Summary ÖROK PUBLICATION NO 193 – ÖREK PARTNERSHIP "RISK MANAGEMENT FOR GRAVITATIVE NATURAL HAZARDS IN SPATIAL PLANNING"

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1 ÖREK Partnership "Risk Management for Gravitative Natural Hazards": Issues and Policy Objectives

Gravitative natural hazards (landslides, esp. landslips, mudslides; debris avalanches: esp. rockfalls and rockslides; *snow avalanches*[3]) have a decisive influence on spatial development in the Alpine region. These hazardous processes are usually accompanied by intensive and changing land use that triggers social adjustment processes. In this context, the potential consequences of natural hazards and their possible development trends are of significance. In contrast to flooding risk, when dealing with gravitative natural hazards (especially rockfalls and landslides) there are far-reaching deficits and gaps in the fundamental information available with respect to hazard analysis, sectoral planning (hazardous zone planning) as well as risk management for land use in Austria. The biggest policy challenges consist in the development of an integrative evaluation of the threats and risks (security level, protection objectives), a uniform planning system for the cartographic depiction of gravitative natural hazards as well as the use in spatial planning and for achieving a common understanding of protection objectives across sectors. Demographic change in the Alpine area is closely related to gravitative natural hazards. Therefore, this highlights how critical the deficits found in basic research, in sectoral planning and in risk management for spatial planning are when dealing with gravitative natural hazards.

ÖREK Partnerships are a key instrument in the implementation of the Austrian Spatial Development Concept (ÖREK 2011). The ÖREK Partnership "Risk Management for Gravitative Natural Hazards in Spatial Planning" was set up under the leadership of the Federal Ministry for Agriculture, Forestry, Environment and Water Management[4] and GBA[5] to create a new cooperation and development approach at the expert level for this area, which is characterized by fragmented competence and sectoral segmentation, and to successfully address the highly demanding scientific, technical and legal complexity of the issues and master the challenge of achieving harmonization across the sectors. A special strength of the Partnerships was the involvement of numerous disciplines from science, politics, administration, engineering and economy as well as national and international leading experts who have also contributed the keynote articles to this Monograph. Apart from well-founded sector-specific basic research, the most important objective of the Partnership was the preparation of expert recommendations and their presentation to ÖROK as basis for reaching policy agreement and resolutions.

2 Hazardous zones versus living space (Synthesis Chapter III)

Permanent settlement space is severely restricted in the Alpine regions of Austria due to the topography. The high settlement pressure interacts with very limited space available for permanent settlement due to natural hazards. From a historic perspective, the first hazardous zone plans gained acceptance among the population after an introductory phase. With the increasing differentiation of the various hazards and the different areas of competence, it has become very important for municipalities to find ways to implement integrative hazardous zone planning today. The field of tension lies less in the hazardous zone plan itself, but rather in its implementation in accordance with spatial planning and building laws, because the former individual subjective assessment of hazards has been replaced by a formalized, official assessment. The downside of institutionalized hazardous zone planning by government institutions is the potential risk of losing local knowledge. Therefore, it is necessary to find new ways of integrating the affected population and enabling active participation in hazardous zone planning.

1 University of Vienna, Institut für Geographie und Regionalforschung.
2 Federal Ministry for Agriculture, Forestry, Environment and Water Management.
3 Avalanches were not dealt with within the scope of the ÖREK Partnership.
4 Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft.
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An important element of the cross-sectoral implementation of hazardous zone maps and hazardous zone plans is to have generally-accepted and clear terminology for gravitative natural hazards usable by all sectors involved (geology, sectoral planning divisions, spatial planning) in the same manner. There is a special focus on clearly identifying the preparatory, triggering and controlling factors that result in gravitative hazardous processes. The three crucial options for risk management are: the careful recording of the gravitative natural hazards (mass movements); monitoring the processes with integration into early warning systems; the spatial-temporal visualization of gravitative natural hazards to varying degrees of depth. Future investigations must also take the possible consequences of gravitative natural hazards into account. The availability of spatial-temporal information for spatial planning and development opens up new possibilities for sustainable regional development.

As a new approach, within the framework of this ÖREK Partnership “risk" is introduced into the evaluation of the consequences of the gravitative natural hazards for spatial planning and other sectors involved in the management of the natural hazards in Austria. However, the risk concept here is not a traditional legal term like the concept of hazard. In the rationale of risk research, a risk is of relevance for spatial planning if with the help of spatial planning instruments it is possible to influence the probability of occurrence or the consequences of an event for specific, well-known and definitely identifiable areas from where hazards originate and/or that are affected by hazards. Risk assessments though are by far not standard procedure in spatial planning, but are only conducted in special cases. Considering the strategies presented, the uncertainties that most certainly exist regarding future changes in the frequency and magnitude of natural hazards should not be seen as a reason for relinquishing risk management in spatial planning. A barrier to this is the need to establish the concept of risk in law and organizationally in natural hazard management in Austria.

The model of hazardous zone planning serves as guidance for the depiction of gravitative natural hazards and their consideration in spatial planning. In hazardous zone planning for barriers against torrents and avalanches, the hazards stemming from torrents and avalanches are recorded for all surface areas and the entire territory for current and future settlement areas as well as for other land with high priority uses. Starting out from a measurable event with a 150-year recurrence probability, the hazardous zone map shows two hazard intensity classes that are based on reasonable surface use and land development potential. Settlements are not recommended in the red zones, while in the yellow zones, settlement is possible if suitable construction measures are taken (property protection). After 40 years of use, the procedures for the creation, communication and consideration of hazardous zone plans are well established in public perception and administrative practice. Moreover, they have the expected steering effects while enjoying high political acceptance. The integration of gravitative natural hazards into the model for hazardous zone planning, especially at the municipal and building level may be considered a purposeful goal.

Exemplary for giving natural hazards due consideration in Alpine spatial development is the *Land* Tyrol which demonstrates how *Länder* can regulate the various different natural hazards in their respective areas of responsibility and execution of the legal norms. Due to the topographical situation, large parts of the region are located in vulnerable zones and for this reason it is necessary to have detailed legally-binding regulations for permitting land zoning and construction. The small percentage of land usable for permanent settlement requires a differentiated way of dealing with natural hazards while taking risks into account. A basic tenet in this process is to aim for the highest possible protection at an economically reasonable burden while taking into account the special requirements of every specific case. The Spatial Planning Act of Tyrol prevents the expansion of land use in areas with a very high hazard potential and mandates the preparation of the relevant expert opinions for every new construction project.

Other Alpine countries (France, Switzerland) – due to their fully developed system of vulnerability mapping for gravitative natural hazards and the implementation of models for integrated risk management – serve as models for Austria. In France, the Risk Prevention Plan (“Plan des Risques/PPR”) was introduced as early as in 1955 to depict all natural hazards, and in some cases, also technological hazards and related risks, and to be able to take these into account when reaching planning and development decisions. In mountainous regions, landslides, flooding, avalanches and earthquakes with a 100-year recurrence probability are taken into account. The “Plan des Risques” is a key planning document for the French state and municipalities for risk prevention against natural hazards and constitutes the implementation of risk assessment at the political level. The inclusion of decision-makers in the technical aspects of the zoning process has proven successful in France.

In Switzerland, the strategy of a risk-oriented approach to natural hazards in spatial planning has been pursued for many years. It may be assumed that the concepts of integrated risk management and sustainable measures planning are firmly esta-

blished politically in Switzerland and accepted by society. At present, a paradigm shift is under way towards a risk-based spatial planning. As spatial planning in Switzerland has not yet been able to check the trend of rising risks, the strategy for steering settlement development in the desired direction "inwards" will thus focus in future on existing settled space. Spatial planning's task is to steer settlement development in such a manner so as to keep the potential for damage and thus the risks at an acceptable level. The Swiss hazardous zone maps provide detailed information on the location and the magnitude of potential threats, but do not give any information on potential damage to so as to enable risk-based spatial planning to contribute substantially to risk reduction. Therefore, the aim in the future will be to require risk-minimizing measures as the standard procedure in cases of intensifying land use (e.g. building protection) and to prevent uncontrolled, new land use in hazardous zones.

3 Achievements and Results of the ÖREK Partnership (Synthesis Chapter IV–VII)

The ÖREK Partnership analysed the issue in depth and across sectors (cf. this Monograph), and formulated the results in "Recommendations of the Partnership" that may serve as basis for ÖROK's sectoral policy recommendations. This analysis was based on the materials and working papers produced by the working groups Spatial Planning (Chapter IV), Geology (Chapter V) and Sectoral Planning (Chapter VI) which are summarized in this Monograph. These constitute currently accepted knowledge in Austria, but also give an insight into the breadth of implementation and the steps required for development and harmonization in order to establish uniform hazard depiction standards (e.g. modelled on hazardous zone planning for barriers against torrents and avalanches) as well as integrated risk management for gravitative natural hazards (e.g. based on the Swiss model or the flood risk management model[6]). In this context, due consideration was given to the requirements necessitated by the different spatial structures and social conditions that define the scope for action of the Austrian *Länder*. An additional focus was placed on the presentation form of the available knowledge on the monitoring of gravitative natural hazards (Chapter VII).

3.1 Working Group Spatial Planning (Synthesis Chapter IV)

The Working Group "Spatial Planning" worked out the connection to natural hazards in all relevant aspects of spatial planning. One of the areas of focus was the analysis and structured presentation of the legal framework (Study by TU Vienna, Univ.-Prof. Arthur Kanonier).

The future tasks of spatial planning will concentrate on prevention. A general avoidance of hazardous zones works where there are no vulnerable land uses in hazardous zones. Planning materials are required for this purpose that provide information on the type and magnitude of the threats. While such highly advanced basic materials are available for flooding and avalanches, there is still a considerable backlog in materials for gravitative natural hazards, especially rockfalls and landslides. Existing settlements in hazardous zones and tight spatial resources often leave no choice but to use areas threatened by natural hazards. Instead of moving away from vulnerable areas, land use is adapted to the specific threat situation. This task poses a great challenge for effective spatial planning.

In summary, alone at the level of municipalities there are up to five procedural tiers for which different detailed statements on gravitative natural hazards must be drafted. A general and exhaustive regulation of land uses adapted to hazardous zones in spatial planning, however, contradicts the basic tenet of "threat avoidance" and would probably also be too complex to be implemented at the municipal level without needing numerous exemptions and special rules. Therefore, the regional legislation of the *Länder* contains varying approaches to the regulation of land use adapted to natural hazards, with said regulations being oriented on the ones in use for flooding zones. An analysis must be made to which extent modifications need to be made to these regulations for the special features of gravitative natural hazards.

3.2 Working Group Geology (Synthesis Chapter V)

The participating geologists from *Geologischer Bundesanstalt* (GBA), *Landesgeologische Dienste* (geological services of the *Länder*) and universities compiled the current status of accepted knowledge in Austria regarding the analysis, evaluation and cartographic depiction of landslides and rockfalls. There are models and methods for fall processes and planar landslides/mudslides available for detecting the susceptibility of subsoil for landslides and debris avalanches and determining the scope of impact. The presentation for regions and municipalities is given in the form of hazards index maps that depict the vulnerable area (scarp area) and the impact area in a differentiated manner. The comparability of the results requires –

6 Basis: Floods Directive.

apart from the comparable quality of the data base (e.g. breakdown of the terrain models, documentation of historic events, etc.) – a comparable method within the region or administration unit being investigated (e.g. *Länder*) as well as in the neighbouring regions. Assessments of the susceptibility for landslides and loose rocks are conducted using low information densities according to heuristic, expert knowledge-based procedures. If there are landslide records of sufficient quality, a preference should be given to statistical approaches that enable the quantitative classification of vulnerability to landslides based on historic landslide events. Physically-based methods should only be used at the object level (measures planning) due to the detailed geo-technical parameters required. The simulation models the fall processes at municipal and object levels; at the regional level, the simulation models the potential landslide area using a rough assessment of the runout distance based on the equivalent friction angle.

It was possible to show that the indicative nature of the hazards index maps is contingent on the analysis benchmark, data quality and methodology used. Different types of processes – earth slides on loose ground and landslides, falls and rockslides – require a separate treatment or differentiated methodology due to different mechanisms and process-related factors. Quality assurance for hazard zone maps must meet the minimum requirements for data quality and method, and the verifiability of map creation and related indicative feature must be documented. It is especially relevant that the selection of class demarcations depends strongly on the spatial range of the hazard classes and thus determines residual risk, which due to general uncertainties will always remain and must be communicated.

3.3 Working Group Sectoral Planning (Synthesis Chapter VI)

The activities of the Working Group Sectoral Planning consisted of the comparison and development of suitable planning processes and implementation rules. To this end, it used models of cartographic depiction of hazards and risks available and proven in Austria and in other Alpine countries for the planning level under review. Another area of focus was the development and establishment of generally-recognized (standardized) protection goals and security thresholds for spatial planning and risk management for rockfall hazards[7].

In Austria, the two instruments for gravitative natural hazards are available either in only isolated cases (regional) or not at all so that security decisions need to be reached only in individual cases in spatial planning and construction proceedings. For the depiction of gravitative natural hazards a differentiation by method is made between inventory maps, hazard index maps, hazard zone maps, risk index maps and risk zone maps. Hazard zone plans are characterized by procedures regulated by law and by their legitimation by a government body. Each planning document is created using different model approaches contingent on the scale applied. Based on fact sheets completed by the competent institutions at expert interviews (Study by University of Vienna, Univ. Prof. Thomas Glade), different approaches to the depiction of hazards are presented and then compared. Due to divergent data material, different methods and the formal presentation applied, it is not possible to directly compare the hazards depictions available in Austria and Bavaria[8]. The study shows the need for harmonization that would be required to achieve a uniform planning system at the national level for the cartographic depiction of gravitative natural hazards.

The definition of concrete protection goals and security thresholds requires knowledge of the recurrence probability and intensity of the hazardous processes. For rockfall processes, an initial draft for specific protection goals was prepared that are used in spatial planning and construction proceedings as well as criterion for demarcating hazard zones and threat index areas. A special safety criterion is proposed for persons in open space and traffic participants. The model is harmonized with the standard safety level in Switzerland and Vorarlberg.

3.4 Monitoring Gravitative Mass Movements (Synthesis Chapter VII)

When monitoring gravitative natural hazards, landslides are indirectly evaluated by both applied geosciences as well as by spatial planning by comparing data and threshold values and based on indicators for control measures. The recording and surveillance of spatial and temporal distribution of landslide movements is the core task of the various geological and geotechnical monitoring systems. Their use requires the precise geological-geomorphological cartographic depiction of hazards and can be of direct usefulness for spatial planning as well.

7 The concept of protection goals was applied as a model to obtain a better estimate of rockfall hazards, while for landslide processes the uncertain planning materials do not yet permit uniform protection goals to be implemented.

8 The hazards depiction models from France and Switzerland that were already addressed in the keynote contributions were not taken into account.

For example, the historic analysis as part of the spatial monitoring of natural hazard events is an important contribution to the new zoning of building land. The corresponding data base is fed with data from ongoing spatial monitoring and is the basis for risk analysis. The areas at risk due to mass movements can hardly be upgraded to building land by geological-geotechnical monitoring systems. The spatial monitoring of rockfalls or landslides is an important basis for the evaluation of natural hazards for planning purposes.

The use of early warning systems, especially for transport routes that cannot be protected by barrier structures has become a key protection measure. It is noteworthy that monitoring in the interest of the public is not a legally binding means, and therefore, there is no consistent legal basis, but it can be used for private sector interests in monitoring for plant protection (e.g. railway lines, roads, cablecars).

Conclusions

The ÖREK Partnership "Risk Management for Gravitative Natural Hazards in Spatial Planning" is dedicated to the issue of how strong the territorial impact of gravitative natural hazards is, what consequences are possible and what basic materials can be made available for spatial planning and how these can be implemented in spatial planning. Based on a synopsis of the established models and methods used in Austria (and in the neighbouring countries), it was possible to obtain a "status of generally accepted knowledge". A summary of knowledge on the analysis, evaluation and management of gravitative natural hazards is new in Austria in this form and is certainly a quantum step forward. The Partnership conducted an evaluation of this knowledge bearing in mind the regional bandwidths and made recommendations for the implementation and harmonization of risk management for gravitative natural hazards in spatial planning and sectoral planning. The results – though non-binding and preliminary – are made available to ÖROK and its members as a basis and proposal for further strategy development and for the preparation of "sectoral policy" recommendations (ÖROK recommendations). Furthermore, this process made it possible to set up a network of experts that work across areas of competence and institutions and can advance the harmonization and standardization process in this important sectoral domain also after the end of the ÖREK Partnership. The cooperation established in this Partnership between experts from different sectoral divisions is exemplary for the entire area of natural hazards risk management in Austria.