazard zones planning procedure. HZPs may be created not according to the area affected but to the origin of the hazard. Hence, a HZP should be created for affected area of *each* avalanche or other source of hazard (one HZP per avalanche etc., chapter 3.2.2.2.) (IN0.9) This regulation is of primary administrative nature. Nevertheless, it has potential impact on the municipalities and the WLV. In consequence, HZPs could be revised more often and easier, and in faster response to a change of natural conditions (e.g. barrier constructions or changed land use). Future development of the WLK will have to show if this regulation will be introduced in the practice of the WLV. This cannot be estimated as the wording of the regulation is making it optional.

5.3.2. Success of hazard zones planning

It is not the main subject to this thesis to determine the success of the implemented or old hazard zones planning. However, an answer to this question gives better understanding of the necessity of effective HZPs and also highlights the reason for the new border setting criteria (1TBS).

The declared aim of the WLV is the creation of hazard zones plans which in effect should reduce risk in living and settlement area. Hence, success of HZPs could be measured in

terms of accomplished increase of safety. After introduction of the 1TBS, objects in the red hazard zone are moved to the yellow zone by means of avalanche barrier constructions. Despite the risk being reduced, remaining risk still prevails and cannot be eliminated due to the incomplete controllability and predictability of natural processes. It is not possible to account for every degree of risk, so the WLV established a level of risk that is accounted and planned for (150-year-event). For every expectable event within this limitation, people should be safe, with an accepted remaining risk.

Discussions within the WLV of the last decades and finally the disaster of Galtür led to the understanding that the border setting of 2.5 t/m^2 is not appropriate and does not provide the sufficient level of safety. This was shown by the disaster of Galtür where insufficient fortifications and precautionary measures led to human losses. This caused the implementation of the 1TBS, which is enforcing changes in settlement and construction of avalanche barriers, resulting in an overall reduction of risk.

The 1TBS caused many changes for affected citizens, it took time and effort for the WLV to implement this new border setting and have all shareholders accept it and take it seriously.

The effects of the 1TBS are not visible immediately. By physical means, the condition is just safer beginning from the moment of finished barrier constructions. By political and social means, the HZP has to be revised after the finished constructions and spatial planning laws are complied with. In consequence, the **safety increases**.

The 'spiral of risk' (chapter 1.3.3.) describes ongoing spatial development which is followed by the construction of avalanche barriers, resulting in new development and therefore the failure to reduce risk efficiently. If settlement would remain as is, the barrier construction would increase safety. Nevertheless, settlement occurs with time going. This confirms the paradox 'spiral of risk'. This development can theoretically be abated if spatial planning laws are thoroughly exerted by the municipality and settlement is completely hindered. Practically, though, settlement is happening and cannot be completely stopped.

The question to the success of hazard zoning planning leads to the question of the success of avalanche barrier constructions. For Telfs, the value of averted danger (houses getting out of the red zone) was calculated with 40 million Euro by a cost-benefit analysis, compared with maximum 7 million Euro of construction costs. Cost-benefit analyses are not addressed in this study, but this number shows that barrier constructions have benefits to the objects at stake as well as for the municipality.

5.4. Role of avalanche barrier constructions

To reduce risk from avalanches in an area, it is either possible to build protective measures (barrier constructions) or to completely withdraw settlements from the affected area.

The second possibility was not issued in this thesis as is it not a practical or realistic approach.

The 1TBS changed the hazard zoning and shifted the zoning of objects from yellow to red. To revert this, it is universally accepted and necessary to construct **avalanche barriers**. With this measure, it is possible to **reconcile the hazard zones planning procedures with the 1TBS**. No new approaches of dealing with the risk were discovered in the proceedings of the WLV.

The mayor of a municipality is responsible for the safety of his citizens (by criminal, administrative and civil law, and also by the regulation for revocation). He/she has to take initiative and apply at the WLV for construction barriers. In both case studies, this happened years before the 1TBS came into action.

The fact that the mayor is responsible for the safety of his citizens improves the safety as he/she actively takes measures for risk reduction.

Because of the effects by the regulation for revocation, the role and accountability of the mayor is continually strengthened. During the time of the implementation of the 1TBS, he/she may face many citizens' objections concerning risk reduction e.g. by hotel owners who tend to ignore the risk. It is the mayor's responsibility to enforce necessary steps for the measures demanded by the 1TBS (e.g. site-planning and development)

Avalanche barrier constructions aim to establish safety for existing objects and houses by reducing the danger and destructiveness of avalanches. It is not their immediate aim to reduce the size of the hazard zones but to reduce the risk for existing houses (compare regulation for revocation, 3.2.2.2). So, avalanche barrier constructions are designed to primarily reduce risk of objects in the red zone. **After finished construction measures and a new zoning by a HZP, these areas will be in the yellow zone** and further building measures are again possible (respecting prerequisites of site-planning and spatial planning).

Avalanche barrier constructions did always cause an increase in safety and also caused the decimation of affected hazard zones. The 1TBS did involve a new factor. Following hypothesis was formed to prove if the role of the barrier constructions stays unchanged.

» The stricter guideline and consequently the avalanche barrier construction counterbalance each other.

Zoning before and after the implementation of the 1TBS are comparable. Both case studies and interviews confirm this. **This is possible by the construction of avalanche barrier constructions.** Therefore, the hypothesis (chapter 1.2.) can be confirmed.

Not all risk can be cancelled out by avalanche barrier constructions. Therefore, the spatial planning laws are crucial for the limitation of the further increase of risk; the municipality has to enforce these to keep the risk low and not to increase risk again. (See risk spiral, chapter 1.3.1.)

6. Conclusion and outlook

This thesis took under scrutiny the genesis of the new criteria for border setting in avalanches hazard zones planning and the implementation of the corresponding regulation by the ministry. Interviews with relevant actors and the selection of two case studies (municipalities) were chosen as methodology. As interviewees were chosen actors of the WLV (the Austrian Torrent and Avalanche Control Service) as well as other experts involved in case studies. As case studies, two municipalities were selected according to the amount of factors influencing the implementation of the border setting, having a range of effects as broad as possible.

The WLV is responsible for following tasks.

1. Providing information. Knowledge and information about natural hazards and processes is generally provided to the public. In the process of hazard zones planning, the WLV assists municipalities and helps citizens by informing them about general proceedings and affected citizens are advised about their possibilities (e.g. to initiate an expert review rectifying WLV's hazard zone plan). The WLV also creates cost-free expert assessments of houses which may be built or altered.
2. Hazard zones planning. Based on the design-event of an avalanche occurring every 150 years, hazard zones are created for avalanches. They incorporate the degree of risk in two zones. Red zone: high risk, houses are expected to not withstand the pressure of the avalanche; therefore new settlement is not safe. Yellow zone: existing risk, but development is possible with special requirements. The degree of risk is represented as pressure hence kg/m^2. The WLV is creating hazard zones plans by simulating avalanches based on elevation models and combining this with the historical data of the avalanche zone (silent witnesses, interviews of locals).
   A new hazard zones plan does not have direct legal implications; spatial planning authorities i.e. the municipalities have to halt further building measures (red

zone) and require special building requirements (yellow zone), by means of e.g. site-planning and building site plan ('Flächenwidmungsplan', 'Bebauungsplan')

3. Construction of avalanche barriers. This is the commonly accepted solution to enhance safety by obstructing the flow of an avalanche. In consequence, the zoning of hazardous area can be reduced in size.

Staff of the ministry considered in the last decades to introduce nation-wide border setting criteria for hazard zoning. Also, the value determining the border between red and yellow zone should be changed from 2.5 to 1 t/m^2 (1 ton border setting, 1TBS), resulting in an enlarged red zone where building measures are stopped and overall safety is increased. The perseverance to issue this invasive regulation was not possible until the regulation was issued in 1994 on a provisional basis. The 1TBS caused protests in Vorarlberg (e.g. provincial unit of the WLV, a district commissioner), many citizens affected by the 1TBS did not understand why the until then finally accepted border setting would have to be replaced by another 'not necessarily safer' border setting. Also, it was argued, that different topographical properties of different provinces would oppose a nation-wide approach for border setting criteria. The protest by the WLV caused the regulation to be quasi-nullified. This showed that the **provincial unit of the WLV had sufficient influence on the ministry for it to withdraw the regulation**.

The disaster caused the public opinion to wish for a more safe approach of hazards. Protests after the 1994 regulation were the reason for the regulation to be withdrawn, but the disaster of Galtür and the public opinion enabled the ministry to **irrevocably re-enact** the 1994 regulation. This resulted in the **enlargement of the red hazard zones and in the immediate stop for building** and development projects that were affected by new zoning. Projects for changing buildings were strictly regulated and controlled by the WLV.

Reactions to this change were manifold, citizens were either accepting it or complaining and objecting it. Reactions did depend on the kind of building in the enlarged red zone; family houses did not face many changes, but industry and business areas were confronted with a vast amount of working precautions, limitations and regulations. Hotel-owners in tourism regions felt threatened by the media as they could report that the hotel was less safe because of being in the red hazard zone.

The regulation implementing the 1TBS changes the border setting to a more strict value, therefore, the **red zone is always enlarged by the 1TBS**. Because of new houses in the red zone, avalanche barriers are constructed. When they are finished and a new HZP is assessing and formalising the new degree of risk (which was decreased by the barrier construction), the zoning of buildings does typically change from red back to yellow, as it were before the introduction of the 1TBS. So, **the effects of the barrier constructions by tendency**

nullify the effects of the 1TBS. (Second hypothesis confirmed.) Then, the municipality has to care for the preservation of security; if new settlement would be done towards the avalanche, gained safety is again reduced (spiral of risk). It can therefore be said that the 1TBS is increasing over-all safety.

Beginning from the introduction of the 1TBS, during the implementation and until the new HZP, building measures are not possible or under restricted circumstances, respectively. During this time, the WLV reasoned with affected citizens that within a couple of years, the zoning would be as it was before; this helped to reduce objections.

For the creation of the hazard zones plan, computerised **simulations are equipollent with the historic method**, the computerised simulation based on GIS and data from the field deliver a line which is confirmed by the data from silent witnesses, interview of locals and historical documents. (Third hypothesis negated.) Combined, they create the hazard zones which are made official through a hazard zones plan. In the process of the official confirmation by the HZP-commission and the ministry, affected citizens have the possibility to object the zoning e.g. through expert reviews.

Data from interviews and literature indicated that hazard zone planners may have used a planning approach that differed from the then valid border setting criteria by being more strict and thereby anticipating the coming new stricter criteria (1TBS). Also, it was postulated by the ministry, that the 1TBS would not cause much direct change. In the two case studies, it was shown that the 1TBS had large and direct effects in terms of enlargement of the red zones. **Old hazard zones plans did therefore not have more careful border setting than required at that time.** (First hypothesis negated.)

The **postulation of two paradigms** helped to explain the differences between the provinces Vorarlberg and the Tyrol concerning their behaviour during the implementation of the 1TBS. The spatial planning laws of the provinces determine the development within hazard zones: The Tyrolean spatial planning law is restricting development in areas with a higher degree of risk. The WLV follows this approach, as it is compatible with the spatial possibilities - **paradigm of restricted development (the Tyrol)**. In contrast, the spatial planning law of Vorarlberg does not explicitly prohibit development into more endangered zones. The WLV follows this spatial planning approach as development area is scarce and needed - **paradigm of extensive land use (Vorarlberg)**. In consequence, the 1TBS has a more dramatic effect on Vorarlberg as there is smaller 'buffer' area for this stricter border setting situation. These two paradigms of the WLV show the differences in their approach to the 1TBS.

The task of the WLV is to depict the degree of danger by means of hazard zones plans and the 1TBS. The physical risk remained unchanged, but the new assessment criteria

(1TBS) led to changed municipal land use plans. The case studies and experts of the WLV suggested that affected citizens are concerned about the new land use plan but not about the physical danger, because the media reported about negative consequences of the regulation. It was shown that the WLV tried to exert influence on the media to limit coverage about negative effects of the 1TBS (e.g. not holding a press-conference in winter-sport time, or contemplating to use hachured instead of red representations of the zoning).

The WLV generally appears to collaborate closely with the municipalities, its citizens and other official organisations (e.g. spatial planning). The **WLV helps affected citizens** but on the other hand **rigorously obeys its rules and laws**.

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This thesis was taking under scrutiny two municipalities and a selection of documents. A more profound and funded research would be useful to elaborate a representative overview over Austria's situation in the whole of Austria. Also, documents of differing provincial and district units would allow a more holistic understanding of processes within the WLV. The author is aware that the limited selection of interviews and case studies may have involuntarily led to a partially biased or incomplete insight. Nevertheless, the thesis is able to deliver predicative insights in the proceedings of the WLV and prove the existence of contradictions, procedures and roles of actors.

Also, the next years will show to what extent the hazard zones planning varies before and after the implementation of the 1TBS and after the completion of all barrier constructions. According to the interviews, it should be comparable to the zoning before the implementation of the 1TBS, by tendency even safer - as now all houses are safe, and not many of them. This could be a further research question in 5-10 years' time. Also, the thesis was written with an emphasis on the processes of the WLV as they are the main actor. But other actors, such as citizens, could not be included in full detail. This, too, could be used as a research question.

7. Glossary

In this thesis, English language is used. It was necessary to use English words instead of the German expressions and nomenclature - resulting in loss in precision. This chapter aims to explain the used expressions to make the text clear and comprehensible in the English as well as the German language.

Baubehörde ⟶ Building authority

Bebauungsplan ⟶ Building site plan

Building authority — Baubehörde - Spatial planning laws compel municipalities to do spatial planning on municipal level. This municipal office is creating the municipal spatial development concept, the site-planning and the building site plan. The term building authority is not the official translation but describes the role of the office within the municipality.

Building site plan — Bebauungsplan - An illustration/map of a municipal area, scaled down to plot level and showing and determining site-planning and prescriptions for buildings as well as their restrictions and properties.

Bundesland ⟶ Province

Commission of the WLV — The Forest Act determines that a commission has to confirm hazard zones plans by their signatures. This commission has to consist of one deputy of the ministry, one deputy of the WLV, one deputy of the province and one deputy of the municipality.

District commissioner — Bezirkshauptmann - head of the regional administrative unit

District unit (of the Avalanche and Torrent Control Service, WLV) — 'Gebietsbauleitung', 'GBL' - an office of lower hierarchy within the WLV, responsible for the operative duties of the WLV.

DU ⟶ District unit

Flächenwidmungsplan ⟶ Site-planning

ForstG — Forstgesetz - Austrian Forest Act, law regulating the use and state of forests

Gebietsbauleitung or GBL ⟶ district unit

Gefahrenzonplan ⟶ HZP, hazard zones plan

Gefahrenzonplan-Referent ⟶ HZP-Referee

Group G — 'Gruppe G' - describes the assembly of the HZP-referees of the provincial units of the WLV. At least once a year they meet to discuss academic and technical fundamentals of the hazard zones planning.

Gruppe G ⟶ Group G

Hinderungsgründe - Richtlinie Hinderungsgründe ⟶ Regulation for revocation

Hinweisbereich ⟶ Referenced zone

HZP — Hazard Zones Plan ('Gefahrenzonenplan') - a plan on municipal level showing all possible threats through avalanches and torrents

HZP-Referee — Hazard Zones Plan Referee of the WLV ('Gefahrenzonenplan-Referent' or 'GZP-Referent'). Each provincial unit of the WLV has a HZP-referee with academic background, whose tasks are amongst others: coordination of the creation of new hazard zones plans within their provincial unit, discussing basic policies on scientific basis.

Landesregierung ⟶ Provincial government

Ministry — 'Lebensministerium' or 'The Ministry of Life' - the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. It is responsible for the Torrent and Avalanche Control Service (WLV) including hazard zones plans etc. (http://www.lebensministerium.at/en.html)

Municipal spatial development concept — 'Örtliches Entwicklungskonzept' in Tyrol or 'Räumliches Entwicklungskonzept' in Vorarlberg. This strategic concept has to be created by every municipality, showing e.g. (planned) development of the area (settlements, traffic systems..) and free spaces for protection against hazards.

Örtliches Entwicklungskonzept (Tyrol) ⟶ Municipal spatial development concept

Provinces of Austria — Bundesländer - Austria is consisting of nine provinces (federal states): Vienna/Wien, Burgenland, Lower Austria/'Niederösterreich', Upper Austria/'Oberösterreich', Salzburg, Styria/'Steiermark', Carinthia/'Kärnten', the Tyrol/'Tirol' and Vorarlberg.

Provincial government — Landesregierung - the government of a province (federal state)

Provincial unit (of the Avalanche and Torrent Control Service, WLV) — 'PU', 'Sektion' - organisation unit, part of the WLV mid range level, subordinated to the Ministry, seven PUs in Austria.

Planning area ⟶ Planungsgebiet

PU ⟶ Provincial unit

Räumliches Entwicklungskonzept (Vorarlberg) ⟶ Municipal spatial development concept

Raumrelevanter Bereich ⟶ Relevant planning area

Referenced zone — Hinweisbereich - areas that may be affected by hazard zones but are not directly in the catchment area, they may be sensitive in respect to cultivation and management

Regulation for revocation — Richtlinien betreffend die Handhabung von Hinderungsgründen für den Einsatz von Förderungsmitteln des Bundes im Zusammenhang mit Wildbächen und Lawinen, im folgenden kurz 'Richtlinien Hinderungsgründe' genannt - Guidelines concerning the operation and handling for deployment of state funds for avalanches or torrents - a decree of 1980 influencing the behaviour of the municipality, hindering building measures in red zones:

Relevant planning area — in the context of hazard zones planning, not the whole area within the borders of a municipality is taken into consideration, but only the areas which affects settlement, people or structures. This is called 'raumrelevanter Bereich' or here relevant area.

Reservation zone — 'Vorbehaltsbereiche' - zones that should be kept clear for subsequent measures for planning or construction of avalanche barriers. Additionally, these zones have to be managed specifically.

ROG — Raumordnungsgesetz - Spatial Planning Act - law on provinces level regulating spatial planning

Sektion der Wildbach- und Lawinenverbauung ⟶ provincial unit

SGI — Stabstelle für Geoinformation - The administrative department for geoinformatics of the WLV, responsible for IT and GIS.

Silent witnesses — formations of soil, effects on vegetation or traces on human settlement that indicate former forces of natural processes, e.g. could the curved form of a tree indicate former solifluction.

Site-planning — 'Flächenwidmungsplan' - every municipality has to create a plan and map for land utilisation planning consisting of plots and types of use of plots, e.g. for development area (building), free space, traffic space, reservation zones, referenced zones.

Stabstelle für Geoinformation ⟶ SGI

Stabstelle für Schnee und Lawinen ⟶ SSL

Stumme Zeugen ⟶ Silent witnesses

Summation Line — Summenlinie - A method combining different methods to a hazard zone line which indicates the most severe effects shown in the individual methods.

SSL ⟶ 'Stabstelle für Schnee und Lawinen' - An agency of the WLV responsible for the state of the art and simulation concerning snow and avalanches.

TROG — 'Tiroler Raumordnungs-Gesetz' - Tyrolean Spatial Planning Act

VerfGH — Verfassungsgerichtshof - constitutional court - One of Austria's highest courts dealing with constitutional matters.

Vorbehaltszonen ⟶ Reservation zones

Wildbach- und Lawinenkataster ⟶ WLK

WLK — Wildbach- und Lawinenkataster - A geographic information system (GIS) administered by the department for geoinformatics (SGI) of the WLV. This cadastre contains data of avalanches, torrents, hazard zones, reports and projects in cartographic as well as textual form.

WLV — Forsttechnischer Dienst für Wildbach- und Lawinenverbauung - Austrian Service for Torrent and Avalanche Control (= official translation of the ministry)

1TBS — one ton border setting - This describes the main issue of this thesis, the changed regulative setting of the habitable zone. This is measured in applied theoretical pressure on the buildings; change from 25 kN/m^2 to 10 kN/m^2 which equals 1 t/m^2, hence this (inofficial) abbreviation is used for better reading.

8. Sources

8.1. Literature

Atteslander, P. (2010). Methoden der empirischen Sozialforschung. (10th ed.). Berlin.

Burby, R. J. (2006). Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas. The American Academy of Political and Social Science: The Annals of the American Academy, 604. Pages 171-191.

Dickson-Swift, V., James, E. L., and Liamputtong, P. (1998). What is sensitive research? Undertaking Sensitive Research in the Health and Social Sciences. Managing Boundaries, Emotions and Risks. Pages 1-10. Cambridge University Press.

Fuchs, Sven, and Keiler, M. (2008). Variability of natural hazard risk in the European Alps – Evidence from damage potential exposed to snow avalanches. In: J. Pinkowski (ed.): Disaster management handbook. London: Taylor & Francis. p. 267-279

Fuchs, Sven. (2009). Susceptibility versus resilience to mountain hazards in Austria – paradigms of vulnerability revisited, Nat. Hazards. Earth Syst. Sci., 9, 337–352, 2009. http://www.nat-hazards-earth-syst-sci.net/9/337/2009/.

Gamper, C. D. (2008). The political economy of public participation in natural hazard decisions – a theoretical review and an exemplary case of the decision framework of Austrian hazard zone mapping. Natural Hazards and Earth System Sciences, 8. Pages 233–241.

Holub, M., and Fuchs, S. (2009). Mitigating mountain hazards in Austria – legislation, risk transfer, and awareness building. Natural Hazards and Earth System Sciences, 9. Pages 523-537.

Kanonier, Arthur. (2006). Raumplanungsrechtliche Regelungen als Teil des Naturgefahrenmanagements. In: Recht im Naturgefahrenmanagement. Ed.: Sven Fuchs, Lamiss Magdalena Khakzadeh, Karl Weber. StudienVerlag.

Kates, R. W., Colten, C. E., Laska, S., and Leatherman, S. P. (2006). Reconstruction of New Orleans after Hurricane Katrina: A research perspective. PNAS (Proceedings of the National Academy of Sciences of the United States of America). vol. 103(no. 40). Pages 14653-14660.

Keiler, M., Zischg, A., Fuchs, S., Hama, M., and Stötter, J. (2005). Avalanche related damage potential – changes of persons and mobile values since the mid-twentieth century, case study Galtür. Natural Hazards and Earth System Sciences, 5(1), 49–58.

Kienholz, H., Krummenacher, B., Kipfer, A., and Perret, S. (2004). Aspects of Integral Risk Management in Practice - Considerations with Respect to Mountain Hazards in Switzerland. Österreichische Wasser- und Abfallwirtschaft (Heft 3-4, 56. Jahrgang.). Pages 43-50.

Lee, R. M. and Renzetti, C. M., (1993). Researching sensitive topics: Sage Publications.

May, Peter J. 1991. Addressing public risks: Federal earthquake policy design. Journal of Policy Analysis and Management 10. Pages 263-85.

Mileti, Dennis S. (1999a). Disasters by Design. In: The Changing Risk Landscape: Implications for Insurance Risk Management. 1999. Edited by Neil R. Britton. Proceedings of a Conference sponsored by Aon Group Australia Limited

Mileti, Dennis S. (1999b). Disasters by design: A reassessment of natural hazards in the United States. Washington, DC: Joseph Henry Press.

Rappold, Georg. (2001). Partizipation als Instrument einer erfolgreichen Schutzwaldsanierung. In: Moser, A. (Hrsg.). Kompetenz für gemeinsame Aufgaben- Wie praktisch muss Forschung sein? Beiträge zur Österreichischen Forsttagung 2001. Eigenverlag des Institutes für Alpine Naturgefahren und Forstliches Ingenieurwesen, Universität für Bodenkultur Wien. Retrieved 28.07.2013, from http://www.rali.boku.ac.at/fileadmin/_/H85/H855/materialien/aro/GR-VT.pdf

Sieber, J. E., & Stanley, B. (1988). Ethical and Professional Dimensions of Socially Sensitive Research. American Psychologist, 43(1), 49-55.

Sommerwerk, Nike. (2006). Erholung und Tourismus. Inhalte, Neuerungen und Anregungen für die nationale Umsetzung. (2nd ed.). Berlin: Peter Rumm, Stephan von Keitz, Michael Schmalholz.

Smith, Keith, and Petley, David N. (2009). Environmental Hazards. Assessing risk and reducing disaster. (5 ed.). London, New York.

Weber, Gerlind. (2006). Allgemeine Raumplanung. Studienblätter zur Vorlesung. Institut für Raumplanung und Ländliche Neuordnung. BOKU, Vienna.

Weiss, Gerhard. (1998). Bewertung der Massnahmen zur Schutzwaldverbesserung. Band 4: Wildbach- und Lawinenverbauung. Forschungsauftrag des Bundesministeriums für Land- und Forstwirtschaft, Ziffer: GZ 56.810/36-VA2/93.

Weiss, Gerhard. (1999). Die Schutzwaldpolitik in Österreich. Einsatz forstpolitischer Instrumente zum Schutz vor Naturgefahren. Schriftenreihe des Institus für Sozioökonomik der Forst- und Holzwirtschaft, Band 39, Universität für Bodenkultur Wien.

Weiss, Gerhard. (2013). pers.comm., Lecture: 'Alpine Spatial Planning' ('Alpine Raumordnung'), University of Natural Resources and Life Sciences, Vienna. 17.04.2013. Institute of Forest, Environmental and Natural Resource Policy at University of Natural Resources and Life Sciences, Vienna

8.2. Interviews

8.2.1. Anonymised interviews

Nine interviews were conducted with members of the Avalanche and Torrent Control Service and spatial planning offices. In this thesis, the statements of interviewed experts are not linked to their name.

The citations in the text are **anonymised**, it is only referred to randomised interview numbers from 1 to 9. (INo.1 to INo.9)

The interviews were conducted in January, May and April 2013 in Vienna and in locations related to the two case studies.

Bauer, Roland and Aigner, Helmut. (2013). pers.comm., Interview at the premises of the WLV, Vienna. 29.01.2013.

Hofrat Dipl.Ing. **Roland Bauer**

Head of the provincial unit Vienna, Lower Austria, Burgenland. WLV (Austrian Service for Torrent and Avalanche Control), author of many regulations of the ministry.

Hofrat Dipl.Ing. **Helmut Aigner**

Provincial unit Vienna, Lower Austria, Burgenland. WLV (Austrian Service for Torrent and Avalanche Control)

Gwercher, Anton. (2013). pers.comm., Interview in Innsbruck, the Tyrol. 06.05.2013.

Ing. **Anton Gwercher**

Expert/Planner in the district unit 'Mittleres Inntal' (central Inn-valley), the Tyrol, WLV (Austrian Service for Torrent and Avalanche Control)

Heregger, Gerhard. (2013). pers.comm., Interview in Telfs, the Tyrol. 07.05.2013.

RL Dipl.Ing. **Gerhard Heregger**

Leader of the department of planning and building inspection, municipality of Telfs, the Tyrol

Ortner, Robert. (2013). pers.comm., Interview in Innsbruck, the Tyrol. 06.05.2013.

Dipl.Ing. **Robert Ortner**

Leader of division spatial planning, provincial government of the Tyrol.

Pittracher, Manfred. (2013). pers.comm., Interview on telephone. 29.04.2013.

Hofrat Dipl.Ing. **Manfred Pittracher**

HZP-referee for the Tyrol, WLV (Austrian Service for Torrent and Avalanche Control)

Reiterer, Andreas. (2013). pers.comm., Interview in Vienna. 25.04.2013.

Hofrat Dipl.Ing. **Andreas Reiterer**

Head of the provincial unit Vorarlberg, WLV (Austrian Service for Torrent and Avalanche Control)

Schilcher, Wolfgang. (2013). pers.comm., Interview in Bludenz, Vorarlberg. 08.05.2013.

Hofrat Dipl.Ing. **Wolfgang Schilcher**

Head of the district unit Bludenz, Vorarlberg, WLV (Austrian Service for Torrent and Avalanche Control)

Schnetzer, Ingo. (2013). pers.comm., Interview on telephone. 02.05.2013 & Interview at the premises of the WLV, Vienna. 13.05.2013.
Dipl.Ing. **Ingo Schnetzer**
Administrative position for geoinformatics, WLV (Austrian Service for Torrent and Avalanche Control)

Schreiner, Ivo. (2013). pers.comm., Interview in Innsbruck, the Tyrol. 06.05.2013.
Dipl.Ing. **Ivo Schreiner**
Deputy head of the district unit 'Mittleres Inntal' (central Inn-valley), the Tyrol, WLV (Austrian Service for Torrent and Avalanche Control)

8.2.2. Unanonymised interviews

Following two sources are not anonymised because they are an university lecturer unrelated to the thesis and already anonymous passersby who did not state expert opinions.

Fuchs, Sven. (2012). pers.comm., Interview at Boku University, Vienna. 09.10.2012.
PD Dipl.-Geogr. Dr. **Sven Fuchs**
Deputy head of the Institute of Mountain Risk Engineering at University of Natural Resources and Life Sciences, Vienna

Inh.Telfs. (2013). Short interviews of nine random pedestrians in Telfs on 07.05.2013, mostly within the red zone.

8.3. Documents

AK. (2007). Arbeiterkammer Salzburg. Salzburg, am 06.08.2007. Article: Konsumentenfeindliches OGH-Urteil: Lage einer Immobilie in der "gelben Gefahrenzone" ist kein Mangel.

CIA. (2012, 10.09.2012). The World Fact Book: Austria Retrieved 20.09.2012, from https://www.cia.gov/library/publications/the-world-factbook/geos/au.html

CNN. (2001). Austria avalanche kills family of four. Newspaper article of 23.02.2001. Retrieved 27.05.2013, from http://edition.cnn.com/2001/WORLD/europe/02/23/austria.avalanche/index.html?iref=allsearch

Compare Infobase. (2012). Maps of World. Mountains in Austria. Retrieved 21.09.2012, from http://www.mapsofworld.com/austria/tourism-austria/mountains-in-austria.html

BBC. (1999a). Holiday hell for British skiers. Newspaper article of 25.02.1999. Retrieved 27.05.2013, from http://news.bbc.co.uk/2/hi/uk_news/285895.stm

BBC. (1999b). Galtür: Anatomy of an avalanche. Newspaper article of 29.11.1999. Retrieved 27.05.2013, from http://news.bbc.co.uk/2/hi/science/nature/536619.stm

BGBl. Nr. 436/1976. Verordnung des Bundesministers für Land- und Forstwirtschaft vom 30. Juli 1976 über die Gefahrenzonenpläne. 'Gefahrenzonenverordnung', StF: BGBl. Nr. 436/1976 C.F.R. (1976).

BGBl. Nr. 72/1978. Verordnung des Bundesministers für Land- und Forstwirtschaft über Bezeichnung, Sitz und örtliche Zuständigkeit der Dienststellen für Wildbach- und Lawinenverbauung (Wildbach- und Lawinenverbauung – Dienststellenverordnung), BGBl. Nr. 72/1978 idF BGBl. Nr. 84/1985, 963/1994, BGBl. II Nr. 283/1997, 465/2001 und 195/2004 C.F.R. (1978).

BGBl. Nr. 507/1979. Verordnung des Bundesministers für Land- und Forstwirtschaft vom 4. Dezember 1979 über den Aufgabenbereich der Dienststellen und des Bundesministeriums für Land- und Forstwirtschaft in Angelegenheiten der Wildbach- und Lawinenverbauung, StF: BGBl. Nr. 507/1979 C.F.R. (1979).

BGBl. Nr. 576/1987. 576. Bundesgesetz vom 20. Oktober 1987, mit dem das Forstgesetz 1975 geändert wird (Forstgesetz-Novelle 1987).

BGBl. Nr. 59/2002. 59. Bundesgesetz, mit dem das Forstgesetz 1975, das Bundesgesetz zur Schaffung eines Gütezeichens für Holz und Holzprodukte aus nachhaltiger Nutzung, das Bundesgesetz über die Bundesämter für Landwirtschaft und die landwirtschaftlichen Bundesanstalten und das Forstliche Vermehrungsgutgesetz geändert werden.

BH-Bludenz. (1993). Gefahrenzonenpläne der Wildbach- und Lawinenverbauung. Zahl: II-28/3/93 from 15.06.1993. Signed by Leo Walser.

BH-Bludenz. (1995). Gefahrenzonenplanung; Richtlinien für die Gefahrenzonenabgrenzung. Letter to the District Unit Bludenz/Vorarlberg WLV (Gebietsbauleitung Bludenz, Vorarlberg). Zahl: II-28/3/95 from 25.08.1995. Signed by Dr. Walser.

BH-Bludenz. (1999). Aktenvermerk. Gefahrenzonenpläne der Wildbach- und Lawinenverbauung; Richtlinien für die Gefahrenzonenplanung. Zahl: II-28/3/99 from 21.12.1999. Signed by Leo Walser.

BH-Bludenz. (2000). District commission ('Bezirkshauptmannschaft') of Bludenz/Vorarlberg. Gefahrenzonenpläne der Wildbach- und Lawinenverbauung; Richtlinien für die Gefahrenabgrenzung. Zahl: II-28/3/00 from 29.03.2000. From Leo Walser to the federal government Vorarlberg.

BMLF. (1980). Erlass des Bundesministeriums für Land- und Forstwirtschaft. Richtlinie für die Handhabung von Hinderungsgründen. Zahl: 52.240/04-VB-7/80 from 07.04.1980. To WLV and all PUs.

BMLF. (1994a). Erlass des Bundesministeriums für Land- und Forstwirtschaft. Richtlinien für die Gefahrenzonen, Übermittlung des Konzeptes: Weisung. Zahl: 52.240/08-VC8a/94 from 24.02.1994. Signed by the Minister.

BMLF. (1995a). Ministry. Letter to district commission ('Bezirkshauptmannschaft') of Bludenz/Vorarlberg, Dr. Leo Walser. 25.08.1995. Signed by DI Andiel. Keine Ziffer.

BMLF. (1995b). Ministry. Notice to all provincial units of the WLV. Zahl: III/19-13a/56 from 24.11.1995. Signed by Krissl.

BMLF. (1998a). Erlass des Bundesministeriums für Land- und Forstwirtschaft. Kommissionelle Überprüfung und Genehmigung von Gefahrenzonenplänen gemäß § 11, FG 1975; Neuregelung. Zahl: 52.240/13-VC6a/97 from 27.01.1998.

BMLF. (1999a). Erlass des Bundesministeriums für Land- und Forstwirtschaft. Gefahrenzonenplanung; Richtlinien für die Abgrenzung von Gefahrenzonen; Übermittlung zur Anwendung. Zahl: 52.240/10-VC6a/99 from 01.07.1999.

BMLFUW. (2001). Erlass des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft. Änderung der Abgrenzungskriterien für Lawinen. Zahl: 52.240/07-VC6a/2001 from 20.03.2001.

BMLFUW. (2011). Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft. "die.wildbach - Richtlinie für die Gefahrenzonenplanung". Fassung vom 04.02.2011. Ziffer: LE.3.3.3/0185-IV/5/2007. Retrieved 07.09.2012, from http://www.lebensministerium.at/dms/lmat/forst/schutz-naturgefahren/wildbach-lawinen/richtliniensammlung/GZP/Richtlinie_f_r_die_Gefahrenzonenplanung_Druckversion_2seitig.pdf

Drössler. (2002). Statistik Galtür Retrieved 01.12.2012, from http://air.droessler.at/berichte/Galtuer/Galtuer/galtuer_mstatistik.htm

DU-Bludenz. (1994a). District Unit Bludenz/Vorarlberg (Gebietsbauleitung Bludenz, Vorarlberg). Bauführung in der roten Zone des Gefahrenzonenplanes, Möglichkeiten und Handhabe. Letter to municipality Lech from 24.01.1994. Signed by the head of the PU Vorarlberg. 701A-0/140.

DU-Bludenz. (1994b). District Unit Bludenz/Vorarlberg (Gebietsbauleitung Bludenz, Vorarlberg). Gefahrenzonenplanung. Zahl: 701A-0/1302 from 09.08.1994. Letter to provincial unit Vorarlberg. Signed by the head of the PU Vorarlberg.

EU-EC. (2012a, 23.02.2012). European Commission: Introduction to the new EU Water Framework Directive (Directive 2000/60/EC). Retrieved 10.09.2012, from http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

EU-EC. (2012b, 31.08.2012). European Commission. A new EU Floods Directive (Directive 2007/60/EC). Retrieved 10.09.2012, from http://ec.europa.eu/environment/water/flood_risk/index.htm

EU-EP. (2000). European Parliament, European Council: Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy ("Water Framework Directive"), Directive 2000/60/EC C.F.R.

ERFA-Gruppe. (2000). Tourismusbürgermeister. Die Bürgermeister der Gemeinden Brand, Damüls, Flachau, Galtür, Gaschurn, Gerlos, Ischgl, Kitzbühel, Klösterle, Lech, Mayrhofen, Naustift am Stubai, Saalbach-Hinterglemm, Schruns, Seefeld, Serfaus, Sölden, St. Anton a. A., Tux, Warth, Zell am See. Letter to the minister from Ludwig Muxel, mayor of Lech. From 03.11.2000.

ForstG. (1975). Bundesgesetz vom 3. Juli 1975, mit dem das Forstwesen geregelt wird (Forstgesetz 1975), BGBl. Nr. 440/1975 C.F.R. (1975).

Haueis, Daniel. (2000). Newspaper article in Rundschau of 14.03.2000: "Es wird nicht so schlimm". Revision der Gefahrenzonenpläne dauert gut drei Jahre - in Härtefällen soll geholfen werden.

Kärntner Landesregierung. (2012). Amt der Kärntner Landesregierung. Raumordnung in Österreich, ein Überblick. Retrieved 10.03.2013, from http://www.ktn.gv.at/167731_DE%2d

Lebensministerium. (2008, 19.06.2008). Wildbach- und Lawinenverbauung setzt auf lebenslanges Lernen. Retrieved 06.09.2012, from http://www.ots.at/presseaussendung/OTS_20080619_OTS0037/wildbach-und-lawinenverbauung-setzt-auf-lebenslanges-lernen

Lebensministerium. (2010). Grüner Bericht 2010. Bericht über die Situation der österreichischen Land- und Forstwirtschaft. (Vol. 51. Auflage, Wien 2010.).

Lebensministerium. (2011a). die wildbach - Gefahrenzonenplanung 2009. Extract from the ministry's statistical data. Retrieved 19.04.2013, from http://duz.lebensministerium.at/duz/duz/download/obj.941688/pdf, http://duz.lebensministerium.at/duz/duz/theme/view/

Lebensministerium. (2011b). Grüner Bericht 2011. Bericht über die Situation der österreichischen Land- und Forstwirtschaft. (Vol. 52. Auflage, Wien 2011.).

Lebensministerium. (2012). Wildbach- und Lawinenverbauung: Aktuell Bundesländer. Retrieved 06.09.2012, from http://www.ots.at/presseaussendung/OTS_20080619_OTS0037/wildbach-und-lawinenverbauung-setzt-auf-lebenslanges-lernen

Lebensministerium. (2013a). Wildbach- und Lawinenverbauung: Leistungen. Retrieved 28.05.2013, from http://www.lebensministerium.at/forst/schutz-naturgefahren/wildbach-lawinen/leistungen.html

Lebensministerium. (S.A.). Der Gefahrenzonenplan des Forsttechnischen Dienstes für Wildbach- und Lawinenverbauung. Broschüre.

LGBL-TI. (2000). Landesgesetzblatt für das Land Tirol. Herausgegeben und versendet am 12.09.2000. 60. Gesetz vom 6. Juli 2000, mit dem das Tiroler Raumordnungsgesetz 1997 geändert wird (3. Raumordnungsgesetz-Novelle)

LGBL-TI. (2001). Landesgesetzblatt für das Land Tirol. Herausgegeben und versendet am 29.05.2001. 38. Gesetz vom 21. März 2001, mit dem das Tiroler Raumordnungsgesetz 1997 geändert wird (4. Raumordnungsgesetz-Novelle)

LGBL-TI. (2011). Landesgesetzblatt für das Land Tirol. Herausgegeben und versendet am 24.05.2011. 47. Gesetz vom 17. März 2011, mit dem das Tiroler Raumordnungsgesetz 2006 geändert wird.

LGBL-V. (2012). Vorarlberger Landesgesetzblatt. Gesetz über die Raumplanung (Raumplanungsgesetz - RPG), i.d.g.F.

Maußhardt, Philipp. (1999). Gefangen im Paznauntal. Vier Tage unter den Eingeschlossenen von Ischgl: Eine Begegnung mit Menschen und Lawinen. In: Die Zeit vom 04.03.1999. Retrieved 24.05.2013, from http://www.zeit.de/1999/10/199910.lawinen_.xml

PU-V. (1992). Provincial Unit of the WLV (Sektion Vorarlberg). Stellungnahme der Sektion Vorarlberg zum Entwurf von GZP Vorläufigen Richtlinien. From 21.10.1992, signed by the head of the PU Vorarlberg.

PU-V. (1993). Provincial Unit of the WLV (Sektion Vorarlberg). Mit der Bitte um Stellungnahme. To Landesrat Vorarlberg, from 25.03.1993.

PU-V. (1994a). Provincial Unit of the WLV (Sektion Vorarlberg). Richtlinien für die Gefahrenzonenplanung. From 10.01.1994 to both district units of the WLV in Vorarlberg. II/19-13a/1. Signed by head of PU.

PU-V. (2007). Provincial Unit of the WLV (Sektion Vorarlberg). Information Gefahrenzonenplan Lech. 17.07.2007. To the ministry. Signed by the head of DU Bludenz. 701A-21/1435.

PU-V. (2000). Provincial Unit of the WLV (Sektion Vorarlberg). Überarbeitung der Lawinengefahrenzonen in Vorarlberg. Zahl: III/19-13a/6 from 12.01.2000. Signed by the head of the PU Vorarlberg. To the ministry.

PU-V. (2008a). Provincial Unit of the WLV (Sektion Vorarlberg). GZP Lech, Vorbereitung der kommissionellen Überprüfung. Zahl: 3-19-13a-870 from 14.05.2008. Zeitplan.

PU-V. (2008b). Provincial Unit of the WLV (Sektion Vorarlberg). Gefahrenzonenplan Lech (Revision 2007), Übersendung der Niederschrift der ministeriellen Überprüfung. Zahl: 3-19-13a-1075 from 25.06.2008. (Hazard zones plan, Revision of 2007, transmission to the ministry). To Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft. Signed by the head of the PU Vorarlberg.

PU-V. (2008c). Provincial Unit of the WLV (Sektion Vorarlberg). Gefahrenzonenplan Lech (Revision 2007), Gemeinde Lech, Bezirk Bludenz; Übergabe der Unterlagen. (Hazard zones plan, Revision of 2007. Zahl: 3-19-13a-1746 from 04.11.2008. Transmission to the municipality of Lech): the HZP signed on 23.07.2008 with ZI. Le.3.3/0154-IV/5/2008

RGBl. Nr. 117/1884. Gesetz vom 30. Juni 1884, betreffend Vorkehrungen zur unschädlichen Ableitung von Gebirgswässern StF: RGBl. Nr. 117/1884. Retrieved 27.08.2013, from http://www.lebensministerium.at/dms/lmat/forst/oesterreich-wald/Forstrecht/WLV-G/Wildbachverbauungsgesetz--BGBl--Nr--54-1959/Wildbachverbauungsgesetz%2C%20BGBl.%20Nr.%2054-1959.pdf

Spiegel. (2012). Spiegel Online. Unglück in Österreich: Lawine verschüttet niederländischen Königssohn. Newspaper article published on 17.02.2012. Retrieved 01.09.2013, from http://www.spiegel.de/panorama/unglueck-in-oesterreich-lawine-verschuettet-niederlaendischen-koenigssohn-a-816016.html

Statistik Austria. (2011). Österreich. Zahlen, Daten, Fakten. Retrieved 20.09.2012, from http://www.statistik.at/web_de/static/oesterreich._zahlen._daten._fakten_029266.pdf

Statistik Austria. (2012). Statistisches Jahrbuch Österreichs 2013. Access to yearbook at http://www.statistik.at/web_de/services/stat_jahrbuch/index.html. Tourism chapter retrieved 10.01.2013, from http://www.statistik.at/web_de/static/k28_054427.pdf

SSL. (2007). Wildbach und Lawinenverbauung, Stabstelle Schnee und Lawinen. Stellungnahme zur Prüfung der Simulation des GZP Lech. (Statements to the review of simulation for Lech's HZP). Zahl: 345-59-2007 from 18.07.2007. Transmission to DU Tyrol, S.Sauermoser.

Telfs. (2013a). Marktgemeinde Telfs. Umweltmanagement. Retrieved 28.05.2013, from http://telfs.eu/umwelt-natur-mull/umweltmanagement.html

Telfs. (2013b). Marktgemeinde Telfs. Zivil- und Katastrophenschutz. Retrieved 28.05.2013, from http://telfs.eu/rathaus-burgerservice/zivil--katastrophenschutz.html

Telfs. (2013c). Gefahrenzonenplan der Gemeinde Telfs. Scanned on 07.05.2013, Bauamt, Marktgemeinde Telfs.

TROG. (2011). i.d.g.F. Tiroler Raumordnungsgesetz. (TROG 2011). Landesgesetz Tirol. Originally published: Herausgegeben und versendet am 28.09.1993. 81. Stück: Gesetz vom 6. Juli 1993 über die Raumordnung in Tirol (Tiroler Raumordnungsgesetz 1994).

T-LGBl. (1991). i.d.g.F. Gesetz über die Lawinenkommissionen. Landesgesetz Tirol. Gesetz vom 10. Oktober 1991 über die Lawinenkommissionen in den Gemeinden.

Vlbg RPG. (1996). i.d.g.F. Gesetz über die Raumplanung. (Raumplanungsgesetz – RPG). Landesgesetz Vorarlberg.

VN. (n.d.). Vorarlberger Nachrichten. Gefahrenzonen überdenken.

VN. (2007). Vorarlberger Nachrichten. Kommentar: Lech “darf” mitdenken. Newspaper article by Marianne Mathis published on 28.11.2007.

V-LReg. (1997). Amt der Vorarlberger Landesregierung. Finale in der Digitalisierung der Gefahrenzonenpläne von Vorarlberg. VIIa-700.00. Letter to Helmut Aschauer of WLV from 15.05.1997.

WSL. (2011). Swiss Federal Institute for Forest, Snow and Landscape Research. Investigating snow avalanche dynamics at the full-scale test-site: Vallée de la Sionne / Valais. Retrieved 21.07.2013, from http://www.wsl.ch/info/organisation/versuchsanlagen/vallee_de_la_sionne/index_EN

ZAR. (2006). Zentrale Arbeitsgemeinschaft österreichischer Rinderzüchter. 120 Jahre Wildbach- und Lawinenverbauung in Österreich. Retrieved 06.09.2012, from http://www.zar.at/article/articleview/31743/1/4932

Appendix

Interview guideline

After a first literature and document analysis, interview questions were formed coinciding to the research questions in chapter 1.2.

Principal issue:

» How did the genesis of the new criteria for border setting in avalanche hazard zones planning of Austria occur and how are they being implemented?

Secondary issues:

» Which factors influence the implementation and which are the roles of main actors involved?

» How has it been possible to enforce stricter regulation?

Hypothesis were formed and discussed in chapters 1.2. and 5. As supplementary background preparing for the interviews, a more elaborate set of research questions and interview questions was developed.

- How are roles and tasks of ministry as well as the provincial and district units of the WLV (Sektionen+GBL) shared and organised?
  - Which guidelines and regulations are still valid and relevant for the WLV and the HZPs? How and why were they created?
- Which effects (impacts, outputs and outcomes) do they have within the municipality and its effects on planning?
  - Is it right to assume that the red+yellow zones are mostly being enlarged after the 1TBS? Under which conditions could they become smaller?
  - Are there typical patterns or mechanisms?

- Which stakeholders and actors are involved, what role do they play (e.g. economic interests)?
- How was and is the HZP being created and issued within municipalities; which stakeholders and processes were involved?
- What is the role of WLV within the process of the HZ-planning and which deviations to the prescribed way can be found (additional/other routines)?

It is noted that scrutiny was put on the delicacy of the matter: as actors may be influenced by political, economic or social factors, they may not be able to tell freely; it was aimed to hear nuances in language and hints of underlying factors or correlations, indicating e.g. allocation of power within the WLV.

Interview questions

1. Interviewees

This list of persons depicts the planned interviewees for this thesis. In practice, minor alterations (e.g. deputies) were necessary mostly due to limited time of the staff.

- The head of the provincial unit of the WLV ('Sektionsleiter'), both from Vorarlberg and the Tyrol
- The head of the district unit of the WLV ('Gebietsbauleiter'), both from the districts of Lech (Bludenz) and Telfs (mittleres Inntal).
- From the municipalities Lech and Telfs, a person responsible for the hazard zoning.
- From the provinces' administration, a person responsible for the hazard zoning and spatial planning ('Raumordnung').

2. Detailed interview questions

These questions were not used precisely this way but helped as a guideline during the interviews. (Questions in brackets are not to be asked directly; it is aimed to answer them by leading the conversation in this direction.)

- What is the job of the (institution of the interviewee) in general and in context of HZP and their creation? [Are there special features about this institution compared to others?]

- New regulations: Which important legal/official changes were introduced in the last years? Are there other important weighty alterations besides the 1TBS of 1994 and 1999?
    - Are events less frequent than 150-year-events planned for?
    - Was the regulation concerning the height of snow relevant?
- One ton border setting (1TBS): Which relationship has the provincial unit towards the 1TBS and the new red zone?
    - How happened the change from the former (which one?) to the new border? Was there a change of paradigm?
    - Was the 1TBS applied before 1999?
    - Or even before 1994?
    - How fast was the 1TBS implemented? Was this regulated by the ministry?
- Did all HZP get revised because of the 1TBS or did the 1TBS just get included in the revisions that would have been conducted anyway.
    - Which role does have 3D-simulation?
- Which changes brought the changed regulations?
    - What are the restrictions and requirements for red (and yellow) zones? What means adjusted to the local premises ('ortsangepasst')?
- How many building projects are happening in the red and yellow zone?
    - What happens to houses which are not adequate to the level of danger in the red (yellow) zone (not resistant to the estimated pressure of an avalanche)?
    - How happens the alteration in site-planning of a plot?
- How are responsibilities allocated within the ministry, federal and district units of the WLV and the municipality in the context of the HZP.
    - Which processes and working groups exist?
    - What tasks does the district unit have during a revision?
    - Do municipalities take the initiative for the revision of the HZP, what is their role afterwards?
- How takes place the process of the HZP-revision?
    - How many relevant HZP are already revised? Which were revised first and how was this decided?
    - Did property owners object the new zoning? [How did the WLV react to their objections?]
    - How was the reaction of the mayors or spatial planning?
    - Did property owners participate in the process, were there public relation efforts?
    - Was media present?

    - Which hierarchical levels of the WLV were active during the process?
    - Are there other influencing factors?
- Avalanche barrier constructions
    - Which influence do have constructions on zoning (red, yellow, other?)? Are they pushed back?
    - Do they enable site-planning?
    - Does it occur that a barrier construction has the same effects as a less strict hazard zone setting?
    - Are there differences between constructions before and after 1994 resp. 1999.
    - Do uncompleted barrier constructions happen?
- Regulation for revocation concerning use of public means to fund WLV constructions (directive from the ministry 1980 and 1991)
    - Is this directive applied often (is there being built in the red or yellow zone?) and how is the directive dealt with?
    - Is the increase of number of people in a house the most frequent case for application of the regulation? Or alteration of soil, degree of safety, necessity of building?
- Spatial planning
    - Special aspects of spatial planning in the province of Vorarlberg
    - Special aspects of spatial planning in the province of the Tyrol
    - What is the relationship between spatial planning and natural hazards, avalanches, areal zoning plans?
- Is there anything mentionable related to climate change?
- Selection of case studies: Do exist municipalities where the new regulations caused change, i.e. enlargement of zones?
    - Examples for municipalities?
    - Does exist an expectable, typical procedure for municipalities which have implemented the 1TBS?
    - Does the size of the municipality or of the avalanche catchment area have influence on the implementation of the HZP?

3. Special, additional questions for members of the municipality

- What is the relationship between the municipality and hazard zones and natural hazards?
- When was the HZP last revised?
- What is the task of the mayor in the context of HZP?
    - What are the tasks of the municipality, what is the relationship with the WLV?
    - Is there awareness of the 1TBS within the municipality?
- How takes place the process of the HZP, who is involved? How are tasks distributed in the municipality?
- To what extent is this municipality different from others?