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Hazard zone planning in Austria – a tool to link flood risk management and settlement development

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ABSTRACT

The focus of flood risk management in Austria is on retaining water where possible and constructing protecting infrastructure where needed. During recent decades, the approach of managing flood risk changed significantly, driven by lessons learnt from severe flood events. Flood protection nowadays is complemented with ecological and hydro-morphological goals as well as tools to reduce - and even avoid - new risks in potentially inundated areas. Spatial planning and building regulation obligations and permits proved to be particularly efficient when it comes to risk avoidance. In a federal state like Austria, this is a challenging task, as the water legislation is being taken care of on federal level and the legislation for spatial planning, building regulation, emergency management and nature conservation is being defined on provincial level. Furthermore, municipalities generally regulate zoning and issuing of building permits. Therefore, there was a clear need to link the administrative levels and sectors to ensure a flood-aware settlement development.

Decisions for zoning and construction permits, however, have to be made upon reliable basis which is provided by an advisory opinion of flood risk managers derived from two dimensional hydrodynamic models. The decision criteria are related to flood intensities with recurrence intervals of 100 and 300 years. This ensures that risk and residual risk is considered, as the strived design level of dykes and retention basins in Austria is a 100-year flood event. In a first step, the hazard is calculated based on flood intensities for the 100-year flood event and subdivided in yellow and red zones. These zones are referenced in the spatial planning regulations and building codes accordingly, as red zones have to be kept free of development and for yellow zones there are at least some obligations to fulfil when building inside these zones. Based on the 300-year flood recurrence interval, zones with specific hydrological function are defined. These zones need to be kept free as they serve for retaining water, providing conveyance routes for extreme events and avoid the increase of flood risk further downstream. The delineation of zones as well as respective exposures are, in a first step, consulted with the public and interested parties. Based on feedback from public participation, the final version is elaborated and approved by the minister for water management. If significant hydrological changes are observed in the catchment area or flood related parameters change due to occurred flood events or climate change, the hazard zone plan has to be reviewed and revised accordingly.

The findings of a decade of implementing this coordination approach to close the gap between flood risk management, spatial planning and building regulation show that advisory opinions with a plot scale resolution provide reliable information for decision making on local level. However, they also require significant resources especially for the active involvement of potentially affected citizens.

KEYWORDS: Flood Risk Management, Austria, Hazard Zone Plan, Spatial Planning, Building Regulation, Settlement development, Risk avoidance

1 INTRODUCTION

The total number of approximately 9 million inhabitants in Austria whereof 1,4 million people live or work in areas prone to floods combined with a limited area suitable for permanent settlement due to topographical boundary conditions makes a sound approach in managing flood risk inevitable. In post-World War II decades, food security was of utmost priority. However, priorities changed significantly over time, essentially driven by flood events. Until the 1960s, flood protection by embankments and river straightening as well as land drainage were state of the art, reflecting the strong confidence in the ability to control rivers. In the middle of the 1960s, in two consecutive years 1965 and 1966, this concept proved wrong in large parts of southern Austria. Rivers overtopped dykes and inundated whole valley plains mainly used as arable land.

These catastrophes were the starting point to rethink the approach of dealing with floods in Austria by incorporating environmental goals such as retaining water in floodplains. An ecologically oriented flood management was established, prioritizing water retention over embanking rivers.

After some decades without severe flood events in Austria, the event in 2002 along the Danube and 2005 in Alpine areas stressed the need for an intersectoral, forward looking approach of flood risk management. Not only first signs of climate induced changes in frequency and severity of flood events led to casualties and significant damages, but especially human behaviour in terms of settlement development highlighted the need for an anticipatory approach to reduce and, where possible, avoid flood risk.

Therefore, two comprehensive research projects in close cooperation with administration were set up including all relevant sectors with the potential of contributing to risk reduction. The need for intensified cooperation with spatial planning, building regulation and emergency management in all phases of the risk cyle was one of the key conclusions in terms of setting up a new understanding on how to manage flood risk. Key conclusions related to the 2002 and 2005 flood events also triggered the negotiations of the EU Floods Directive under Austrian Presidency in 2006. After only one and a halfyears of negotiation, the Directive for the Assessment and Management of Flood Risk (2007/60/EC) was set into force in 2007. This was the starting point of a holistic management approach accompanied by an institutionalised inter-sectoral cooperation (Web-1).

After the implementation of the EU Floods Directive, two more large-scale flood events – comparable to the event in 2002 – hit Austria in 2013 and 2024. Measures for flood retention and flood protection, implemented in cooperation with river basin management, nature conservation, recreation, agriculture and forestry, spatial planning, building regualtion and emergency management, proved to be efficient, as overall monetary damages decreased.

One of the lessons learnt will be discussed in the paper, as reliable information from flood risk management is the key foundation for making robust decisions in spatial planning and building regulation. This link is being ensured by the hazard zone planning process which is a participative and, therefore, awareness raising and well accepted approach including the potentially affected population (Web-2).

2 THE HAZARD ZONE PLAN

As a local planning tool on plot scale, the hazard zone plan aims at achieving multiple goals: The overarching one is to avoid the generation of new flood risk, further ones are to reduce existing risks and at the same time raise awareness. These multiple benefits are achieved through an institutionalised inter-sectoral cooperation amongst flood risk management, spatial planning and building regulation authorities. The hazard zones are based on the results of a 100-year flood event referring to the current situation of settlement development and hydrologic boundary conditions, whereas, the areas with a specific function are used as a tool for future decisions and are based on a 300-year flood event. They are based on the same model, however, with different decision spheres.

A hazard zone plan, which generally corresponds to a map scale of 1:2000, is based on 2D hydrodynamic model results. The models are based on an 1x1 m elevation model which is available for the whole territory of Austria. Relevant topographic characteristics are complemented by terrestrial survey. Hydrologic boundary conditions are based on gauge data or precipitation-runoff models.

Calibration and validation are done by reference measurements or documented historic events. The main outputs of these models are maps of inundation areas, water depths, and flow velocities for each hydrologic scenario.

Based on the hydrodynamic model results, a flood risk manager distinguishes and identifies relevant hazard zones and areas with a specific function or indication as an advisory opinion. In this process the model results are revised to identify potential conveyance routes, areas to retain water, spillway options and the smoothing of model results by delineating the inundation area considering calculated low value water depth and the deletion of islands resulting out of e.g. houses, installations, etc. in the digital terrain models.

2.1 Hazard Zones

Hazard zones are identified based on the flood intensity (Figure 1). A function of water depth and flow velocity distinguishes between yellow and red hazard zones within the inundation area of 100-year flood scenarios. This indicates yellow zones - areas where building obligations or adaptation of buildings and infrastructure might enable development if absolutely necessary - and red zones, where development and settlement have to be avoided by any means.

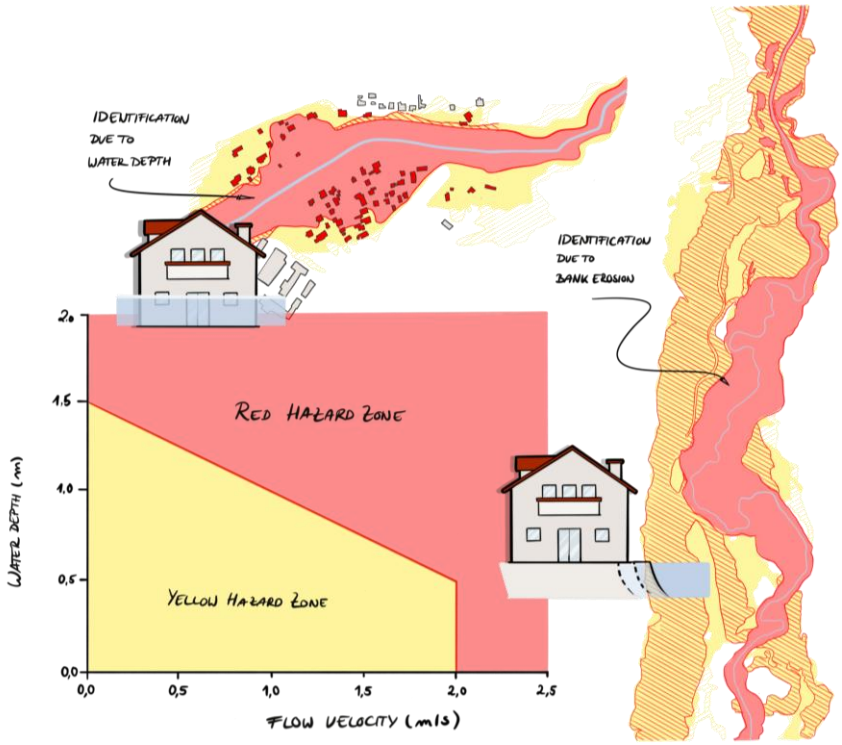

Figure 1: Hazard zones based on 100-year flood scenarios

2.2 Areas with a specific function or indication

In addition to the hazard zones based on 100-year flood scenarios, areas with a specific function or indication are definitions based on 300-year flood scenarios. The primary goal of these area definitions is to avoid risk and increase awareness of residual risk. The areas are indicated as yellow, red and red/yellow shaded areas, accordingly (Figure 2):

Yellow shaded areas indicate areas with no flood protection which are inundated by a 300-year flood scenario, red shaded areas indicate areas with flood protection which are inundated by a 300-year flood, therefor focussing on overtopping and failure scenarios. In terms of awareness raising these areas focus on indicating that total safety is not possible and there is always residual risk.

Figure 2: Areas with a specific function or indication based on a 300-years flood event

Red/yellow shaded areas delineate areas within a 300-year flood scenario with a specific function for the flood process and resulting risk itself. These areas are related to flood conveyance, flood retention and avoidance of increasing the damage potential. To avoid additional risk, these areas shall be kept free of development.

The red/yellow shaded areas are also calculated based on flood intensity and are, therefore, based on the same method like the red and yellow zones. The intensity diagram to calculate the areas with a specific function is pictured in Figure 2.

2.3 Legal context

Austria as a federal state has two levels of jurisdiction – the federal level and the level of nine provinces. The water law as a federal law has, therefore, to be implemented by all federal provinces. At the same time flood risk management as part of the water law can only provide recommendations for provincial laws such as spatial planning, building regulation and emergency management.

Generally, in all nine provincial legal frameworks it is intended to keep the 100-year flood area free of settlement development and infrastructure. However, due to restricted availability of land especially in alpine areas there are some exemptions. For this reason, the differentiation in yellow and red zones is of hight relevance. As an advisory opinion by flood risk managers the hazard zone plan can be seen as a reliable recommendation to spatial planning and building regulation.

However, in the end these plans can be overruled in the frame of the weighing of different, and sometimes contradicting, interests. For such cases, at least red zones shall be avoided by any means.

In terms of funding flood retention and protection measures the hazard zone plans are a prerequisite. If areas with a specific function are defined to be kept free by the municipality their funding share - which in average is 20 % of the overall investment - is reduced significantly by 5 percentage points.

Depending on the provincial legal framework, there is a strong commitment that red hazard zones are to be kept free from spatial dedication as building area. Some exemptions for the expansion of buildings and settled areas with high land-use pressure e.g. in touristic areas or areas for industry and trade are defined. For yellow zones based on 100-year flood events, the commitment is broad to at least restrict settlement development or oblige for flood adapted construction of new buildings.

For areas with a specific function, spatial planning starts to consider keeping free these areas to secure retention and conveyance areas based on 300-year flood events. These areas also prove as a valuable tool to communicate residual risk. Nevertheless, a stronger incorporation of the advisory opinion on areas with a specific function are of high interest as efficient risk reduction is associated to the planning principle.

In building regulations there is also a strong commitment that red hazard zones, independent from their spatial dedication, do not receive a building permit. For exemptions in yellow zones, conditionality is defined by means of having the ground floor elevated in reference to the 100-year flood level. Filling to elevate the terrain are prohibited, as it can cause deterioration in up- or downstream areas.

2.4 Public participation

To achieve active participation and, at the same time, raise flood awareness, hazard zone plans have to be submitted to the mayor of the respective municipality for four weeks of public consultation. All flood prone inhabitants are invited to review the plan and, if needed, suggest changes. These suggestions are then discussed and, if reasonable, taken care of in the frame of the endorsement of the hazard zone plan.

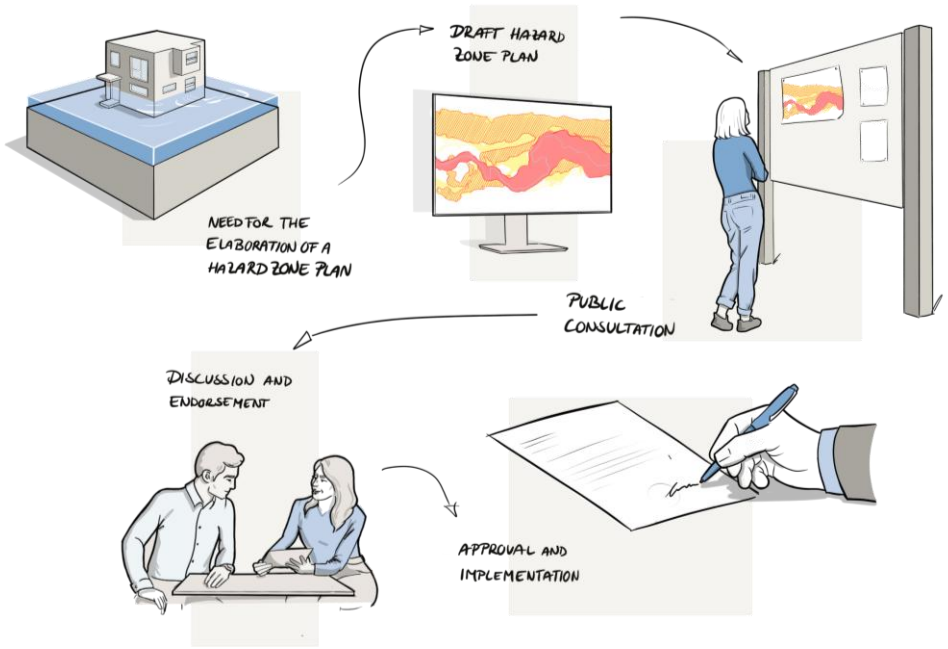

Figure 3: The process of active public participation in the frame of elaborating a hazard zone plan

If significant hydrological changes are observed in the catchment area or flood related parameters change due to occurred flood events or climate change, the hazard zone plan has to be reviewed and revised within the same setup, accordingly.

3 DISCUSSION AND CONCLUSION

Due to the federal administration in Austria, there are different time periods of experience with hazard zone planning in Austria. For torrent and avalanche control in Alpine areas hazard zone plans have been implemented for 50 years, however, applied criteria are differing from those presented in the paper (Web-3). The tool in these areas is widely accepted and well understood by people and the administration. For the water management sector - for rivers and streams - in Austria, hazard zone planning has been systematically applied since 2011. Nevertheless, the tool already proved its applicability in several occasions. Since the hazard zone plan is a funding prerequisite for flood protection and retention measures, the areal coverage of these plans is constantly and significantly increasing. Flood protection and retention measures are generally funded by three entities in Austria: the municipality, the federal province and the federal state. If municipalities commit to keeping areas with a specific function (retention, conveyance, damage potential) free of new settlement development the funding rate by the federal state is higher than without this commitment. This clearly highlights the link provided by flood risk management to spatial planning and building regulation.

This approach institutionalises the effort to avoid new flood risk by keeping potentially inundated areas free from settlement and infrastructure development. At the same time, the designation of hazard zones and areas with a specific function or indication raises awareness and highlights the need (i) for other relevant sectors to take action respectively (ii) for people potentially affected to set measures at their own property, such as demountable barriers or waterproof installations.

For zones with hazard of low probability, the implementation of emergency plans is an effective tool to reduce flood risk through better preparedness for the case of emergency. At the same time, property owners are encouraged to consider object-oriented measures in order to be better prepared for floods.

In terms of flood preparedness and awareness raising, the hazard zone planning approach proofs to be an efficient tool (Web-4). Its incorporation into to the Austrian funding scheme supports the implementation substantially. Achieving key goals – such as the avoidance or risk by keeping free hazard zones, the reduction of risk by adapting buildings in hazard zones or even resettlement and the raising of flood awareness and inherent uncertainties such as overtopping and failure - is therefore a realistic perspective.

The main lessons learned, despite having set up a participatory approach, refer to the permanent need to inform potentially affected people and to keep their level of flood awareness high. One key is to convey and highlight facts and figures on residual risk, uncertainty and the efficiency of self-responsibility for different target groups.

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