Austrian Partnership on Risk Management for Gravitational Hazards in Spatial Planning: A policy process in a vague legal framework

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In Austria no comprehensive and nationwide common standards for hazard mapping and risk management concerning gravitational hazards (rock-fall, landslides or debris flow on slopes) were established yet. The paper summarizes the Austrian legal, political and social framework conditions for natural risk management concerning these hazards and points out the specific problems and obstacles that inhibit the implementation of common legal and technical standards in this field. A strategic partnership, embedded in the Austrian Conference for Spatial Planning (ACSP), has been established that involves stakeholders from all relevant sectors (institutions), in specific from areal planning, technical planning and geology. The partnership carries out a governance process aiming at the elaboration of comprehensive standards for protection goals, planning methods and the principles for application of hazard maps in areal development. Furthermore the paper presents a proposal for a harmonized risk management policy and planning hierarchy, which stands in line with the various approaches by Austrian provinces in treating gravitational hazards in spatial planning between the foothill and inner Alpine regions.

Key words: rock fall, landslide, risk management, spatial planning, areal development

1. INTRODUCTION

This article introduces an ongoing policy process in the framework of the Austrian Spatial Development Concept (ASDC), which aims at the development and implementation of an integrated risk management system for gravitational hazards in spatial planning. A strategic partnership, embedded in the Austrian Conference for Spatial Planning (ACSP), has been established in order to bridge the gaps of fragmented competences in the Austrian federal state system. According to the Austrian constitution areal planning as well as natural risk management is a cross-cutting legal issue divided among federal, provincial and municipal authorities and administrated by a multitude of public and private institutions. Common legal and technical regulations (standards) as well as an overarching institutional coordination are missing in this field. Governance processes are required to overcome these deficits and to initialize an interdisciplinary process of harmonization in technical, legal, and organizational respect.

This article describes the framework conditions and the state of discussion of this policy process and shows first proposals for common (minimum) standards for risk management concerning gravitational hazards (rock fall, landslides) in areal planning. The specific value of this paper lies in a rarely published insight into a current policy advice processes, applying governance approaches. The article stands in contrast to a multitude of scientific papers dealing with risk governance [e.g. De Marchi & Ravetz, 1999; De Marchi, 2003; Renn, 2008; Walker, 2011] which seldomly contrast the theoretical principles of governance with the practical applicability of governance methods under real political impact.

2. FRAMEWORK CONDITIONS FOR AREAL DEVELOPMENT IN AREAS AT RISK

In many Alpine regions the living space is exposed to natural hazards. A specific strong impact exists in the mountain valleys (by flash floods, torrents, mass-movements and snow avalanche) (Fig. 1) and in the main river basins (by river flooding and high groundwater levels). In addition hazards with widespread effects such as earthquakes, storms or severe weather (lightning, hail) play a significant role. Areas free of impact by natural hazard rarely exist.

Because of the mountainous topography of Austria and the climatic conditions, only 38% of the national territory is suitable for permanent settlement. Consequently, regional development is concentrated in of the lowlands and valley of big rivers (Rhine, Inn Valley, Salzach, Mur). These areas are subject to an on-going urbanization process (population density up to 243 inhabitants per km²). The damage potential caused by natural disasters is particularly high in these regions. Other trend is the steadily increasing demand for building land, triggering to a severe shortage in the availability of safe building sites. Further causes for the increasing consumption of land lie in the intensive development of industrial and commercial areas and the trend towards shopping centers and leisure facilities with land-intensive parking areas. In the Alpine regions land consumption required for tourist facilities (hotels, cable cars, golf courses, and recreational facilities) is particularly high. Many of these land-uses take place on foot slope areas endangered by gravitational natural hazards.

The regional development in Austria is not equally balanced in all parts of the country rather showing major disparities. Especially remote rural areas and economically disadvantaged regions are subject to negative trends in demographic change, like rural exodus, suburbanization and ageing of population. Among the major trends of Austrian areal development further urbanization around the metropolitan areas, along the major traffic axes and in the main valleys are expected, while the depopulation of the remote Alpine valleys and rural areas will proceed.

Fig. 1 Alpine settlement areas are subject to multiple risks by gravitational hazards such as rock fall, debris flow and avalanches (Rock avalanche at Randa, Valais, Switzerland).

Almost all basic functions of living (e.g. housing, supply, mobility, leisure, work, education) [*Werlen, 2004*] as well as many sectors of the economy are regularly - directly or indirectly - affected by natural disasters. In order to provide sufficient safety for endangered regions, not only the settlement area, but also labor, education and recreation space as well as the intermediate transport ways, supply lines and other usable area require permanent or temporary protection. Furthermore the availability of safe industrial and commercial areas has become a key factor for the attractiveness and economic competitiveness of municipalities and regions.

The leisure behavior of people shows the increasing trend to seek more remote, not secure (alpine) areas in order to meet the need for individuality and untouched nature. By doing this people accept more and more risk or are simply not familiar with natural hazards in an unknown environment [*Rudolf-Miklau, 2009*]. The growing interference of land use with natural hazards has dramatically increased the importance of a development planning policy that limits the use of areas at risk and adapts building trade to impacts by natural hazards. Hazard maps, where they exist, play a key role as source of information and steering tool for spatial planning.

3. RISK MANAGEMENT FOR GRAVITATIONAL HAZARDS

Gravitational hazards are by definition processes of displacement of great masses of earth, rock or snow mainly governed by gravity. High energy processes such as debris flows on slopes, rock fall, rock slides, earth slides and snow avalanches count among the gravitational hazards [*ONR 24800:2009*].

Gravitational hazards caused by these processes are bounded to local areas and predominantly affect single or small groups of objects, houses and estates (building sites). On a closer look at the properties of gravitational hazards, these processes show significant differences concerning frequency and intensity. The effects of a catastrophic rock fall, debris flow or landslide event cannot directly be compared to a 100-years flood or large-size snow avalanche. Predominantly the available knowledge about physical properties (triggering, displacement, reach and spread) of slope processes and mass movements in the Alps is poor in comparison to water related hazards as the latter kind of events are much easier and more frequently to observe, to document and to measure. Consequently it is often argued that the available numerical models for rock fall and landslides, appropriate for engineering application are far less reliable than numerical flood or avalanche models. Deficits concerning the theoretical principles, the experiences in application and the lack of reliable data to calibrate these models seem to obstruct their application in risk assessment on the local level (high precision). Furthermore the risk perception of geologist differs in a comprehensible way from e.g. a hydrologist or an avalanche expert, as hazardous geological processes are hardly to predict and even to monitor and have a much larger time scale. This might be the major reason why hazard maps for rock fall and landslides still are available only for some limited areas in Austria on the supra-regional and regional scale, while hazard zone maps on the local level (high precision maps referring to the single building site or estate) are widely missing.

Furthermore risk management in areal planning requires protection objectives for all relevant natural hazards on the same level of safety. The lack of these harmonized protection goals is another gap to be filled in establishing a comprehensive risk management system. Currently natural risk management in Austria is dominated by strong sectorial approaches, such as flood risk management or avalanche protection, that obstruct a synopsis of different kinds of hazard maps for areal planning purposes.

In the last years gravitational hazards have gained a growing importance in spatial planning as limited availability of building land and insufficient information on impending hazards have fostered an adverse areal development in regions exposed to erosion, rock fall or landslides. Severe deficits in areal development and building administration have raised the damage potential by mass-movements significantly triggering a growing demand for protection measures. [*FMAFEW, 2013*] Due to the lack of reliable hazard maps this development is still ongoing especially in areas with dynamic touristic development and expensive building land. A general trend for land use in slope areas, which is obvious in many narrow Austrian Alpine valleys, on chic suburban areas with nice vista, on sun-exposed mountain terraces or on humid soils not appropriate for agricultural purposes, is alarming and raises public expenses for structural defense measures. Road construction on slopes, in order to link these estates, alters the slope water system and slope stability in a critical way and causes erosion and slope movements due to percolating water where they have not been observed before.

Hence there is an urgent need in Austria for a comprehensive risk management in spatial planning concerning gravitational hazards on slopes (comparable to the integrated flood risk management). Neither a risk management system for gravitational hazards does exist in Austria yet nor has taken place a political initiative to establish such a system until now.

4. THE FUNCTION OF INTEGRATED RISK MANAGEMENT

3.1 Principles of risk management

Environmental and societal changes have induced an increasing risk potential related to natural hazards, hence the adaptation of risk management concepts is urgently required. The increasing vulnerability of society and multiple impacts by natural hazards on human living space have raised the need for flexible protection concepts and new approaches in risk management.

Based on these considerations, the concept of "*integrated risk management*" has been developed within the last decades and was frequently describes in literature [*Ammann, 2006; Schanz, 2006; Bründl et al., 2009*]. This term describes by definition the combination of all feasible measures against natural hazards, with the aim to achieve a desired level of security and to adapt safety planning to changing circumstances. [*Ammann, 2006; ONR 24800:2008*; *Rudolf-Miklau, 2009*] This holistic concept refers to the entire *risk management cycle*, consisting of the phases prevention, preparedness, intervention and restoration [*FOCP, 2013*]. The risk management cycle embraces all kind of legal, technical, planning-related, organizational and economic measures. The effectiveness of these measures depends largely on taking into account all relevant factors of society, in particular the socio-economic conditions, the legal principles of the state, the values and the performance in behavior of people affected, the total and regional economic impact, the technical standards and the real policy processes established in society. Risk adapted land use and regional development play a key role in integrated risk management in Austria.

3.2 Public risk management for natural hazards in Austria

According to the prevailing legal opinion protection against natural hazards is a public responsibility (task of the federal state) in Austria. [*Weber, 2006*] However, neither the federal constitution nor individual laws grant a subjective "right to protection". Referring to the trend-setting law case "Budayeva versus Russia", the European Court of Human Rights has defined the scope and limits for the precautions a state has to take in order to protect his people from natural catastrophes.

[*Rudolf-Miklau, 2014*] It was stated that there is a positive obligation of states to set reasonable steps "to protect the lives of the citizens", furthermore a duty to create a legal and administrative framework for natural disaster protection and finally an obligation to inform the public about life-threatening emergencies. On the other hand it falls within the legal and political judgment of the state, to which extent the task of natural risk management is performed by own institutions respectively which parts of the protection function are left to the responsibility of the individual (self-care).

The predominant structure and organization of the risk and catastrophe management system in Austria (as a state responsibility) is primarily a function of its historical development, but can also be explained economically. [*Rudolf-Miklau, 2009*] Benefits from risk management count among the "public goods". In principle no potential beneficiaries shall be excluded from a consumption of these benefits, in addition their availability to the public is not restrained, if used by specific persons. Measures taken for natural risk management also meet the criteria of a preferred "public interest". [*Weck-Hannemann & Thöni, 2006*].

Risk management related to gravitational hazards counts among the highly fragmented cross-sectional public matters, with a patchy legal basis and a diffuse distribution of competences between authorities [*Kerschner, 2006*]. Consequently a wide range of institutions from federation, provinces and municipalities as well as a lot of private players are involved. One of the major challenges is the coordination and cooperation of these institutions. Efficient risk management require trans-competence and cross-sectorial strategies as well as a common perception of hazards and risks by all stakeholders. [*Rudolf-Miklau, 2009*]

Nevertheless risk management for natural hazards is well established in the Austrian political and administrative system. Legal regulations – e.g. in the water act, the forest act, the areal planning and building acts as well as the catastrophe acts of the provinces – provide a comprehensive framework for the public services such as flood control, torrent and avalanche control, protection forest management and catastrophe management. The federal disaster relief fund guarantees sustainable financial support for protection measures and recovery after catastrophes. Hazard maps and hazard zone plans provide nation-wide public information about areas at risk. A well-established crisis management system on regional and local level guarantees an efficient and quick reaction to emerging catastrophes. Furthermore hazard and risk maps are partially available to the public on the internet.

Since the avalanche catastrophe of Galtür 1999 and the flood disaster of 2002 Austria was able to improve the efficiency of its risk management significantly especially concern floods and avalanches. The implementation of the flood risk management plans in the framework of the EU flood directive in 2015 will be a key step towards an integrated risk management system. This development provides an exemplary model for risk management concerning gravitational hazards but requires important adaption for this purpose.

3.3 Gaps in risk management concerning gravitational hazards

Austria was one of the first countries in Europe to establish a legal basis for hazard zone plans for torrents and avalanches in the Forest Act 1975. Recently a nation-wide coverage by hazard zone plans was reached. Furthermore in 2011 the legal basis for hazard zone plans on floods was settled in the Water Act fostering an intensive planning progress in this field in agreement with the EU flood directive [*Rudolf-Miklau, 2014*]. This European legal norm requires the elaboration of hazard and risk maps for all water-related (including sediment-related) hazards. The integrated risk management system related to the river basin was comprehensively implemented in all relevant Austrian legal and technical standards and will be the guiding policy principle also for areal development in the future.

While the establishment of flood risk management is expected to be a paradigm shift this policy will bring with it some side effects that have to be taken into account especially in the Alpine environment:

1. The strong legal integration of flood risk management will not be equivalently established for other natural hazard, especially those with local effects (avalanches, debris flow, and rock fall).
2. The consequent execution of flood hazard maps in the regional development for Alpine valleys will strongly limit further zoning and building in areas exposed to floods. Due to limited available space this could encourage developers and building owner to focus more and more on slope areas exposed to gravitation hazards. (Fig. 2)
3. Risks by gravitational hazards have another characteristic than flood risks, typically endangering few objects but with high potential for total destruction and loss of

lives.

4. Slope areas are often protected by forests. (Fig. 2) The protection function of forests in steep terrain is precarious, as avalanches, storms or wild fires can destroy large forest stands at once and give place for other gravitational hazards.
5. Alpine valleys are as a rule exposed to a wide range of natural hazards. Consequently risk management for specific areas should focus on all these hazards and also take into account various interdependencies. The "multiple-hazard approach" is still not standard in the Austrian risk management policy while most institutions and decision makers focus on single hazards and risk within in their scope of competence.
6. The awareness of people for the various hazards in Alpine living space is inconsistent. Especially hazard on slopes are not as evident to the public as floods or avalanches.

In order to balance these side effects comparable public information on risk by other natural hazards would be necessary. Especially all kinds of geological and ground risks gain more and more importance for building trade. In spite of the growing importance, a corresponding legal basis for hazard mapping in this field is still missing in Austria.

Fig. 2 Land use on slopes exposed to gravitational hazards where the protection function of forest stands is essential (Paznaun Valley, Tyrol, Austria).

Another problem to be mentioned is the perspective of municipalities in Alpine areas. Their focus is directed on the availability of building land. Hazard maps are primarily understood as a restriction to areal development. While majors have become used to handle the effects of well-established hazard zone maps, the outline of new maps (plans) for other kinds of hazards will most probably cause disorder in the system and bring about resistance movements by local policy makers and the population affected. Municipalities fear to be in the stugglehold of natural hazards and warn from a total cessation in areal development if large areas of the community are covered by hazard zones. Land owners experience hazard zones as a public intervention limiting the free availability of private property and loss of value for their estates and houses. The primary expectation of both groups is the immediate reduction of risk by technical protection measures. This means great challenges for risk communication on local level if new types of hazard maps shall be implemented without comprehensive preparation [*Rudolf-Miklau, 2014*].

3.4 Hazard mapping for gravitational hazards: Recent initiatives in Austria

Recently some Austrian provinces have realized the importance of planning tools concerning slope and ground risks for regional development and have issued large scale susceptibility maps for geological hazards or ground risk cadasters (e.g. Lower Austria, Upper Austria, Burgenland, Carinthia). (Fig. 3: Example for a Geological hazard indication map from Lower Austria) These maps mainly aim at a pre-evaluation of risk in order to steer and dose the planning requirements (efforts) for concrete building projects in endangered areas. Nevertheless specific hazard zone plans with information on local and object scale concerning rock fall and landslides are as a rule still not available.

Some provinces bridge the gap by cooperating with the Austrian Torrent and Avalanche Control Service in hazard zone mapping. So-called "brown" indication zones are charted base on an assessment of gravitational hazards graded according to the process intensity (e.g. Vorarlberg). Also from the point of view of the federal state as a holder of the disaster relief fund, the tension between a growing demand for an intact protective function of forests and the realization of additional technical protection measures on the one hand and the financial limitations of public funds on the other hand, the targeted application of subsidies for risk prevention urgently requires a prioritization based on a comprehensive hazard mapping. These arguments seem to justify the urgent establishment of a hazard zone mapping standard for rock fall and landslides in Austria comparable to the existing hazards maps for floods, debris flow and avalanches. This standard for hazard mapping shall be established together with other function of an integrated risk management system for gravitational hazards.

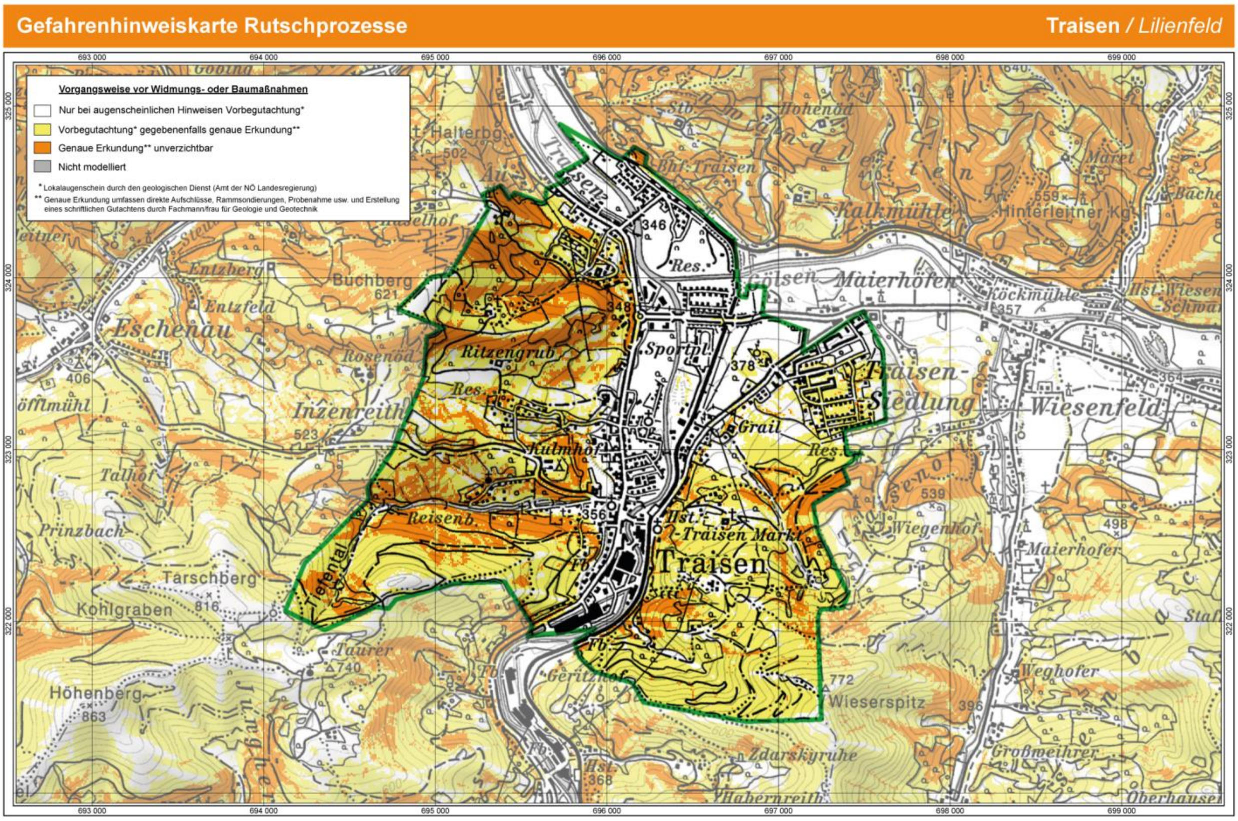

Fig. 3 Hazard indication map for landslides (example from Lower Austria: Municipality of Traisen) (© Provincial Government of Lower Austria)

5. AUSTRIAN PARTNERSHIP FOR "RISK MANAGEMENT IN SPATIAL PLANNING CONCERNING GRAVITATIONAL HAZARDS"

The Austrian Spatial Development Concept (ASDC) is a strategic management tool for the general governmental policy in urban and regional development, as well as those of provinces, cities and communities and is published by the Austrian Conference on Spatial Planning (ACSP). The "action program ASDC 2011" contains proposals for strategic actions and describes the work packages whose further implementation takes place in the context of so-called "ASDC partnerships". An ASDC partnership consists of thematically concerned ACSP members and other relevant institutions, with the aim to develop an issue of ASCD 2011 in co-operative or bring it to implementation.

The partnership "Risk Management for Gravitational Hazards in Areal Planning" (RMAP-partnership) was originally initiated by the Federal Ministry for Agriculture, Environment, Forestry and Water Management together with the Geological Survey of Austria in order to coordinate and bundle promising initiatives in the field of risk management concerning gravitational hazards. The partnership was officially proposed to the steering council of the ACSP and approved in December 2012.

The strategic objective of the partnership is the design and implementation of an integrated risk management system concerning gravitational hazards in spatial planning (as congruent process to the implementation of the EU flood directive). The technical goal is the establishment of harmonized minimum standards and a cross-sectorial planning process concerning protection from gravitational natural hazards to bridge the gap of partitioned competences and fragmented legal norms. The operational objectives of the partnership comprise the development of common design principles and of methods for risk analysis and assessment, the harmonization of safety objectives and safety concepts, furthermore the selection of criteria for the prioritization of public protective services. The work of the partnership is based on a comprehensive survey of the legal-political framework conditions in hazard mapping and risk management in Austria. [*Kanonier*, *2014*] The goal of risk communication is to develop a standardized form of information about gravitational hazards for policy makers and the public and common actions of the actors to improve risk awareness and self-care.

The partnership comprises representatives of the majority of the Austrian provinces (Lower Austria, Upper Austria, Styria, Carinthia, Salzburg, Tyrol, Vorarlberg) from the fields of geology, development planning, torrent and avalanche control, forestry, water management and law, furthermore representatives of the major traffic enterprises (Austrian Federal Railways, Austrian Motorways) and experts from several universities. Of specific importance for the process is the involvement of representatives of municipalities (majors from Alpine villages directly concerned by gravitational hazards) who contribute from the point of view of their local experience.

The partnership currently works in several working parties (geology, areal planning, and technical planning) on various products which shall serve as a basis for a consecutive standardization and policy development process. Some examples can be mentioned:

1. Definition of the working area for hazard assessment
2. Requirements and accuracy of input data for numerical models as well as hazard and risk maps
3. Requirements for the application of numerical models for assessment of rock fall and shallow landslides
4. Glossary and definition in order to harmonize technical communication on gravitational hazards among different disciplines
5. Overview of existing hazard mapping standards in Austria and neighboring countries
6. Legal basis for risk management in development planning.

It is intended to make the results accessible for a public discourse. The partnership will keep on working until the end of 2014. Results will be published in form of ACSP political recommendations and an ACSP technical publication.

6. HARMONIZED HAZARD AND RISK PLANNING PROCESS AND HIERARCHY

6.1 Framework conditions for harmonization in hazard and risk planning in Austria

Due to the heterogeneous structure of the Austrian “catastrophe management law” no comprehensive legal basis is available for hazard and risk mapping concerning gravitational hazards. As a rule risk management is an annex to a multitude of legal matters and fragmented in competence among the federal state, the provinces and municipalities. [*Kerschner, 2006*] There are significant differences in the treatment of gravitational hazards in spatial planning policy of the Austrian provinces. [*Kanonier, 2014*] These differences result from diverse topographic conditions that characterize the landscape between the foothills of the Alps and inner Alpine valleys. Eastern provinces like Styria, Lower and Upper Austria with a high portion of lowlands are able to treat natural hazards in land use planning quite restrictively and putting general building bans on highly endangered areas. The predominant strategy in areal development is a totally avoidance of areas at risk, while fostering the development of new settlement areas in relatively safe regions. These provinces have the advantage that still enough space for areal development is available. Hence the provincial governments and political decision makers in extra-alpine regions tend to associate hazard zones with absolute restrictions to zoning and building.

In contrast western Austrian provinces like Tyrol, Salzburg, Vorarlberg or Carinthia with a high portion of mountain areas have limited living space available and people are used to live with risks by natural hazards. The willingness of political decision makers in these regions is much more open to facilitate spatial development in risk-prone areas. Especially in narrow Alpine valleys there are practically no “safe” areas, hence the tolerance of the local population for risks by gravitational hazards is significantly higher than in foothill regions. A strong trend towards the development of building land on slopes is obvious.

These significant differences in the perception and acceptance of gravitational hazards, comparing eastern and western Austrian provinces, were evident during the constitution of the RMAP-partnership. There was an urgent need expressed by the partners to take into account and respect the necessary sphere of influence for the regional governments to shape the policy for risk treatment according to the regional characteristics and framework conditions. This political demand was a fundamental obstacle for the establishment of a general nation-wide regulation on hazard mapping for gravitational hazards. Furthermore several provinces had launched individual initiatives to establish planning procedures in order to take gravitational hazards into account in spatial development (cf. 3.4) It was clearly signaled by the representatives of these provinces that there is no interest to abandon the ongoing developments and replace them by a common Austrian planning standard.

Other challenges for the harmonization are the different qualities of information in the different type of hazard (indication) maps. The available procedures range from scientific maps and expert specialist planning to informative hazard maps open to the public. Practically all maps have in common that the precision ranges from supra-regional to regional level, while high-precision hazard zone maps on local level are hardly available. An exception exists in the province of Vorarlberg, where hazard zones for rock fall and landslides were integrated into the hazard zone plan of the Austrian Torrent and Avalanche Control Service.

This wide scope of types of hazard maps brings about the problem that the abstract information included either is limited to the application by experts or requires further interpretation in order to transfer hazard information to administrative or authority (political) decision making. If these maps shall be applied by the public (mainly laypersons) the displayed information has to be simplified (e.g. for presentation in geographical information systems on the web) taking into account a loss of accuracy.

Another problem lies in the fact that hazard maps as a rule are elaborated by institutions other than the administrative bodies or authorities that apply the information. As decisions related to natural hazards have severe impact on human life and private property there is a high risk of liability in case of incorrect information or false expertize. Consequently geologists elaborating those maps have strong reservations to a common public use of the maps (or even information derived out of them) according to the methodical uncertainty in hazard assessment and the multiple sources of misinterpretation by persons without sufficient expertize.

All these arguments have encouraged the RMAP-partnership to establish a policy process that aims at a harmonized framework for planning procedures, focusing more on general planning principles, protection goals and planning hierarchy than on specific mandatory regulation in hazard mapping. The result of the partnership will be a recommendation and best practice examples that take into account the regional peculiarities in risk acceptance and treatment.

The partnership has no statutory basis and consequently is designed as a governance process aiming at the negation of common principles and compromises concerning minimum planning standards. Most of the results will be policy proposals not being legally binding in any way. Thus the success of the partnership depends on a strong agreement among participating institutions, on the creation of a follow-up political network that is able to promote and disseminate the results as well as on the quality and applicability of the results in order to convince decision makers and practitioners (engineers).

6.2 Proposal for a planning hierarchy concerning for areal development gravitational hazards and risks

The RMAP-partnership has proposed a new planning hierarchy for the treatment of gravitational hazards in areal development. As shown in Fig. 43 the proposed hazard planning hierarchy is based on a matrix that shows all different levels of planning times a graded information quality of hazard maps (in the range from specialist planning to regulative planning). In general the different types of graphical hazard presentation take place on four levels of planning:

1. National (supra-regional): scale 1 : 500,000
2. Regional (provincial): scale 1 : 25,000 to 100,000
3. Local (municipal): scale 1 : 5,000 to 25,000
4. Object (property parcel): 1 : 5,000

As gravitational hazards are mainly a regional or local matter no European level of planning was relevant (in contrast to flood risk management). Furthermore different qualities of maps exist in Austria (and adjacent Alpine countries) depending on the purpose and content of the geographical presentation:

1. *Scientific maps* (based on geological investigations): e.g. inventory maps, event register, susceptibility maps, disposition maps process models.
2. *Expert specialist maps*: e.g. hazard indication maps, geological risk maps.
3. *Hazard maps* or *hazard zone plans*, outlining graded hazard intensities.
4. Expertize and planning for specific building projects.

Level of planning	Scale	Spatial planning	Geological investigation (scientific maps)	Expert (specialist) planning, administrative directive	Hazard map (public geographic information)	Regulative planning (Formal regulatory act)
National (supraregional) level	1 : 500,000	Natioanle guidance planning	Inventory maps Event register Basic geological maps			
Regional level	1 : 25,000 – 100,000	Regional development concept	Map of phenomena Susceptibility map Disposition map Process models	Hazard indication map Geological risk map Administrative directive for intensity of expert investigation		
Local (municipial) level	1 : 5,000 – 25,000	Local development concept, land use planning			Hazard zone plan (Hazard zones) Outline of hazard zones in land use plan Limitations for zoning Building ban	
Object level (property parcel)	< 1 : 1,5000	Areal zoning and building approval			General expertize for zoning areas	Expert report Expertize for specific building projects Limitations for building Regulatory requirement
Graphic hazard presentation in spatial planning			No presentation	Internal expert maps (administration, limited public access)	Presentation in geographic information systems (GIS, unlimited public access)	Building plan
Quality of information			Abstract scientific information	Abstract expert information (limited applicability of political decision-makers)	Public information (applicable for polititcal decision-makers and laypersons)	Specific expert information for authority decisions
Internal bindingness (administration)			Non-binding	Binding	Binding	Binding
External bindingness (public)			Not accessable	Limited accessibility	Informative, non-binding	Administrative, binding

Evaluation of hazard information by authority obligatory

Blue ..... Geological specialist planning; Red .... General spatial (administrative) planning

Fig. 3 Proposed scheme of planning hierarchy concerning hazard maps for gravitational risks and their application in spatial planning in Austria (© Rudolf-Miklau)

While scientific maps in general are limited to the application by experts (geologists) and support their specific expertise and investigations, some specialist maps and hazard maps are, with some restrictions, appropriate for the application by administrative bodies and political decision makers. The application is strictly limited to the task of the administration or authority within the limits of its competence. On the contrary these maps are as a rule, not accessible to the public. The use of these maps for administrative purposes, such as the decision of the further intensity of investigation or as a basis for planning, brings about internal binding effects for the institution.

If hazard maps for gravitational hazards shall be accessible to the general public there are other requirements to fulfill. The use of information by layperson brings about the risk of misinterpretation. In practice published hazard maps require a common standard of planning and clear regulation for users that protect the producer from liability. These legal and technical standards do not exist in Austria yet and would require further standardization processes among experts beyond the scope of the RMAP-partnership.

Furthermore if hazard zones are translated into regulative planning acts or binding administrative decisions it is obligatory for authorities applying hazard zone information to perform own evaluation sand assessments for the specific planning case. Thus a strict distinction between the abstract hazard mapping process and the specific risk assessment for a concrete building project is gained. The responsibility for the application of hazard zone information is clearly assigned to the deciding authority. Hazard maps applied in formal regulatory acts only serve as a means of evidence but cannot replace the decision by these authorities.

This proposed, clear and graded hierarchy of planning and application of hazard maps seems to be appropriate to give a framework for the various existing types of maps and their application in spatial planning. The general principles of this procedure should facilitate the transfer of information from geologists and expert planners to administration in regional development and spatial planning authorities and provide a reliable basis for a common level for risk evaluation.

The planning hierarchy shown in this paper currently passes through a process of discussion and will be integrated into the material volume resulting from the RMAP-partnership. At the end of this process the hierarchy will gain the status of a policy proposal. The implementation into real policy will be further step beyond the scope of the partnership.

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