REFLECTIONS ON A (AVALANCHE) RISK-ADJUSTED APPROACH IN SPATIAL PLANNING IN AUSTRIA

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ABSTRACT: Spatial planning has an increasingly important role in natural hazard management due to its prevention character and influence on spatial distribution and intensity of uses. In terms of proactive planning, land use adapted to the natural forces with the aim of reducing the risk should be promoted (Fuchs et al. 2017; Löschner et al. 2017). The approach of a risk-adjusted spatial planning is rather novel, because the current spatial use decisions usually are hazard-oriented and derived from the hazard zone plans (Seher and Löschner 2018). The consideration of residual risks (ISO 31000:2018) in the range of technical protection systems has played a less important role in spatial planning so far due to the lack of a corresponding legal framework. This paper presents a decision tree that can be used as support for zoning and construction consideration with the scope of protective measures to strengthen a risk-adapted approach in spatial planning and therefore contributing to the avoidance of new (avalanche) risks.

KEYWORDS: Risk-adjusted, spatial planning, natural hazard management, residual risk

1. INTRODUCTION

As recent events dramatically show, also in the public perception, natural hazard-related damage is increasing worldwide. Due to the limited permanent settlement area, especially in Austria, it is necessary to manage natural hazards and their associated risks and to use planning measures in addition to technical and organizational measures in order to achieve a long-term reduction of damage and to inhibit the emergence of new risks. New societal challenges in natural hazard management (Thaler et al. 2018) not only include general socioeconomic changes in relation to exposure in settlement areas (Fuchs et al. 2017; Löschner et al. 2017), but also for example aspects of demographic change (Nordbeck et al. 2020). Spatial planning holds a key position in terms of the precautionary principle.

1.1 Situation in Austria

Due to the topography of Austria, only around 39% of the area is suitable for permanent settlement. Because of the Alps this value is even lower in the western parts. However, the need for usable space for housing and business purposes increasingly grows. (Dittrich et al. 2011) At the same time, the frequency and intensity of natural hazards are increasing due to climate change, resulting in an increase of hazard potential in the already scare permanent settlement areas. This results in a field of tension between limited safe living space and growing settlement pressure, especially in the alpine regions. A consequence is that there is an increasing overlap between hazard and settlement areas (Fuchs et al. 2015; Heiser et al. 2019; Schlögl et al. 2021).

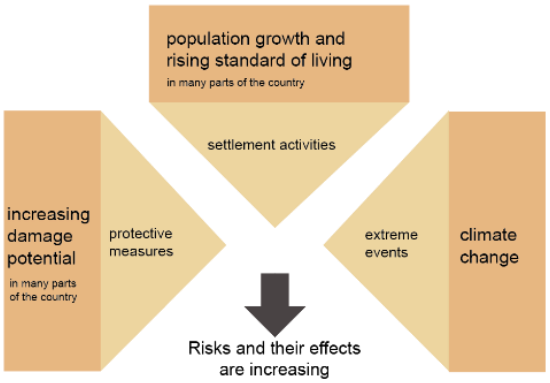

Figure 1: Increasing Risk (Steinbrunner 2020)

1.2 Natural hazards in Austrian spatial planning

Spatial planning constitutes the whole set of measures and activities of public territorial authorities that target the shaping of the territory, based on political objectives (Gruber et al. 2018). Regarding the management of natural hazards, including avalanches, spatial planning in the sense of integrated planning is considered to play an important role in linking hazard analysis, vulnerability and risk assessment. Spatial planning restrictions on use and construction have a controlling effect on the development of land use and are considered a public task. In Austria such restrictions are implemented through legislation

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of the federal states (Gruber et al. 2018). Referring to the nine different spatial planning laws of the federal states the following basic claims of sovereign planning can be summarized, which also have relevance in terms of natural hazard management (Kanonier and Schindelegger 2018):

- Future-oriented: Spatial planning should be oriented towards the future and thus take into account future effects of any kind as well as anticipate future developments.
- Area use related: A spatial planning consideration should be related to an extensive area and not (only) make statements for small areas.
- Decision and design orientation: Future perspectives and developments are to be guided by spatially relevant decisions.
- Coordination and optimization claim: Spatial planning should bundle, coordinate, weigh and finally prioritize the various existing and often diverging interests and claims.
- Public interest oriented: In principle, public interests should have a stronger weight than individual interests and should therefore be weighted higher when considering different claims.
- Rationality requirement: Decisions relevant to space should be proportionate and comprehensible, and their basis should be transparent and justifiable.

The objectives of spatial planning law include an extensive range of various matters. Regarding the scarce permanent settlement area in Austria, a compact settlement structure can be described as an essential public interest. These include for example economical use of land as a limited resource, an inward settlement development, good location planning and optimal use of spatial potential.

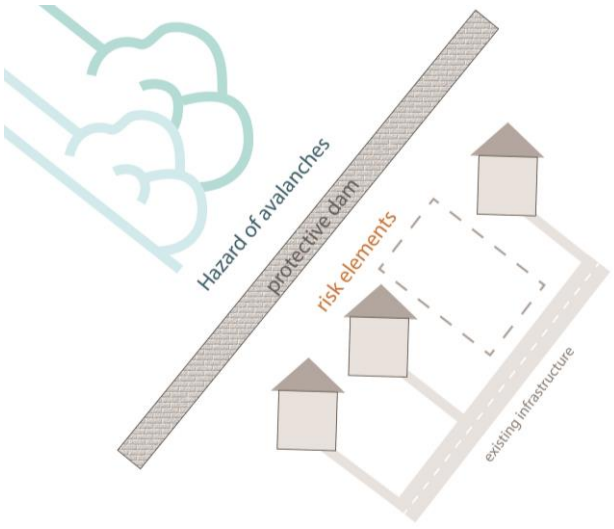

Figure 2: Weigh interests

1.3 Hazard-oriented versus risk-oriented approach in spatial planning

The current approach to natural hazards in Austrian spatial planning is hazard-oriented. Only sporadically a reference to risk is found in the relevant regulations, but this is only formulated in general terms and does not allow planning decisions to be made on the basis of a quantified limit value or protection target for instance. So far such protection targets have only been formulated in a few federal states and with reference to risk. (Gruber 2018)

A risk-oriented planning approach is essentially characterized by differentiating land use decisions not only according to the hazard, but also considering the potential extent of damage. Therefore the question of vulnerability assumes a yet neglected importance and allows for building land dedication under cost-benefit considerations or construction constraints (Attems et al. 2020; Holub et al. 2012). This seems particularly interesting in areas with medium and low vulnerability (Seher and Löschner 2018).

2. MODEL OF RISK-ADAPTED USE OF SPACE

In order to combine natural hazard management and risk-based spatial planning, knowledge about the risk is needed in the first step and further a defined procedure in the decision-making process in which the vulnerability of building uses is taken into account (Holub et al. 2012). Therefore, this plays a significant role because in some cases it will not be possible to compensate for the protection deficits by reasonable efforts (ARE et al. 2005). In certain areas, it will be necessary to allow construction activities even in hazardous areas. In consequence adjustments of the uses or a restriction of certain uses are necessary to reduce damages as well as possible. Based on these considerations, an application model of a risk-adjusted use of space is proposed. With the help of this model, it can be decided which use is to be classified as suitable in the area of effect of a technical protective measure. Starting point are uses that require a building land dedication. Thus, green land uses are not addressed, although uses with significant damage potential are certainly possible here as well.

2.1 Materials and Methods

The method used was primarily a literature research. This was supplemented by an analysis of the legal bases including the spatial planning laws. Furthermore interviews were conducted with actors from planning practice whose information were relevant for the analyses of three case studies and the design of the model. Both two case studies are located in Tyrol (Austria). One is a settlement area behind an avalanche dam that includes a museum, a parking garage and emergency organizations. Another one is a retirement home in an avalanche hazard zone.

2.2 Description of the model and indicators

The individual indicators for differentiated risk assessment are briefly described below. The model is structured according to the four categories (1) assessment of hazard, (2) assessment of use, (3) spatial planning considerations and (4) assessment of organizational measures. Hierarchically sequenced decisions are embedded in these four categories. While some indicators have clear limits in decision making, other indicators (for example the number of people in potentially hazardous areas) were not formulated with clear limits to allow for discretion in decision making. Some of the decision options lead to an indicator which, due to its special significance, was defined as an exclusion criteria in the sense of a prohibition of use. This is particularly the case for those indicators that would lead to a significantly increased extent of damage and thus to a significantly higher risk.

Assessment of the hazard

(1) Usually for any area with development in planning, a review of the hazard zone plans as well as other natural hazard maps should be undertaken to gain knowledge of any potential hazard. In this process the hazard zone plans show a graded hazard assessment at a specific geographic location but do not provide information on the level of risk. Hazard zone plans classify red hazard zones as unsuitable for development. Yellow hazard zones include those areas where hazards of lower intensity are present.

(2) The implementation of a technical protective measure is intended to reduce the negative consequential effects on the settlement area. The protective measures can be divided into measures with permanent and temporary protective effects. Permanent technical protective structures are fixed structures made of long-lived materials such as steel, concrete and stone. These structures include dams, walls, galleries, steel snow bridges, etc. When constructed according to the state of technology, these exhibit high resistance (Rudolf-Miklau and Sauermoser 2011) combined with a long life-cycle (Ballesteros Cánovas et al. 2016).

Temporary protective structures are understood to include mobile elements. This also implies protective structures where supporting components are made of wood, such as wooden snow support structures. Since weathering and erosion result in a reduction of the carrying capacity, the service life or useful life here is usually less than 50 years (Rudolf-Miklau and Sauermoser 2011). A comprehensive protective effect of these measures is only given if they are properly maintained and repaired at comparatively short intervals, which in turn is influenced by political and economic decisions, among other factors.

(3) As technical protective structures, like any structure, they have a certain service life (80-100 years) and wear out over time, they must be regularly monitored and maintained. Periodic maintenance measures are necessary to avoid irreversible damage. In this step the reliability of the measure in question should be assessed. The structural safety, serviceability and durability should be included in the impact assessment (PLANAT 2008). The assessment must be carried out by expert staff.

Assessment of the usage

(4) This step involves checking whether deterioration for other uses in the nearby area can be excluded. Similar to a prohibition of deterioration. The assessment must be carried out by expert staff.

(5) The question of insurable uses is relevant because it allows the risk to be passed on to a larger community (Fuchs 2009), economic losses are reduced and reconstruction is supported. However, there is no obligatory building insurance for damages caused by natural hazards in Austria yet, as for example in Switzerland. In contrast to commercial enterprises, private residences and public buildings cannot be specifically insured against natural hazards. In the case of commercial and industrial enterprises there is the possibility of insurance coverage for damage to equipment and materials, provided that the event occurs suddenly and unexpectedly and therefore the risk can be passed on.

(6.1.) If a commercial or industrial company is planned, the possibility of damage to third parties must be checked, since in the event there may be a release of substances harmful to the environment or health from tanks, machinery, storage facilities, etc. The risk of damage to third parties depends on the planned use and the hazardous substances potentially present as well as on the uses in the neighborhood. If the damage potential and therefore the risk are considered too high, the planned use in this area is not suitable. If extensive risk-reducing measures are possible, these must be considered in the object protection measures indicator.

(6.2.) In addition to the monetary value of the building tangible assets also include inventory and equipment. Although commercial and industrial companies can insure themselves against damage caused by natural hazards, high losses can still occur if the infrastructure is particularly expensive. In the case of manufacturing companies, consequential damage is often also caused by loss or interruption of production and an exodus of customers.

The presence of an above-average number of people is also considered unsuitable. In principle uses with a longer duration of stay of people also show a higher risk. Accommodations with a larger supply of overnight guests are classified as unsuitable, whereas restaurants are classified as a permissible use due to a smaller number of people and the associated shorter evacuation time of people who are usually not

local. The model deliberately refrained from using an absolute measure as a limit value, so it must be weighed on a case-by-case basis.

(7.1.) Uses that are not insurable against natural hazards are further divided into single-family houses and public/social facilities or buildings with multiple apartments. It is considered whether the building has a few apartment units or is a multi-story residential building with a high number of inhabitants. In the case of a single-family house, a low number of people can generally be assumed (average household size in Austria 2.21 persons). The category "other" covers all other uses in the model. Public/social facilities include kindergartens, retirement homes, municipal administrations and museums. In such uses there are usually many people on site, even if the length of stay varies.

(7.2.) Public facilities also include critical infrastructures which are generally classified as unsuitable because these uses are either highly important for maintaining public safety or represent an essential supply facility in the event. These include hospitals, buildings of the emergency services but also sewage treatment plants or power supply buildings.

Buildings that are either cultural assets or contain important irreplaceable cultural assets (e.g., museums with special exhibits) are also classified as unsuitable.

(8) Object protection measures can help to reduce the vulnerability of buildings to natural hazards (Attems et al. 2020, Holub et al. 2012). They make an important contribution to natural hazard prevention, especially in the context of self-protection and are therefore significant in risk-based spatial planning. The object protection measures must be adapted to the degree of hazard and must comply with the state of technology to reduce the extent of damage as far as possible in the case of an event. The cost of protection should be proportionate to the benefits. This is to be assessed by experts.

Spatial Planning considerations

(9) In some spatial planning regulations exceptions for building activities in hazardous areas are defined (Gruber et al. 2018). These include exemptions for closed settlement areas, where closing gaps makes sense from a spatial planning perspective. Compact settlement structures can reduce land consumption and represent the best possible use of existing infrastructure, which contributes to economically viable and socially acceptable structures. However, this is primarily relevant for residential buildings, social or public facilities and less so for business uses. If the planning area is not within the developed area or directly connected to it, the project is classified as unsuitable.

(10) In the case of a closed settlement area or one directly adjacent to it, it must be assumed that the necessary infrastructure is available. In case of a commercial use, which can also be located outside the settlement area, the next step is to assess if the infrastructure can be established at an economically justifiable effort (see 10.1.). An adequate infrastructure includes a central water supply of sufficient quality and quantity, a wastewater disposal system, an energy supply system and a functional public access road.

(10.1.) If proper infrastructure that is adequate for the planned use is not available, construction should be done with an economically justifiable effort. If this is not possible, the project is not suitable regarding the spatial planning objectives.

Assessment of organizational measures

(11) Civil protection plans are an essential tool for risk reduction. They define how to proceed in the case of an emergency and the distribution of tasks to all stakeholders. (Jachs 2011) They can contribute to a risk-adapted use of space by planning emergency supplies in advance. The prerequisite is that they are continuously adapted, more specifically they should be updated at least once a year. Especially in the case of industrial uses, it is essential that the plans are also regularly practiced by the emergency response organizations to be able to react quickly.

Depending on if civil protection plans are kept up to date and contain detailed information about the existing conditions, the following questions (11.1.) and (11.2.) of the model can be skipped.

(11.1. and 11.2.) Evacuation capability is defined as the scheduled removal of people from a hazardous area to a safe area prior to the occurrence of a natural event. Evacuation time varies according to the number and mobility of people present. Evacuating hospitals and retirement homes is more challenging than evacuating single-family homes or offices. In addition, schools and larger businesses regularly practice evacuation procedures. Evacuation capability also implies the ability to secure property.

Evacuation is possible if the evacuation time is less than the pre-warning time. If this is not the case, the use is classified as unsuitable due to the excessive risk to persons and damage potential.

A natural hazard-adapted use of space also implies ensuring accessibility in the event of an incident. It must be checked whether it can be assumed that the emergency services will be able to reach the area in case of an event. This depends on how and where the access routes run, whether these are also protected against natural hazards and if there is an emergency route.

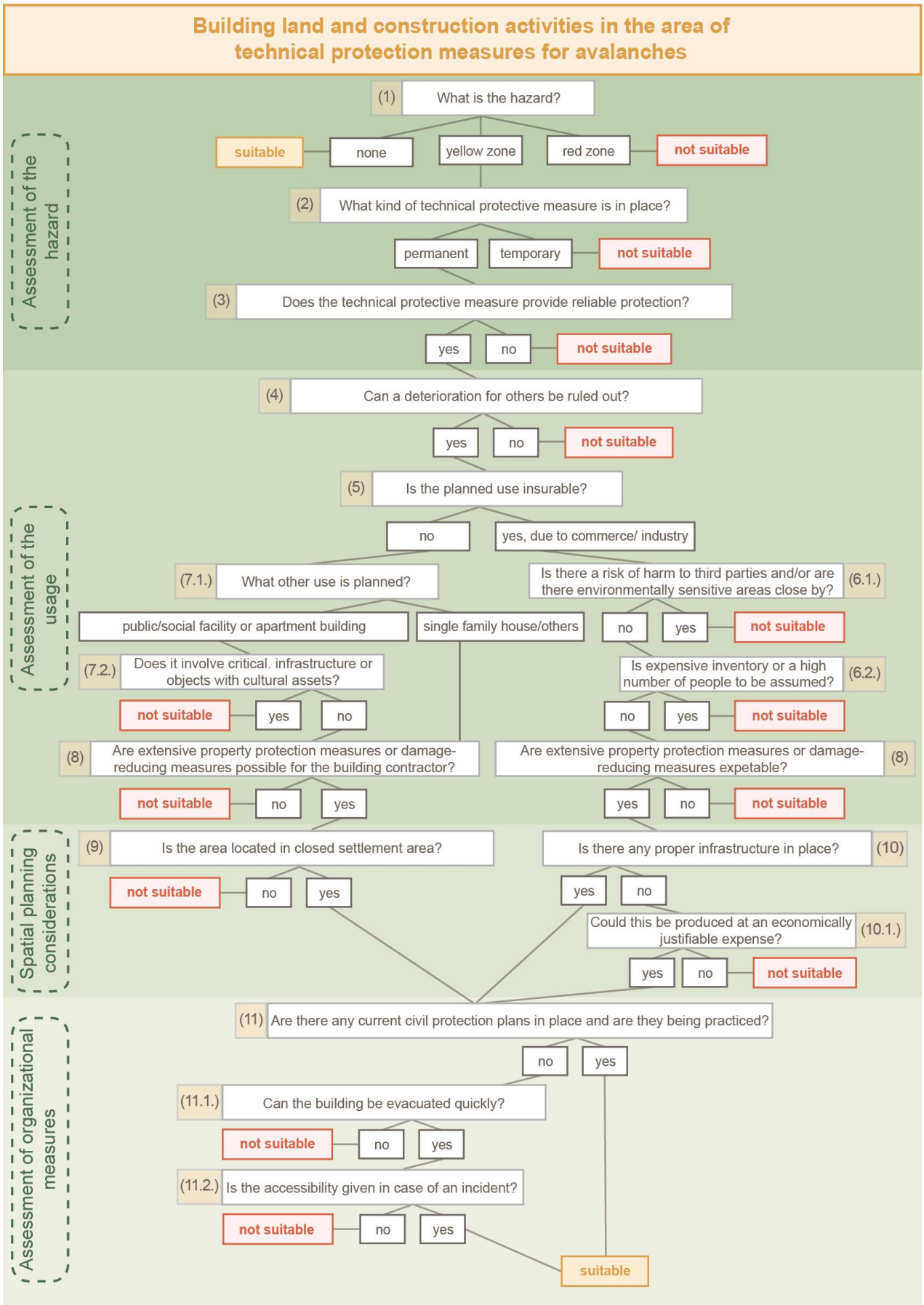

Figure 3: Model

3. CONCLUSIONS

Settlement development takes place in the area of tension between increasing settlement pressure and growing avalanche hazard potential. The risk should be within an acceptable range. In risk-oriented spatial planning, the vulnerability of the risk elements would also be considered in addition to the hazards. Vulnerability reduction can be achieved by evaluating the type of use in connection with the risk intensity. Risk-oriented spatial planning addresses the question of "What can be admissible where?". This requires more collaboration between spatial planning and the organizations of natural hazard management. Implementation of such an interdisciplinary approach requires adaptation of the existing planning instruments.

The four-phase model of the risk-oriented approach considers not only the hazard but also the vulnerability and exposure of objects. By evaluating different factors it is possible to determine a building land suitability that goes further than the traditional hazard assessment. In addition, a risk-based approach can also contribute to the discussion on the cost-effectiveness of technical protection measures, since under certain circumstances, redensification in the building areas becomes possible. Although the present proposal does not provide a fully comprehensive implementation model, since this can still be further developed and must be adapted to the country-specific framework conditions, it does offer a variety of connecting factors. Thus, in addition to a scientific discussion on a risk-oriented approach in spatial planning, a discourse in planning practice should also be initiated with the aim of reducing the extent of damage in future events as far as possible.

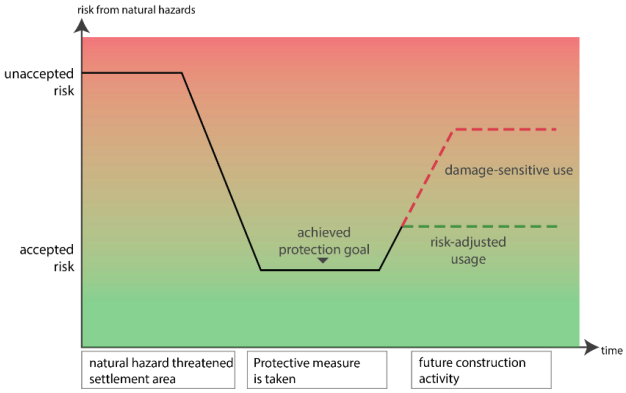

Figure 4: Advantages of risk-adapted spatial planning (Steinbrunner 2020 based on PLANAT 2014)

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