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Flood-risk (areas) in land-use planning decisions in Austria and Sweden

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Abstract

Natural phenomena, like floods, can be very dangerous for settlement areas and their inhabitants. Thus is necessary to observe these flood risk areas separately since their land-use options are restricted.

Flood-risk plans or similar maps help to visualise or identify areas which are endangered by natural hazards. These maps and other relevant information, like run-off analysis, are useful information about the delimitation of affected areas. This information is necessary to implement knowledge about natural hazards in land-use planning, before zoning decisions are made.

Due to different natural and geographical conditions flood-risk has a different relevance and flood awareness is different within the European countries. Furthermore, the legal basis and planning system varies. Despite varying relevance and based on the actuality of flood-risk the European Union took action in this field and published the directive for the assessment and management of flood-risk, aiming at the reduction of the adverse consequences of inundation.

The present thesis wants to show how spatial planning is related to flood issues and tries to compare the regulation framework within the European Union where Austria and Sweden serve as examples. Beside the analysis of spatial planning legislation the treatment of floods, in particular the information about endangered areas and the effect of the floods directive will be analysed.

In Austria an extensive coverage of flood risk plans had already existed before the floods directive was implemented. These plans display the areas which are endangered by floods. Flood-risk information did not exist in a comparable extend in Sweden. Although Sweden is known as a country with many rivers and lakes.

With reference to Austria and Sweden, it will be shown how a delimitation of flood-risk areas can be made and which legal basis is used to provide flood-risk plans. In addition, the legal basis of spatial planning and its interrelation to flood-risk issues is shown. Due to the lack of a federal law regarding spatial planning in Austria — spatial planning is competence within the federal provinces, which leads to nine different laws — the focus within this thesis will be the two federal provinces Lower Austria and Salzburg. Beside that theoretical and legal aspects, the relevance of flood-risk areas for zoning decisions in practical spatial planning will be illustrated.

Kurzzusammenfassung

Naturereignisse, wie Hochwasser, können eine große Gefahr für den Siedlungsraum und deren Bewohner darstellen. Daher ist es nötig, Bereiche, welche von Hochwasser gefährdet sind, gesondert zu betrachten, da die Nutzungsmöglichkeiten eingeschränkt sind.

Mittels Gefahrenzonenkarten oder ähnlicher Pläne können diese gefährdeten Bereiche dargestellt werden. Diese Karten und weitere Informationsquellen — wie Abflussuntersuchungen — ermöglichen Gefährdungsbereiche räumlich abzugrenzen und stellen daher eine wichtige Informationsgrundlage für raumplanerische Entscheidungen, z. B. Flächenwidmung, dar.

Aufgrund von unterschiedlicher natürlicher und geographischer Gegebenheiten ist das Hochwasserrisiko unterschiedlich groß und die Relevanz und das Bewusstsein dieses Themas ist daher nicht in allen Mitgliedsstaaten der Europäischen Union gleich groß. Darüber hinaus können die gesetzliche Grundlage sowie das Planungssystem unterschiedlich sein. Obwohl Hochwasser in den Mitgliedsstaaten unterschiedlich relevant ist, hat die Europäische Union, aufgrund der aktuellen Hochwasserproblematik, eine Richtlinie zur vereinheitlichten und länderübergreifenden Vorgehensweise zur Bewertung und Management von Hochwasserrisiken (zur Verringerung der hochwasserbedingten nachteiligen Folgen) erlassen.

Anhand von Österreich und Schweden will die folgende Arbeit aufzeigen, wie Raumplanung mit der Hochwasser-Thematik verknüpft ist und versucht die unterschiedlichen gesetzlichen Grundlagen innerhalb der Europäischen Union miteinander zu vergleichen. Neben der Analyse der Raumplanungsgesetze wird der Umgang mit Hochwasser, im Speziellen die Information über von Hochwasser gefährdete Bereiche und die Auswirkungen der Hochwasser-Richtlinie, analysiert.

In Österreich gab es weitreichende Gefahrenzonenpläne, welche die gefährdeten Bereiche darstellen und Informationen über Hochwasserrisiken, bevor die Hochwasser-Richtlinie umgesetzt wurde. Hingegen in Schweden, einem Land welches für seine vielen Seen und Flüsse bekannt ist, gab es diese Informationen hinsichtlich Überflutungsbereichen nicht in einem vergleichbaren Ausmaß.

In der folgenden Arbeit soll anhand von Österreich und Schweden beispielhaft aufgezeigt werden, wie die Abgrenzung von Gefahrenzonen erfolgen kann und welche (rechtlichen) Grundlagen für Gefahrenzonenpläne nötig sind. Darüber hinaus wird die gesetzliche Grundlage der Raumplanung und deren Verknüpfung zur Hochwasserthematik analysiert. Da es in Österreich kein Bundesgesetz betreffend Raumplanung gibt, sondern vielmehr die Kompetenz bei den Bundesländern liegt, gibt es daher neun unterschiedliche Raumplanungsgesetze. Der inhaltliche Fokus wird in dieser Arbeit auf die beiden Bundesländer Niederösterreich und Salzburg gelegt. Neben dieser theoretischen Analyse, welche sich vor allem auf gesetzliche Grundlagen bezieht, wird darüber hinaus die Relevanz von Hochwassergefährdungsbereichen bei Widmungsentscheidungen aufgezeigt. Im Speziellen sind in diesem Sinne der raumplanerische Umgang mit gefährdeten Bereichen sowie Maßnahmen die der Verminderung von Hochwasserrisiko dienen, zu verstehen.

Table of content

1 Introduction

1.1 Why is the issue of flood-risk relevant in Europe?

Floods are one of the most widespread natural hazards in Europe, since flooding has occurred almost every year somewhere within Europe during the last decade (cf. Fuchs and Lipiatou, 2006: 5). Prominent events, to name a few since 2000, happened in Central and Southern Europe, like France, Switzerland, Austria, Germany, Romania and Bulgaria (2005), at the river Elbe and Danube (2002), Southern France (2002) (cf. Fuchs and Lipiatou, 2006: 5), Eastern and South Eastern Austria (2009) (cf. BMLFUW, 2012: 13-20), Southern Sweden (2007) (cf. Pettersson et al., undated: online), Serbia, Bosnia and Croatia (2014) (cf. Format, 2014: online).

"Urban areas are often located in lowlands, river mouths and flood plains, they are particularly vulnerable (...) to extreme rainfall throughout the catchment, dam-break and downstream river obstructions" (Thorsteinsson et al., 2007: 486). This means that inundations can cause large damages and endanger the population of jeopardised areas. For example the floods "in central Europe in the summer of 2002 resulted in over 110 deaths and total economic damage estimates (...)" exceeding "€ 15 billion" (cf. Begum et al., 2007: xi).

Apart from vulnerability of living environment, due to climate changes the risk of big floods in Europe could double in frequency until 2050. (cf. Jongman et al., 2014: 264) This presumable future increase of flood-risk and the alarming events in the recent past "(...) renewed impetus to the development of improved policies and techniques for flood risk management across Europe" (Begum et al., 2007: xi).

In this thesis the interrelation of land-use planning and the problem of flooding, as well as the impacts of transnational approaches of the European Union will be discussed by using the examples Austria and Sweden. The following part outlines the assumptions, aims and questions of this thesis.

1.2 Objectives of the thesis

In the first part of this study the choice of the processed sample countries, as well as a short overview about their characteristics and the actuality of flood-risk is given. After some basic definitions, an overview of options to reduce flood-risk and relevant EU directives as well as their consequence in changes of flood prevention (measures) will be given. Changes of flood-risk in the future and their possible reasons will also be discussed in this chapter.

Secondly, (see chapter 3) the legal basis of spatial planning in Austria and Sweden and its relation to flood-risk issues will be analysed in order to show the relevance of floods in the spatial planning laws to find out if there are regulations that should be considered by land-use planning decision makers. However it needs to be mentioned, that in Austria there is no federal spatial planning law, due to that fact, this aspect will be analysed exemplarily with the example of two federal provinces to show the similarities and differences of the laws within one country.

Moreover other additional laws, beside the spatial planning legislation, which are relevant for flood-risk issues, will be touched as well as policies of the European Union (see chapter 3.3) and the implementation of the flood-risk directive in the sample countries.

Thirdly, (see chapter 4) after the explanation of this legal basis the existing information regarding flood-risk will be presented. At this part a distinction of already existing information and information based on the implementation of the floods directive will be made.

The fourth block (see chapter 5, 6 and 7) covers the handling of flood-risk issues and flood-risk areas in spatial planning and wants to investigate — by the help of examples of practical (spatial) planning — their relevance in land-use planning decisions in Austria and Sweden.

As it will be shown, it is not directly possible to compare Austria and Sweden in terms of legislation and planning instruments. Thus, the analysis focuses on the comparison of instruments, which are similar in content and aims. Furthermore also flood-risk as a consequence of sea-level rise is only analysed to a limited extent, the focus is set on river and lake floods.

Chapter 8 deals with core issues relating to the relevance of flood-risk in spatial planning.

Within this thesis it will be tried to answer the following research questions:

- How relevant is the issue of flood-risk in practical spatial planning?
- In how far (land-use) decision makers deal with flood-risk issues?
- How do (land-use) decision makers implement flood-risk areas in their planning decisions?
- Which kind of information is needed to take flood-risk issues into account in land-use planning?
- Who are the addressees of flood-risk related information?
- Which kind of (legal binding) regulations exist?
- What are the pros and cons of the Austrian and Swedish approaches?
- Can a flood-risk management plan be a link between water-/flood issues and spatial planning?

Based on the primary analysis in the last part (see chapter 10) conclusions will be drawn. Moreover, recommendations relating to the dealing with flood-risk will be given and the difference in relevance of flood-risk areas in the two sample countries will be pointed out.

1.3 General Information about the sample countries

Referring to two member states of the European Union — Austria and Sweden — this thesis wants to give a comparative overview of the regulation framework relating to flood-risk management and land-use planning within the European Union.

The impetus for the choice of these two countries is based in various reasons. First of all it is worth to look at two different political systems and existing problems in matters of spatial planning. Secondly the relevance of flood-risk, due to geographical circumstances seems different in Austria and Sweden. While thirdly the existing floods directive makes a similar approach assumable.

Furthermore personal reasons, which are based on first research experiences within this topic in Austria and on an exchange semester in the master programme at the Royal Institute of Technology (KTH) in Stockholm explain the choice.

The following part of this study wants to give a short overview of the two sample countries.

1.3.1 Austria

Austria is located in the southern part of Central Europe and has a size of about 84,000 km² and a population of around 8.5 million people (cf. Statistik Austria, 2013: 8 — 12).

Austria as a federal state is divided into 9 federal provinces (*Bundesländer*), 95 administrative districts (*Bezirke*) and 2354 municipalities (*Gemeinden*). (cf. Statistik Austria, 2013: 9) As stated in its federal constitution, Austria is a democratic republic and its law emanates from the people, which is implemented in direct elections for the federal president (*Bundespräsident*), the national council (*Nationalrat*), and the provincial parliaments (*Landtage*). (cf. Statistik Austria, 2013: 26) Also the government on the local level — in the municipalities — the municipal council (*Gemeinderat*) is directly elected by the members of each municipality.

In Austria, caused by the alpine location in central Europe, the area which is suitable for permanent settlement is relatively small, as shown in the chart on the next page, in average only 37 percent of the country are suitable for permanent settlement.

Area suitable for permanent settlements in Austria

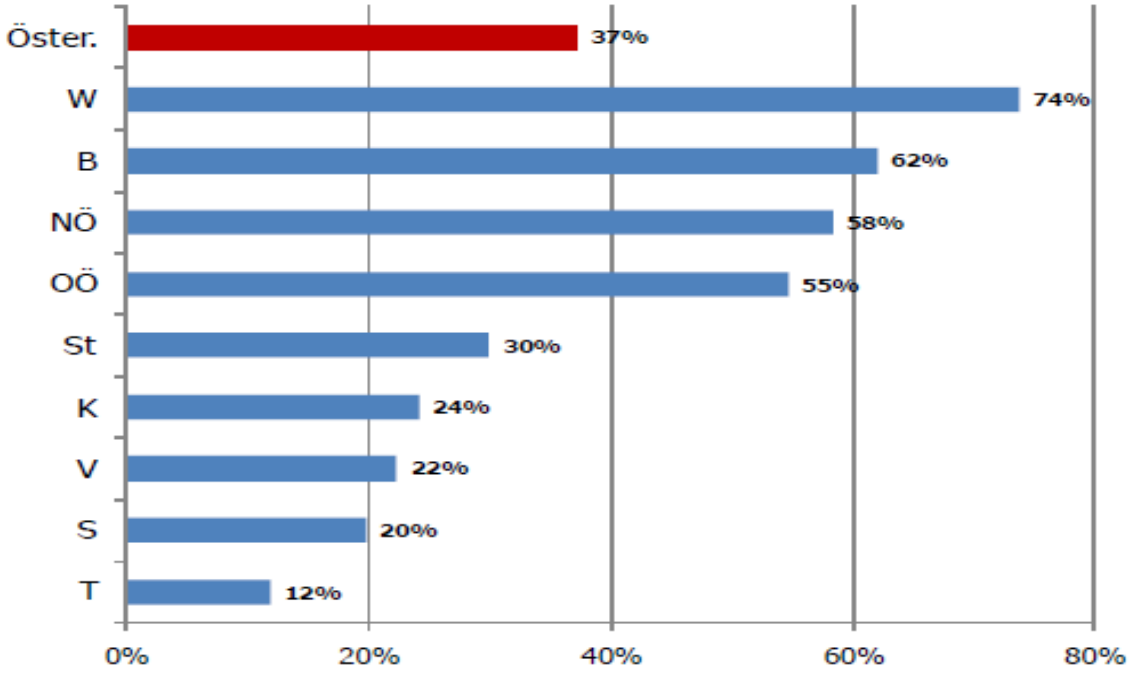


Figure 1: Area for permanent settlement in Austria (BMLFUW, 2011 a: 5)

This means that, on one hand existing buildings and infrastructure, as well as future constructions, based on (legal binding) zoning decisions for building plots, are endangered. As a result older but still valid building zones are in conflict with the spatial planning aims set in the spatial planning laws and in many regions of Austria it is just possible to separate settlement areas and hazard areas with a disproportionate effort. (cf. Kanonier, 2012: 64)

In the chart below the land use of Austria is illustrated. In total, only 3 percent of the country is built-up land and quite a big part is covered by forest.

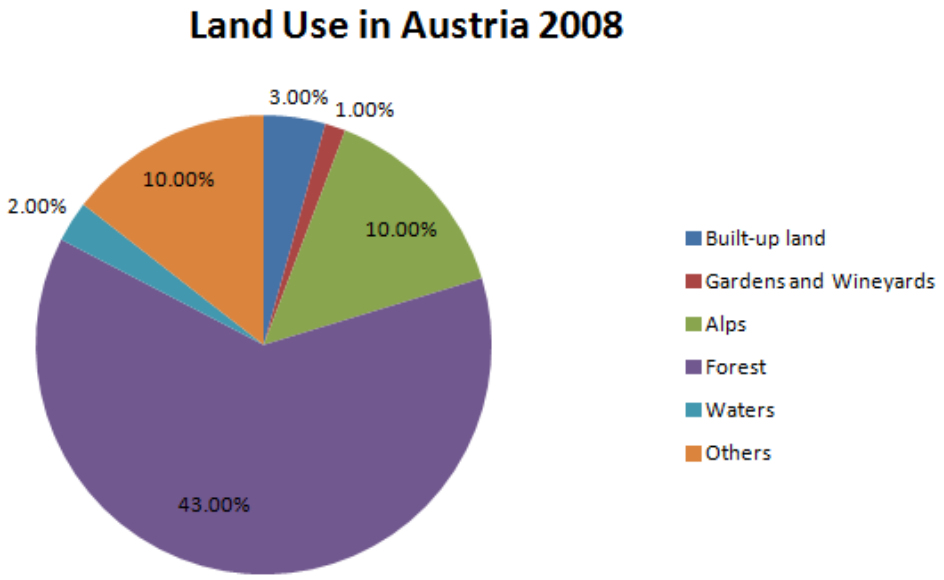


Figure 2: Land-use in Austria 2008
(Bundesamt für Eich- und Vermessungswesen in Umweltbundesamt, 2014 a: online)

The percentage of areas which are suitable for permanent settlement and the relation to land-use is shown in the map below.

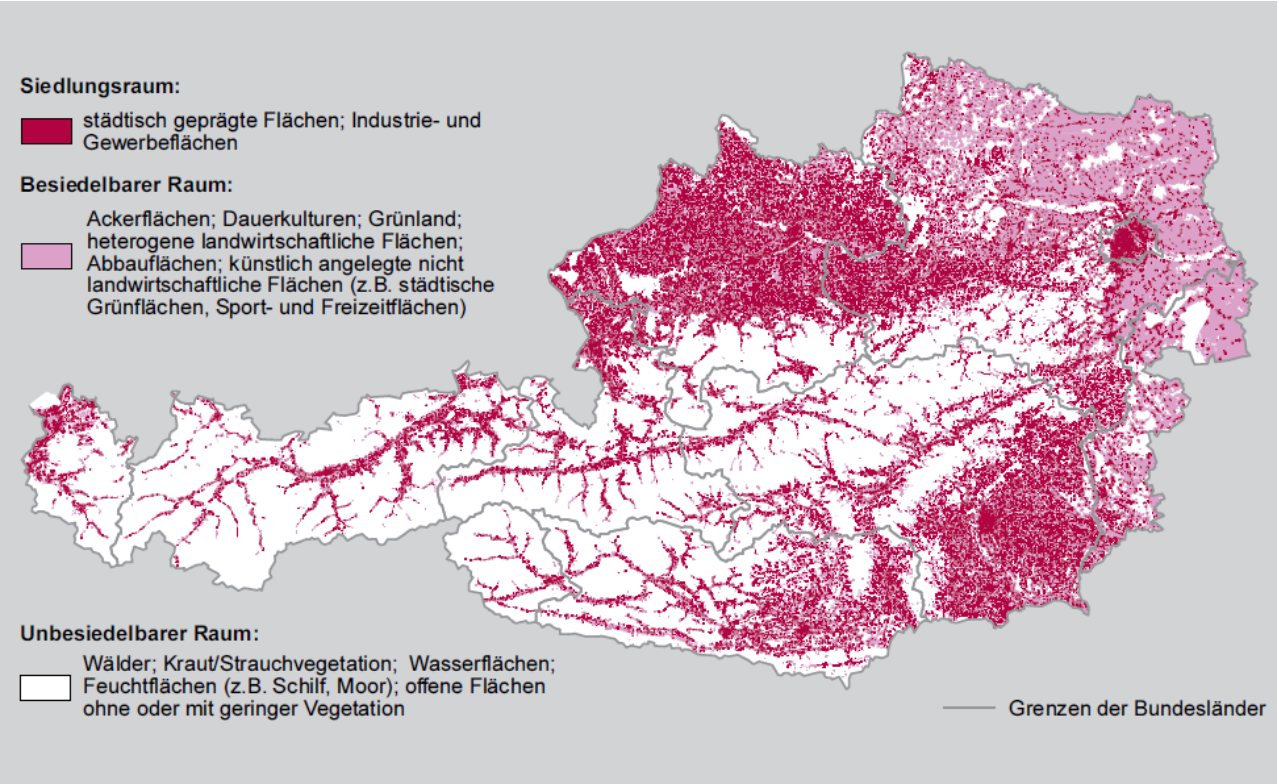


Figure 3: Map of permanent settlement area in Austria (Wonka, 2008: 437)

The suitable area for permanent settlement is visualised in pink (dark pink: actual settlement areas, light pink: amenable for settlement, agricultural and green areas, etc.) and in white the unsuitable area (alps, forests, wetlands, waters, etc.) is shown.

It is evident that a relatively large area of Austria is not suitable and suitable areas are often concentrated in some valleys. The rivers which are located in valleys result in zones with a potential of flood-risk.

1.3.2 Sweden

"Sweden has a population of nine million people living in an area of approximately 450,000 km², making it one of the most sparsely populated countries in Europe"(Hägglund, 2013: 59).

"Sweden is a constitutional monarchy, and has a parliamentary system of government" (Hägglund, 2013: 60). The political system has three directly elected, democratic political levels, the local level, consisting of 290 municipalities (*kommuner*), the regional level with 20 County Councils and regions (*landsting*) and the national level with the Swedish Parliament (*Riksdagen*) and the Government (*Regeringen*). (cf. Hägglund, 2013: 60)

"People are increasingly moving from rural areas to urban areas, and this trend towards urbanisation is reflected in the fact that 85 % of Sweden's population lives in villages, towns, and cities, with most Swedes living in the southern part of the country" (Hägglund, 2013: 59).

The fact that Sweden is a very sparsely populated country, with only 9 percent built-up land, is shown in the chart below.

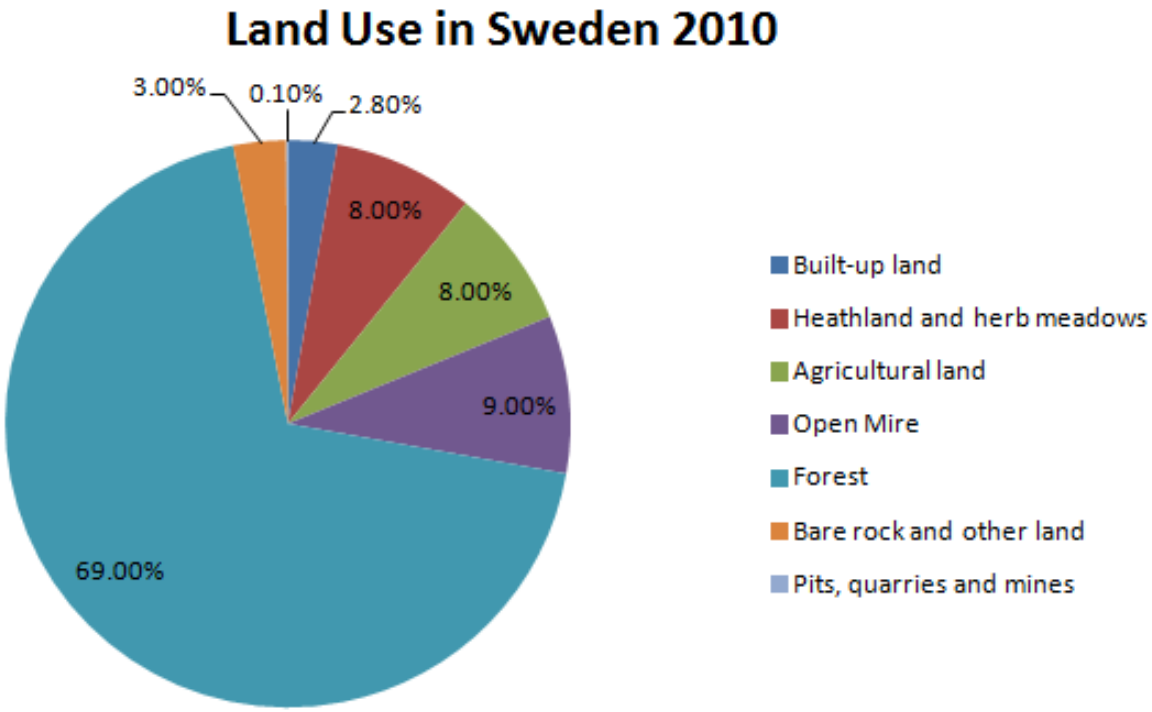


Figure 4: Land-use in Sweden 2010 (Statistics Sweden, 2013 a: online)

The following figure shows that the denser populated areas, the bigger cities, with a higher share of built-up land within the municipality are located in the southern part of the country.

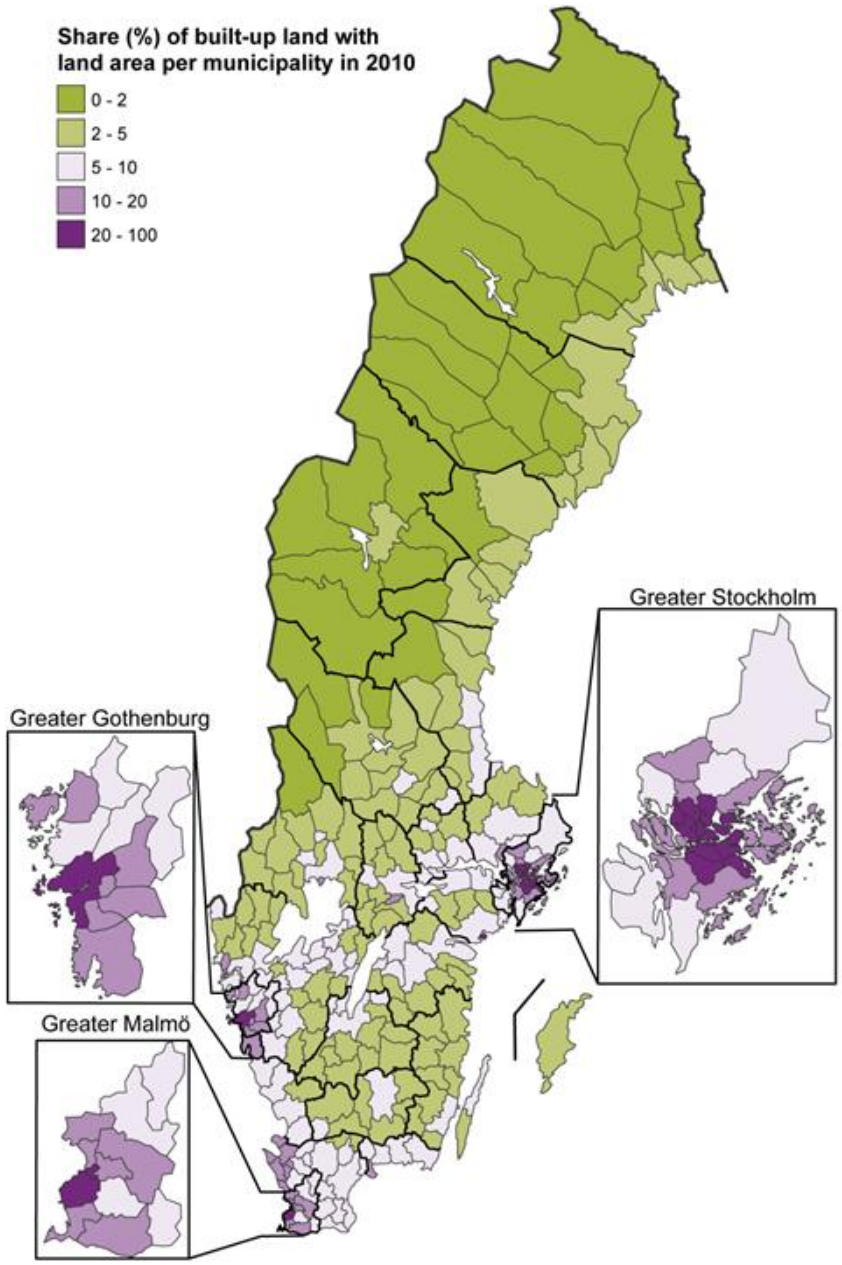


Figure 5: Share of built-up land in Swedish municipalities (Statistics Sweden, 2013 a: online)

Unfortunately in Sweden the area which is suitable for permanent settlement is not calculated. Land has been seen as something abundant in Sweden for a long time. "Naturally perhaps, considering that the built-up land in Sweden amounts to less than 2.8 percent of the land area." But in the recent years competition between the need for dwellings and the need for agricultural land has increased.
(cf. Mostrom, 2015: interview)

2 Floods and flood-risk

In the following pages the differences of the terms flood and flood-risk, as well as other relevant terms related to this issue will be explained. Furthermore, an overview about the occurrence of floods, the relevance of floods within Austria and Sweden, reasons for changes in flood-risk and the relations to spatial planning will be given.

2.1 Terminology

The term **flood** is defined as "the temporary covering by water of land not normally covered by water" in article 2 subsection 1 of the Floods directive by the European Union (Directive 2007/60/EC), and it is possible to differ between different types of floods, e.g. river floods (also from mountain torrents), flash floods, urban floods and floods from the sea in coastal areas (cf. Directive 2007/60/EC: 2f.).

Flooding of an area is a **natural phenomenon**, which can be defined as a natural process that is spatially and chronologically delimited. However, there are no impacts on human living environment. (cf. Rudolf-Miklau, 2009: 2) These processes have always happened at locations near water and had not caused problems, when preparations had been made. Natural phenomena become a problem only if they are in conflict with land-uses, e.g. agricultural areas or settlements, etc.

If that conflict results in a possible damage, a natural phenomenon is identified as a risk. In that case a **natural hazard** is defined as a natural process, which can be a threat to humans, environment, material- and property assets (cf. Rudolf-Miklau, 2009: 2).

"The risk of a population to natural hazards has been defined (...) through the risk triangle, where the risk is a combination of the potential magnitude of the hazard, the exposure of the population in terms of where it is located in relation to the impact of the hazard, and the vulnerability of the population in terms of how great the impact or damage may be" (Crichton, 1999 in Kundzewicz et al., 2012: 14).

Figure 6: The risk triangle (Crichton, 2008: 123)

The term **flood risk** is defined, in the floods directive article 2 number 2, as "the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event" (Directive 2007/60/EC).

Usually the frequency of occurrence and the intensity of the impact are used for the description of natural hazards, like floods (cf. Rudolf-Miklau, 2009: 2f.).

2.2 Origination of flooding

"River (fluvial) floods[1] are generated by several different mechanisms. Intense precipitation and lengthy periods of rain are the most common causes, but colder regions may be subject to snowmelt floods (sometimes enhanced by rain). Other natural factors that may induce floods include the sudden failure of inhibiting structures, such as the collapse of ice jams, landslides or outbursts from glacial lakes. Also, high tides and tidal surges may result in floods in the lower reaches of rivers and estuaries. Occasionally, the failure of a dam, or a dike (breach or break) will bring about flooding, as will blockage of bridges and culverts by debris" (Kundzewicz et al., 2012: 11f.).

The majority of bigger floods in Europe within the last ten years were mostly caused by heavy rain and sometimes increased by rapid snow melt (cf. Kundzewicz, 2012: 6). The following figure shows how snow and/or rain can lead to a flood.

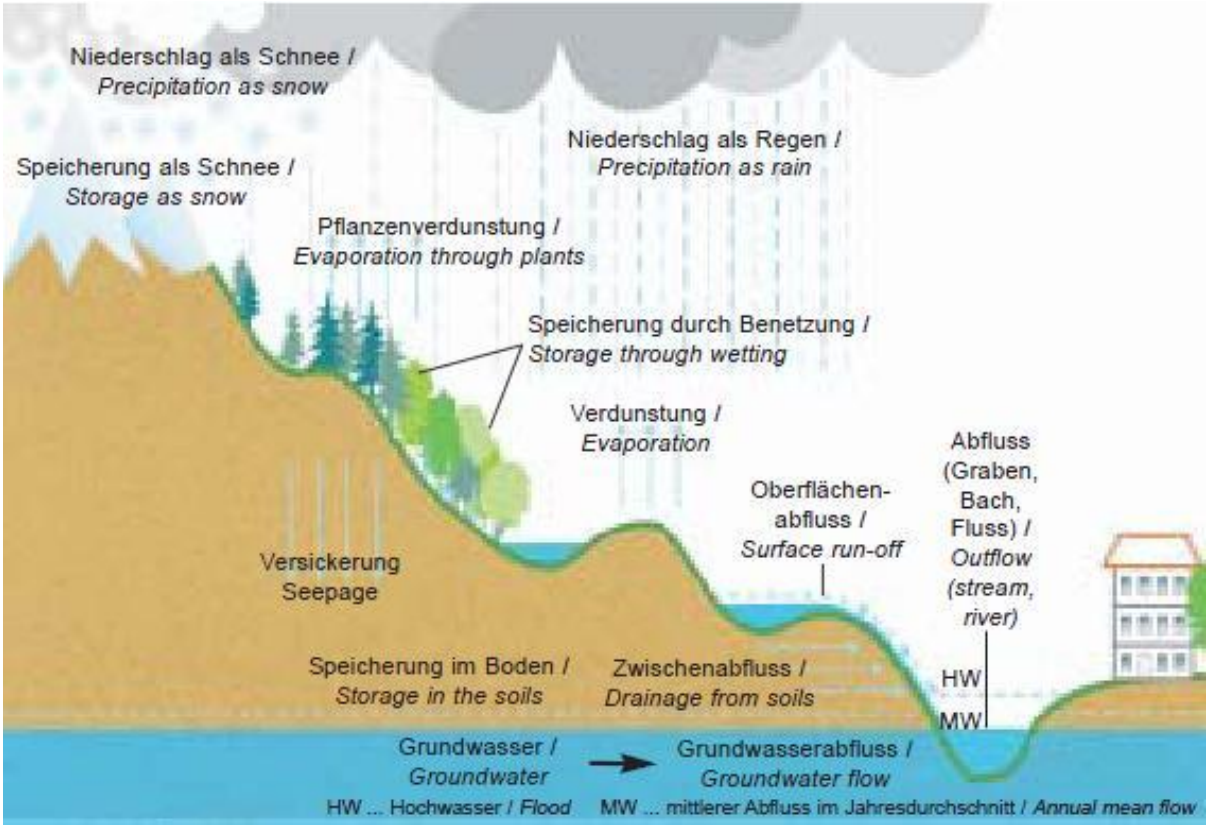


Figure 7: Origination of floods (BMLFUW, 2012: 6)

The natural basis for floods is precipitation, rainfall and snow (melt). The amount of precipitation, natural vegetal cover, soil, terrain and its slope form the frame conditions for infiltration, evaporation and overland discharge. If the capacity of

[1] In Sweden, since large lakes exist, lake floods are a relevant issue too. The main difference of these kind of floods is that large "(..) lake floods occur over an extended time span (months)" (cf. Grahn and Nyberg, 2014: 305).

the ground is limited and the intensity and the duration of rainfall is too high for the soil capacity the consequence is a flood event. (cf. Rudolf-Miklau et al., 2012: 18)

This means the "antecedent conditions in a river basin are important. Should storage be limited because groundwater levels are elevated and soil moisture is near field capacity, then even moderate amounts of rain can generate a large flood. However, the opposite effect can also induce flooding: rain falling on very dry, hard or crusted soil will be converted rapidly to runoff, resulting in a flash flood" (Kundzewicz et al., 2012: 11). Other options are for example urban floods as results of heavy rains and soil sealing within urban areas, or a "groundwater flood (which may last for months) (...)" which "(...) occurs when the water table in an aquifer, such as limestone, comes to the ground surface at low places in a basin." (cf. Kundzewicz et al., 2012: 13)

2.3 Floods and land-use planning

Because of climate change, population growth and urbanisation, the number of natural disasters can increase (cf. Statistics Sweden, 2013 b: 151). Nowadays, an increasing impact on areas is also noticeable (cf. Hornich, 2009: 6). As one can see in the following figure space is needed for many reasons. However, that can lead to competition within land use.

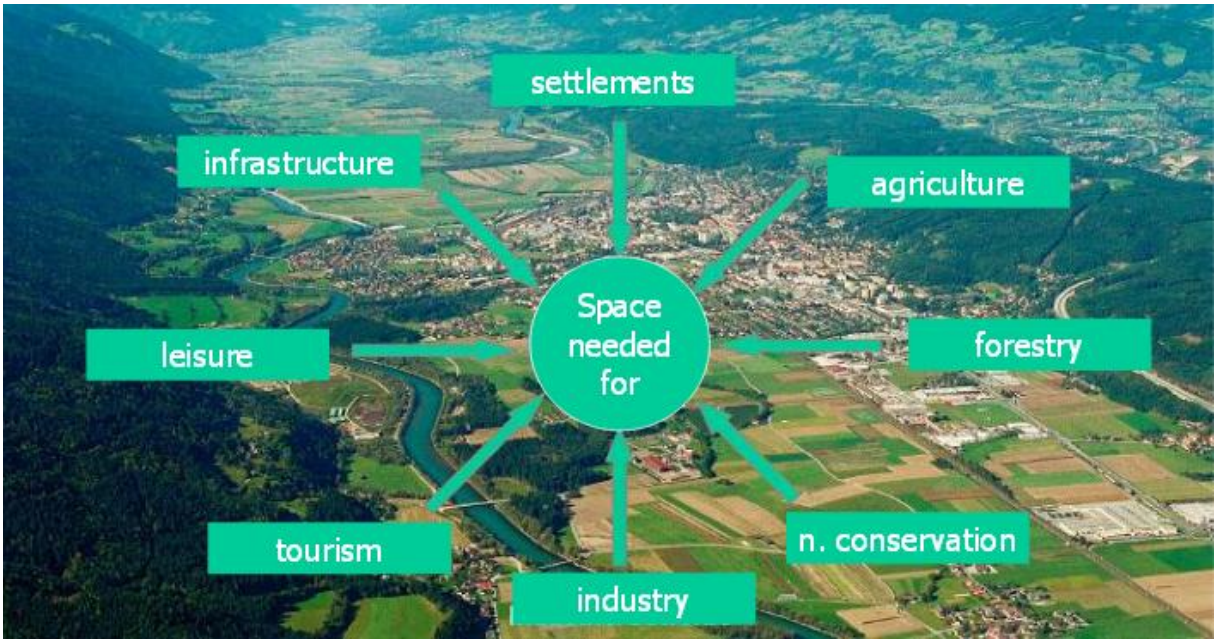


Figure 8: Increasing impact on areas (Michor in Hornich, 2009: 6)

In general, it is to say that this increasing impact on areas as well as an increasing natural hazard occurrence possibility can cause an overlap of living environment — with its settlements — and hazard areas.

The overlap of living environment and danger zones is relevant for spatial planning and leads to limited use possibilities. Both sides of this issue are affected by certain factors. Some can be influenced by planning while others — such as climate change —cannot.

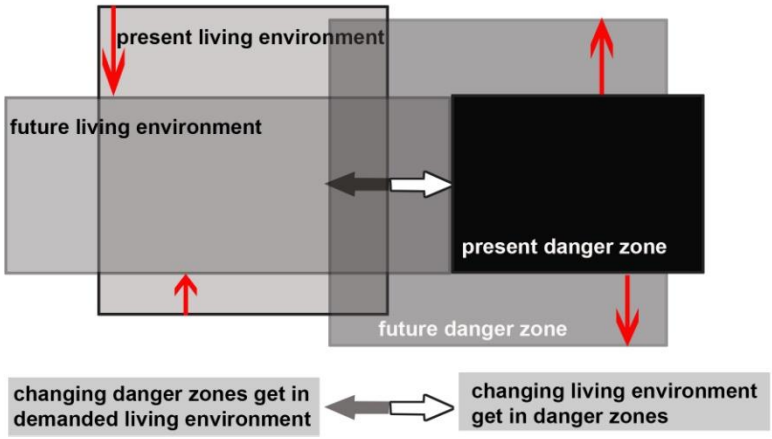


Figure 9: Overlay of living environment and hazard areas (own representation based on Bundesamt für Raumentwicklung, 2005: 34)

As regards living environment, spatial planning can control or steer settlements or other development activities into a certain direction. Danger zones can be subject to activities within the river-basin (e.g. upstream activities), flood protection measures, etc. with various outcomes.

This overlap, or the origination of flood endangered living environments can be explained with the following figures, which display a river in an alley with built environment nearby.

Figure 10: River without endangered settlements (Hornich, 2009: 9)

Below, the occurrence of a flood ,as a natural event without negative effects on settlements is depicted.

Figure 11: Flood event (Hornich, 2009: 9)

The river still got space, so the inundation only affects the surrounding part of the river — maybe also some agricultural areas beside — and must not be seen as a dangerous natural hazard.

Figure 12: Regulation of the river bed (Hornich, 2009: 10)

As shown in the figure above, the river bed was regulated, e.g. as a first flood protection measure, and also parts of the flood plain forest were stubbed to enlarge the agricultural area beside the river bed.

At a later time, as displayed in the figure below, this area is often used as settlement area in an urbanisation process. Until that flood protection was just considered very little.

Figure 13: Development of living environment in former rural areas (Hornich, 2009: 10)

Due to the former river regulation, smaller flood events could be prevented.

But (larger) inundation could happen, because of little consideration of flood protection measures. Thus, inundation area is quite big and settlement, infrastructure and the population are affected by the flood.

Figure 14: Inundation of flood-risk areas (Hornich, 2009: 11)

After the flood event rebuilding of the city and the construction of flood protection measures was done to protect the settlements from future inundation.

Figure 15: Flood protection and flood-risk management is in place (Hornich, 2009: 11)

As one can see, land-use planning measures are not part of this more or less typical flood-risk situation. Effective land use planning and zoning regulations could reduce the damage caused by floods and could possibly be a cost effective alternative to technical flood protection measures.

After this general explanation of the occurrence of floods and its relevance in land use planning, the relevance of floods within Europe, especially in Austria and Sweden will be explained in the following chapter.

2.4 Relevance of flood-risk ...

Despite "its economic and social development and the progress in technology, Europe has not been immune to severe flooding. In fact, floods are the most prevalent natural hazard in Europe. Despite much investment in flood defence works, flooding remains a serious problem throughout the continent, causing considerable damage and, at times, loss of life" (Kundzewicz, 2012: 1). "In some European countries, floods are rare, while in others they recur frequently. Floods happen in all climates, including the semi-arid areas of Europe, where river flow variability is strong and some rivers are ephemeral, carrying no water for part of the year" (Kundzewicz, 2012: 3).

The occurrence likelihood of floods is different within the member countries of the European Union as one can see in the figure below.

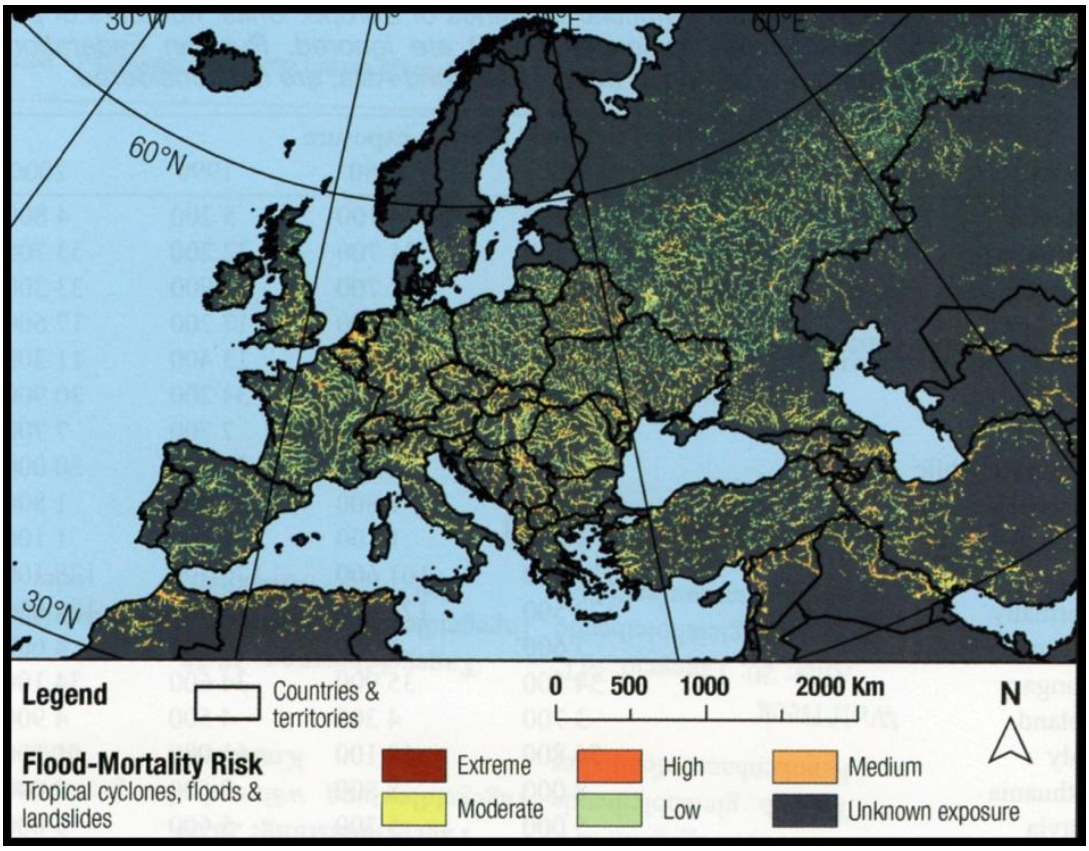


Figure 16: Spatial distribution of flood-risk in Europe (Pinskwar et al., 2012: 92)

The next part of this study will be a short overview about flood events in Austria and Sweden.

2.4.1 ... in Austria

In the last decade Austria has experienced big flood events, e.g. in 2002 the Kamp catchment in Lower Austria, experienced a flood, which was 70 percent higher than the largest rainfall event in the past 100 years (cf. Gutknecht et al., 2002 in Blöschl et al., 2012: 169). The flood events in the year 2002 registered in history as the flood of the century, because floods occurred at the beginning of June in Lower Austria, in August in the north and in November in the south of Austria (cf. Godina et al., 2004: 1). After this flood of the century, further big flood events happened in the alpine areas of Austria in 2005 and events with a 50 to 100 year occurrence possibility happened in the east and south eastern part of the country (cf. BMLFUW, 2012: 13 – 20).

"The interplay of climate input and catchment processes is the main control of flood generation in Austria and is reflected in the seasonality of the floods" (Blöschl et al., 2012: 169).

In some parts inundation tends to occur in early/mid summer, due to seasonality of rainfall distribution at high elevations as well as high antecedent soil moisture due to snowmelt, while in other areas floods in summer are caused by large-scale

rainfall events of long duration. In the following map of Austria, the average seasonality of maximum annual floods is shown. The colours identify the mean dates of occurrence and the degree of seasonality is visualized with the intensity of the colour. (cf. Blöschl et al., 2012: 169f.)

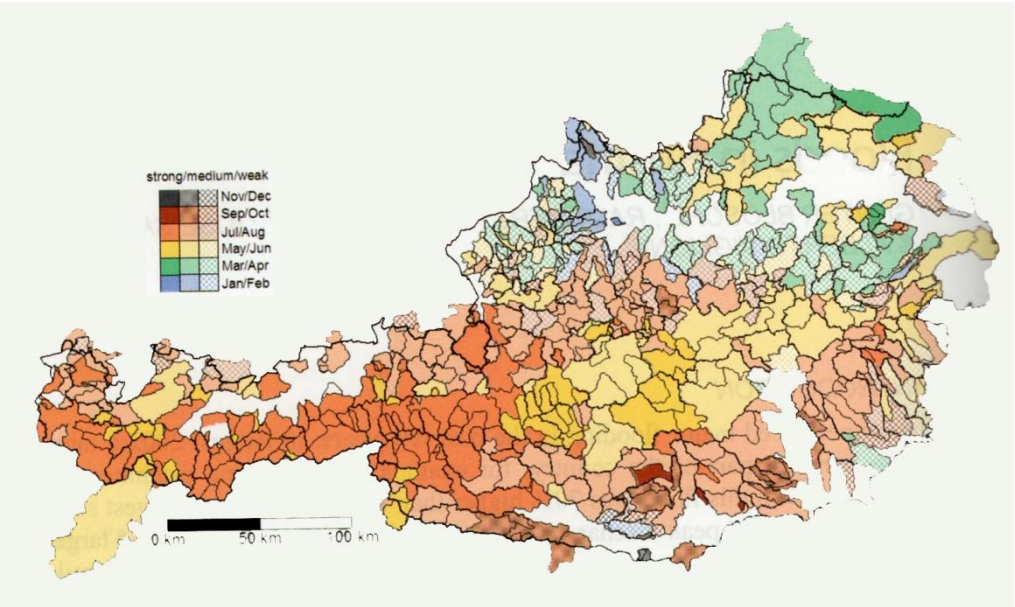


Figure 17: Average seasonality of maximum annual floods in Austria (average of 1957 — 1997) (Merz and Blöschl, 2003 in Blöschl et al., 2012: 170)

The major factors for this flooding is the "interplay of the seasonality of climate drivers and catchment conditions" (Sivapalan et al., 2005 in Blöschl et al., 2012: 170), the catchment scale and convective storms (cf. Blöschl et al., 2012: 170).

2.4.2 ... in Sweden

A big difference to Austria is that land "is in general not a scarce resource in Sweden, but in densely populated areas or in areas of major importance for biodiversity or recreation there can be conflicts in land use" (Statistics Sweden, undated: 14). Due to that the problem of settlements in areas endangered by natural hazards is not as big as in Austria and problems due to inundation are minor in Sweden, compared to a general international perspective. Furthermore many Swedish rivers are regulated heavily for hydropower production. These regulations reduce natural high peak flows and have a great influence on flood risk. (cf. Thorsteinsson et al., 2007: 485)

But also in Sweden serious flooding occurred, for example in Kristianstad (2002 and 2007) (cf. Johannessen et Hahn, 2012: 374), Arvika (2000) as well as widespread flooding in parts of south Sweden (2004). Additionally some towns which were inundated in 2002 were unprepared for the floods in 2004, this fact shows that Sweden also has a demand for flood risk management and measures for flood protection. (cf. Thorsteinsson et al., 2007: 486)

In the following figure the location of flood events between 1901 and 2010 is illustrated as well as the areas where MSB developed flood maps. About 90 percent of the historic floods happened in areas within the flood maps. (cf. MSB, 2013 in Statistics Sweden, 2013 b: 153)

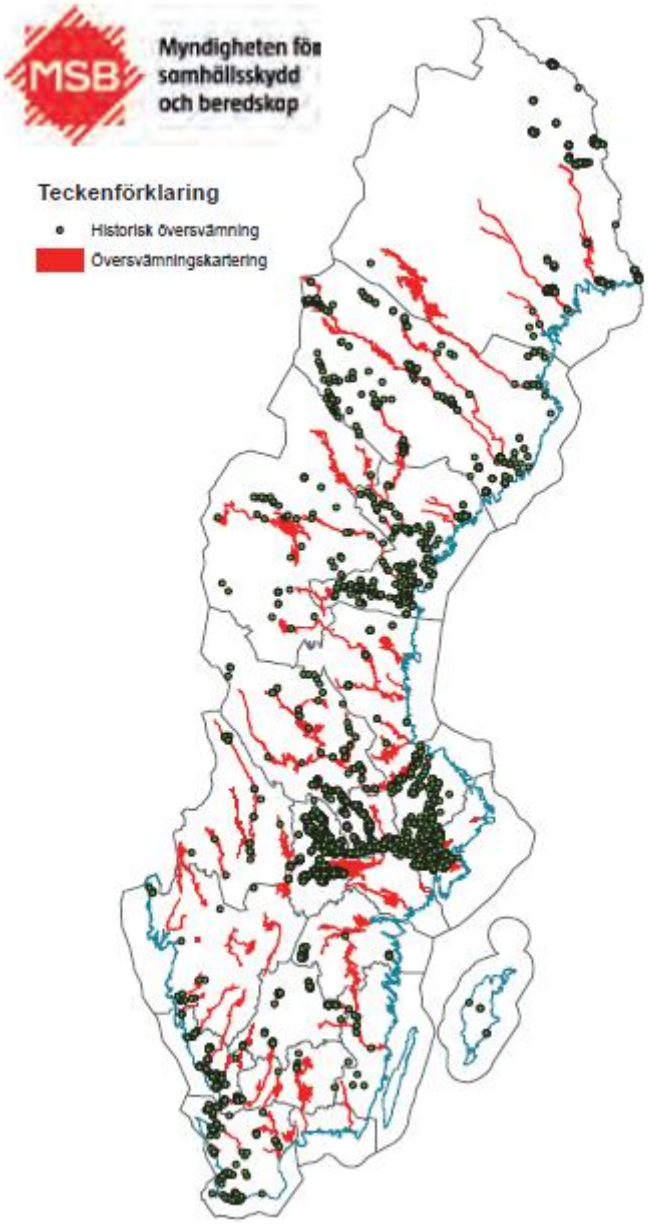


Figure 18: Floods in Sweden 1901-2010 and flood mapping by MSB (MSB, 2013 in Statistics Sweden, 2013 b: 153)

Another extensive and prolonged flood event in Sweden happened between autumn 2000 and spring 2001 at lake Vänern and lake Glafsfjorden. The flooding at lake Glafsfjorden is seen as the most severe flood in Sweden in modern times. (cf. Grahn and Nyberg, 2014:306)

"Lake Glafsfjorden (94 km^2) is situated in the River Byälven catchment up stream to the large Lake Vänern. A prolonged period of excessive precipitation (...), about three times normal, substantially increased water input to the lake," and the lake reached a level about 3 m above normal level. That lead to a partly flooding of the municipality Arvika. (cf. Grahn and Nyberg, 2014: 306)

Lake Vänern (5 650 km²) is the largest lake within the European Union. The water level was 1.3 m higher than normal level and several big cities which are located at the lake were affected. The general problem about lake floods is that lakes have slow dynamics and that lake floods last very long. (cf. Grahn and Nyberg, 2014:306) The slow process due to the large storage capacity of these big lakes, is a problem on the one hand, because the floods last very long, but on the other hand this slow process has a positive aspect, since there is plenty of time to implement damage prevention measures (cf. Sawa, 2005: 3). "Lake Vänern and Göta älv River are used for hydropower production, shipping, tourism, recreation, fishing, drinking water supply, and as recipients of waste water from municipalities and industries, etc." (Nyberg et al., 2014: 9), in that case the consequences of a lake flood can be much more problematic than river floods.

2.4.3 Relevance of the understanding of planning

The existing understanding of planning is an important factor, relating to flood prevention and the avoidance of loss and damage as a negative consequence due to these events.

A high level of individual responsibility and a high level of awareness and insight of the responsible planning actors for a necessity of consideration and implementation of flood-risk issues could help to implement these issues successfully.

For example, if a high level of risk awareness and consequently, a limited interest or need to use endangered areas exists, vague regulations as "flood-risk has to be considered within the planning process" are possible instead of strict building prohibitions.

2.5 Changes in flood-risk

As mentioned before, an overlap of living environment and (flood) risk areas exists and the situation can change in the future for the better or the worse.
Blöschl et al. stated that "climate variability, land-use changes and river works such as the removal of flood plains" are the main factors to "changes in river floods in Austria" (cf. Blöschl et al., 2007 in Blöschl et al., 2012: 173).

In the table below one can see examples of the different drivers of changes in flood hazard and vulnerability.

Table 1: Examples of drivers of changes in flood hazard and vulnerability (own representation based on Merz et al., 2012: 437)

Examples of drivers of changes in flood hazard and vulnerability

Compartment	Processes	Variables	Drivers for change	Influence on:
Atmosphere	Precipitation, antecedent catchment conditions	Total precipitation, intense precipitation, snow cover, snowmelt, seasonal distribution of climatic variables	Natural climate variability on different timescales, anthropogenic climate change	Hazard
Catchment	Runoff generation and concentration	Infiltration capacity, runoff coefficient, water storage capacity, rate of impervious area	Urbanization, deforestation, agricultural management practices, construction of flood retention basins	
Rivers	Flood routing, superposition of flood waves	River morphology, conveyance, roughness, water level, discharge, inundated area	River training, construction of dikes and weirs, operation of hydropower plants and dams	
Inundation areas and indirectly affected areas	Exposure, susceptibility	Number of fatalities, number of evacuees, total material damage, insured losses, losses in cultural heritage, destroyed infrastructure, health damage, loss to animal husbandry, wildlife damage, indirect damage	Population growth, urbanization, land use planning, asset value changes (e.g. inflation, lifestyle changes), building codes, flood-proofing, flood forecasting and early warning, emergency measures (e.g. dike strengthening), risk perception, changes in social vulnerability (e.g. aging of population at risk), dependence on flow or services and information	Vulnerability

As one can see, the changes in flood-risk are not only a result of changes of hazards but also the vulnerability changes. This thesis focuses on both aspects and the following part of the study deals with changes relating to land-use planning issues and furthermore with climate change related changes in flood-risk.

2.5.1 Reasons for changes in flood-risk

"Flood vulnerability and risk vary with the wealth of the respective communities" (Kundzewicz and Takeuchi, 1999 in Kundzewicz et al., 2012: 15). "When an extreme flood takes place in wealthy countries, it may not be possible to avoid high levels of material damage, but it is often possible to save lives, via effective forecast-warning systems and availability of technical means for fast evacuation"

(Kundzewicz et al., 2012: 15f.), but Kundzewicz et al. also showed that the occurrence frequency of extreme hydrological events like floods and landslides has considerably increased in the last three decades and also the damage caused by these events has risen more rapidly than population or wealth (cf. Kundzewicz et al., 2012: 16f.).

The "(...) question as to whether flood damage increases over time, and if so, why is very relevant for policy response in terms of flood risk management, adaptation strategies and reducing greenhouse gas emissions" (Merz et al., 2010 and Bouwer, 2011 in Merz et al., 2012: 450). But there is an obstacle for studies relating to the increase of flood damage, the lack of reliable data of flood damage. Observations about vulnerability are poorly quantified. (cf. Merz et al., 2012: 450) This means that some factors lead to increasing vulnerability and others increase the probability of inundation.

Drivers in the compartment of rivers, like effects of river works are related" to hydraulic processes with clear boundary conditions" and are relatively easy to identify (cf. Blöschl et al., 2012: 173).

"Changes in floods due to land use are more difficult to assess" (Blöschl et al., 2012: 175), because they are "caused by socio-economic factors" and "condition the transformation of rainfall into runoff. If land use is modified within a catchment (e.g. resulting in conversion of a rural area into an urban area), then water levels and discharges in response to a given precipitation input would increase" (Kundzewicz et al., 2012: 17).

Although urbanization and the reduction of flood retention areas and soil sealing within the urban areas are relevant and also "(...) other types of land-use change are important to the generation of floods. Deforestation, certain forms of cropping, the drainage of flood plains, wetlands, lakes, ponds and other surface retention areas diminish the available water storage capacity in a basin, adversely affecting flood risk" (Kundzewicz et al., 2012: 18).

It is necessary to say, that changes in floods due to land-use are usually more likely on small scales, like changes in inundation of smaller catchments of a few hectares or square kilometres (cf. Blöschl et al., 2012: 173).

However, as the example of Salzburg shows, urbanization can be measured with concrete numbers. From 1971 to 1991 about 0.42 hectare per day and between 1991 and 1999 about 1.27 hectare per day were used for building land. Beside the use for building land also areas for streets and other transport infrastructure were used. This leads to developments overflowing the settlement borders and infiltrating flood prone and flood retention areas. (cf. Loizl, 2012 b: 11)

2.5.2 Flood-risk and climate change

"A severe problem in flood trend studies is the difficulty of distinguishing between changes as a consequence of natural climate variability and anthropogenically-induced climate change. There is widespread evidence that flood frequency and magnitude vary at different timescales, from interannual and decadal to even

longer timescales. The variability of floods due to natural/internal climate variability is largely unknown, and the instrumental record is frequently too short for a well constrained estimate of natural variability" (Merz et al, 2012:439).

Floods and also sea-level rise are seen as climatic hazards (cf. Pachauri and Reisinger in Wamsler and Brink, 2014: 1361), but it is quite difficult to identify climate factors, due to the seasonal interplay of climate and catchment processes (cf. Blöschl et al., 2012: 173).

Rainfall is clearly an important factor, because a comparison of rainfall trends and flood trends showed a similar increase in the catchments at the northern Alpine fringe, also less snowfall due to higher air temperature leads to more frequent flooding. (cf. Blöschl et al., 2012: 173ff.).

"Climate change poses a serious challenge to sustainable urban development worldwide (...)" (Wamsler and Brink, 2014: 1359). However, the problem is that science cannot deliver precise information about future flood hazard of sufficiently operational character yet (cf. European Environment Agency, 2007 in Kundzewicz et al., 2012: 24).

"Climate-driven changes in flood frequency exhibit a huge complexity that depends on the generating mechanisms. That is, flood magnitudes are expected to rise where floods result from increasingly heavy rainfalls, while flood magnitudes may decrease where floods are generated by a smaller spring snowmelt" (Kundzewicz et al., 2012: 18). This means in areas where snowmelt is the major flood-generating mechanism "the time of greatest flood risk has shifted from spring to winter" while in other areas "snow cover may have increased (...) where the temperature still remains below 0°C" (cf. Kundzewicz et al., 2012: 18).

Due to that, there "are considerable scientific difficulties in detecting and attributing a climate-change signal in flood records. So far, flood projections for the future remain highly uncertain. Hence the tantalizing question "adapting to what?" arises, bearing in mind that adaptation to an increasing flood risk poses a difficult challenge to integrated flood management systems, which should include an optimal, site-specific, mix of structural and non-structural measures" (Kundzewicz et al., 2012: 19).

"Observations to date provide no conclusive and general proof as to how climate change affects flood behaviour. Ubiquitous increase in flood maxima is not evident" (Lins and Slack, Mudelsee et al, Kundzewicz in Merz et al., 2012: 453). However, positive trends have been identified in some areas across Europe and overall maxima between 1961 and 2000 occurred more frequently in the second half of the observation (cf. Merz et al., 2012: 453).

Thus means it is quite hard to implement climate change factors into flood risk planning, apart from the fact that "anticipating changes in demography, wealth and future use of the flood plain over a longer time horizon is even more difficult than

estimating design events[2]" (*Bemessungsereignis*) (Kundzewicz et al., 2012: 19). Climate change adaptation is also seen as a task of spatial planning by the . Austrian Conference on Spatial Planning[3]. This organisation suggests that the prevention of future risks on the basis of hazard zone maps should be implemented in land-use planning. Consequently, regionalised climate models would be needed for this integration, but scientific and legal requirements are missing. (cf. Austrian Conference on Spatial Planning, 2012 b: 43)

On the whole, the changes in flood-risk and the "increase in flood damages over time is the result of a complicated puzzle of various factors such as economic development, population growth, land-use change in the catchments, river training, changing flood mitigation and climate-related changes" (Merz et al., 2012: 455).

2.6 Integrated risk management

This risk management, or more precisely, integrated risk management "assumes that all types of measures for natural disaster reduction are considered. Generally, measures of preparedness, response and recovery (reconstruction) should be equally implemented" in this holistic approach of risk management (cf. Federal Office for the Environment, 2007: 12).

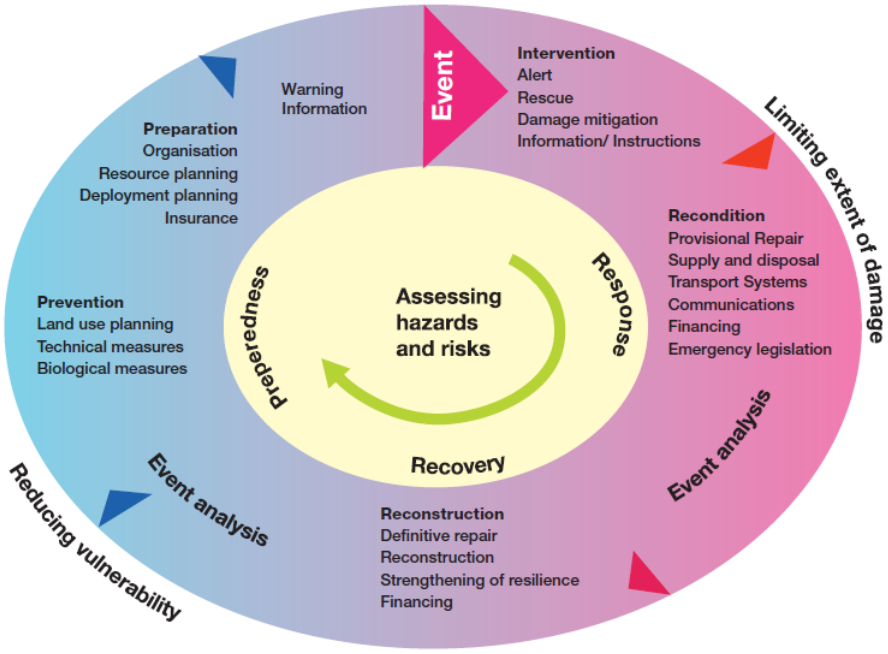


Figure 19: The cycle of integrated risk management
(The Federal Office for Civil Protection in Federal Office for the Environment, 2007: 12)

As it is evident in the figure above, land-use planning, beside technical and biological measures — which are not part of this study — is one of the prevention

[2] The design event, e.g. a centennial flood or other occurrence probabilities sets the basis for calculation of water flows, depths, etc.

[3] Information about the Austrian Conference on Spatial planning and their legal status is pointed out in chapter 3.1.1.

measures. The focus of this thesis is on the connection of flood-risk management and land-use planning, or land use planning as a part of flood-risk management.

But why is land-use planning an important aspect of flood-risk management? — "Land use plans can designate areas to keep them free of urban development, it can support adaptive development (architecture or type of use) or it can mitigate the dimension of the hazard by land uses which retain water in the catchment" (Evers et al., 2012: 2). Wetlands, agriculture, urban development, forestry, etc. as different types of land use are especially relevant for flood issues, but in practice quite often aspects of water- and/or flood issues are badly or too late implemented in land-use planning processes. (cf. Evers et al., 2012: 2) Beside that prevention possibilities, which lie in the hands of spatial planning, settlements or urban areas are also often located close to rivers and close or within flood-prone areas.

However, flood prevention measures within the hands of spatial planning, are not the only option, and often — especially for already existing buildings and constructions — technical measures are needed for protection. Some of these technical measures — which are not part of this thesis — are named and can be seen in the following schematic figure.

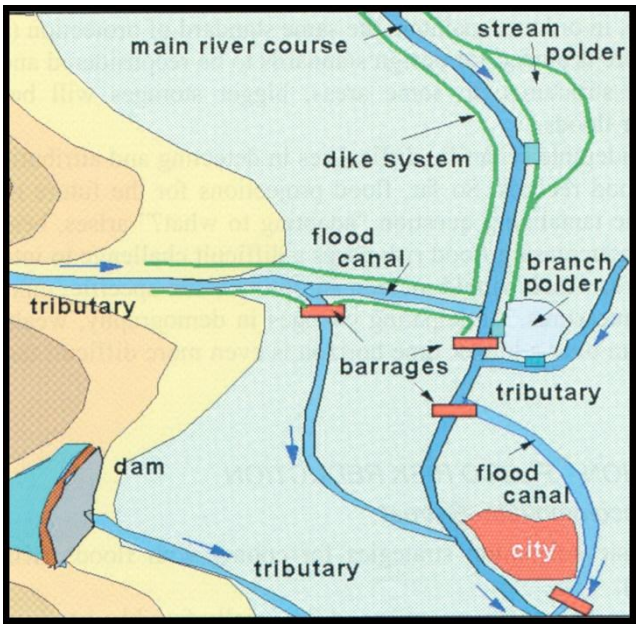


Figure 20: Measures of flood protection, schematic (Kundzewicz et al., 2012: 20)

The options are various, but due to financial aspects and technical limits the protection through technical measures are not unlimited. In some cases a relocation of endangered buildings or infrastructure would be the better option.

3 Relevance of flood-risk in legislation

In the following chapter the relevant parts of legislation, in terms of flood-risk and spatial planning the links of these laws as well as relevant directives of the European Union and their implementation in Austria and Sweden are presented.

3.1 Spatial planning laws

3.1.1 Spatial planning laws in Austria

The legal base for spatial planning in Austria is the sweeping clause of Article 15 B-VG which says that the federal provinces (*Länder*) are responsible for legislation and execution as long as it is not a legal competence of the federation (*Bund*) or of the municipalities (*Gemeinden*). That means that spatial planning in Austria is a typical example of interdisciplinary matter (*Querschnittsmaterie*). (cf. Lienbacher, 2012: 458)

The federation is responsible for sectoral planning of land utilisation for railroads, highways, aviation, shipping, mail and telecommunications, mining, forestry and laws pertaining to water and waterways, torrent regulations, cross-state-border power lines, waste planning constructions and military constructions. (cf. Lienbacher, 2012: 458)

The provinces are responsible for all matters of spatial planning, which falls not within the remit of the federal planning competence, as mentioned above. That means the provinces are responsible for building development, land improvement, landscape management, nature protection, roads, etc. (cf. Lienbacher, 2012: 458)

Local spatial planning competences are regulated by the municipalities (cf. Lienbacher, 2012: 458). These develop land-use/zoning plans (*Flächen-widmunspläne*), which define the land-use of the whole municipality (cf. Lienbacher, 2012: 470) and building regulation plans (*Bebauungspläne*) which set the constructional order of the municipality area. (cf. Lienbacher, 2012: 475f.)

As mentioned before, Austria is separated in nine federal provinces, and the competence of spatial planning falls within the competence of these federal provinces, with nine different laws in each province and no "federal law in its own right governing spatial planning." But a coordinating federal body exists, the Austrian Conference on Spatial Planning (ÖROK[4]). (cf. Hornich, 2009: 21) The ÖROK has policymaking powers and one of the main task is the development of the Austrian Spatial Development Concept (ÖREK[5]), besides, other products, like basic studies (ÖROK publication series) and the periodically reports on spatial planning are published (cf. Austrian Conference on Spatial Planning, 2012 a: 2).

[4] The federal government, federal province governors, the presidents of the association of towns and municipalities (*Städtebund and Gemeindebund*) and — in advising position — the economic and social partners are part of this organisation, which was established in 1971 to coordinate spatial planning on a national level (cf. Austrian Conference on Spatial Planning, 2011: 7).

[5] The current concept was published in October 2011 (cf. Austrian Conference on Spatial Planning, 2012 a: 2).

Due to the missing federal laws relating to spatial planning, the not legally binding concepts and recommendations of the ÖROK are an useful supplement.

Spatial planning laws in Lower Austria and Salzburg

In this thesis the focus is set on two of them, Lower Austria and Salzburg. The spatial planning laws of the provinces in Austria formulate principles and goals, which can be seen as the framework for public interests and the future development.

In Lower Austria one of the objectives is the avoidance of risks for health and safety of the general public. Due to this aim, consideration of nature risks for site selections is necessary for the protection of foreseeable nature hazards (cf. NÖ ROG § 1 subsection 2 clause 1 lit i, 2015) The spatial planning laws of Salzburg determined in § 2 subsection 1 clause, that spatial planning has the aim to protect the population of nature risks with best possible location selection for permanent used facilities and with the aid of safety measures in the best way (cf. Slbg ROG § 2 subsection 1 clause 4). The aims and principles are addressed to regional or supra-local (*überörtlich*) spatial planning authorities as well as to local spatial planning administrations.

3.1.2 Spatial planning laws in Sweden

The two most important laws for matters of spatial planning in Sweden are the Planning and Building Act and the Environmental Code (*miljöbalken*). (cf. Hägglund, 2013: 63) The main aim of the Environmental Code is to promote sustainable development and deals with protection of the environment and human health, management and protection of valuable natural and cultural environment, long-term management and use of land, water and physical environment, etc. (cf. Commin, undated: 10f.) "The Planning and Building Act is the main act within the spatial planning system (...)" and forms the framework for the municipalities and "regulates the planning of buildings, land, and water areas, and sets out a series of general requirements for (...) detailed development plans (*detaljplan*) and building permits (*bygglov*)." (cf. Hägglund, 2013: 63)

If issues of land-use and water zones concern more than one municipality, the planning and building act determine that these issues have to be concerned jointly. And if comprehensive planning of several municipalities has to be co-ordinated it is required that the state has to set up a regional planning body (e.g. an association of municipalities). (cf. Johnson, 2013: 97) "Currently, only the Stockholm and Gothenburg (..) regions have undertaken such regional planning in line with the rules set out in the Planning and Building Act" (Johnson, 2013: 97) and "(...) physical regional planning is limited to a few urban regions" (Johnson, 2013: 97).

"Compared with other EU member states, Swedish municipalities and County Councils have relatively wide-ranging responsibilities (...)" and are in authority for spatial planning (cf. Hägglund, 2013: 62).

The Planning and Building Act empowers the municipalities in the fields of spatial planning and the regulation of the use of land and water areas. This act also includes requirements to consider the risk of accidents, floods and erosion in the planning decisions for the location of buildings and other (built) structures. The municipalities are also primarily responsible for emergency planning and preparedness. (cf. Star-Flood, 2014: 13)

"Land use planning under the Planning and Building Act (...) is a municipal concern. Basically, the municipality alone decides where, when and how a plan is to be drawn up. (...) Furthermore, the Government cannot make an order for the municipality to adopt, revise or cancel plans, except where necessitated by national interests or by interests involving several municipalities" (Kalbro, 2005: 4).

Due to the Planning and Building Act "new buildings and constructions should be located to land that is suitable for the purpose considering the flood risk when it comes to planning and planning permissions (2 kap. 5 §[6]). During the municipal planning process, the County Administrative Board ('*Länsstyrelsen*') has monitoring and supervising function. The CAB has the task to promote that the municipality locates new buildings and settlements to land that is suitable in that respect" (Hjalmarsson, 2014: interview).

A similar position is also evident in D. Thorsteinssons article about flood risk planning on the local level. He mentions that beside land-use planning "local government is responsible for flood protection in urban areas" (Thorsteinsson, 2007: 486).

But "the importance varies greatly depending on the context. Some exposed municipalities (and CAB:s) are very affected and concerned. In general, if a municipality proposes a plan that may lead to that the proposed settlement may be unsuitable considering the flood risk" (Hjalmarsson, 2014: interview).

The Planning and Building Act defines in § 5 beside the general suitability for constructions due to soil, rock and water conditions, possibility for transport, water supply, sewerage, etc. the risk of flooding (*översvämning*) and erosion must be considered in the planning process. (cf. SFS 2010:900)

Beside that, based on chapter 11 § 10 of the Planning and Building Act, the County Administrative Boards are the supervision of municipal decisions. Due to chapter 11 § 10 subsection 5, the County Administrative Boards have to interfere if a settlement is inappropriate with respect to the health or safety or at risk of accidents, flooding or erosion. (cf. SFS 2010:900) In that case, due to chapter 11 § 11 of the Planning and Building Act, the County Administrative Board should revoke the municipalities zoning decision (cf. Thorsteinsson, 2012: 244).

In practice "the CAB requests a survey on how the municipality has considered the flood risk. In general, flood hazard maps are often used nowadays. However, sometimes the risk has to be assessed on a detailed level. The Swedish

[6] Planning and Building Act

Meteorological and Hydrological Institute have been involved in a number of cases during the last years" (Hjalmarsson, 2014: interview).

But also the rights of the municipalities are limited. For "planning of areas of national interest or along all shorelines of lakes and rivers" there are regulations set in the Environmental Code[7] and the Planning and Building Act (cf. Commin, undated: 13). "However, there are (so far) no detailed rules in the Planning and Building Act that specifies certain limits. That means that the risk must be assessed on a case by case basis" (Hjalmarsson, 2014: interview).

In the older act about planning and building, since 1989 the municipalities were obliged to consider water conditions and risk of accidents for the location finding of new building and constructions, but the concrete term flooding was added only in the year 2008. (cf. Hjalmarsson, 2014: interview) A similar adoption in the old planning and building legislation of 1987 was only implemented in September 2009 (SFS 2009:530); before that, the County Administrative Boards did not have the power to revoke the municipal decisions in case of floods (cf. Thorsteinsson, 2012: 244).

In the table below a comparison of the general flood-risk issues within the spatial planning laws of the sample countries is displayed.

Table 2: Comparison of general flood-risk issues in the spatial planning laws of the sample countries

Country	Legislation	Regulatory area	Regulations
Austria (Lower Austria)	§ 1 subsection 2 clause 1 lit i NÖ ROG	Spatial planning objectives	Avoidance of risks for health and safety of the general public. Due to that consideration of nature risks for site selections is necessary for the protection of foreseeable nature hazards
Austria (Salzburg)	§ 2 subsection 1 clause 4 Slbg ROG	Spatial planning objectives	Protection of the population of nature risks with best possible location selection for permanent used facilities and with the aid of safety measures in the best way
Sweden	Chapter 2 § 5 (SFS 2010:900)	Public and private interests	Beside the general suitability for constructions (soil, rock and water conditions, possibility for transport, water supply, sewerage, etc.) the risk of flooding and erosion must be considered in the planning process.

3.2 Other laws with flood-risk relations

Beyond spatial planning laws, flood-risk issues are also an issue within other pieces of legislation. The following chapters displays selected examples of the Austrian and Swedish legislation which deal with flood-risk issues.

3.2.1 Selected pieces of flood-risk related legislation in Austria

In Austria three acts are relevant for flood risks, the water rights act, the waterworks promotion act and the forest act but in contrast to the spatial planning laws, they are federal laws.

[7] See Chapter 3.2.2 Environmental Code.

There are two major information instruments for land-use planning, the hazard zone maps of the Torrent and Avalanche Control (WLV) and the Federal Water Engineering Authority (BWV), which inform about risks due to floods, mudflows, landslides and avalanches. These expert opinions, based on the Forest Act and the Waterworks promotion Act, must be considered due to regulations in the spatial planning laws. Another important fact about the consideration of these two expert opinions is the relevance for promotion measures — regulated in the waterworks promotion act — and is considered in the design of insurance premiums. (cf. Oberleitner, 2006: 155)

Forest Act

The forest act is insofar relevant for spatial planning in Austria, as a large amount of Austria is covered by forests. Besides, the regulations for hazard zone maps for torrents are defined in the forest act § 11. Catchment areas of torrents (and avalanches) have to be shown as well as red and yellow risk areas and blue reserved spaces (*Vorbehaltsflächen*) and brown reference areas (*Hinweisbereiche*) for other risks. (cf. Giese, 2012: 300)

The red risk zones of the hazard zone maps do not have direct consequences for spatial planning, e.g. a building ban zone. Only if spatial planning laws or building laws are related to the hazard zone maps, direct consequences for land-use planning (decisions) can arise. (cf. Jäger, 2006: 182)

Zones endangered by torrents can be seen as the most important link of the forest act to spatial planning (legislation).

Water Rights Act

The Water Rights Act forms the legal framework for water and the surroundings, e.g. riverbeds and riverbanks. This act regulates the use, sustainable management, protection, pollution control of the waters as well as the protection of risk caused by waters, like floods. This act also forms the framework for organisations, e.g. water boards or co-operatives, connected to the use of formed for the use of water. These organisational structures and its legal regulations can be relevant for flood risk measures too. (cf. Baumgartner, 2012: 246) The fourth part of the water rights act mainly rules the protection of risks caused by waters, by dams or other measures. (cf. Baumgartner, 2012: 268) In the water rights act the regulations for flood risk plans and its risk zones (cf. Baumgartner, 2012: 270), as well as for the implementation of the floods directive are set (cf. WRG § 55 — 55 m).

Another important aspect of the Water Rights Act — in relation to spatial planning — is the obligatory permit — beside other necessary permits — for constructions or changes of bridges and buildings within flood run-off areas[8] (and in water management regional programmes[9] determined areas) (cf. WRG § 38 subsection 1).

Waterworks Promotion Act

The main focus of this act, is the financial promotion of technical measures relating to water, e.g. water supply, sewage disposal, protection measures for floods, avalanches, landslides etc. (cf. WBFG § 1 subsection (1)), but it is also responsible for the development of hazard zone maps, as well as for land acquisition and compensation payments for limited use possibilities in case of technical prevention or regulation measures. (cf. WBFG § 1 subsection (1) 1 — 4)

3.2.2 Selected pieces of flood-risk related legislation in Sweden

In the following, two pieces of Swedish legislation, the Environmental Code and the Act on Extraordinary Incidents, which can be seen as relevant in respect of flood-risk issues are displayed.

Environmental Code

In the Environmental Code no regulations regarding floods or flood-risk are mentioned. However, regulations about water operations, like the "construction, alteration, repair and removal of dams or other water structures in water areas, filling and piling in water areas, the removal of water from or digging, blasting and cleansing in water areas, as well as other measures in water areas whose purpose is to change the depth or position of the water" exist within the Environmental Code (cf. Ministry of the Environment, 2000: 59). Furthermore diversion of groundwater, recharging in order to increase the volume of groundwater or measures to drain land, etc. are named. These regulations can be relevant for flood-risk measures (cf. Ministry of the Environment, 2000: 59) and regulations concerning water regulations at certain rivers in Sweden also exist (cf. Ministry of the Environment, 2000: 23).

Additionally, the Environmental Code provides shore protection areas[10] which have the aim "to guarantee public access to these water bodies for recreational purposes and to protect the habitats" of plants and animal species. Within these "shore protection areas" prohibitions like "the erection of new buildings, the alteration of buildings (...), the erection of other structures or works which hinder public access" and "other measures which may (..) affect the living conditions of animal and plant

[8] Which are defined as the area inundated in case of a flood with a thirty years occurrence probability (HQ30) (cf. WRG § 38 subsection 3).

[9] These programmes can be worked out to ensure a restoration of waters and for an achievement of the objectives, if quality objectives are not met (cf. Land Oberösterreich, undated, online), furthermore they could be used for flood-risk issues (cf. Ginzinger, 2015: interview), e.g. for the safeguarding of flood retention areas (cf. Lunz, 2015: interview).

[10] "100 meters from the shore line at the normal average water level but the area may be extended by the authorities to a maximum of 300 meters from the shoreline" (Cullinan, 2006: 178).

species" exist (cf. Cullinan, 2006: 178f.) and these provisions of the Environmental Code "apply conjointly with those of the Planning and Building Act" (cf. Lindgren, 2011: 303).

However, there are exceptions for "buildings, structures and works or measures (..) for certain activities" in place, if "a particular shore area is not important for purposes of shore protection and is included in a detailed development plan or regulations under the Planning and Building Act, it may be exempt[11] from the shore protection regime." (cf. Cullinan, 2006: 179) Furthermore, since 2009, "shoreline building development is permissible in certain parts (...) if the development/project furthers rural development[12]" (cf. Lindgren, 2011: 303). Besides, projects which must located near or in water, "measure caters to an urgent public interest" or if buildings or detailed development plans or buildings already exist, developments at shorelines are possible. (cf. Lindgren, 2011: 304f.)

The following figure, which shows the influence of buildings (within 100 meters) at shores and at the coast of Swedish municipalities visualizes that waterfront developments are existing at a high extent within Sweden.

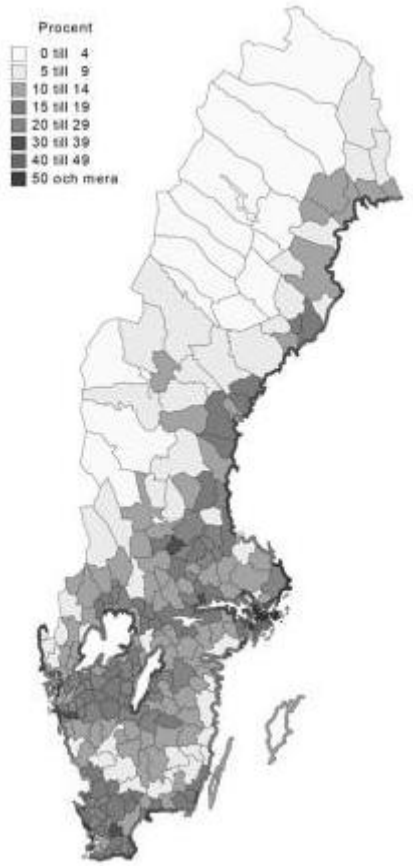


Figure 21: Coast and shores influenced by buildings (buildings within 100 m), by municipality (Statistics Sweden, 2002 in Lindgren, 2011: 319)

[11] I.e. Forssander stated in "Södermanland 90 % of the applications for exemption from the shoreline protection were granted" (Forssander, 2013: online).

[12] "These areas are to be indicated in the municipal comprehensive plans" (Lindgren, 2011: 307) and do not apply to "single buildings in remote locations" (Lindgren, 2011: 303).

In summary one can say in general shoreline protection and other regulations of the Environmental Code seem relevant in case of avoidance of development in flood endangered areas or waterfronts or for measures related to flood prevention. However, in detail the outcome for spatial planning or flood-risk management is very limited.

Act on Extraordinary Incidents

Another important Swedish act, regarding flood-risk, is the Act on Extraordinary Incidents[13]. It regulates the obligations of municipalities and county councils "in relation to complex, extraordinary incidents that disrupt or can severely disrupt vital societal functions" within the borders of the municipal area. Due to that, municipalities and county councils have to establish a plan for the management of these extraordinary incidents, based on a risk and vulnerability analysis. (cf. Star-Flood, 2014: 13) With this in mind, the municipalities and county councils can be named as the relevant and responsible actors regarding flood-risk issues.

3.3 Flood related directives by the European Union

The topic of floods and flood-risk management or natural hazard management in general is a late-breaking topic within Europe. This fact was also noticed by the European Union, which created two directives relating to flood-risk issues.

3.3.1 Water framework directive

The main focus of the water framework directive is the improvement and preservation of the quality of waters within the European Union (cf. European Commission, 2014: online) and the treatment of flood-risk or how a reduction of negative effects caused by floods should be achieved is not explicitly named. However, the Water framework directive "promotes a 'river-basin approach' and refers explicitly to interrelations between water management and land-use" (Kaika et al. in Wiering and Immink, 2006: 423) and the member states were "obliged to establish a new territorial organisation in terms of river basin districts and river basin management authorities" (Gullstrand et al., 2003: 241).

It was also mentioned in article 1 of the water framework directive that "a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which (...) contributes to mitigating the effects of floods (...)" is needed (Directive 2000/60/EC).

The new method, introduced in this directive, is the approach within **river basins**, defined in the water framework directive § 2 number 13, "the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta" (Directive 2000/60/EC).

[13] Act on Measures to be taken by Municipalities and County Councils in Preparedness for and during Extraordinary Incidents during Peacetime and Periods of Heightened Alert (cf. Star-Flood, 2014: 13).

Furthermore a **river basin district**, defined in the water framework directive § 2 number 15 "means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3 (1) as the main unit for management of river basins" (Directive 2000/60/EC).

What implies the concept of river basin management actually for the organisation of water policies (in relation to spatial planning issues)? "On one hand, it leads to new cross-border policy practices (...). On the other hand, river-basin management barely leads to new organisational structures" (Wiering and Immink, 2006: 435). However, some "(..) states have implemented river basis institutions; others pursued the approach of coordination different existing authorities" (Louka in Hartmann and Driessen, 2013: 3). In Austria and Sweden in terms of spatial planning and its interrelation flood-risk management river-basin issues are not noticeable as a current subject.

3.3.2 Floods directive

Later, in the year 2007, the European Union formed a regulation framework for the treatment of flood risk and published the directive 2007/60/EC, the directive of the European parliament on the assessment and management of flood risks, also simplified known as the floods directive, which is based on the water framework directive. (cf. Wallnöfer and Stanger, 2006: 30)

This directive was a big step forward in flood risk management within the European Union and set the basis for a consistent way of working. However, some member states were against[14] the floods directive, because the implementation created new administrative burdens for the member states. (cf. Neuhold, 2015: interview) Also Sweden was against the floods directive and "argued that this directive should be compulsory for trans boundary waters. Since Sweden have very many rivers and lakes that starts and ends within the country the management of flood risks in those rivers affects only Sweden. To make several steps compulsory within the directive could hamper the Swedish administration of flood risk management which was already in place" (Nordlander, 2014: interview).

However, the member states now have to implement the floods directive, but in spite of the directives, the EU is not empowered to prescribe how the directives are implemented within the member states, just basic characteristics of the expected organisational structures are specified, but the individual detailed organisational and institutional implementation is the responsibility of the member states. (cf. Moss, 2004: 88f.)

[14] E.g. Great Britain was against the floods directive even if they already implemented mechanisms for flood protection (cf. Neuhold, 2015: interview).

The main reasons for the European Union to establish the floods directive were:

- Floods have the potential to cause fatalities of people and damage to the environment and economic development.
- Floods are a natural phenomenon which cannot be prevented, but human activities and climate changes can increase the likelihood and impacts of floods.
- The risk should be reduced.
- Flood risk management for flood prevention and protection should be arranged on Community level.
- (cf. Directive 2007/60/EC (1) — (5))

The purpose of the floods directive, set in article 1, "is to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community" (Directive 2007/60/EC).

As set in Article 4 to 8 of the floods directive, the member states have to undertake a preliminary flood risk assessment and prepare flood hazard maps and flood risk maps for each river basin district or unit of management within their territory. The flood hazard maps have to cover the geographical areas which could be flooded by floods of a low (extreme events), medium (likely return period ≥ 100 years) and a high probability. Based on these maps the member states have to establish flood risk management plans, until the 22nd of December 2015. The flood risk management plans have to address all aspects of flood risk management, like prevention, protection and preparedness, they may also include the promotion of sustainable land use practices. (cf. Article 7 subsection 3 Directive 2007/60/EC)

Hereby it is noteworthy that the floods directive "asks for a cross-sectoral integration of the flood issue in sectors" (Hartmann and Driessen, 2013: 3) like "soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure" (Article 7 subsection 3 Directive 2007/60/EC).

This directive and its measures, like the flood risk management plan, are based on river basin districts and this special issue "(...) changes flood risk management from being predominantly the responsibility of water engineering, to incorporate spatial planning in the management process" (cf. Hartmann and Juepner, 2014: 1). Traditionally water engineers try to keep water out of flood plains and provide "lines of defence" against water, which is usually achieved with technical solutions like levees etc. This "technical flood defence was and still is clearly the predominant approach in many European countries." (cf. Hartmann and Driessen, 2013: 1, 6) That is contrasted with the spatial planning position, which is more multidisciplinary and "(...) coordinates and integrates different sector activities" and is located "in-between diverse stakeholders" and deals with complex issues. (cf. Hartmann and Driessen, 2013: 2) The flood risk management plan " interweaves water policies and spatial planning in a way that nurtures 'spatial water governance'" (Hartmann and Driessen, 2013: 1).

Spatial Water governance "describes a process of interaction between spatial planning and water management entities that ultimately aims to integrate the spatial dimension of land use issues and water issues to achieve a more sustainable and viable management of land and water" (Hartmann and Driessen, 2013: 1).

"The new plan challenges the future treatment of flood risk by stimulating considerations of uncertainties (i.e. future projections of flood risks), trans-boundary issues, or societal risk perceptions. This claim fits a trans-disciplinary approach (...)" (Hartmann and Driessen, 2013: 7). The emphasis of the aims within the flood-risk management plans should be set within the fields of not structurally measures (cf. Bmfluw, 2009: 157).

With this approach of the directive and also the new tool, the flood risk management plan, "it is clear that contemporary flood protection is changing towards flood risk management" (Hartmann and Juepner, 2014: 1).

3.3.3 Implementation of the floods directive

The implementation of the floods directive is undertaken in three steps, the preliminary flood-risk assessment, the development of flood hazard and flood-risk maps and the establishment of flood-risk management plans.

In general, the first step — the preliminary flood-risk assessment — identifies the areas with significant flood-risks or a likely occurrence of floods (cf. Article 4, Directive 2007/60/EC). In the next step flood hazard maps — which have to show the flood extent, water depths or water level and where appropriate, the flow velocity or the relevant water flow (cf. Article 6 subsection 4 lit. a — c Directive 2007/60/EC) — and flood-risk maps — which have the aim "to provide a rough picture of the social, economic and environmental impacts that can be foreseen as a result of flooding" (Sawa, 2010: 8) — have to be developed. These maps serve as basis for subsequent flood-risk management plans, which have to content cross sectoral measures for a "reduction of potential adverse consequences of flooding" (Article 7 subsection 2 Directive 2007/60/EC).

Implementation of the floods directive in Austria

In Austria the floods directive was implemented in the national legislation, with the legal amendment of the Water Rights Act 2011. The directive is related to federal laws (Water rights, shipping, torrent and avalanche Control) and provincial laws (spatial planning, civil- and environmental protection), which is why a task force for the implementation was established. (cf. Umweltbundesamt, 2014 b: online)

The localization of flood risk areas and endangered areas of floods already existed in Austria before the floods directive was published. With the digital risk map HORA flood risk areas and endangered built sites and buildings are published online. (cf. BMLFUW, 2014 a: online) Also flood hazard zone maps, developed by two different federal governmental authorities existed before the flood directive was decreed.

The implementation of the floods directive in Austria is the consistent continuation of the strategy to deal with the consequences of the floods in 2002 and 2005, with the aim of the integration of "established methods into the new planning instruments or combine them to advantage." (cf. Pleschko and Kaufmann, 2012: 329)

The new flood risk management plan will be presented in December 2015 (cf. Umweltbundesamt, 2014 b: online) and plan will be valid for the period 2016 to 2021 (cf. Bmlfuw, 2014: 1).

These plans should become a well established planning instrument, based on the preliminary assessment[15] of the impacts and risks of floods (*Vorläufige Bewertung des Hochwasserrisikos*), the defined risk areas (*Ausgewiesene Gebiete mit potenziell signifikantem Hochwasserrisiko*) and the flood hazard maps (*Hochwassergefahrenkarten*) and flood-risk maps (*Hochwasserrisikokarten*). (cf. Pichler, 2014: interview)

Implementation of the floods directive in Sweden

"In Sweden the floods directive is implemented by the ordinance of floods (SFS 2009:956) and the MSB regulations" (Norlander, 2014: Interview).

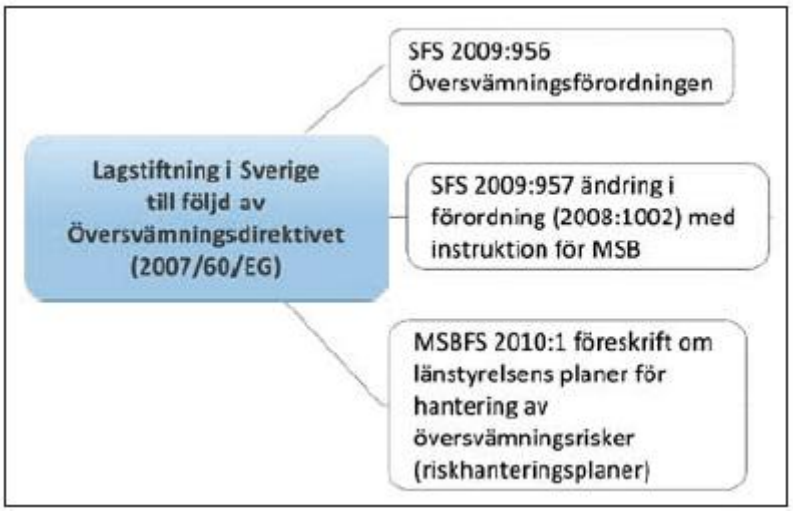


Figure 22: Implementation of the floods directive in Swedish legislation (Thorsteinsson, 2012: 242)

The ordinance of floods provides the legal basis and is linked to other Swedish laws, in case of the definition of a river basin districts, etc. in the Environmental Code. It is directly based on the floods directive and regulates future flood-risk management in case of the development of flood-risk maps and the responsibilities for the development and updating of these maps. It is noteworthy, that this ordinance only regulates flood-risk management but does not take land-use planning into account. (cf. SFS 2009:956)

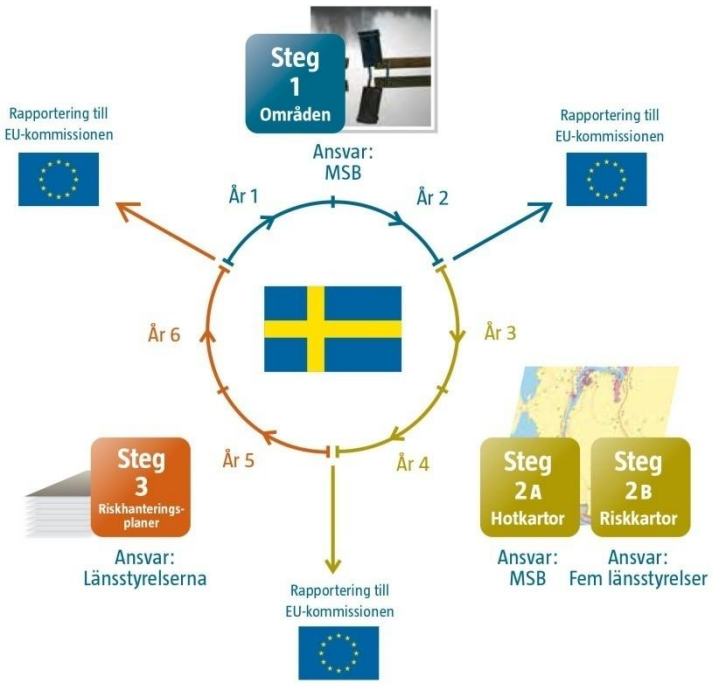
[15] A nation-wide assessment of flood risk — about the flood-related adverse effects on human health, the environment, cultural heritage and economic activity — enabled the selection of risk areas where potential significant flood risk exists (cf. Bmlfuw, 2015 b: online).

In the modification of the ordinance (2008:1002) the Swedish Civil Contingencies Agency, MSB (*Myndigheten för samhällsskydd och beredskap*), was authorised as the responsible authority for flood risk management and empowered to report the European Commission about the implementation of the floods directive (cf. SFS 2009:957).

The third part in the figure above is one of the regulations by MSB, specifically, a regulation for the County Administrative Boards about the handling of flood risk.

Although in case of flood-risk planning MSB can be seen as the most important authority within Sweden. Nevertheless, "MSB does not have the mandate to enforce action on flood risk, which instead falls to the individual municipalities. What efforts the MSB's work will trigger is not yet known (...)" (Johannessen and Granit, 2014: online).

In the figure below the steps of the implementation of the floods directive in Sweden are shown.



Förordningen om översvämningsrisker spänner över en cykel på sex år. Efter varje steg sker rapportering till EU-kommissionen. Första cykeln utförs i Sverige under perioden 2009-2015. Direktivet reglerar tidpunkter för översyn och uppdatering av preliminära bedömningar, kartor och planer.

Figure 23: Implementation of the floods directive in Sweden (MSB, 2012: 4)

In the first step, the nationwide preliminary assessment of the impacts and risks of floods was done by MSB, to localize the areas with significant flood-risk[16] (cf. MSB, 2012: 3). The 18 areas with significant flood-risk, as a result of this assessment, can be seen in the map on the next page.

[16] In order to identify these areas, the adverse effects on floods on four main objectives (human health, environment, cultural heritage and economic activity) have been analyzed. (cf. MSB, 2011 b: 32) In these terms "something in relation to the four main objectives has to be flooded. The flooded area should affect 100 persons at a 100 year flood and 500 persons at extreme flooding" and furthermore "(..) also (...) a historical flooding" should be considered. (cf. Nordlander, 2015: interview)

Figure 24: Areas with significan flood-risk in Sweden (Länstyrelserna, undated: 5)

In the second step, flood hazard maps (*hotkartor*) by MSB and flood-risk maps (*riskkartor*) by twelve County administrative boards have been developed (cf. Norlander, 2014: Interview). The third and last step, which is currently in progress, contains the development of flood-risk management plans (*riskhanteringsplanerna*) by the county administrative boards. These management plans are based on the flood hazard maps and the flood risk maps and should be based on objectives decided by the provincial governments. (cf. MSB, 2012: 3) MSB provided regulations for the development process of these flood-risk management plans. (cf. MSB, 2013 a: 1)

"The EU floods directive has had no direct impact on the Planning and Building Act. However, through the Ordinance (2009:956) on Flood Risks (that was adopted in order to implement the directive in Sweden), the new flood hazard maps have made it significantly easier to assess the flood risk. That means that the directive indirectly has had a significant impact on spatial planning in Sweden" (Hjalmarsson, 2014: interview). Due to the obligate implementation of the flood directive, there "are more government resources spent on flood risk material, which means more comprehensive support for municipalities. In city planning, the issue as such has the same weight as before though although we can identify the issues more easily at this point in time" (Elgström, 2014: interview).

4 Information about flood-risk areas

"One of the cornerstones of flood risk management is the information of people at risk and of the authorities and agencies responsible for flood management." Maps help to visualize this information, because they can give a direct and "stronger impression of the spatial distribution of the flood risk (...). In Europe, there are no standardised nomenclature or agreed practices for flood mapping" (Merz et al., 2007: 231).

Furthermore, measures within spatial planning — the preservation of flood retention or run-off zones, areas for technical measures, area regulations, etc. — are only possible if sufficient information about flood-risk and endangered areas is available. (cf. Weber and Seher, 2003: 71)

However, "spatial planning is not able to carry out risk analysis. Decisions of spatial planning have to be based upon hazard information" (Seher, 2011: 256). The basis for an integration of this information in spatial planning instruments, e.g. land-use plans, etc. can be hazard maps and other expert statements which are hazard related. (cf. Seher, 2011: 256)

It is possible to describe flood-risk on many different scales. There are maps concerning floods related to climate change in Europe and a world map of natural hazards (Berz et al. in Merz et al., 2007: 232) as well as maps on the local scale (1:2 000 to 1:20 000) which show the flood situation for single land parcels or built objects and infrastructure. The latter, the mapping on the local scale, is the most used approach of flood-risk mapping. (cf. Merz et al., 2007: 232)

As previously mentioned, due to the regulations of the floods directive the member states had to establish flood hazard maps and flood risk maps. "Flood hazard is defined as the exceedance probability of potentially damaging flood situations in a given area and within a specified period of time" (Merz et al., 2007: 235). The flood hazard maps can show the intensity of an event with indicators like water depth, "which has the biggest influence on flood damage", and/or flow velocity and the associated exceedance probability. Another possible indicator for the intensity of a flood can be the "duration of the flood situation and the rate of the water rise." (cf. Merz et al., 2007: 235f.)

Options for flood hazard maps are maps of the inundation area for a 100-year flood with the distribution of water depth or maps of inundation areas for events with different return periods, like the overlaying of flood limits of 10, 20, 50 and 100 year events, etc. (cf. Merz et al., 2007: 240)

As highlighted afore, flood hazard maps do not show consequences of floods on built environment or society. To visualize that a second type of flood related maps, the flood-risk maps are needed. Since the "extent of flood damage depends not only on the flood characteristics but also on the vulnerability of the inundated area" (Merz et al., 2007: 237), this type of map shows the "spatial distribution of flood vulnerability" and "information about the exposure and/or the susceptibility of flood-prone elements (population, built environment, national environment)" (Merz et al., 2007: 239).

4.1 Flood-risk maps in Austria

The motive for the development of hazard maps in Austria were the floods in the years 1965 and 1966 in Carinthia and Eastern Tyrol. As described in chapter 3.2.1, the legal basis for these maps was the Forestry Act 1975, which empowered the Torrent and Avalanche Control (WLV) to develop hazard maps. (cf. Bmlfuw, undated: 2) There is also a second authority responsible for hazard zone maps in Austria, namely the Federal Water Engineering Authority (BWV). This authority identifies flood hazard zones for more than 20 years to fulfil the aims of flood protection and show the current state of flood-risk (cf. Rudolf-Miklau et Suda, 2012: 189f.). Because of that flood-risk mapping has a relatively long tradition in Austria, but the separation of competence within two authorities causes difficulties. Often the WLV is responsible for the river at the beginning, when they are seen as torrents[17] and in the later part the BWV is responsible when they are seen as rivers. The Austrian Court of Auditors noticed this fragmentation and has mentioned its negative effects quite often in reports. (cf. Court of Auditors, 2014: 163) In terms of legislation, the Court of Auditors mentioned missing measures for a competence interrelationship. (cf. Court of Auditors, 2014: 174) With respect to that, binding determination and harmonisation of the design events was introduced in 2010. In the year 2013 also binding minimum standards for simulation models for the development of hazard zone maps for the WLV were introduced. These were the same as the already existing standards valid for the BWV. (cf. Pichler, 2014: interview) Both hazard zone maps (WLV and WBV) have the legal status of an expert statement[18], which have to be considered in spatial planning (cf. Neuhold, 2015: interview).

4.1.1 Hazard zone maps (WLV)

As stated afore, § 11 of the Forestry Act 1975 (ForstG 1975) provides the legal basis for the development of hazard zone maps for torrents and avalanches, in § 102 the Torrent and Avalanche Control is named as the responsible department. The hazard zone maps are seen as a forestal spatial plan named in § 8 ForstG and detailed regulations for the hazard zone maps were set by the federal minister in hazard zone ordinance 1976 (cf. Bmlfuw, undated a: 2) The hazard zone map is an

[17] Since the stream is bed-load carrying and located within an alpine area.

[18] As stated in the waterworks promotion act § 2 number 3 WBFG, the hazard zone maps of the WLV and BWV are seen as expert statements which inform about flood and landslide endangered areas.

expertise for the endangered by torrents, avalanches and erosion for the whole municipal area or parts of it, and can be seen as a basis for decisions of spatial- and construction planning and security services. (cf. Bmlfuw, 2014 c: online) Hence, the hazard zone map is not legally binding; yet, the Constitutional Court decided that even if the hazard zone map does not oblige municipalities planning decisions directly, the decision makers are authorized to use hazard zone maps for decisions regarding the suitability as building land. (cf. VfSlg. 15.136/1998 and VfSlg. 16.286/2001)

The hazard zone maps of the WLV provide a parcel-specific visualisation of red (no permanent use for settlements or transport infrastructure due to high risk) and yellow (permanent use for settlement or transport infrastructure is impaired of the hazard) hazard risk zones, blue reserved areas (e.g. needed for flood protection measures), brown (e.g. risks due rockfall) and violet identified zones (e.g. necessary inundation zone). (cf. Bmlfuw, 2014 c: online) How the distinction of these areas is drawn is regulated in the guidelines by the Ministry of Agriculture, Forestry, Environment and Water Management for the torrent avalanche control in the actual version (2011). (cf. Bmlfuw, 2011 b: 3) The scale of the map has to be 1:5 000 or more precise (Hazard zone map ordinance 1976 § 5 number 4), and regarding to the hazard zone map ordinance 1976 § 6 the typical design event for a hazard in this hazard zone map should have a 150 years probability. (cf. BGBl. Nr. 436/1976)

Currently, relations to areas with residual risk are not part of the hazard zone map, but considerations about a future implementation are evident. However, a change of the hazard zone map ordinance would be necessary to achieve this. (cf. Rudolf-Miklau, 2015: interview)

As stated above, it deals with a variety of hazards in alpine areas and flooding is merely a (small) part of it. Torrents are defined as permanently or temporarily (bed-load carrying) flowing water, which due to strong rainfall in the catchment area can transport large sediments, rocks etc. from the riverbed and the catchment area in enormous and dangerous proportions and deposit them outside the riverbed or move them to other waters downstream. (cf. Bmlfuw, 2011 b: 17) The development of hazard zone maps of the WLV is obligatory (cf. Loizl, 2015: interview). Quite a large part of Austria is located in an alpine area and as a result, hazard zone maps are available for a great extent of the country, but for the other (bigger and mainly not bed-load carrying) rivers not the WLV, but the BWV is responsible.

4.1.2 Hazard zone maps (BWV)

The hazard zone maps of the BWV are expertise documents which inform about areas endangered by floods and also show the areas which have to be kept free for protection measures or need a special management. The technical and formal foundation for these maps are the guidelines for hazard zone maps of the Federal Water Engineering Authority. (cf. Rudolf-Miklau and Suda, 2012: 194)

For more than 20 years the BWV creates hazard zones maps to reach the aims of flood protection. In this term the hazard zone map shows the current status of the risk situation of floods. (cf. Rudolf-Miklau and Suda, 2012: 189f.)

Guidelines for the creation of hazard zone maps of the BWV have existed in 1983 and new guidelines were published in 1994, which were based on the waterworks act and form the basis for the content and design of these maps. (cf. Loizl, 2015: interview)

Hazard zone maps were — as set in the guidelines — developed for areas which are not part of the catchment area of torrents or avalanches. However, the hazard zone maps of the BWV just got a legal basis with the amendment of the water rights act 2011 (cf. Rudolf-Miklau and Suda, 2012: 194); in concreto it means hazard zone maps could be generated until 2011 by the BWV, but the generation was not obligatory. After the amendment in 2011 this changed and hazard zone maps became obligatory, especially for areas with significant flood-risk (cf. Loizl, 2015: interview). The areas with significant flood risk are defined in § 42a subsection 2 WRG. Flood hazard zone maps have to include the scenarios set in § 55k subsection 2 WRG. The flood hazard zone maps of the BWV also have the legal status of an expert statement (*Fachgutachten*), which shows the flood catchment areas. This means the status — as an expert statement — is the same as for hazard zone maps in the Forestry Act. (cf. Kanonier, 2013: 15)

Before 2002 — in Salzburg — flood-risk areas were often equated with the HQ30 inundation areas (cf. Loizl, 2009: 89) until in 2008 the first hazard zone maps were shared with the public and published afterwards. Until 2012 the BWV created hazard zone maps for about 90 % of the supervised municipalities. The last 10 % should be finished until the end of 2015. (cf. Loizl, 2015: interview)

The basis for the risk zone identification are hydraulic run-off analysis, which should reproduce natural run-off. Not only a digital elevation model but also land-surveying work at the river basin is needed to achieve this. In a second step a two dimensional hydraulic calculation is done. (cf. Prodinger, 2013: 5)

These run-off analysis itself can be an important information basis for spatial planning decisions (cf. Pomaroli, 2015: interview). Run-off analysis can be prepared in different ways, usually with different colouring and for municipalities usually inundation areas are shown. (cf. Neuhold, 2015: interview)

Figure 25: Unscaled Run-off analysis Golling (Land Salzburg, 2011: 7)

The important fact about the hazard zone maps is that they show the intensity — the product of water depth and flow velocity. In this term the maps are easier to understand than simple water depths or flow velocities. (cf. Neuhold, 2015: interview)

The flood hazard zone maps contain a map (1:5 000 or more precise), an explanation and relevant data. (cf. Bmlfuw, 2014 b: online) In the guidelines (version 2006) for hazard zoning by the BWV, also regulated by the Ministry of Agriculture, Forestry, Environment and Water Management, necessary risk areas — which have to be visualized in the map — are defined. (cf. Bmlfuw, 2006: 2) At the present state new guidelines are prepared, which will include a better and closer cooperation with the WLV and will be available until the end of 2015 (cf. Schmid, 2014: interview). The design event for this flood hazard zone map is in general a centennial flood (HQ100), but also a flood with a 30 year appearance and an extreme event (HQ300) is calculated, bed-load carrying feeder torrents and driftwood as well as other factors are included in the simulation models. (cf. Loizl, 2012 a: 2) The flood hazard zone maps show the HQ30 zone by flood attack lines (zone for the permit under the Water Act), red hazard risk zone (construction ban zone), red-yellow zone (for necessary flood retention and run-off areas), yellow hazard risk zone (permanent use for settlement or transport infrastructure is impaired of the flood hazard), blue zones (needed for special management e.g. for flood protection measures) and the identified zone for hazards, bigger than the design event, up to HQ300. (cf. Bmlfuw, 2006: 3ff.) Areas with residual risk are shown as yellow or red hatched areas, and show the areas which are effected by floods up to HQ300 or in case of a failure of a flood protection, e.g. behind dikes (cf. Bmlfuw, 2011 c: 6).

The basis for these hazard zone maps are run-off analysis as well as more complex risk scenarios, e.g. washout or log-jam processes. Due to that the explanatory power is very high because it is not a simple statistical observation. (cf. Neuhold, 2015: interview)

A total adaptation or standardisation of these two similar, but different in details, hazard zone maps is due to many – professionally grounded – reasons not reasonable. The hazard zone maps of the Torrent and Avalanche Control also deal with different intensive processes (like landslides and avalanches); to consider these risk maps just with the aspect of flooding is too short-sighted. (cf. Pichler, 2014: interview)

However, the visual representation of these two hazard zone maps are similar and for example as part of the flood protection in Altenmarkt im Pongau at the river Enns, both hazard zone maps were joined in one map, as one can see in the map below.

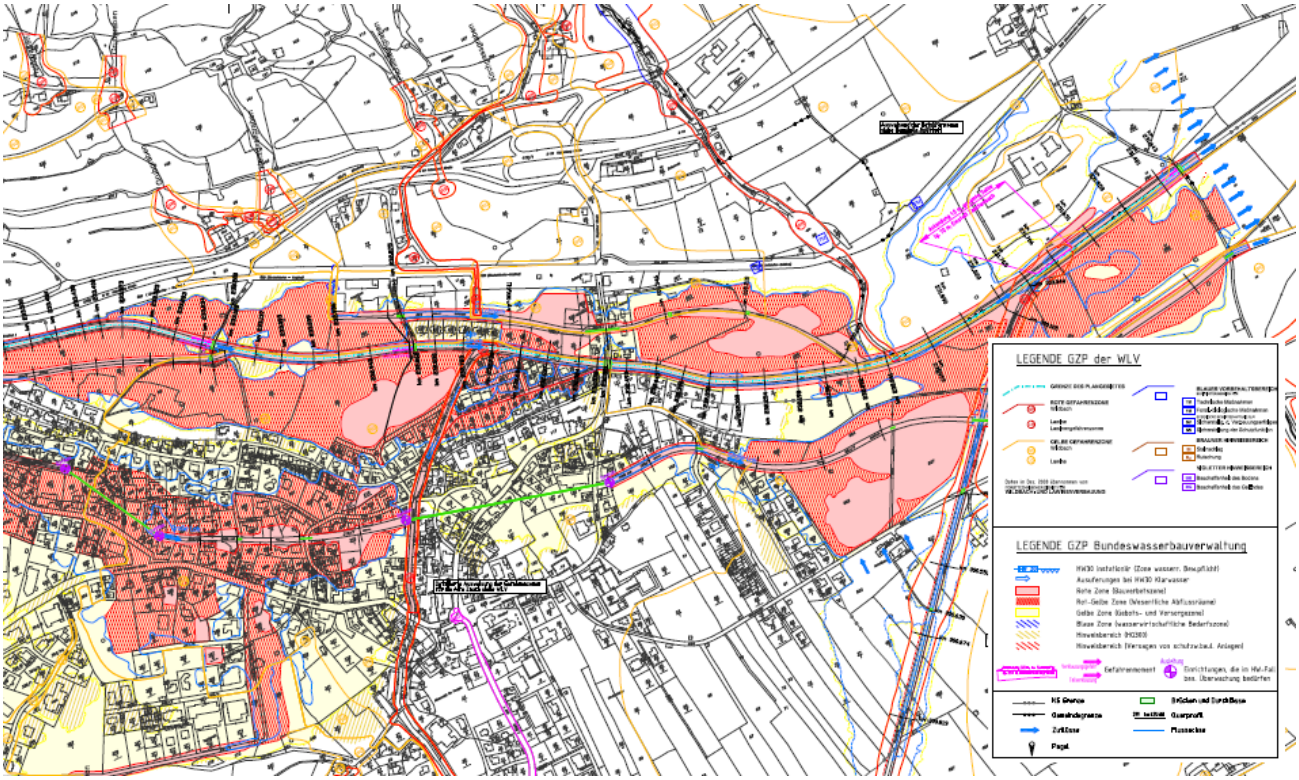


Figure 26: Unscaled cutting of the hazard zone map (WLV and BWV) Altenmarkt im Pongau (slightly adapted representation based on Land Salzburg, 2010)

Information/Visualisation of flood-risk areas

It is possible to take a look at the flood risk of a certain area, with HORA, the Natural Hazard Overview & Risk Assessment Austria, on the internet. It intends to serve as preliminary information for possible risks due to different natural hazards. In the map danger-visualisation flowing waters, the declared flood areas are shown and on a smaller scale also the existing hazard zone maps.
(cf. Bmlfuw, undated b: online)

Figure 27: HORA danger-visualisation flowing waters Hadersdorf am Kamp (Bmlfuw, undated: online)

Due to the implementation of the floods directive in Austria, two more maps are developed, which are also – similar to HORA – available on the internet on WISA, the Water Information system Austria. (cf. Bmlfuw, 2013 a: online)

Areas with significant flood risk

It is the first step of the measures of the floods directive, and shows areas, and the waters which cause the significant flood risk. Also the flood risk zones of extreme events (HQ300) are shown. (cf. Bmlfuw, 2013 a: online)

391 areas with a significant flood risk are declared, 112 are in the sphere of competence of the WLV, for 180 the BWV is responsible, and the left 99 are shared competence of BWV and WLV. The length of the risked water sections contains 2654.3 km. (cf. Amberger, 2014: interview)

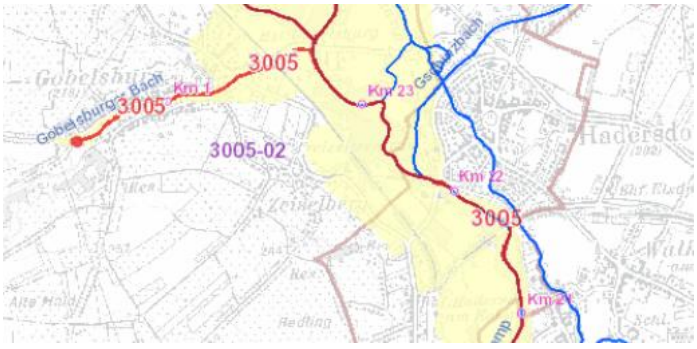


Figure 28: Unscaled cutting: area with significant flood-risk Hadersdorf-Kammern (Bmlfuw, 2013 a: online)

The significance of floods is analysed by past floods and the possibility of an extreme event. (cf. Bmlfuw, 2013 a: online)

4.1.3 Flood hazard maps (according to the floods directive)

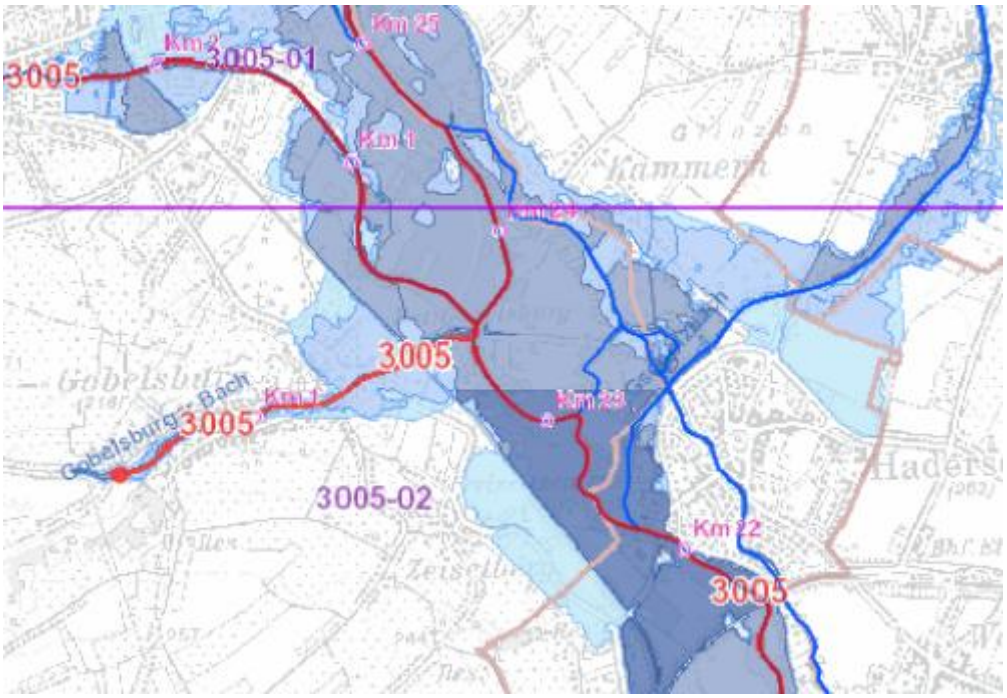


Figure 29: Unscaled cutting of the flood hazard map Hadersdorf-Kammern (Bmlfuw, 2013 b: online)

This is one of the possible flood hazard maps WISA offers, it shows the areas affected by floods with a low (HQ300, light blue), medium (HQ100, medium blue) and high (HQ30, dark blue) appearance possibility. Apart from that, maps with water depth and flow velocities are available for the all three design events. (cf. Bmlfuw, 2013 b: online) The maps are based on the most-accurate existing information, like hazard zone maps, detailed investigation, etc. The flood hazard maps are available nationwide and the valid scale is 1:25 000. (cf. Neuhold, 2015: interview)

Missing information (e.g. HQ30 and HQ300) in the maps, developed by the WLV, have been added simplified via a "pragmatic method". Unfortunately it is not possible to show flow velocities with this technique and the visualisation of water depths is limited. HQ100 (BWV) and HQ150 (WLV) have been treated equally, because the quantitative difference in case of runoff is very small. These kinds of map are not a real harmonisation of the two hazard maps of the authorities in Austria, but efforts were made to show the areas with a significant flood risk in terms of the floods directive with the existing data set of Austrian flood hazard zone maps. (cf. Amberger, 2014: interview)

4.1.4 Flood-risk maps (according to the floods directive)

The third type of maps available on WISA, based on the regulations in the floods directive, are the flood-risk maps. These maps relatively detailed[19] show what is affected by floods. There are maps available for all three design events. And it shows the number of affected inhabitants in the flood risk area, the categories of

[19] Based on the Austrian Map 1: 50 000 (cf. Bmlfuw, 2013 c: online)

land-use, infrastructure and special risk factors (e.g. Industrial sites). (cf. Bmlfuw, 2013 c: online) In the figure below the flood-risk map for an extreme event in Hadersdorf-Kammern at the river Kamp in Lower Austria is visualized.

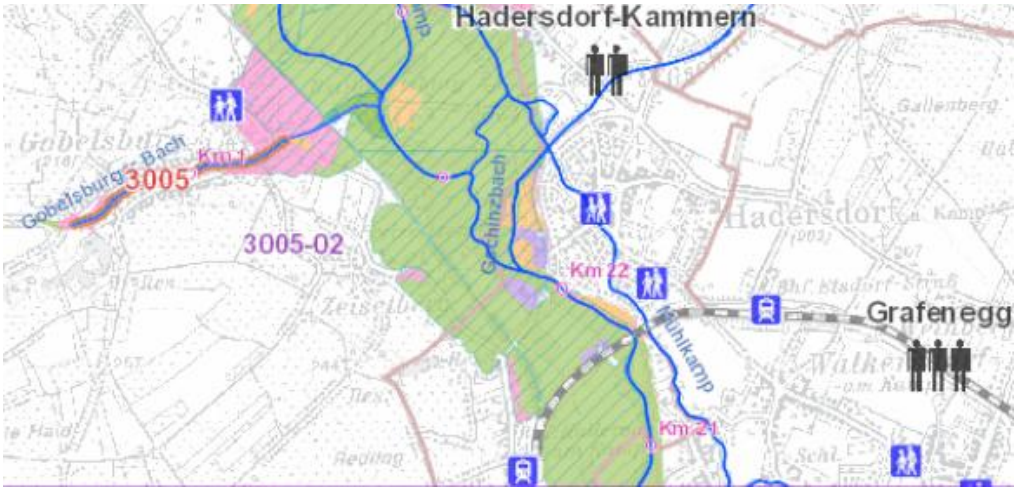


Figure 30: Unscaled flood-risk map HQ 300 Hadersdorf-Kammern (Bmlfuw, 2013 c: online)

4.2 Flood-risk maps in Sweden

"Urban areas bare the brunt of the major consequences of floods, so planning and risk management in cities and towns greatly influence flood risk. An important part of the flood risk mitigation strategy in Sweden is the creation of comprehensive flood risk maps for many Swedish catchments. The low resolution of these maps, however, limits their use in city planning" (Thorsteinsson et al., 2007: 485).

4.2.1 General inundation maps

Since 1998 (cf. Van Alphen and Passchier, 2007: 131) "the Swedish Meteorological and Hydrological Institute (SMHI[20]) has created overview flood maps for most Swedish rivers under a commission from the Swedish Rescue Services Agency" (cf. Swedish Rescue Services Agency in Thorsteinsson et al., 2007: 490). The contents of these maps are the area flooded by a centennial flood and a design-flood for risk class I dams (~ 10 000 year flood). The problem with these maps was that the resolution was not very useful for detailed development planning[21]. It was also questioned if the implication of a 100 year and a ~ 10 000 year flood was sufficient for municipal flood risk management. (cf. Thorsteinsson et al., 2007: 490) With HQ10 000, "Sweden established the highest European safety standards of flood extent maps. (cf. de Moel et al. in Kalantari et al., 2014:70) The maps were based on a hydraulic model, which calculated water levels and discharges. These maps were seen as basic data for municipality risk assessment and general land-use planning. They were also a basis for permanent preventive measures in the municipalities, which could be supported with governmental

[20] SMHI is "(...) not responsible for the flood mapping" anymore and at the present "it is the task for MSB as the Floods Directive" (cf. Näslund-Landenmark, 2014: interview).

[21] The scale of these general inundation maps by SMHI was 1:100 000 (cf. SMHI, 2002: 14) to 1:50 000 (cf. MSB, undated: online).

subsidies. (cf. Näslund-Landenmark, undated a: 29 — 35) Even if the aim of these maps was the use for municipal comprehensive planning, to identify risks within the municipal area and the planning of responses for the Fire and Rescue Services, unfortunately the resolution was limited by former limits of digital elevation models (cf. Näslund-Landenmark, 2014: interview). Thus, the practical use for land-use planning was very limited.

The goal of these maps was to achieve maps of about 10 percent (~ 10 000 km) of Sweden's waterways and intended as general information for overall planning of fire & rescue service work and land-use planning and covered governed, for hydropower production, and ungoverned waterways. (cf. Van Alphen and Passchier, 2007: 131)

"The (..) flood hazard maps were done on an elevation grid of 50 x 50 m with a accuracy of ±2 m" (Nordlander, 2014: interview) and the major problem for the development of flood-risk maps was the coarse data, based on the national elevation data. At the present stage a new national elevation database), which should reduce these limitation in the future, is developed by Lantmäteriet (national land survey), which is expected to be finished by 2015. In some cases, municipalities — for example Karlstad — also performed an own laser scanning to receive more exact data. (cf. Sawa, 2010: 5) "The new elevation model is a grid of 2 x 2 m with accuracy of 0.2 m. This gives a much better resolution and accuracy" (Nordlander, 2014: interview).

In general — before the floods directive was in place — Sweden's disaster reduction and assistance activities were not incorporated in national plans. That was based on the fact that disasters were very rare. "Plans for prevention, preparedness, response, and recovery for all types of risks (...)" have been "(...) handled at the local level by the municipalities" (cf. Swedish Rescue Services Agency, 2004: 3).

"Emergency preparedness in Sweden is to a large extent based on the activities of actors at the local, regional and central levels of society, who handle threats, risks and vulnerabilities in Sweden. Later on in the process, the MSB aims to supplement these levels with a national perspective" (MSB, 2011 a: 7). Presently, MSB is the responsible authority for flood mapping, in that case MSB is also updating flood hazard maps which were generated by SMHI, since 2012, to improve the resolution[22] of these maps (cf. Näslund-Landenmark, 2014: interview). It is estimated "that before the next cycle all the older flood inundation maps will be exchanged for the newer ones" (Nordlander, 2014: interview) and the flood maps will be available on the internet (cf. MSB, undated: online).

Due to the binding regulations of the floods directive, nowadays there are two official flood related maps for areas with significant flood-risk existing in Sweden. MSB — the Swedish Civil Contingencies Agency — as the national authority dealing with natural disasters and the responsible authority for the implementation of the floods directive in Sweden is involved in the development of these maps.

[22] The scale of the updated maps is 1:50 000, or 1:20 000 for areas within areas with significant flood-risk (cf. MSB, 2013 d: 29ff.).

4.2.2 Flood hazard maps (according to the floods directive)

There are flood hazard maps for flooded areas for 50 year flows, 100 year flows and a calculated maximum flow (10 000 year flow). The separate maps (scale 1:20 000) for each scenario show the water depth of the affected areas. (cf. MSB, 2013 c: online)

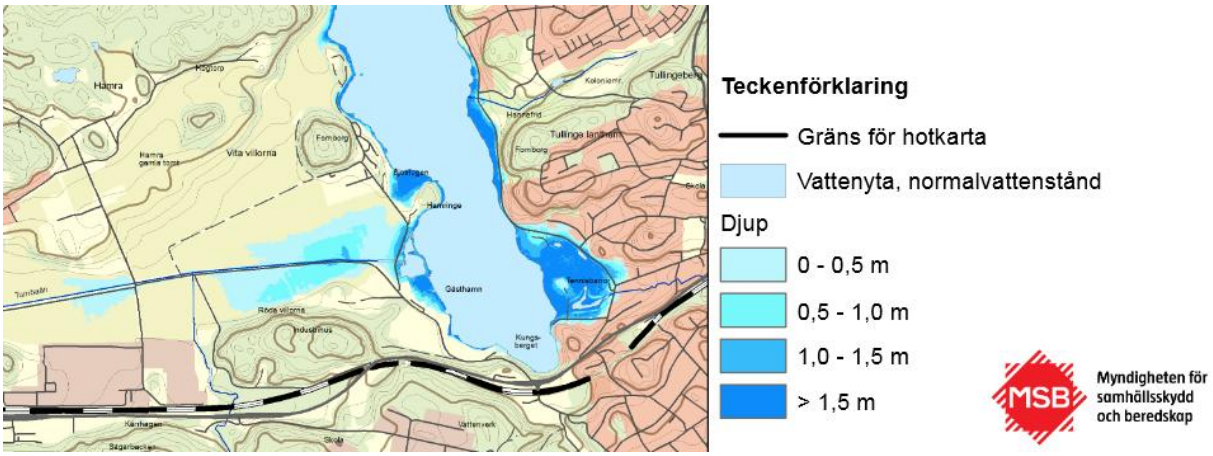


Figure 31: Unscaled flood hazard map Mälaren for the calculated highest scenario (MSB, 2013 b: 1)

Because of the flood hazard maps it is "significantly easier to assess the flood risk. That means that the directive indirectly has had a significant impact on spatial planning in Sweden" (Hjalmarsson, 2014: interview).

4.2.3 Flood-risk maps (according to the floods directive)

Flood-risk maps (scale 1:20 000) show the population, areas, objects or special activities affected during flooding. The flooded areas and objects are presented either in colours, special symbols or in higher contrast than non-flooded interests. (cf. Länsstyrelsen Stockholm, 2013 a: 6)

Figure 32: Unscaled flood-risk map for Stockholm (Länsstyrelsen Stockholm, 2013 b: 6)

4.2.4 Detailed flood maps

Detailed flood map Arvika

As mentioned before, the flood hazard maps and flood-risk maps were developed for the eighteen areas with significant flood-risk, but beside these areas there are also other flood endangered municipalities, and also in the past the existing maps — and their resolution was not seen as sufficient. Arvika, to name one, is located at lake Glafsfjorden and is not endangered by fluvial river floods, but by lake floods. Due to that a laser scanning of the municipal area took place, to get sufficient elevation data. (cf. Axelsson, 2015: interview) The municipality of Arvika does "(..) not use the flood hazard maps that MSB provide. The laser scanning of Glafsfjorden (...) is of better quality and gives us the information we need" (Axelsson, 2015: interview)

"After the big flood in 2000 Arvika entered a project with Säffle and Eda municipalities, County Administrative Board of Värmland and Centre for Climate and Safety at the University of Karlstad named Project Byälven" (Axelsson and Nordahl, 2015: interview). This project can be seen as a starting point of the climate change and flood adaptation work of the municipality. The aim was on the one hand to "identify measures which could mitigate flood effects" and on the other hand to "create a model with good accuracy elevation data" which can be used for analysis relating to flood-risk. (cf. Axelsson and Nordahl, 2015: interview)

Based on the information due to the laser scanning — with the new elevation model a detailed flood map was developed (cf. Axelsson, 2015: interview). This map is very detailed (scale ~ 1:7 000) and shows inundated areas at a certain water level (rising water level at the lakes) as well as vulnerable infrastructure (cf. Arvika Kommun, undated a: 1) and was "(...) a result of an EU-project called Climate Proof Areas that Arvika was a part of during 2007 to 2011. Instead of using data that is 50 meters x 50 meters, this measuring is done with a precision of 15 cm" (Andersson, 2015: interview).

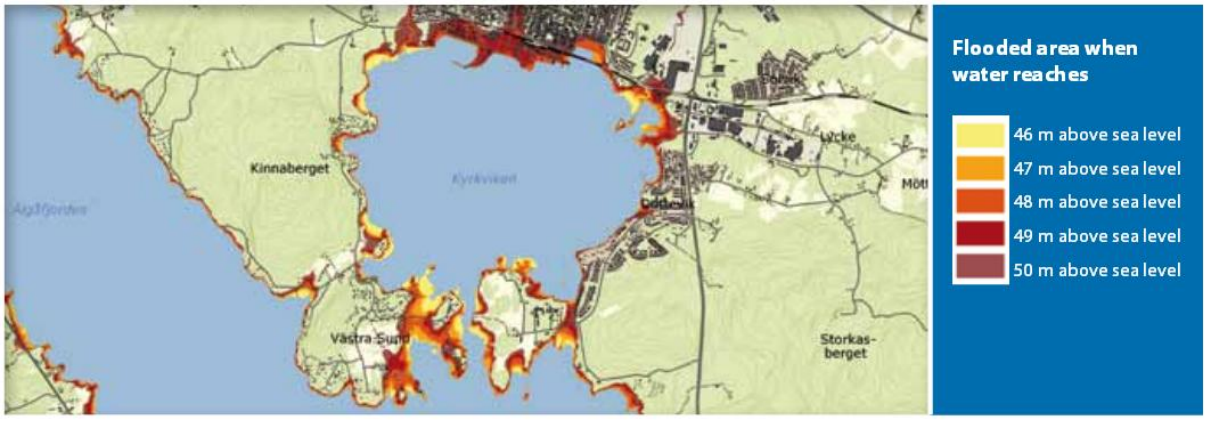


Figure 33: Unscaled inundation map of Arvika (Arvika Kommun et al., 2011: 6)

"Together with the simulations of future water levels in Glafsfjorden and the results from the hydraulic model it will be a reliable and highly useful tool when issuing building permits, in the spatial planning process and in the identification of vulnerable properties and areas" (Arvika Kommun et al., 2011: 6).

Figure 34: Unscaled cutting of the Kyrkviken detailed flood map (slightly modified representation, based on Arvika Kommun, undated a: 1)

Furthermore also more detailed maps for certain areas have been generated, e.g. for the area around Stadsparken (scale 1:360) which can be seen on the following page, where a dam with railway infrastructure is located. (cf. Arvika Kommun, undated b: 1)

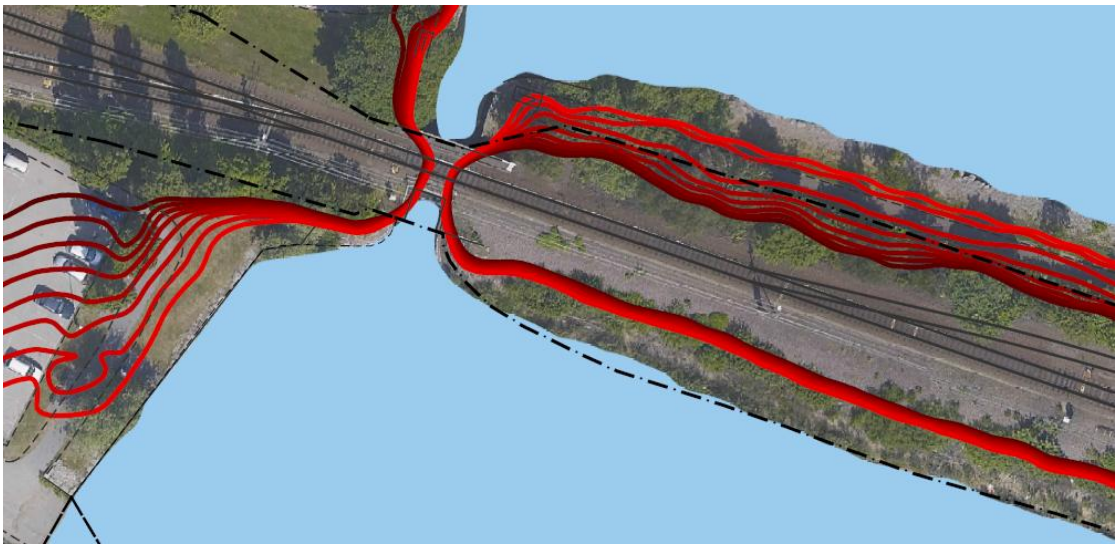


Figure 35: Down scaled cutting of the inundation map at Stadsparken (slightly modified representation, based on Arvika Kommun, undated b: 1)

The inundation map "gives information about which buildings, roads etc that are affected at different water levels" and is an important tool in municipal planning, where it can be used to create maps for detailed development plans. (cf. Axelsson and Nordahl, 2015: interview)

Detailed flood map Norrköping

Another example for flood-risk mapping for an area with flood-risk, which is not included within the 18 areas with significant flood risk, is the municipality Norrköping.

Already in 2001 the Swedish Rescue Services Agency (*Räddningsverket*) presented an overview flood mapping along the Motala river, which shows areas at risk of flooding in Norrköping Municipality. (cf. Norrköping Kommun, 2012: 37)

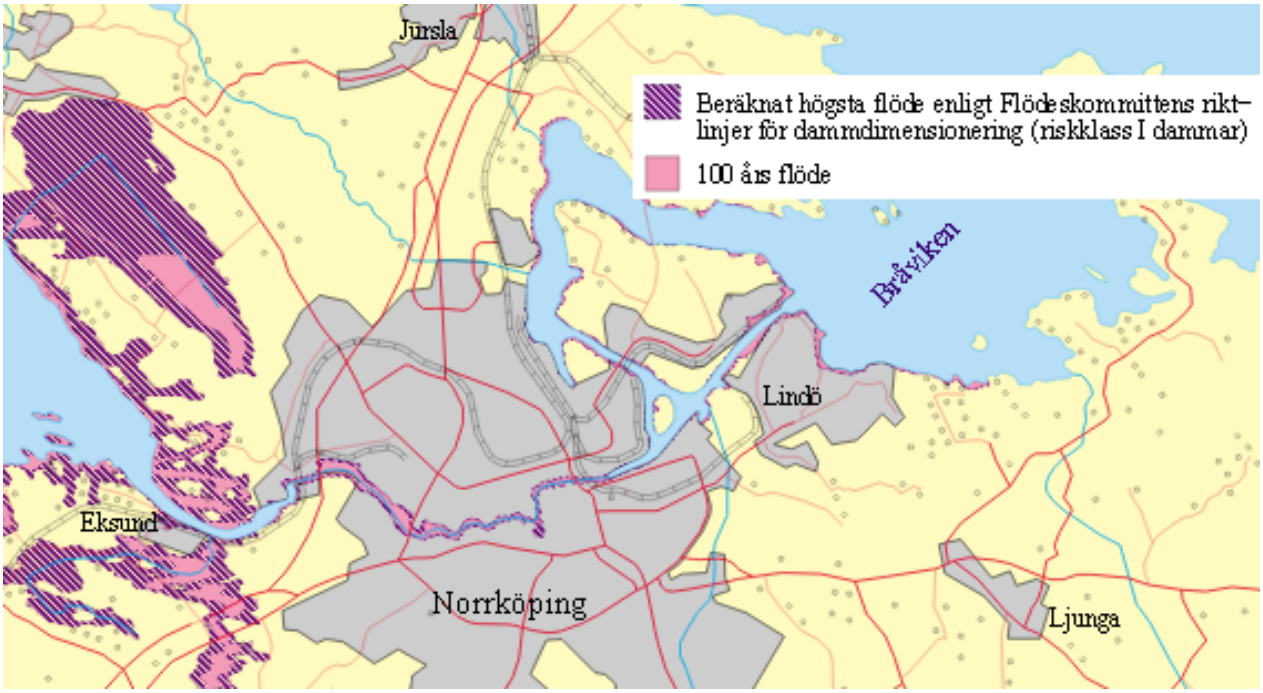


Figure 36: Unscaled cutting of the overview flood map Norrköping (cf. slightly changed presentation based on Räddningsverket, 2001: 20)

As one can see, the map shows the inundation areas of a centennial flood and of an extreme event (HQ10 000). The only problem — as mentioned previously — the maps were not very detailed. Therefore Norrköping and Linköping municipality decided to instruct SMHI to develop a detailed flood map. (cf. Norrköping Kommun, 2012: 37)

This detailed flood map covered Motala River, Roxen, Glan and Bråviken. This map from 2009 showed that flood-risk exists in Norrköping in the present and the future climate. The map included water levels based on scenarios for floods with an occurrence probability of 100, 1000 and 10 000 years. (cf. Norrköping Kommun, 2012: 37)

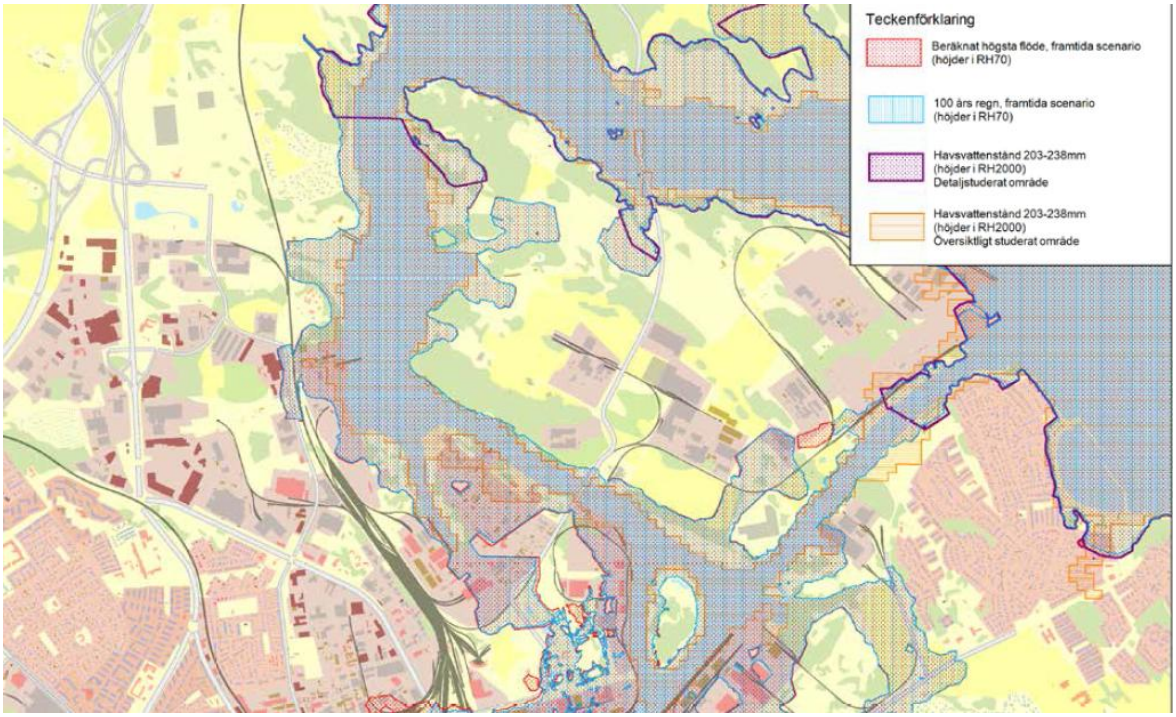


Figure 37: Unscaled cutting of the detailed flood map Norrköping (cf. slightly changed presentation based on Norrköping Kommun, 2012: 84f.)

Unfortunately the map of Norrköping is without a named scale and the detailed flood maps SMHI generated had different scales, depending on the assignment. However maps with scales from 1:75 000 to very detailed observations with a scale of 1:4 000 have been developed. (cf. SMHI, 2014: 1 – 8 and SMHI, 2011: 3)

4.2.5 Other flood maps

The Stockholm City Planning Administration and the Environment and Health Administration produced some maps which show the expected sea level in 100 years and the highest dimensioned sea level to "enable an in-depth study of the areas at risk of flooding" (cf. City of Stockholm, 2007: 14)

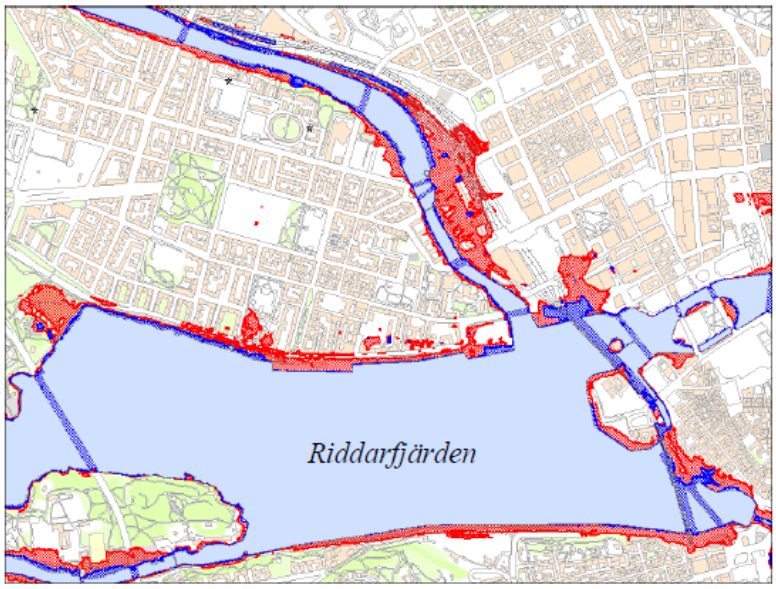


Figure 38: Sea level rise in Riddarfjärden (blue 100-year and red highest dimensioned level) (City of Stockholm, 2007: 15)

As one can see in the map above, the scale of the map is relatively large and shows affected areas within the City.

In general, it is possible to see that the quality of flood related maps is not uniform within Sweden, but the implementation of the floods directive could raise the awareness and a better extend of flood related maps could be available for spatial planning in the future.

The table — at the following page — shows a summarizing comparison of the different flood-risk related information/maps in Austria and Sweden and their design events as well as their contents and scale. For decisions in local land-use planning just the hazard zone maps of the BWV and WLV are applicable (scale 1:5 000 or more precise) because they are parcel-specific. The maps in frame of the floods directive, published at WISA, are made — per definition — for the public and not for planning decisions as the hazard zone maps, due to that they addressed to the public and in this case they are more useful for awareness raising or also for supra-local uses, e.g. regional strategies or co-operations of more than one municipalities. (cf. Neuhold, 2015: interview) The Swedish maps, created within the implementation of the floods directive, address both the public and the municipalities. However, the municipalities receive the data as digital files, "which is much more useful for them in land-use planning." In general, the visualized information is seen as useful for municipalities, county administrative boards, land-owners, etc. (cf. Nordlander, 2015: interview) In this terms, beside the maps additional more precise information seem necessary for spatial planning uses.

Table 3: Comparison of flood-risk related information/maps in Austria and Sweden

Country	Planning document	Responsible Authority	Scale	Contents	Design events
Austria	Hazard Zone Maps	WLV	1:5 000 or more precise	Hazard Zones: red (no permanent use for settlements/infrastructure due to high risk); yellow (permanent use for settlement/ infrastructure is impaired of the hazard); blue reserved areas (e.g. for protection measures); brown (e.g. risks due rockfall); violet identified zones (e.g. necessary flooding zone)	150 years occurrence probability and additional risk-processes (e.g. bed-load carrying torrents)
Austria	Hazard Zone Maps	BWV	1:5 000 or more precise	HQ30 zone (for the permit under the Water Rights Act), red hazard risk zone (construction bans), red-yellow zone (for necessary flood retention and run-off areas), yellow hazard risk zone (permanent use for settlement/ infrastructure is impaired), blue zones (e.g. for flood protection measures); identified zone for hazards up to HQ300, red yellow hatched zones (areas with residual risk)	30, 100 and 300 years occurrence probability + more complex risk scenarios(e.g. washout or log-jam processes)
Sweden	(General) Inundation Maps	SMHI (now MSB is up-dating them)	1:100 000 - 1:50 000	Flooded area and water level	100 and 10 000-years occurrence probability
Sweden	Detailed Flood Maps	e.g. SMHI	1:75 000 - 1:4 000	Flooded area and water level	100 and 10 000-years occurrence probability
Austria	Flood hazard maps	BWV	1:25 000	Separate maps for each scenario: areas affected by floods water depth flow velocities	30, 100 and 300 years occurrence probability
Sweden	Flood hazard maps	MSB	1:20 000	Separate maps for each scenario showing the water depth	50, 100 and 10 000-year flows
Austria	Flood-risk maps	BWV	1:50 000	Separate maps for each scenario: Number of affected inhabitants, the categories of land use, infrastructure and special risk factors (e.g. Industrial sites)	30, 100 and 300 years occurrence probability
Sweden	Flood-risk maps	County Administrative Boards	1:20 000	Separate maps for each scenario show: flood affected population, areas, objects, infrastructure or special activities	50, 100 and 10 000-year flows
Sweden	Detailed Inundation Map Arvika	Arvika/Pro-ject Climate Proof Areas	~ 1:7 000 + additional detail maps 1:360	Flooded Areas + vulnerable infrastructure	Increasing water levels at the lake

4.3 Flood-risk management plans (according to the floods directive)

Based on the maps — according to the floods directive — flood risk management plans are developed. These flood-risk management plans intensify "(...) the collaboration between spatial planning and water management" and therefore have "(...) the potential of bringing the topic of flood risk to the agenda in nearly all kinds of spatial activities" (cf. Hartmann and Juepner 2014: 1f.). In the following chapters the realisation with a comprehensive national plan in Austria and individual plans for the areas with significant flood-risk in Sweden will be illustrated.

4.3.1 National flood-risk management plan in Austria

In Austria one national flood risk management plan is developed and will be available by the end of 2015.

Austria defined four aims for the implementation of the flood-risk management plans: Avoidance of new and reduction of existing risks prior a flood event, reduction of existing risks during and after a flood event and strengthening of risk- and hazard awareness. To reach these targets, the flood risk management plans have to contain measures. According to the information transmitted by Pichler hazard zone mapping represents two of total 22 fields of measures of strategic planning, to reach the four aims. (cf. Pichler, 2014: interview)

In the first planning cycle 2015 — 2021 the following targets should be reached:

- Establishment of the flood-risk management plan as a mainstream planning instrument.
- The flood-risk management plan should show an overview of already introduced measures, as well as the interdisciplinary actions in different disciplines (according to the approach of the disaster cycle), e.g. documentation of existing, planned, possible measures and their sphere of action and their hierarchy.
- Strengthening the interdisciplinary cooperation and coordinated planning- and realisation processes.

(cf. Bmlfuw, 2014 cited from Pichler, 2014: interview)

For the areas with a significant flood-risk, the flood risk management plan will provide an extensive overview, which will be an improved level of information for a selected, but meaningful area. For land use decisions or decisions for the development of building regulation plans and building permits; the hazard zone maps of BLV and WLV as well as the run-off analysis made by the BWV will be the appropriate foundation. HORA and the flood hazard- and flood risk maps, developed within the framework of the floods directive, are available on WISA target at a broader public audience and give an initial overview of flood risk. Land use and building decisions need a more detailed information which can be provided with the parcel-specific hazard zone maps of the BWV and WLV. (cf. Amberger, 2014: interview)

At WISA also the feedbacks of the federal provinces, which are a base for the national flood-risk management plan, are available for the public. (cf. Neuhold, 2015: interview) These feedbacks show details and the actual status of the realisation of measures part of the flood-risk management plan and their coordination among each other as well as the size of the flood endangered areas and the number of affected population. (cf. Bmlfuw, 2015 a: 1 – 5) These pieces of information of the single areas with significant flood-risk are summed up in the national document, the national flood-risk management plan. (cf. Bmlfuw, 2014 d: 1f.) This document provides an overview about the general flood-risk existing within the country. In general, about 2650 km (of total about 100 000 km) of waterways are areas with significant flood risk, but compared to this relatively small share a big part of population is endangered by floods, which can be seen on the one hand in the amount of endangered land-use with the category (predominant living) 15.9 percent (HQ30), 20.6 percent (HQ100) and 23.5 percent (HQ300) and on the other hand in the number of population 150 000 (HQ30), 340 000 (HQ100) and 650 000 (HQ300). (cf. Bmlfuw, 2014 d: 18)

Table 4: Analysis of the flood-risk maps in Austria (own representation based on Bmlfuw, 2014: 19ff.)

	risk scenario	flood plain (ha)	affected population	Land-Use living (%)	Land-Use industry (%)
Lower Austria	HQ30	14416	31684	17.6	2.8
	HQ100	18977.6	57309	20.9	4.4
	HQ300	26009.2	117476	22.7	3.7
Salzburg	HQ30	4106.6	59791	45.6	0.3
	HQ100	6711.9	99242	47.1	0.8
	HQ300	8065.8	119472	48.3	0.8
Austria	HQ30	65685.6	150259	15.9	2.2
	HQ100	90332.2	343394	20.6	3.8
	HQ300	124525.2	651963	23.5	4.7

As a planning document, in difference to the hazard zone maps, the flood risk management plan can be seen as an instrument for awareness raising and not as a basis for practical land-use planning decisions. (cf. Neuhold, 2015: interview)

4.3.2 Flood-risk management plans in Sweden

As well as in Austria, flood-risk management plans are developed in Sweden for the (18) areas with significant flood risk. They will be finished by December 2015. Responsible Authorities are the County Administrative Boards, which already develop the flood risk maps. (cf. Norlander, 2014: interview) The specifications, e.g. content (measures, etc..), maps, etc. of the flood risk management plans are set in the Swedish Civil Contingencies Agency's regulations on the County Administrative Board plans to manage flood risks (risk management plans) (*Myndigheten för samhällsskydd och beredskaps föreskrifter om länsstyrelsens planer för hantering av översvämningsrisker (riskhanteringsplaner*) (cf. MSB regulations on flood-risk management plans, 2013: 1)

Between the end of February and Summer 2015 — depending on the county administrative boards which develop the management plans — the first drafts will be available for public examination. The biggest difference, compared to Austria, is that there will be individual plans for the areas with significant flood-risk. At the time this thesis was in progress — February 2014 — no draft versions were available from the county administrative boards. (cf. Carstens, 2015 and Ljunglund, 2015: interview)

Within these flood risk management plans, appropriate risk management objectives should be established. Accordingly, measures regarding incorporate relevant aspects, like the promotion of sustainable land-use practices, etc. are to be taken into account, in some cases even on a transnational basis (with Norway or Finland). (cf. MSB, 2014: online)

5 Supra-local spatial planning and flood-risk issues

Supra-local spatial planning, or regional- or federal state or country planning is delimited from local spatial planning, like town planning and is defined as supra-local planning of space (cf. Akademie für Raumforschung und Landesplanung, 2005: 897). Federal state planning means a spatial, interdisciplinary, supra-local planning regarding a provincial area for the development of the whole country or a part of the country. (cf. Akademie für Raumforschung und Landesplanung, 2005: 561) Regional planning is one step below this federal state planning and means the most concrete development of a subspace of a country — a region — and the task of regional planning is the foresighted, multidisciplinary, summarising, long term coordination of the spatial and settlement development of that subspace. (cf. Akademie für Raumforschung und Landesplanung, 2005: 965).

The following part will provide a short overview of the supra-local spatial planning within the case studies and show the relevance for flood risk issues.

5.1 Regional/supra-local spatial planning in Lower Austria/Salzburg

In general there are no explicit connections to nature risk topics in regional spatial planning measures of Lower Austria and Salzburg, but there would be options to refer to them in regional development programs or similar plans and programs (cf. Kanonier, 2004: 14f.), but it is possible that the province also refers to nature risks in regional programmes, but measures concerning nature risks are not the key contents of regional plans. (cf. Kanonier, 2004: 13)

One example for a programme, developed on a provincial base, would be the sectoral program for Flood-Safe Development in Settlement Area made by the Styrian government. The focus of this development program is minimising the hazard and damage potential as well as general minimising of the flood risk within the federal province within the measures of spatial planning. (cf. Land Steiermark, 2005: 8f.)

This programme is unique for Austria. In general flood risk is no topic in the regional development programmes of Lower Austria and it is not involved in any of the actual programs. The implementation of this complex of problems in regional programmes is quite thinkable but from an actual point of view not exactly, since it is treated in an adequate way on the local level. (cf. Bauer, 2014: interview)

However, the Austrian Conference on Spatial Planning mentioned, that the provincial government of Salzburg decided to visualize the essential flood retention- and run-off areas — determined by the BWV and WLV — within regional spatial planning instruments (cf. Austrian Conference on Spatial Planning, 2005: 55), but this has to be seen in the temporal context — the floods directive was not in place — and spatial planning interventions seemed necessary, today these aspects are more part of water-management regional programmes[23]. However at the moment — in Salzburg —these plans are not in place, but they would be necessary basic data for land-use plans and would be essential relating to fields of the Water Rights Act. (cf. Ginzinger, 2015: interview) Also in Lower Austria, at the moment there is no water-management regional programme with a flood-risk relation[24] existing, but in Upper Austria activities with these programmes are currently approaching[25] (cf. Neuhold, 2015: interview).

However, examples for the relevance of flood-risk issues within a regional context are the programme "site development for living and working in the central region of Salzburg", which mentions — in the environmental report — that a flood protection project is needed for a planned industrial area, because the whole area is endangered by a centennial flood (cf. Land Salzburg, 2008: 74f.) and the spatial development programme for the province Salzburg. The latter sets aims for the protection of nature risks, like the protection of permanent settlement area from natural hazards, consideration and safeguarding (*Freihaltung*) of the run-off area of floods and flood storage areas as well as a sustainable water management in the framework of settlement development. (cf. Land Salzburg, 2003: 27) Furthermore areas which have to be kept free can be also found in the regional development programme Pinzgau. (cf. Ginzinger, 2015: interview).

In comparison in the development concept of Lower Austria, flood risk is mentioned too. The creation of holistic flood risk concepts, zoning of flood run-off areas and preservation of flood storage areas by means of spatial planning are the main goals which should be aspired. (cf. Land Niederösterreich, 2004: 58)

[23] As based in WRG § 55g these programmes can contain zoning for certain water management purposes (cf. WRG § 55g subsection 1), the contents of these programmes are various, but the main reason is seen in the achievement of objectives of the water-framework and flood directive (cf. Winkler, 2015: interview).

[24] However there are two of these programmes for groundwater protection existing in Lower Austria, but these two programmes are two former water-management framework decrees (*Rahmenverfügungen*) (cf. Winkler, 2015: interview).

[25] It considered to develop such a programme for the zoning of retention areas, but at the moment the necessary basis data is not available for the objective area. These zones would have to be displayed in the land-use plan and would have to be considered in local land-use planning decisions. (cf. Lund, 2015: interview)

For future regional development programmes, it could be possible to implement flood risk issues are implemented within the scope of regional green areas. However at the moment flood-risk issues are usually[26] not a part of spatial planning on the regional level in Austria. (cf. Bauer, 2015: interview)

5.2 Austrian Spatial Development Concept

First of all, this concept and other recommendations of the Austrian Conference on Spatial Planning do not have the status of a law — as afore mentioned there is no federal spatial planning law or authority existing in Austria — and due to that the publications of the ÖROK can be only seen as recommendations.

The most important paper of the ÖROK is the Austrian spatial development concept — an overall concept with an action program in the sense of a policy paper which, is a strategic control instrument — for a time horizon of ten years — not only with a national spatial development significance but also on a regional and local level. The implemented topics are various challenges of today's spatial development, like internationalisation of economy, competition of locations, migration, climate change, land use, etc. Furthermore, it points out political fields of action with a spatial relevance. (cf. Austrian Conference on Spatial Planning, 2011: 13) The concept has four pillars; regional and national competitiveness, social diversity and solidarity, climate change adaptation and resource efficiency, and cooperative and efficient action structures. Flood risk is part of the third pillar. (cf. Austrian Conference on Spatial Planning, 2011: 10f.).

Flood district based contexts, as well as a consideration of cost and benefits of measures, coordination of upstream/downstream conflicts are specified within the scope of risk and damage potential reduction within this concept. In connection to the flood risk directive an emphasis on non-structural measures was found. Furthermore, the zoning of necessary flood retention areas, within HQ100 inundation boundaries, and measures for reduction of future risk and damage potential of not built-on properties are named. In the latter, the protection of ownership is also mentioned, because a reallocation is usually connected with a loss of value. Important recommendation are a more strict land-use practice and successful anchoring of hazard zones within the spatial planning and building laws. (cf. Austrian Conference on Spatial Planning, 2011: 67ff.)

Beside this development concept there was also a recommendation with respect to preventive handling of natural hazards in spatial planning published. In this publication the ÖREK gives recommendations concerning the implementation of flood-risk issues in the spatial planning laws as well as a better implementation of hazard zone maps within local spatial planning. The prevention of run-off and

[26] One example of flood-risk issues in regional programmes it the redefinition of the regional green area of the regional spatial planning programme "NÖ Mitte", where an area handover took place. The boundary of the regional area was changed, and an area used for a football field, was taken away, and instead a flood plain was added to the regional green area. A benefit is that, the floodplain forest can be developed much more successful than within the original area. (cf. Bauer, 2014: 1)

retention areas as well as measures within the building laws are part of these recommendations. (cf. Austrian Conference on Spatial Planning, 2005: 12)

5.3 Regional planning/supra-local spatial planning in Sweden

As mentioned in the previous chapter, municipalities must coordinate issues concerning more than one municipality, but in "Sweden, there is no formal level of planning between the national and the local level, implying that complex political issues of value — e.g., sustainable development — are to be handled at the local municipal planning level" (Nilsson 2001, Asplund and Hilding-Rydevik 2001 in Nilsson, 2013: 186). Furthermore Hedström and Lundström mentioned that "Spatial planning does not generally exist on a regional level in Sweden; only Stockholm County has a 'regional plan' that is in accordance with the Planning and Building Act" (Hedström and Lundström, 2013: 70). "Whereas all parts of Sweden prepare Regional Development Programmes" (Johnson, 2013: 97).

As one can see the regional level is quite fragmented and far from complete (cf. Johnson, 2013: 98). On one hand, there are the regulations in the Planning and Building Act for the regional plan (*regionalplan*) as a policy instrument for the use of planning issues concerning several municipalities. The creation of these plans is not compulsory, even if the form of regional planning is stipulated in this legislation, but the contents are not regulated. (cf. Johnson, 2013: 98) On the other hand the Ordinance Governing Regional Development Work (*förordningen om regionalt tillväxtarete*) also addresses regional planning and the generation of Regional Development Programmes. The responsibility for these programmes is partly in hands of the county administrative boards, regional cooperative associations of local municipalities (*regionala samverkansorgan*) or the county councils. (cf. Johnson, 2013: 98)

The contents of these regional development programmes can be national objectives as well as regional concerns (cf. Johnson, 2013: 98).

The regional plan "(...) is formally considered as 'guidance' and is thus not legally binding for the municipalities." (cf. Johnson, 2013: 98) In general, issues concerning natural hazards could also be implemented in regional plans or regional development programmes too.

5.3.1 Regional Development Plan for the County of Stockholm

One example for regional planning in Sweden is the Regional Development Plan for the County of Stockholm, RUFS 2010. This plan "has a formal status as both a regional plan according to the Planning and Building Act (...) and a regional development programme according to the Ordinance on Regional Development Work (...)" (Johnson, 2013: 99). In this plan increasing flood risk, for certain areas, is mentioned as a consequence of climate change. "In the future, certain areas will be unsuitable for development and infrastructure due to the risk of flooding. Gradually increasing precipitation (autumn and winter) means that more water and larger volumes of substances are running into the watercourses" (Office of Regional Planning, 2010: 73). There are also concrete recommendations for planning around

Lake Mälaren and along the Baltic Coast, because higher safety margins for new constructions would be reasonable (cf. Office of Regional Planning, 2010: 82).

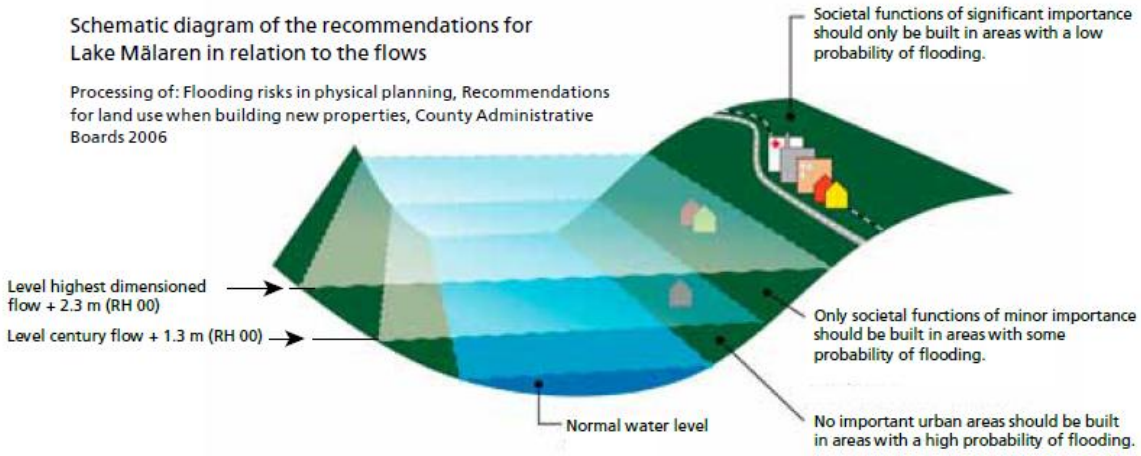


Figure 39: Recommendations for physical planning
(County Administrative Boards in Office of Regional Planning, 2010: 83)

"For Lake Mälaren, the county administrative boards (...) have had recommendations in place since 2006 regarding where it is possible to build without taking (...) measures with regard to high flows" (Office of Regional Planning, 2010: 83) In cases of other uses — than the recommended — a risk analysis must be done and measures to reduce flood consequences must be implemented, also for buildings constructed above the highest flood level, stability issues must be considered as a result of a flood event. (cf. Office of Regional Planning, 2010: 83) Other recommendation are that shorelines should not be privatised due to flood risks (cf. Office of Regional Planning, 2010: 105), and "New construction should not be located in areas with a risk of flooding" (Office of Regional Planning, 2010; 156 and 158). In Stockholm the issue of flooding is also an environmental issue, because the infiltration of salt water in the drinking water reservoirs of the lakes must be prevented. (cf. Office of Regional Planning, 2010: 83)

5.3.2 Gothenburg Regional Association of Local Authorities

The approach in Gothenburg is different, compared to Stockholm. There a regional planning body — the Gothenburg Regional Association of Local Authorities (*Göteborgsregionens kommunalförbund*) — was formed in accordance with the basic rules in the Planning and Building Act, but this authority does not use formal regional plans (cf. Johnson, 2013: 97f.), but also this planning authority mentions flooding — as a challenge due to climate change, as a result of extreme weather conditions — in the passing (cf. Göteborg Region Association of Local Authorities, 2012: 6 and 14). One measure relating to flood risk within the Gothenburg region was the raise of the minimum floor level for new constructions (cf. Göteborg Region Association of Local Authorities, 2012: 14).

5.3.3 Supra-local recommendations with flood-risk relations in Sweden

Today, no national guidelines for municipalities in relation to the management of flood-risk in physical planning exist.

Flood-risk in the climate change adaptation of planning and construction report

However the report Building for tomorrow's climate adaptation of planning and construction (*Bygg för morgondagens klimat. Anpassning av planering och byggande*) of Boverket addresses rules and examples of how climate adaptation of planning and construction should be done.

The main indicated measure is the avoidance of new buildings and infrastructure which will be affected by flooding. Due to that the choice of location within spatial planning is seen as the main option within municipal spatial planning.
(cf. Norrköpping Kommun, 2012: 42) As the relevant instrument for this, the municipal comprehensive plan is named. (cf. Boverket, 2009 a: 15)

Flood-risk in physical planning, recommendations for new developments

Relating to the importance of the right choice of location within municipal land-use planning, the county administrative boards in central Sweden jointly developed the recommendations Flood-risk in physical planning, recommendations for new developments (*Översvämningsrisker i fysisk planering, rekommendationer för markanvändning vid nybebyggelse*). These recommendations concern new constructions and are based on 100 year floods as well as floods with the calculated maximum flow (10 000 year). (cf. Norrköpping Kommun, 2012: 43). Avoidance of buildings in flood endangered areas are part of the recommendations. They also ask for risk analysis if municipalities intend to use flood endangered land and measures to limit consequences of floods. (cf. Länsstyrelserna Stockholm, Uppsala, Södermanland, Östergötland, Värmland, Örebro, 2006: 17ff.)

Guidelines of the County Administrative Boards for municipal planning at lake Mälaren

The county administrative boards developed guidelines for planning along the coast of Mälaren, they are not finished yet — February 2015 — but available as a draft (cf. Åström, Gauffin and Lagerblad, 2014: interview). In general it is necessary to say that lake Mälaren is a bit special compared to other bigger lakes in Sweden. Since it is regulated and controlled by the ponds in Stockholm. Due to the fact that the lake can be seen as a constructed lake, the water levels and also the flood-risk can be foreseen in advance most of the time. (cf. von Sydow, 2015: interview)

Figure 40: Läke Mälaren (Länstyrelserna Stockholm, Södermanland, Uppsala, Västmanland, 2014: 2)

The guidelines are not legal binding, but include recommendations for the municipalities — which have a long time perspective and also take aspects of climate change in account — e.g. regarding to type of houses and infrastructure. (cf. von Sydow, 2015: interview) These recommendations are based on the regulations within the planning and building act — e.g. consideration of risks and climate change adaptation — and are planned in a cooperation of the involved county administrative boards around lake Mälaren (cf. Stockholm, Södermanland, Uppsala, Västmanland, 2014: 1). Recommendations are i.e. minimum heights for important buildings and infrastructure, beside that also background information about the current situation at lake Mälaren and the changes due to climate change are part of the (draft) of the guidelines (cf. Stockholm, Södermanland, Uppsala, Västmanland, 2014: 3 — 6).

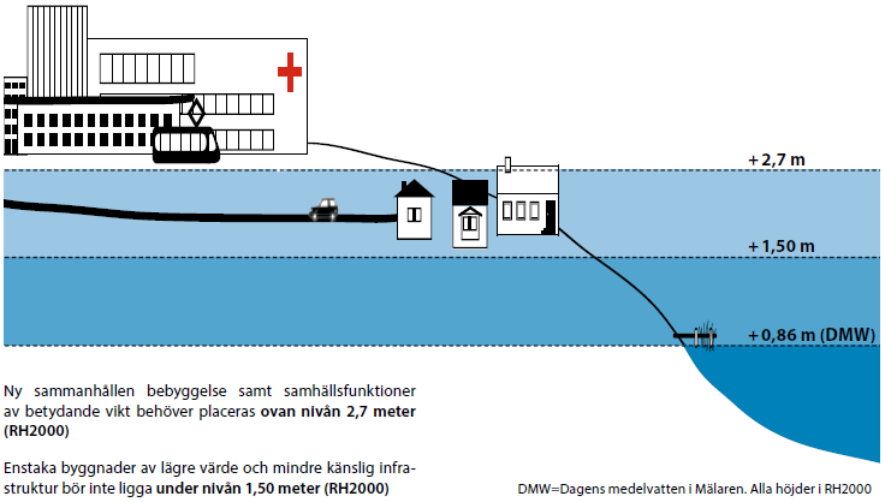


Figure 41: Building recommendations at lake Mälaren (Länstyrelserna Stockholm, Södermanland, Uppsala, Västmanland, 2014: 3)

6 Land-use and local spatial planning and flood-risk issues

Land use planning is important for an ordered built development of towns and cities. Due to regulations for constructions, land-use planning can influence the value of properties.

As mentioned before, in Austria and Sweden the municipalities are the authorities for land-use planning. This thesis highlights that local spatial planning and land-use planning is the most important addressee of flood-risk issues within the field of spatial planning. Actors on the local level are responsible for inundation areas and the respective implementation of flood-risk issues within their planning decisions.

In the following part land-use plans of Austria (Lower Austria, Salzburg) and Sweden and the existing flood-risk regulations are described.

6.1 Land-use planning in Lower Austria/Salzburg

In Austria the local planning level and its planning tools are responsible for the treatment of nature risks in spatial planning issues. The planning instruments in Austria at the local level are a development concept and the hierarchical subjacent land-use plan (*Flächenwidmungsplan*) and the building regulation plan (*Bebauungsplan*). (cf. Kanonier, 2004: 18)

Beside these two plans also a hierarchical superior local development concept exists. It is based on the following articles of the spatial planning laws:

In Lower Austria, the spatial planning law obliges the municipalities in § 13 subsection 1 and 2 NÖ ROG to create a local spatial planning programme (*Örtliches Raumordnungsprogramm*), which must be based on the aims of the spatial planning law, sets the planning goals, names the planning measures and has to contain a development concept and a land-use plan.

Flood-risk is taken into consideration[27] when it comes to the creation of local development concepts. Guidelines for the handling of risks have existed in the spatial planning laws of Lower Austria since 1999. Due to that Lower Austria was a leader in flood risk handling on the local spatial planning level in Austria. (cf. Pomaroli, 2014: interview)

The municipalities in Salzburg have to create a spatial development concept (*Räumliches Entwicklungskonzept*) which serve as base for the development of the municipality in particular for land-use- and city planning. The development concept contains a development plan (*Entwicklungsplan*) and a description and is legally binding for the municipalities development strategies. (cf. Slbg ROG § 23 subsection 1 – 3, 2009) The contents are spatial development goals and measures about demographic-, economic-, settlement-, public space- and traffic-development as well as the forecasted demand of building land for the next 20 years. (cf. Slbg ROG § 25 subsection 1 – 2, 2009) Aims or measures for areas

[27] A consideration of nature risk is necessary, since a zoning prohibition for building plots located in inundation areas of centennial floods exists (cf. Pomaroli, 2014: interview).

endangered of natural hazards are not explicitly named in the spatial development concept, but in practice some municipalities relate to natural hazard issues within this instrument (cf. Kanonier, 2004: 19). For example in Salzburg, in connection to the prohibition of zoning as building land in flood run-off and retention areas, these areas are also not allowed to be seen as building land[28] within the spatial development concept (cf. Ginzinger, 2015: interview). Due to the different but similar province laws and the varying legislative authority, the local spatial development concepts are named different in the provinces. The content is more or less the same.

On the following page, a cutting of the map of the local development concept of Gutenstein (Lower Austria) is shown. Visualisation of hazard zones, measures like building bans and reallocation are also part of this local development concept. (These contents will be explained in the following chapters.)

Figure 42: Legend of the local development concept Gutenstein (Gutenstein, 2014: 1)

[28] Except zoning for protection measures, etc. if the construction of these is planned in the planning period of the spatial development concept (cf. Ginzinger, 2015: interview).

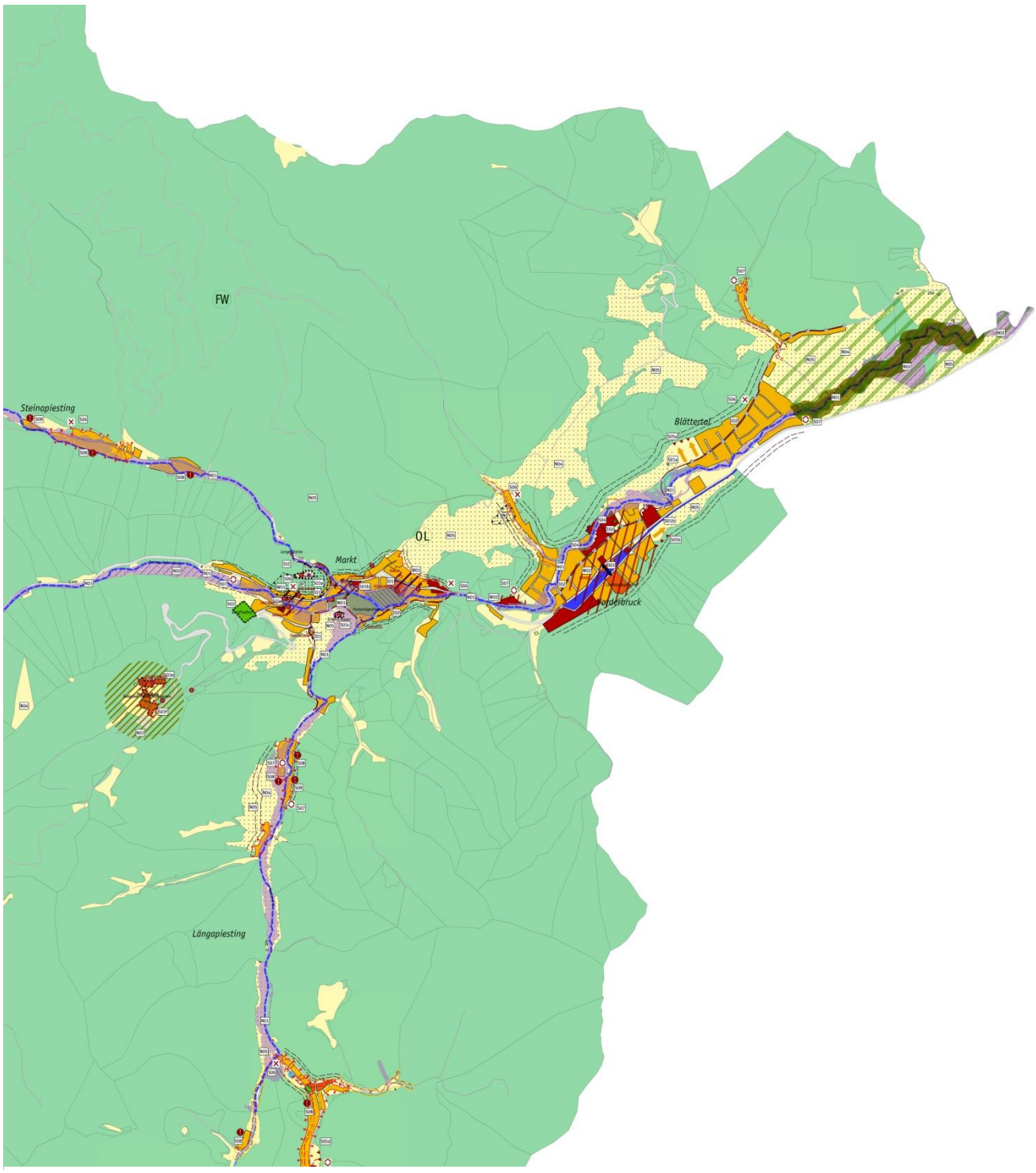


Figure 43: Unscaled cutting of the local development concept Gutenstein (Gutenstein, 2014: 1)

As mentioned in the beginning, spatial planning, in Austria, is primarily a business of the federal provinces, which means also the task of developing land-use and building regulation plans are based in the spatial planning laws of the provinces. Subject to § 14 subsection 1 NÖ ROG the municipalities have to structure and set land-use categories in the land-use plan for the whole area of the municipality. As it is the case in Salzburg, § 27 subsection 1 and 3 Slbg ROG obliges the municipalities to create a land-use plan for the whole municipal territory and to divide it into land-use categories (building land, green zone and traffic area).

The subordinated building regulation plan, which may not contradict the higher ranking land-use plan and the local development concept specifies the details of the construction, building design criteria and rules the designed urban order (cf. Kanonier, 2004: 39).

In Lower Austria the details for the building regulation plans were set in the building code (*Bauordnung*), while in Salzburg, it is part of the spatial planning law and is stated in § 50 to § 64 Slbg ROG. With the new spatial planning law 2014 and the new building code 2014, also Lower Austria moved the regulations for the building regulation plan to the spatial planning law, § 29 to § 36 NÖ ROG.

6.1.1 Land-use plan in Lower Austria and Salzburg

The land-use plan is the central planning instrument for local spatial planning in Austria. All municipalities are obliged to develop land-use plans, which show the concrete type of land-use, for the total municipal area. The legal binding plan has the legal status of an act and is legislated by the municipal council. (cf. Lienbacher, 2012: 470)

The regulations of the land use plan — the defined land use zones — cannot force the land owner to realise the defined land use, but it prohibits other uses beside the allowed uses due to the land use category on the site. It should not only show the current status; the land-use plan should be the visualisation of the target state. (cf. Leitl, 2006: 113)

Building land zoning is only allowed if the natural and infrastructural conditions are suitable for constructions. If the site is not appropriate, the zoning as green area is necessary. Conversely, this does not mean an obligatory building land zoning if a site is generally suitable for building land. The demand for building land must be considered as well as the principle of orderly development and the conservation of recreational areas. (cf. Leitl, 2006: 114f.) In principle, land-use decisions can be seen as property restrictions with a public interest, i.e. also future changes in land-use restrictions must be commensurate and based on a public interest. (cf. Hauer, 2006: 12f.)

On the one hand the property owners should be able to rely on the determined land use (cf. Hauer, 2006: 14), but on the other hand there is no claim on a certain land-use decision (cf. Stellner-Bichler, 2015: interview).

It should not be left unmentioned that also constructions in areas zoned as green area are allowed under specific requirements[29] if the construction is necessary for the use of the green area (cf. Leitl, 2006: 117). But also for these constructions, regulations can relate to natural hazards[30] and prohibit buildings in endangered green areas.

The land-use plan is the most important instrument of spatial planning in Austria, which deals with nature risks. The spatial planning laws include regulations to be

[29] Set in the spatial planning laws, e.g. NÖ ROG § 20, Slbg ROG § 36.

[30] E.g. NÖ BauO § 55 subsection 2.

applied in case of nature risk (like floods) endangered areas. The task of the sovereign land-use plan in general is to prohibit building in endangered areas and to direct settlement activity to safe areas[31]. (cf. Kanonier, 2004: 20)

According to § 15 subsection 2 NÖ ROG, flood plains must be indicated in the land-use plan beside the localisation of building land, green zone and traffic areas. These indications have a declarative informational purpose and point out spatial determination of external competences, which either limit or remove the municipal planning possibilities (cf. Seher, 2010: 14).

§ 15 NÖ ROG also determines, that areas which are not suitable for constructions due to special site conditions are not allowed to be set as building land in the land-use plan. Especially sites which would be flooded in case of a centennial flood, areas which are below the highest ever recorded groundwater level, endangered by floods of torrents (*Wildbach-gefährdet*) as well as sites with groundwater levels higher than necessary supply and disposal connections are inappropriate for a land-use as building land. (cf. § 15 subsection 3 NÖ ROG) As a result, usually centennial flood areas, red and yellow flood risk areas are visualized in the land-use plan in Lower Austria. (cf. Kanonier, 2004: 22)

The regulations in Salzburg are quite similar, regarding to § 28 subsection 3 Slbg ROG, areas which are not suitable for building land due to natural conditions, like areas endangered of floods or must be preserved as run-off area of floods or as flood storage areas, are forbidden to be zoned as building land —excluded access areas (*Aufschließungsgebiet*) according to § 37 Slbg ROG.

As already mentioned before, the land-use plan has the legal status of an act and is legally binding. The development of a land-use plan can be simplified into the following steps. The major must inform the public[32] about the municipal plans to develop a new land-use plan or to change an existing plan. Afterwards the municipal council decides the land-use plan, the objections must be included in this decision process. Subsequently the province government has to authorise the land-use plan and has to check if it is according with the spatial planning laws, regional development programmes as well as if land-use restrictions and orders are adhered. The new plan must be available for inspection at the town hall. (cf. Lienbacher, 2012: 470f.)

In the following figure an unscaled cutting of the land-use plan of Leobersdorf, in Lower Austria is displayed. In terms of flood-risk inundation areas are identified within the map. (cf. Leobersdorf, 2013 a: 1)

[31] Site utilisation is restricted for these jeopardised zones, which are not suitable for building development (cf. Austrian Conference on Spatial Planning, 2005: 42).

[32] The municipality has to include neighbouring municipalities, hierarchical higher planning authorities in the development process and has to exhibit the plan proposal to the public and objections from affected parties are possible (cf. Lienbacher, 2012: 470f.).

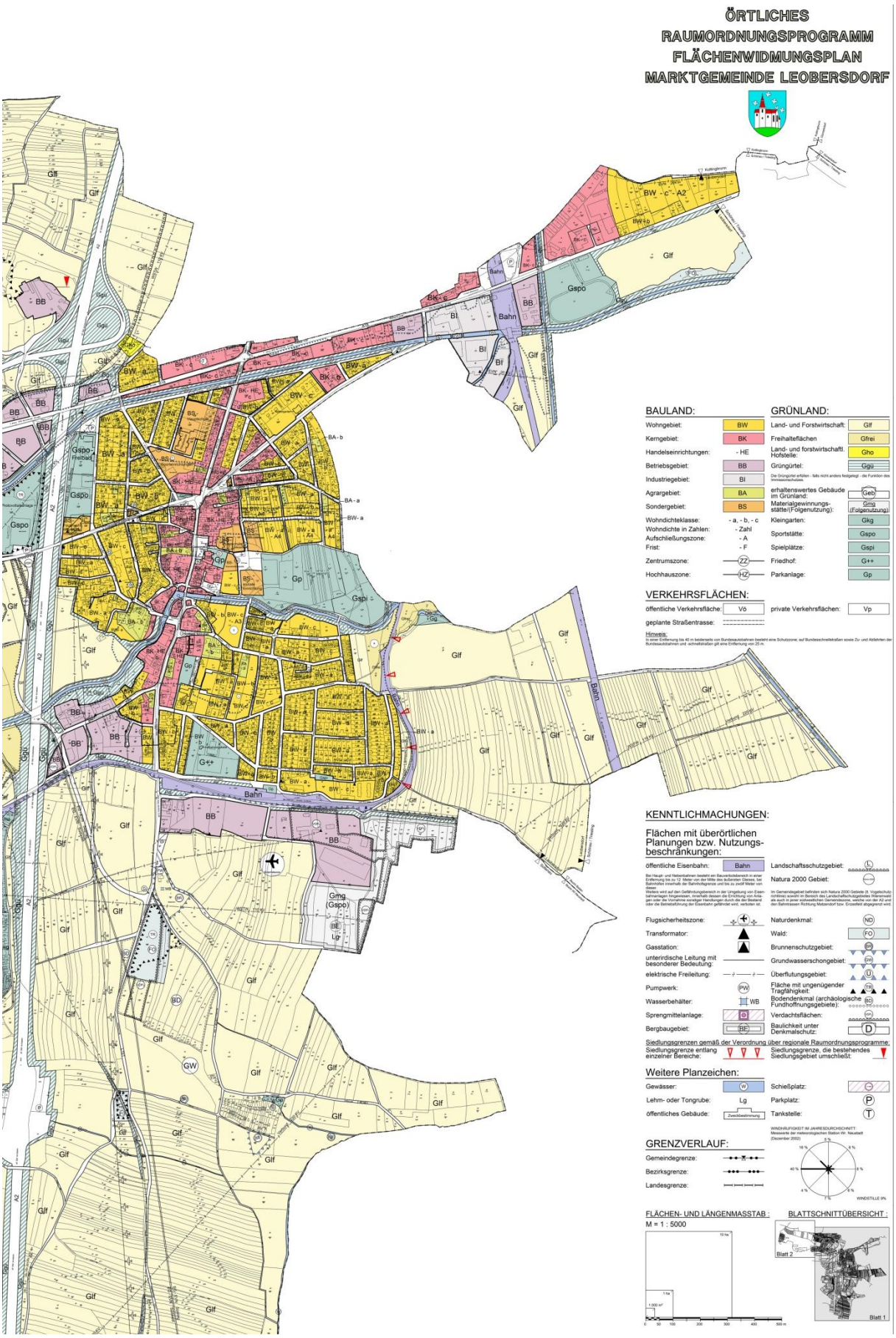


Figure 44: Unscaled cutting of the land-use plan Leobersdorf (Leobersdorf, 2013: 1)

The land-use plan is legally binding for the building regulation plan (*Bebauungsplan*), the building plot declaration (*Bauplatzerklärung*) and the building permit (*Baubewilligung*). All of these legal acts must be in accordance with the regulations of the land-use plan. (cf. Lienbacher, 2012: 474)

6.1.2 Reallocation and building bans in Lower Austria/Salzburg

In Austria the handling of built-on and not built-on building land is different. The planning options within the hands of the local spatial planning authorities relating to flood risk is bigger for not built-on land than for building land with buildings on it. The regulations within the spatial planning laws are more or less limited on passive protection measures. Active regulations, like mandatory constructive protection measures or instructions for the handling of endangered buildings, are not part of the spatial planning laws. (cf. Kanonier, 2012: 66)

In general, within spatial planning laws danger-related expropriations (*Enteignung*), e.g. relocation or the use of properties for the construction of structural measures, etc. within inundation areas are not possible. But use restrictions or zoning regulations — which do not affect the existing uses and buildings — are part of the spatial planning laws. For built-up building land, measures to reduce the risk potential and to protect existing buildings are possible approaches. On the contrary for building land without existing buildings/constructions the same measures are possible and furthermore plan changes — which prohibit future uses and buildings — to prevent a long-term increase of risk/damage-potential are feasible. (cf. Bmlfuw, 2009 a: 163)

Two options of passive protection measures are building bans and reallocation of building land. Due to the regulations of the spatial planning laws in Lower Austria, areas which are not suitable for constructions, due to special site conditions, are not allowed to be zoned as building land in the land-use plan (cf. § 15 subsection 3 NÖ ROG). Building land prone to inundation in case of a centennial flood has to be reallocated. (cf. § 25 subsection 2 NÖ ROG) The first step before a reallocation would be a building ban, which is valid for an unlimited period of time (cf. § 26 subsection 2 b and 3 NÖ ROG). In case of a reallocation, due to the risk of a natural hazard, the reallocation is without financial compensation. (cf. NÖ ROG § 27 subsection 1 lit c)

In contrast of this reallocation regulation, an exceptional rule which allows building land zoning within endangered areas exists for areas, such as plots for buildings whose function is connected to a certain place and must be constructed at that particular site (e.g. a river mill), or for zones located within a closed residential area[33] (*geschlossenes Ortsgebiet*). (cf. NÖ ROG § 15 subsection 4)

[33] A consequence of this exception rule is that building bans and reallocation are not obligatory within closed residential areas (cf. Siegl, 2015: interview).

However, risks due to natural hazards cannot be ignored in general within a closed residential area. If a high risk (e.g. red zone in the hazard zone map) is existing, the suitability as building land is not existent and the building-land prohibition applies. Just after an analysis, if the risk potential is "acceptable" zoning as building land is allowed for sites[34] within a closed residential area. (cf. Scherz, 2012: 87)

In general a reallocation would be necessary after 5 years of an existing building ban, if the risk had not been reduced, but sometimes it is better to keep the building ban instead, because on the one hand due to derogation rules a conversion to building land could be possible in some special reasons, and on the other hand, the area could be secured by changes of terrain or flood protection measures like dams etc. One important step is the analysis of the retention effect of the area. In case it is a zone which is important for retention, or the risk of neighbouring buildings would increase, a reallocation should be done immediately, to avoid additional future potential damage. However, if there is no important retention effect existing and the area could be ensured in the future a building ban is the more suitable solution. The main basis for the decisions of reallocation or building bans are the hazard zone maps and run off studies. (cf. Pomaroli, 2015: interview)

Even if zoning restrictions — for areas endangered by a natural hazard — exist in Salzburg, there are no rules for building bans[35] or the reallocation[36] of endangered building land within the spatial planning law. Furthermore, exceptional rules for zoning of areas seen as access area (*Aufschließungsgebiet*), if the risk can be removed with an economical afford, exist (cf. Slbg ROG § 37 subsection 1 (1)). Also a labelling (*Kennzeichnung*) of the plot naming the obstacle (*Hinderungsgrund*) can be done if the area is located within an area, seen as widely built area or if the obstacle can be considered within the building plot declaration or the building permit (cf. Slbg ROG § 37 subsection 2 (1) and (2)). Beside that the municipality has also the discretion to decide in individual cases[37] on request of the landowner (cf. Slbg ROG § 46 subsection 1 — 2)

In general a reallocation in Salzburg can take place. In contrast to the reallocation is the trust of the landowner on the land-use category definitions in the land-use plan. The Austrian Constitutional Court decided, that this trust on the defined land-use category is allowed to drift into the background if the public interest requires a reallocation. (cf. Kanonier, 2015: 74)

[34] Also in other areas building land zoning is possible in practice, for example if ground filling take place and analysis in frame of a Strategic Environmental Assessment (cf. Scherz, 2012: 87).

[35] Building bans — valid up to three years — can be imposed, i.e. in case of a planned change of a spatial development concept, land use plan or building regulation plan or if a land-use or building regulation plan has been repealed by the Constitutional Court or the supervising authority (cf. Slbg ROG § 21 subsection 1 (1), § 22 subsection 1 (1), § 22 subsection 3 (1)).

[36] The reallocation regulations in § 44 Slbg ROG do not refer to natural hazards.

[37] If a special reason justifies the exception, if the area is suitable for the project and if the project is not contradicting the spatial development concept and the general planning intention of the municipality (cf. Slbg ROG § 46 subsection 2 (1) — (4)).

Although there are no detailed reallocation rules in case of endangered building land named within the spatial planning law of Salzburg, reallocation is required[38], if new investigations report red hazard risk areas. Furthermore, this reallocation is without compensation[39]. (cf. Mair, 2014: 11 and Ginzinger, 2015: interview)

A reallocation of building land to green area, as part of a land-use plan adaptation, was also reviewed by the Austrian Constitutional Court. The legality of this approach in case of an existing natural hazard risk has been approved in this case. (cf. VfSlg 16.286/2001)

In general, it is important to state the necessity of the adherence to all legal regulations within the reallocation procedure, since the Constitutional Court is also able to revoke these decisions in case of a violation of the law, e.g. procedural errors like missing notification of the land-owners. (cf. VfSlg 19.186/2010)

However these restrictive regulations within the spatial planning laws, especially in the range of reallocations without financial compensation represent a hardship and the future development of some settlement areas is very restricted. With regard to already existing infrastructure a development possibility in respect of an adaptation of buildings — in the sense of "living with floods" — would offer an easier realisation as well as increasing acceptance of these measures. However the realisation of adaptation measures on the level of buildings can be an obstacle, especially within the question of liability. But improvements would be possible, for example for fringe locations where inundation is possible at a small/limited extent. (cf. Fleischmann, 2015: interview)

[38] Due to Slbg ROG § 44 subsection 1 and 2.

[39] Compensation is not necessary, as set in set in Slbg ROG § 49 subsection 1, if the reallocation is founded on investigations relating to hazard risk areas (red risk zone) or essential flood run-off and retention areas (cf. Mair, 2014: 11 and Ginzinger, 2015: interview).

6.2 Comprehensive planning in Sweden

The land-use planning system in Sweden, as you can see in the following figure, is a four-tiered planning system and is the responsibility of municipalities. The four parts will be described, and the relevance for flood risk planning will be shown within the next parts.

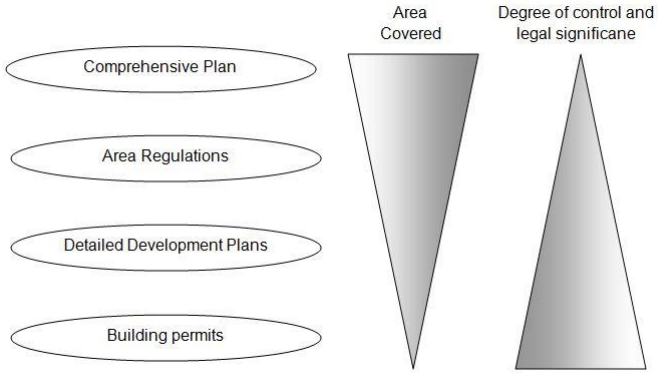


Figure 45: Schematic of the planning hierarchy in Sweden, indicating the relative area covered and degree of regulation at each level (own representation based on Thorsteinsson et al., 2007: 488)

The wide-ranging responsibilities of the municipalities "is referred through the term municipal planning monopoly." In every municipality a (long-term and forward-looking) comprehensive plan (*översiktsplan*) exists "which guides decisions about land and water usage, and which acts as an instrument for both political strategic spatial planning, for integrating diverse perspectives (...) and for citizen participation." (cf. Hägglund, 2013: 63) In general, "no change to the use of land can take place unless it is based on a municipal plan" and "(..) land-owners cannot build on their land if the building development is not in agreement with the municipal plans" (cf. Commin, undated: 5).

6.2.1 Municipal comprehensive plan in Sweden

As mentioned before, "land-use planning in Sweden is almost exclusively decentralised — it is performed at the municipal level, through the set of responsibilities popularly referred to as 'the municipal planning monopoly'. This implies that the municipality decides where, when, and how development may take place" (Blücher, 2013: 47). These decisions are first of all based in a compulsory municipal comprehensive plan, which has to cover the entire municipal area (cf. Commin, undated: 4). The municipalities are obliged to develop this comprehensive plan and it must be considered by the municipal council at least once during an office term, which lasts four years (cf. Commin, undated: 5).

The comprehensive plan has "to present and describe the main features of the intended use of land and water areas (...)" (Commin, undated: 12). But, the comprehensive plan is not legally binding for individuals or authorities, not even for the subsequent detailed development plan (cf. Commin, undated: 14), "but is meant to form the basis of decisions on the use of land and water areas" (Commin, undated: 5).

Since the municipal comprehensive plans "should include basic guidelines for water and land use" (Gullstrand et al., 2003: 242) and "are supposed to point out all the relevant risks as an aid for decisions regarding land use (...)", but "only a handful of these plans mention flood risk to any great extent, and the majority have no reference to them at all" (Thorsteinsson et al., 2007: 500).

"During the process of developing a comprehensive plan, the municipality must repeatedly consult the County Administrative Board, regional cooperation bodies, neighbouring municipalities, and other stakeholders. The aim is to improve decision making and provide the opportunity to influence the design and content of the plan" (Hedström and Lundström, 2013: 73). The necessary procedures[40] for the development of a comprehensive plan are regulated by the Planning and Building Act.

An inventory by the National Board of Housing, Building and Planning (*Boverket*) "of comprehensive plans for different municipalities has shown that most make no mention of flood risks" (Lundquist in Thorsteinsson et al., 2007: 489). Beside that Thorsteinsson mentions that "most municipalities (...) face some flood risk", but the approaches are different. Some municipalities made serious attempts to identify flood risk areas while others just mention it in a few sentences (cf. Thorsteinsson et al., 2007: 489), but "municipalities are obligated to prepare for extraordinary events" and therefore "Environmental safety and risk factors, e.g. floods, should be mentioned in (...)" the comprehensive plans (cf. Gullstrand et al., 2003: 245).

The comprehensive plan consists of three maps (use of land and water, regulations and recommendations and national interests), a consultation statement and an impact assessment and a summary (cf. Göteborg Stad, 2009: 3).

"In some cases comprehensive plans function as information resource material for potential residents and new businesses (...)". Beside the use for municipal planning decisions the comprehensive plan is some kind of information sheet "which highlights the advantages and disadvantages of the municipality." In need of new residents and attracting new businesses, "there may be a tendency to neglect risks in the text." (cf. Thorsteinsson et al., 2007: 489)

Due to the lack of a legal binding comprehensive plan in Sweden, regulations within this plan relating to prohibitions of building within endangered areas are not possible, only recommendations can be made within the comprehensive plans (cf. Thorsteinsson et al., 2005: 4).

[40] Public consultation (*samråd*) of a preliminary plan proposal is necessary, as well as comments from the County Administrative Board, the public and other stakeholders must be considered by the municipality. Afterwards the plan proposal is revised and exhibited for examination (*utställning*), followed by an inspection statement (*granskningsyttrande*) by the County Administrative Board, which is added to the comprehensive plan documents. The comments are compiled in a separate statement (*särskilt yttrande*). After these steps, if there is no need of significant changes (which would oblige a re-exhibition of the revised plan), the plan is adopted by the Municipal Council (*kommunfullmäktige*). (cf. Hedström and Lundström, 2013: 73)

An example is Kristianstad where the comprehensive plan states that "long-term investments in low-lying areas for example below 5 meters above mean sea level" should be avoided (cf. Thorsteinsson et al., 2005: 4).

Another example of recommendations relating to flood-risk can be found in the comprehensive plan of Lidingö. Also there it is based on a future climate change, and flood endangered areas — where flood-sensitive buildings should be avoided (see purple areas in the figure below) — are marked. (cf. Lindingö Stad, 2012: 102 and 105)

Figure 46: Cutting of the map part of Lidingö comprehensive plan (Lindingö Stad, 2012: 105)

In practice these areas are "(..) not a big issue here. If you build here you must use waterproof constructions for the ground levels" (Lidingö Stad, 2014: interview). In some areas also the ground was filled up to a safe level for building (cf. Lidingö Stad, 2014: interview).

Flood issues are addressed on both levels, the comprehensive plan and the detailed development plan. "On the comprehensive level, the general policy can be addressed and the CAB can assess the issue early in the planning process. However (...) it is usually difficult to fully address this issue on the comprehensive level. In order to fully address the issue, the risk has to be assessed in a detailed development plan" (Hjalmarsson, 2014: interview).

6.3 Detailed plans and flood-risk issues

One level below the land-use plan more detailed building regulations on a local level exist for the built environment. These plans — the building regulation plan in Austria and the detailed development plan in Sweden — determine the possibilities for property owners and developers. Furthermore, building restrictions can exist or be part of the plans.

6.3.1 Building regulation plan in Lower Austria and Salzburg

The building regulation plan is also a municipal act and regulates the building order of an area taking into account economic land consumption and controlled settlement development. The contents are the determination of the street lines (*Straßenfluchtlinien*) and building lines (*Baufluchtlinien*), municipal street course and the level of development of the site (*bauliche Ausnutzbarkeit der Grundfläche*). (cf. Lienbacher, 2012: 475f.)

Similar to the land-use plan, the building regulation plan contains a map and its description, also the creation process is quite similar. The only difference is that in Salzburg the approval by the supervisory authority, the federal province, is not needed. (cf. Lienbacher, 2012: 475f.)

The building regulation plan is important if flood-risk exists at a limited extent and future buildings are not completely excluded within the land-use plan. In this case the building regulation plan can rule the spatial distribution[41] and design of the construction and open spaces as well as the type and location of infrastructure connection. (cf. Seher, undated a: 2)

Regulations about measures on the building (no basement or waterproof basements, etc.) or mandatory technical protection measures, are not part of the building regulation plan, further more the building laws[42] (e.g. NÖ BauO) disallow such requirements within the building regulation plan (cf. Pomaroli, 2015: interview).

The figure on the following page shows a part of the building regulation plan of Leobersdorf in Lower Austria. As one can see, retention areas are identified within this map. (cf. Leobersdorf, 2013 b: 1)

[41] E.g. the building lines steer the location of the building within the site, due to that if not the whole site is located within an endangered area, the building lines can rule that the building has to be located outside the inundated area (cf. Seher, undated a: 2).

[42] The building laws of the provinces consider flood risk and include regulations relating to minimum floor levels, use of (flood) resistant materials, etc. (cf. Seher, undated a: 2).

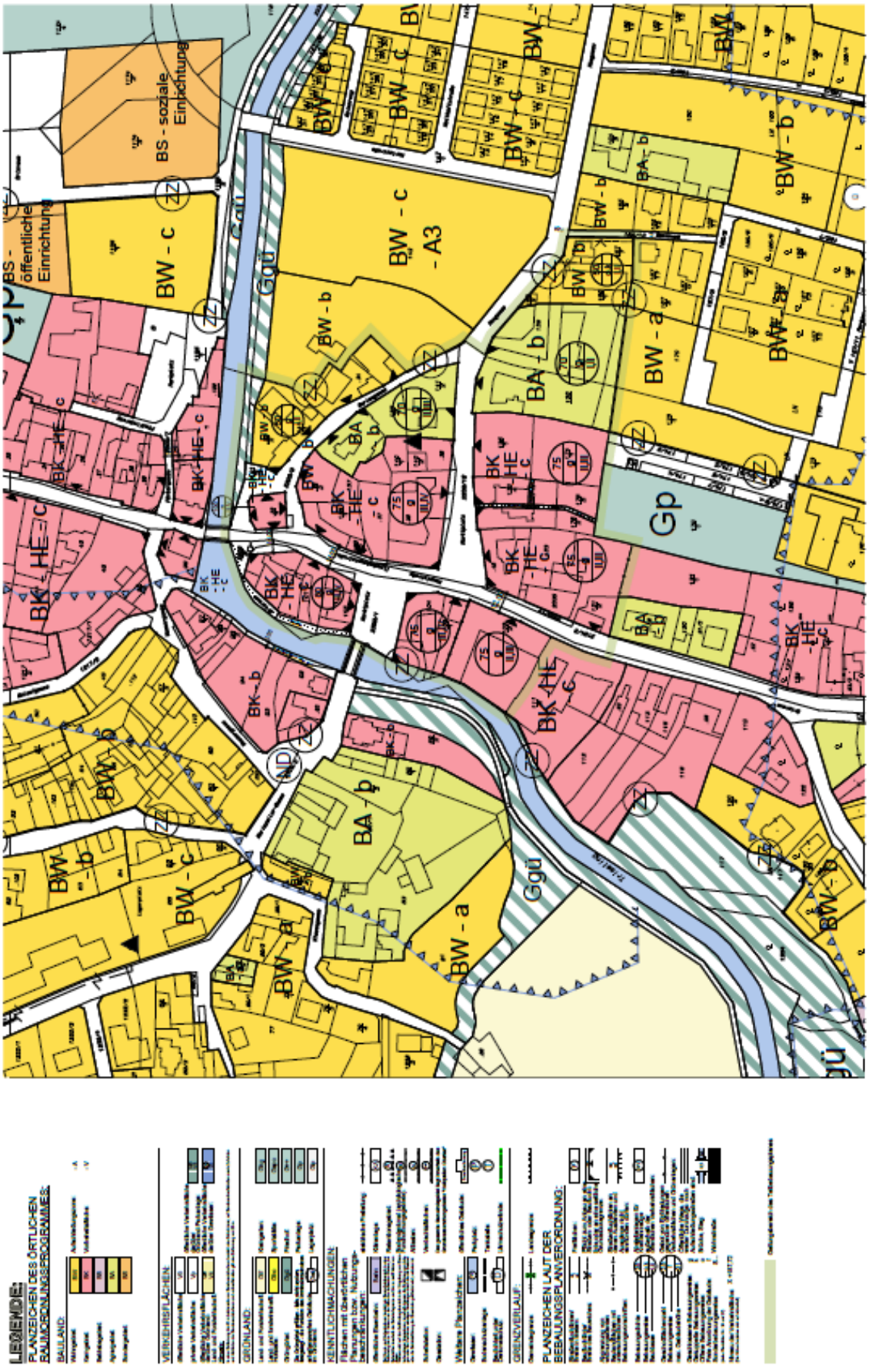


Figure 47: Unscaled part of the building regulation plan Leobersdorf (Leobersdorf, 2013 b: 1)

6.3.2 Building restrictions in Lower Austria and Salzburg

Beside the option to keep endangered areas clear of uses in the land-use plans, building restrictions for existing developments or regulations for new constructions are options for flood-protection.

Building precaution in general is based on two strategies risk adapted use of buildings and measures to reduce the impact of natural hazards or a sealing of buildings. It is possible to differ in measures for an adapted planning of buildings and adaptation of existing buildings. (cf. Rudolf-Miklau, 2012: 37)

As mentioned before, building bans or reallocation are an option to prohibit buildings in endangered areas. Furthermore, options — mentioned in the previous part — to regulate the location of buildings on the building plots are the building lines and the level of development of the site regulated in the building regulation plan. These regulations can keep constructions out of endangered areas within the building plot, for example if not the whole site is endangered, or they can limit soil sealing.

Moreover, construction guidelines and regulations can be regulated within the building laws (e.g. BauO, BauTg, etc.) to reduce vulnerability and damage of natural hazards. Currently just the building laws of Upper Austria separates a flood proof design of buildings[43] from general regulations. In other building laws there are also similar regulations, but not subordinated in one regulation relating to flood issues. (cf. Giese, 2011: 211f.)

In Salzburg in cases of risk due to natural hazards subsequent requirements are possible if a construction is not protected sufficiently (cf. Slbg BauPolG § 20 subsection 10); in contrast in Lower Austria subsequent requirements are possible in general, but not in relation to natural hazards. (cf. Kanonier, 2005: 147)

6.3.3 Detailed development plan in Sweden

Beside the comprehensive plan, the detailed development plan (*detaljplan*) is the second planning instrument of Swedish municipalities. The higher-ranking comprehensive plan should "(...) guide the detailed planning so the case is also valid the other way around, i.e. municipalities should also use information that is not included in the comprehensive plan, if that information is important" (cf. Carstens, 2015: interview).

In contrast, the detailed development plan is legally binding, during the implementation period of 5 to 15 years (cf. Commin, undated: 14).

[43] New constructions, changes and additions at existing buildings within the run-off area of centennial floods must be flood-proof. In detail it means waterproof or elevated construction and measures to prevent water entry, water-consistent materials, regulations relating tanks of heating systems, floor level above flood elevation, etc. are necessary. (cf. Giese, 2011: 211f.)

In general, the detailed development plan[44] regulates where, how and to which end land and water areas may be used. It shows which kind of functions, like housing, industry, road, etc. are allowed as well as quality regulations like building size, height, number of floors or design features or pedestrian paths. (cf. Hedström and Lundström, 2013: 74)

"The detailed development plan consists of a map with brief regulations (codes) — this is the most important legal document, an auxiliary written report (*planbeskrivning*), an implementation description (*genomförandebeskrivning)*, and a list of property owners" (Hedström and Lundström, 2013: 75).

The following particulars are mandatory:

- "Delimitation of public spaces (*allmänna platser*) such as streets, roads, squares and parks and responsibility for the provision and maintenance of public space".
- "Delimitation of building sites, (*kvartersmark*) and of the use to be made of this land for housing, offices, shops, industry, parking, community centre amenities, schools etc. (more than 20 different categories of use can be specified)."
- The implementation period (*genomförandetid*) for detailed development plans "to be put into effect" has to be between 5 and 15 years.

(cf. Kalbro, 2005: 5)

However, in the current Planning and Building Legislation "there is no specific discussion on how detailed the plans should be" (Kalbro et al., 2013: 9). Although the detailed development plan "(...) provides scope for extensive regulation of land use and building development" and a closer definition — "(...) of land use, the extent of settlement, its location, design and workmanship, and questions concerning land and implementation" (Kalbro, 2005: 5) — is possible, this act also points out "(...) that the plan must not be made more detailed than its purpose demands" (Kalbro, 2005: 5) and it should not "(...) include more detailed regulations than those that are necessary in order to achieve the purpose of the plan" (Hedström and Lundström, 2013: 74).

It is noteworthy to point out that it is not only possible to include information about flood-risk in the detailed development plan, furthermore, it is also possible to define measures relating flood-risk within this plan.

Since new buildings and constructions should be located on land that "is suitable for the purpose considering flooding, the water conditions and the risk of accidents[45]" and in "many cases, the only way to ensure these requirements is to regulate safety measures[46]" (cf. Hjalmarsson, 2015: interview).

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[44] Beside the detailed development plan area regulations — which are admissible in limited areas, e.g. in the countryside if there is no need for a detailed development plan —. can be used to regulate the issues of land and water use for buildings, roads, etc. to ensure that the purpose of the comprehensive plan is maintained and implemented. (cf. Hedström and Lundström, 2013: 74)

[45] As regulated in Planning and Building Act 2 kap. 5 § (cf. Hjalmarsson, 2015: interview).

[46] Safety measures are optional regulations of detailed development plans as set in Planning and Building Act 4 kap. 12 § (cf. Hjalmarsson, 2015: interview).

With this in mind, Hjalmarsson confirmed this assumption and stated that due to the current Swedish legislation "flood-risk issues should be included in the detailed development plan if a flood-risk exists in that area" (Hjalmarsson, 2015: interview), although flood-risk issues and measures are not an obligatory content.

Since the detailed development plan is the only legal binding planning instrument/document a clarification within legislation seems recommendable.

"When it comes to flood risk, the municipalities with greatest awareness have zones where either all new construction is prohibited or where special restrictions[47] apply" (Thorsteinsson et al., 2007: 489f.). The problem in Sweden is that very often the flood risk areas are identified after a flood event, without detecting the likelihood of the area for inundation of how extreme the event was. That approach, to base "flood risk management on an event of unknown probability is a shot-in-the-dark." (cf. Thorsteinsson et al., 2007: 490)

Flood-risk management in Sweden usually is involved within the planning process on the level of detailed development plans or area regulations. "Unfortunately, a scientific basis for defining flood risks is usually lacking, that is, if risk is addressed at all. Flood risks are met on an ad hoc basis; the plans quantify neither flood frequency nor consequences" (Thorsteinsson et al, 2007: 500).

A problem about the implementation of flood-risk within the detailed development plan is, that these documents cover only limited areas. Since flood-risk issues concern more than single plots or developments, also an implementation in the planning instrument below, the comprehensive plan would be advisable.

However, it is also unclear how flood-risk issues can be regulated in the detailed development plan. Since the "Planning and Building Act is pretty clear on what the municipality can and shall regulate", but "it doesn't say how the regulation should be 'designed'. (...) That means that the municipalities are free to 'design' the regulations themselves, but that the regulation must not exceed the limits of the Planning and Building Act" (cf. Hjalmarsson, 2015: interview).

6.3.4 Building restrictions in Sweden

"Generally, there are no restrictions to building in sensitive areas for flooding. On the contrary, municipalities along larger rivers allow recreational houses at lower areas for financial reasons" (Fiselier and Oosterberg, 2004: 106).

Beside recommendations in the comprehensive plan, it is only possible to discuss the desired land-use in relation to safety measures, foundation levels etc. on the level of the detailed development plan (cf. Hjalmarsson, 2014: interview).

[47] E.g. "no basement or minimum elevation for the ground floor" (Thorsteinsson et al., 2007: 490).

"Nevertheless, it is costly to develop detailed development plans and surveys etc. Therefore, in order to avoid that entire projects have to be abandoned at a late stage due to the flood risk, it is often a cost effective method to address the general policy on the comprehensive level. By doing so, it is possible to avoid projects that cannot be accepted due to the flood risk" (Hjalmarsson, 2014: interview).

With this in mind, as well as the vague legal specifications it is "(...) difficult to show explicit flood risk counter measures that have been specified in the map of the detailed plan. Instead, the flooding situation is usually described in the 'plan description' (*Planbeskrivning*), and in related planning material produced during the planning phase, and measures like a certain ground level is specified in the detailed plan map" (Elgström, 2015: interview).

In general the implementation must be judged on a case by case basis and is strongly depending on the specific location. In general regulations as specific zones which must not be built on or that buildings must not be placed under a specified height above sea level, waterproof basements, or regulations that certain zones might be used for certain purposes — "it may be OK to use a flood-risk area as a park or to build a garage or a small cottage on, but nor for a power plant, a fire station or at hospital" — but the "variations concerning the design of individual regulations are almost endless." (cf. Hjalmarsson, 2015: interview)

Since it is not obligatory to implement flood-risk issues in this plan, but the municipalities have to consider flood-risk issues and a building plot must be suitable in that way — which can be interpreted that flood-risk issues should be included in the detailed development plan if a flood-risk is existing in that area — specifications of legislation or guidelines for municipalities could improve the situation, i.e. the "(..) law could be developed to include better formulations on what has to be done in the planning phase, more than what is described today" or guidelines from the Boverket or MSB — preferably done together — to regulate or direct municipal actions in a certain way would be an option (cf. Elgström, 2015: interview).

6.4 Building procedures in Austria and Sweden

The following part gives a short additional overview of building procedures in Austria and Sweden.

6.4.1 Building procedures in Lower Austria and Salzburg

In general the mayor of a municipality is building authority of first instance (cf. NÖ BauO § 2 subsection 1, Slbg BGG § 26), but that varies in the federal provinces[48].

The procedures in Austria are different, due to the different building laws. These building laws regulate, where and how constructions are allowed. Furthermore — similar to regulations in the land-use plans — these laws can include use- or construction prohibitions. In general, notifiable or constructions which need authorisation, usually cannot get permitted if they are located in a risk area. Due to that they are checked for risks regarding natural hazards within the construction procedures. These procedures are normally subdivided in three parts, the building plot declaration, the preliminary and the building permit. (cf. Kanonier, 2004: 40)

Building plot declaration

The building plot declaration is a procedure before the building permit, which clarifies if a building plot is appropriate for a building and should try to remove the risks of expensive incorrect planning, but it extends the necessary time for planning. A building plot declaration must be rejected in case of conflicts to the land-use, or the building regulation plan or other legal regulations, as well as if the building plot is not suitable for constructions due to flood risks or unsuitable ground- and groundwater-circumstances. (cf. Jahnel, 2012: 493)

This natural suitability check of building plots is necessary in all provinces of Austria except Vienna[49] and Lower Austria — where a review of the eligibility of a building plot is only necessary for constructions in green areas[50] — but the procedures are different, depending on the building laws of the provinces. (cf. Giese, 2011: 206)

In Salzburg the building plot declaration can be part of the procedure of the building permit or a previous procedure, depending on the procedure regulations set in Slbg BGG § 12a subsection 1.

[48] The building authority first instance can be also the district authority, the magistrate or the provincial government; e.g. for buildings on an area part of more than one municipality or district (cf. Kanonier, 2005: 127).

[49] The building laws of Vienna do not know regulations with regard to natural hazards (cf. Giese, 2011: 206).

[50] As regulated in NÖ BauO § 55 subsection 2.

The building plot declaration must be declined in case of unsuitable soil conditions or if the site is endangered by a natural hazard — e.g. flooding, avalanches, etc. — or if the site is a necessary flood retention area. However, exceptions in case of a possible removal of these risks with economically feasible afford and if the site is within a built-up area a building plot declaration is allowed too. (cf. Slbg BGG § 14 subsection 1 lit. b)

The building plot declaration deals more or less with the same suitability criteria as the criteria for building land, this duality is useful, because not all constructions take place in areas zoned as building area and building land can exist in endangered areas. (cf. Kanonier, 2005: 130f.) In Lower Austria the plot has to be declared as building plot on request of the land owner if the plot is suitable for constructions in case of size, conditions and shape. (cf. NÖ BauO § 11 subsection (2) 2) Within the building plot declaration an inspection of natural conditions in case of hazard risk must not be done (cf. Kanonier, 2005: 131).

The regulations in Salzburg are opposite, here the building plot declaration of land zoned as building land must be rejected if the area is located within risk areas of floods, landslides, etc. and if the area must be preserved as flood run-off or retention area, (cf. Mair, 2014: 14), except the exceptional rules of Slbg § 14 subsection 1 lit. b — named above — apply.

Preliminary

In Lower Austria and Salzburg, the preliminary checks if the project is contrary to the land-use or building regulation plan, e.g. right land-use category, existing building ban, etc. (cf. NÖ BauO § 20 subsection 1, Slbg BauPolG § 8 subsection 1, Slbg BauPolG § 9 subsection 1). In Salzburg the project must also be in accordance with the building plot declaration (cf. Slbg BauPolG § 9 subsection 1 2 — 2a).

Building permit

If a project passes the building plot declaration and the preliminary, a building permit can be granted. The building permit contains the right to construct a building and to use it after its completion (cf. NÖ BauO § 23 subsection 1), and is temporarily valid (cf. NÖ BauO § 24 subsection 1 and Slbg BauPolG § 9 subsection 7).

6.4.2 Building permit in Sweden

"A building permit is virtually always needed before construction may start" (Hedström and Lundström, 2013: 75). This applies to new constructions, extensions, changes concerning the use of the building, but a building permit is not needed "for the construction of minor extensions or sheds (...) for one- or two-family houses outside planned areas and outside densely populated areas or areas of cohesive development" (Hedström and Lundström, 2013: 75).

"To be awarded a building permit, the proposed building must be in accordance with the regulations set out in the detailed development plan, although some minor departures may be accepted" (Hedström and Lundström, 2013: 75).

6.4.3 Compensations due to planning decisions in Sweden

In municipalities "(...) the decisions of planning authorities do not generate claims of compensation. It is assumed that planning authorities, when making planning decisions, will balance public and private interests by considering the damage to a property and the effects on the property's value" (Planning and Building Act in Kalbro, 2007: 29) "property owners can qualify for compensation only as a result of decisions concerning the detailed development plan and building permits" (Kalbro, 2007: 33), but the "basic principle is that only encroachment on the current land-use is taken into account. Compensation must equal the difference in market value of the property before and after the detrimental decision or action" (Planning and Building Act in Kalbro, 2007: 29) In that case decisions relating to flood issues should not cause compensation payments.

7 Examples of practical planning in relation to flood-risk issues

As the analysis of Austrian and Swedish legislation pointed out, differences in term of dealing with flood-risk within spatial planning exist in these two countries. In the table below, an over viewing simplified comparison of the flood related regulations within the legislation of Austria and Sweden is displayed.

Table 5: Comparison of the flood related regulations within the legislation of the sample countries

Country	Legislation	Regulations
Austria (Lower Austria)	§ 15 subsection 3 NÖ ROG	Sites which would be flooded by a centennial flood, areas which are below the highest ever recorded groundwater level, endangered by floods of torrents, sites with groundwater levels higher than necessary supply/ disposal connections are inappropriate for a land-use as building land.
Austria (Salzburg)	§ 28 subsection 3 Slbg ROG	Areas which are endangered of floods or must be preserved as run-off area of floods or as flood storage areas, are forbidden to be zoned as building land — excluded access areas.
Sweden	Chapter 2 § 5 (SFS 2010:900)	Consideration of flooding (the regulations are depending from case to case)

With this different legal basis and subsequently different approaches are natural.

In the following part of the thesis selected examples of the implementation of flood-risk and relevant actions within spatial planning in the two sample countries served to underlined possible limits for decision makers and difficulties and obstacles within land-use planning.

7.1 Local land-use planning and flood-risk issues in Austria

In Austria, the regulations for visualisation of flood-risk issues in legally binding land-use plans are clear. In the part below examples for implementation of flood-risk issues in local/spatial development concepts in Austria are displayed.

7.1.1 Flood issues in the spatial development concept of Hadersdorf-Kammern

Hadersdorf-Kammern (Lower Austria) was affected by the big flood at the river Kamp in August 2002. A flood in this area was not excepted due to reservoirs and river regulations. (cf. Pomaroli, 2015: interview) Overflowing and bursting of dams took place. Some towns had to be evacuated, bridges were destroyed and roads were impassable. (cf. Godina et al., 2004: 20)

Beside structural measures for flood protection at the river Kamp (cf. Bmlfuw, 2014 e: online) reallocations[51] (see chapter 7.3.7) and building bans[52] in Hadersdorf-Kammern took place. (cf. Pomaroli, 2015: interview)

As mentioned before, in practice the local development concepts can include flood issues, as it is the case in the local development concept of Hadersdorf-Kammern. Special zones which must be kept free of constructions due to flood risk are marked. And also the reallocations and building bans took place as part of the development of the local development concept. (cf. Pomaroli, 2015: interview) For an existing industrial area, beside the reallocated (industrial) area, it was also determined in the local development concept that no more developments apart from the existing buildings are allowed (red in the following map). This, as well as a part of the area which must be protected with structural measures or must be reallocated to green land (as marked in the legend), are shown in the following map. (cf. Hadersdorf-Kammern, 2012)

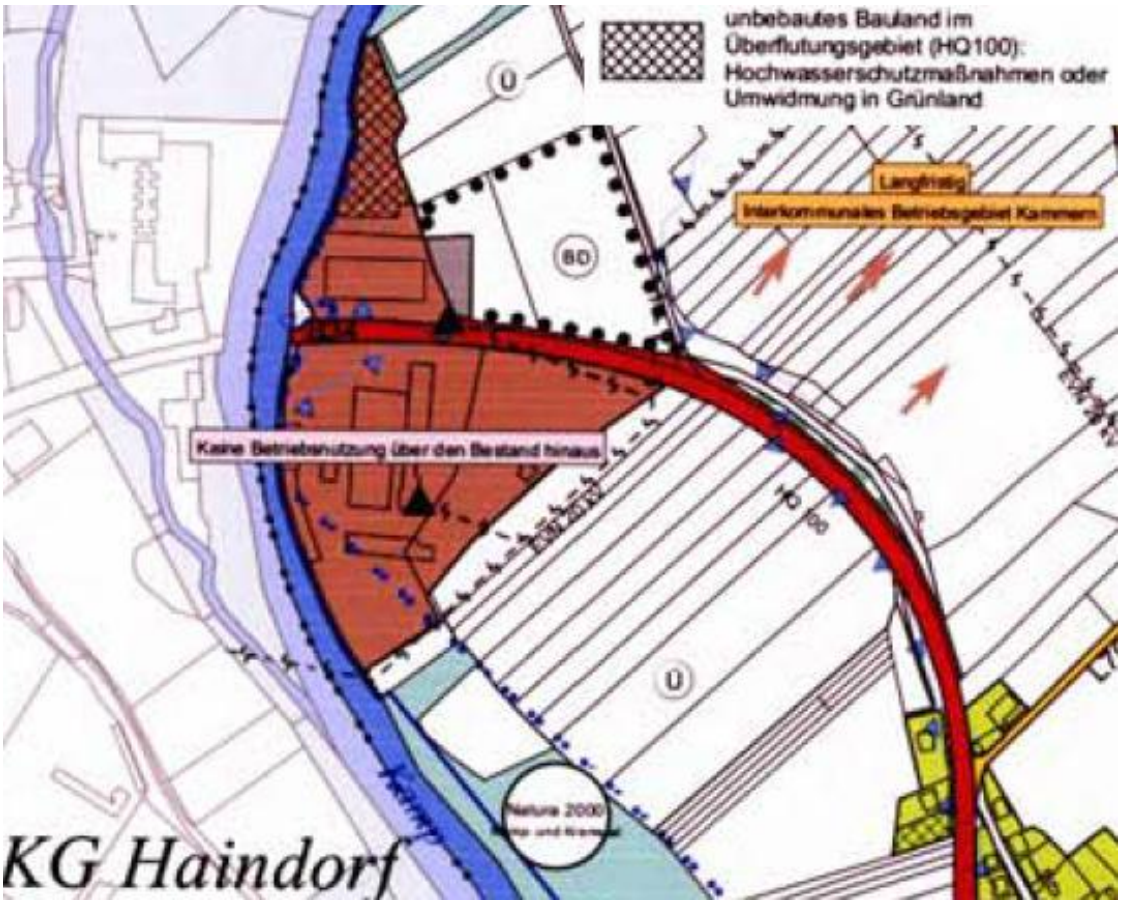

Figure 48: Cutting local development concept Hadersdorf-Kammern (slightly modified representation based on Hadersdorf-Kammern, 2012)

[51] In 2005 — due to new documents about flood-risk within the municipal area — reallocations and building bans have been recommended for (not built-up) building land within the run-off area of a centennial flood (cf. Hadersdorf-Kammern, 2005 a: 2ff.).

[52] In 2005 building bans for building plots located in the flood run-off area — based on basic research for the hazard zone maps — have been decreed (cf. Hadersdorf-Kammern, 2005 b: 1f.).

7.1.2 Relevance of flood-risk areas in Langenlois

Langenlois (Lower Austria) was also affected by the Kamp floods in 2002, and reallocations and building bans took place after run-off analysis were created (cf. Obkircher, 2015: interview). In contrast to Hadersdorf-Kammern the municipality[53] got a "stock" problem[54] instead of endangered areas conflicting future building land-zoning. (cf. Pomaroli, 2015: interview) For the small number of non built-up building land within existing structures — which were zoned and developed before the flood event of 2002 — building bans were decreed. The local development concept of the municipality is relatively old — of 1997 — and due to that flood-risk is not part of it, because floods were not an issue in Langenlois before 2002. For future development concepts or adaptations of the old one, there are certain areas which are not allowed to be built-up or zoned as building land due to flood-risk and for other areas — upslope/mountainside — flood-risk is not a relevant issue[55]. However, available run-off analysis has to be considered for future developments. (cf. Obkircher, 2015: interview)

A problem with the flood at the river Kamp in the year 2002 was that in the previous 60 years no flood had taken place and due to the basins at the river Kamp a flood was unforeseeable, since a storage hydropower plant was seen as flood protection measure for a long time. With the existing run-off analysis and hazard zone maps of today the negative effects of the flood would be minor.
(cf. Obkircher, 2015: interview)

7.1.3 Flood relations in the local development concept of Achau

In the municipality Achau (Lower Austria) the whole municipal area is seen as suitable for permanent settlement in general and currently, about 13 percent (1.53 km²) are at the used as settlement area (cf. Statistik Austria, 2014: online). However, relating to the data from the draft of the flood risk management plan, some areas within the municipal area are endangered by floods. The total sizes of the risk areas are 1.11 km² (HQ30), 1.75 km² (HQ100) and 2.1 km² (HQ300), but the main part is zoned as agricultural or green area land-use, and only 0.23 km² (HQ30), 0.43 km² (HQ100) and 0.56 km² (HQ300) are used for living and areas respective settlement areas (cf. BMLFUW, 2015 a: 2). But, in a case of an extreme event, bigger then HQ300, almost the whole town could be inundated, especially the older parts of the town, as it was the case in 1997
(cf. Weber, 2015: interview).

Since 1991 hazard zone maps and hydrological analysis have existed for the municipal area, and at the present stage, a newer hydrological analysis is reviewed (cf. Weber, 2015: interview). Flood risk issues were implemented in the local development concept of 2003; in detail, it was mentioned that adequate

[53] Both municipalities, Langenlois and Hadersdorf-Kammern are located within the Kamp catchment.

[54] Existing buildings and some gaps of not built-up building land. (cf. Obkircher, 2015: interview)

[55] Even if small trenches are often underestimated, but they are not endangering settlements (cf. Obkircher, 2015: interview).

dimensioned flood run-off areas should be created and protected within and outside of the settlement areas, as well as a coordination of future development areas with run-off areas should take place (cf. § 3 subsection C and § 4 subsection A örtl. ROP Achau 2003).

7.1.4 Flood-risk issues in the spatial development concept of Zell am See

In the map sheet — settlement mission statement and open space concept —of the spatial development concept of Zell am See (Salzburg), the hazard zones and the reference zones of the hazard zone maps as well as the inundation areas for centennial floods (HQ100) are shown. (cf. Zell am See, 2008 b: 1) Beside the map sheets in the word section, hazard zone maps and endangered areas (cf. Zell am See, 2008 a: 100ff.), as well as inundation areas of the river Salzach — and required safety margins — are named (cf. Zell am See, 2008 a: 107f.). A highlighted problem is that within the municipal area only the areas around the Salzach alley are suitable for settlements, but the soil is strongly soaked and the area is endangered by floods. (cf. Zell am See, 2008 a: 112)

It is also stated that building development in the recent past focused on already zoned building land and the settlement pressure cannot be met due to natural hazard and topographical circumstances. Furthermore, future development options are limited and will be focused on a densification within existing structures. (cf. Zell am See, 2008 a: 125)

7.1.5 Flood-risk issues in Flachau

The spatial development concept of Flachau (Salzburg) was revised about 15 years ago. Potential flood endangered areas were not recorded as possible building land. Since the flood protection development of the river Enns started only some time ago, everything relevant, like zones necessary for the protection structures, etc. was considered. The mapping of areas which have to be kept free for flood protection and recommendations for reallocations or building bans neither existed then. However, the area, which is now used for a retention basin — area within the municipalities Altenmarkt im Pongau and Flachau[56] for the current flood protection development — was not intended to be future building land. (cf. Oberreiter, 2015: interview)

7.1.6 Flood-risk issues in the spatial development concept of Altenmarkt im Pongau

At this time — February 2015 — partial amendments of the spatial development concept of Altenmarkt im Pongau (Salzburg) are drafted, since structural measures for flood protection are realised. Flood-risk issues are in abeyance and in the future the new adapted hazard zone map will be implemented. Before the realisation of the flood protection measures, in limited cases coordination with the protective water management was necessary to enable zoning decisions. Special

[56] Altenmarkt and Flachau are neighbouring municipalities in the province Salzburg.

areas which have to be kept free due to flood-risk or areas which require reallocation in case of no realisation of flood protection were not part of the spatial development concept. (cf. Sigl, 2015: interview)

7.1.7 Flood-risk issues in the spatial development concept of Salzburg

In the city of Salzburg (Salzburg) the spatial development concept is refers to flood-issues with in terms of general recommendations. E.g. areas endangered by natural hazards have to be considered in zoning decisions and constructions furthermore zoning of building land and permissions of buildings are only possible if they are not in conflict with natural hazards. (cf. Stadt Salzburg, 2008 a: 48) Also more concrete measures, e.g. no new building land zoning in areas endangered by natural hazards at the hill Kühberg, are allowed (cf. Stadt Salzburg, 2008 a: 60); no building land zoning in run-off areas of centennial floods, support of flood retention areas by renaturation of alluvial forests and the consideration of recreational needs in the design and a high quality of retention areas and structural flood protection are part of the concept (cf. Stadt Salzburg, 2008 a: 69 and 74f.).

As regards to water management, the significance of flood protection (from structural flood protection measures to measures within spatial planning, like refusing building land zoning) and at the same time the stabilisation and achievement of a good water quality is taken into account. (cf. Stadt Salzburg, 2008 a: 73) Furthermore, measures and benefits of the structural flood protection measures within the city are named in the concept (cf. Stadt Salzburg, 2008 a: 73).

In the map part — Plan Nr. 2/26, which can be seen on the following page — of the spatial development concept of Salzburg, all hazard zones as well as documents of the water protection of the province of Salzburg were also included. Due to that, with a determination of the municipal council these contents of the spatial development concept are ruled as binding planning requirements. (cf. Schmidbaur, 2015: interview)

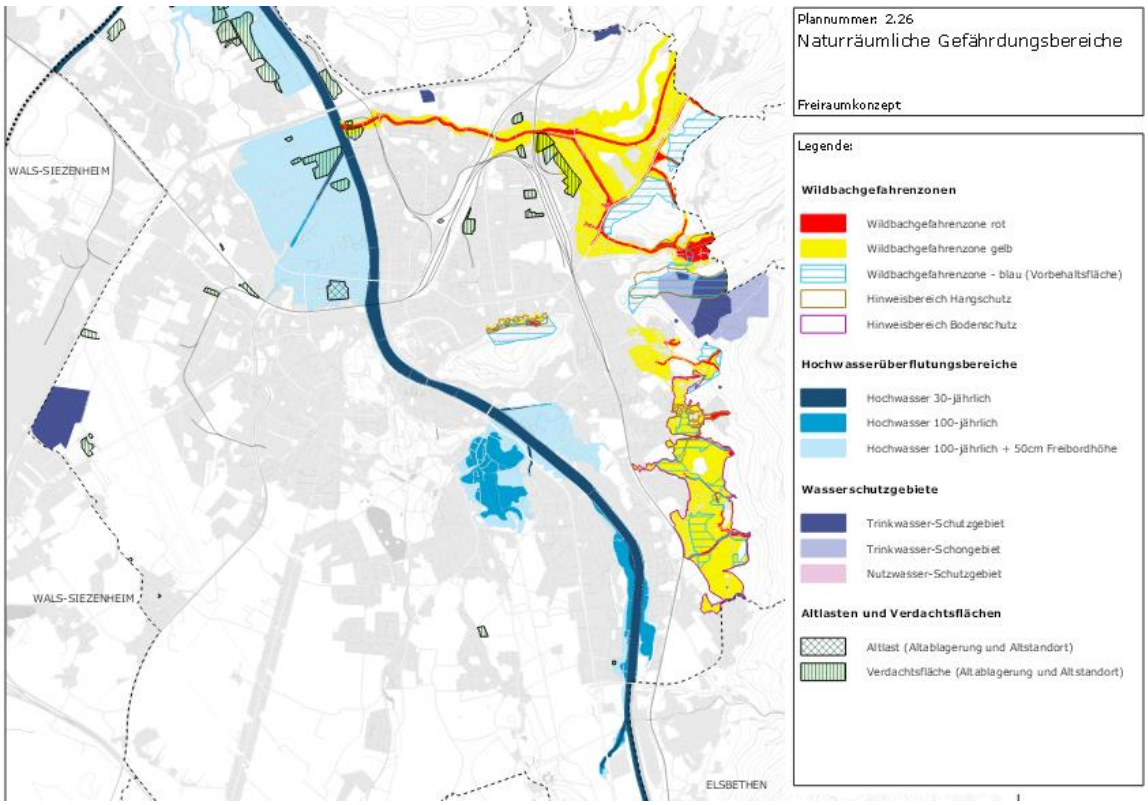

Figure 49: Cutting of the map natural risk areas, part of REK 2007 (slightly modified representation based on Stadt Salzburg, 2008 b: 1)

7.1.8 Flood-risk issues in the spatial development concept of Mittersill

Due to big floods in the 1960s river regulations took place in Mittersill (Salzburg). However, since new hydraulic analyse have been calculated, it was stated that large parts of the densely populated town core would be inundated — as one can see in the following cutting of the flow modelling, yellow risk zones, etc. — if a centennial flood occurs. Due to that flood protection measures have been planned and today the whole municipality is protected from a centennial flood[57]. Alternative measures to high dams, like water retention, etc. were not possible due to river regulations and limited space. (cf. Federal Water Engineering Authority, 2013: 4ff.)

[57] Anyway, within the closed residual area there are no endangered areas. However partly there are older notifications of natural hazard endangered areas existing within the land-use plan. For them a separate " approval procedure" is necessary. (cf. Pfeiffer, 2015: interview)

Figure 50: Cutting of the flow modelling in Mittersill
(slightly adapted representation based on Federal Water Engineering Authority, 2013: 6)

Another important component of the flood protection in Mittersill is a cross-dike, the effects in case of the flood can be seen in the following figure.
(cf. Federal Water Engineering Authority, undated: 1)

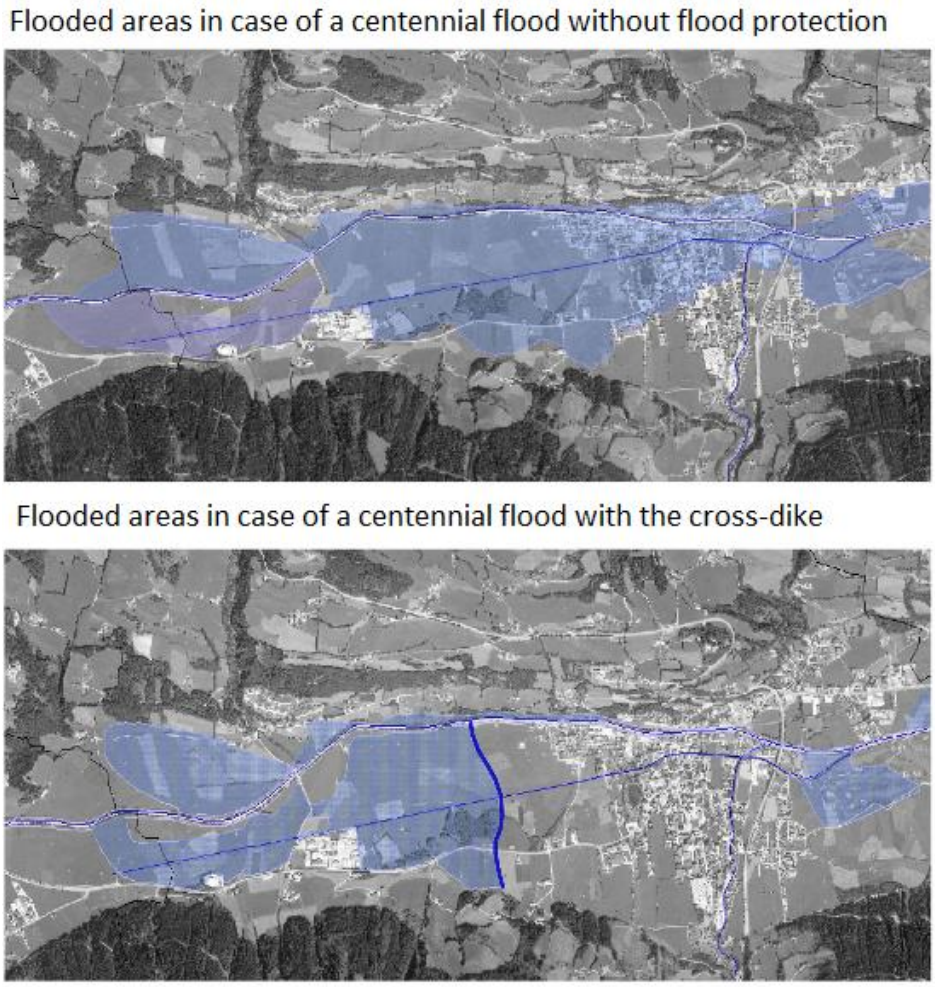

Figure 51: Impacts of the cross-dike in Mittersill
(slightly adapted representation based on Federal Water Engineering Authority, undated: 1)

In the map sheets of the spatial development concept of Mittersill, the red and yellow torrent hazard zones (WLV) as well as the red, red/yellow and yellow inundation areas (BWV) are visualized. (cf. Mittersill, 2011 b) A focus within the spatial development concept relating to flood-risk issues is the value of soil protection within the catchment area, i.e. an increase of retention capacity and a use-extensification. In case of settlements within the catchment area a compensation of retention possibilities for the (soil-) sealed areas is necessary. Other more general recommendations and aims like preservation and creation of retention and inundation areas are also given[58]. (cf. Mittersill, 2011 a: 18f.)

As for urban development, the focus for future settlements and developments is on the central settlement area of the municipality. In surrounding areas, settlement for living should only be possible to a restricted extent, as a landscape balance has to be maintained within areas other than agricultural settlements. The densification of already developed areas is seen as an important aim.
(cf. Mittersill, 2011 a: 20)

[58] These measures are relevant for land-use plan amendments and/or are regulated as specifications within the building regulation plan (cf. Pfeiffer, 2015: interview).

By the virtue of numerous flood protection measures hazard zones decreased and new areas with development potential came up (cf. Pfeiffer, 2015: interview).

Regarding to residual risk in Mittersill always a definite (residual) risk will be existing, but due to the flood related information (e.g. HQ300 flood-risk shown in the hazard zone map BWV) — which has to be considered in spatial planning (land-use plan, building regulation plan, building plot declaration, building permit) — restrictions and followed adaptation measures are possible to deal with the present (residual) flood-risk. (cf. Pfeiffer, 2015: interview)

7.1.9 Flood-risk issues in the local development concept of Gutenstein

In Gutenstein (Lower Austria) especially flood-risked areas had to be considered within the development of the local development concept, since large areas of the settlement area are located within the risk area of a centennial flood of the river Piesting or within hazard zones of torrents. (cf. RaumRegionMensch, undated: online) In the plan documents[59] of the local development concept inundation areas as well as hazard zones of the WLV hazard zone map and rock fall and landslide endangered areas are visualized. In term of measures, areas which have to be kept free (green-land zoning), areas with future building land rationalisation, reallocation and building ban needs are also visualized. (cf. Gutenstein, 2014: 1)

A previous qualitative land area balance under consideration of these spatial restrictions has been achieved. Within the creation of the local development concept — together with a simultaneous implementation in the land-use plan — suggestions for a rearrangement of the building land zones within the development concept were made. (cf. RaumRegionMensch, undated: online) In the local development concept displacements within the municipal area took place. In this way building land reserves which are not endangered by natural hazards have been secured. However, in Gutenstein, enough suitable alternative development areas outside of inundation areas exist. In comparison to other municipalities the handling of these flood endangered areas within the local spatial planning concept was relatively easy. (cf. Fleischmann, 2015: interview)

7.1.10 Flood-risk issues in Leobersdorf

Inundation areas (HQ100 and HQ30) are considered within the local spatial planning programme/concept of Leobersdorf (Lower Austria). Furthermore, in the current, but not legally valid decided yet[60] — March 2015 — local development concept also displays two larger areas within the residual area which should be used for new retention basins in the future. (cf. Fischer, 2015: interview)

[59] In the land-use plan, hazard zones (WLV) and inundation areas are marked, conform with the spatial planning law. Furthermore, in terms of flood-risk, also retention areas are displayed beside other natural hazard endangered areas, simultaneously to the local development concept. (cf. Gutenstein, 2010: 3)

[60] The local development concept should be decided in the near future (cf. Fischer, 2015: interview).

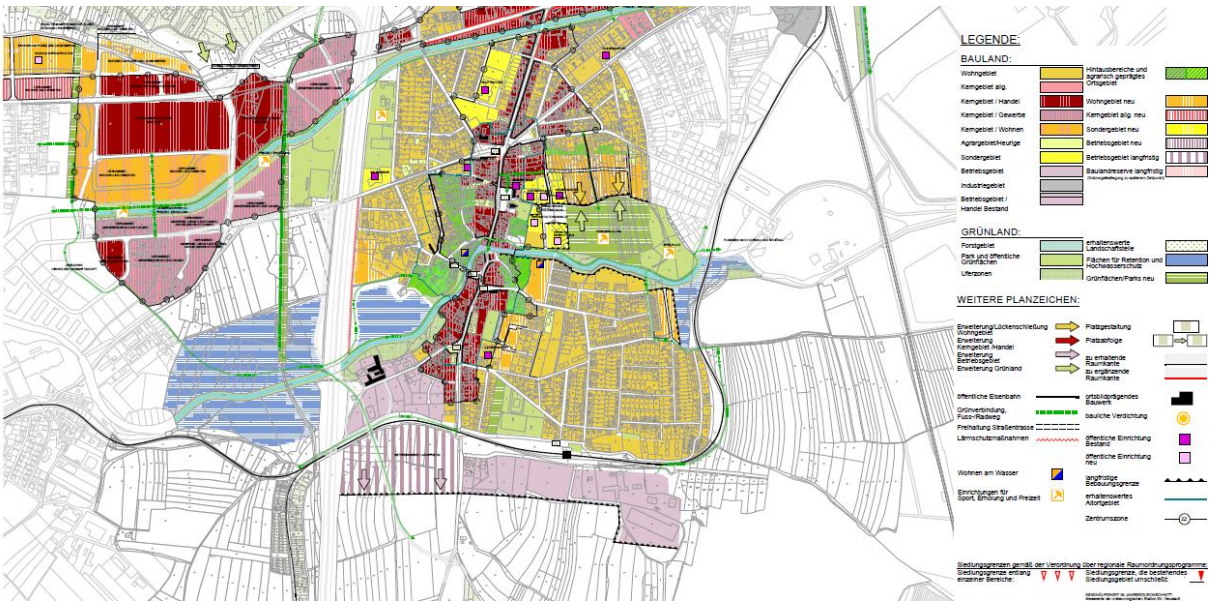

Figure 52: Unscaled cutting of the undecided local development concept 2014 Leobersdorf (Leobersdorf, 2014: 1)

In terms of flood protection it is furthermore necessary to point out that Leobersdorf is part of the waterboard Triesting (cf. Rammler, 2015: interview).

7.2 Local land-use planning and flood-risk issues in Sweden

In Sweden the comprehensive plans themselves are not legally binding and neither are there regulations how the implementation of flood-risk issues in the plans[61] is to be done. In this part examples of the implementation of flood issues in Swedish comprehensive plans are illustrated and a summary of implementation options within detailed development plans will be given.

7.2.1 Implementation of flood-risk issues in Stockholm

"The risk of flooding is an important issue which is handled at several different levels of administration. The County administrative board, with support from the responsible national government administrations (MSB), produce information and guidelines for the municipalities to take into account. In Stockholm, several administrations do take this issue into account, not the least in city planning. The issue is coordinated at the highest level (*Stadsledningskontoret*). Compared to other cities with more acute problems, such as Gothenburg, we do not have the same response in terms of specific resources" (Elgström, 2014: interview).

"Flood risk, and climate change issues in general, is a major issue in Stockholm. It is included as a topic in the comprehensive plan with correlated planning aims (guidelines[62])" (Elgström, 2014: interview).

[61] Risk factors like floods have to be mentioned. (cf. Gullstrand et al., 2003: 245).

[62] E.g. the recommendations within the regional plan or of the County Administrative Boards named in chapter 5.3.

Also the publication "Adapting to Climate Change in Stockholm" deals flood related issues like the consequences of a sea level rise as well as its connection to other topics such as ground contamination (cf. City of Stockholm, 2007: 14 – 18 and 21f.). However, "compared to other cities with more acute problems, (...) we do not have the same response in terms of specific resources. However, the investments in Slussen in Stockholm[63] means that (..) in the future" there will be "(...) better possibilities to respond to changes in water level in lake Mälaren." (cf. Elgström, 2014: interview)

More developed guidelines and materials for the coming comprehensive plan are scheduled, but at the current state flood-risk areas are not marked[64] in the comprehensive plan and it is discussed if information such as flood-risk should be "included in future comprehensive plans as mapped material."(cf. Elgström, 2014: interview)

On the level of the detailed development plan "flood risk is one issue amongst others" and there are – as stated before – no recurring restrictions and the issue is handled specifically in each case where an increased risk is identified", and regulations are specific requirements for new development in flood-prone areas" (cf. Elgström, 2014: interview).

The detailed development plan for Norra Djurgårdsstaden – Norra 2 serves as an example for a detailed development plan in a flood-risk location.
(cf. Stadsbyggnadskontoret Stockholm, 2009 a: 32)

Figure 53: Cutting of the detailed development plan Norra Djurgårdsstaden – Norra 2 (slightly adapted representation based on Stadsbyggnadskontoret Stockholm, 2009 b: 1)

[63] The location of a watergate between lake Mälaren and the Baltic Sea, which have different sea-levels.

[64] At the present state, it is not indicated in the comprehensive plan that material relating to flood-risk is existing (cf. Elgström, 2014: interview).

In the plan description it is stated that the area is at risk of flooding and for this reason requirements such as lowest floor level (regulated by street elevations in the plan) are necessary to minimise the consequences of a future climate change. (cf. Stadsbyggnadskontoret Stockholm, 2009 a: 32)

Although the County Administrative Board would have the power to revoke municipal planning decisions if hazard risks are not considered or if the planned settlement is inappropriate due to flood risk. This has not been the case in relating to flood-risk — in Stockholm — so far. Usually, the municipalities, which plan to build in a flood risk area, discuss that issue with the County Administrative Board to find a common solution (cf. Åström, Gauffin and Lagerblad, 2014: interview).

7.2.2 Sweden: flood relations in the comprehensive plan of Arvika

As mentioned before, Arvika created their own detailed flood map — within the scope of the Climate Proof Area project — for lake Glafsfjorden. This map is an important tool for municipal planning and is used also as foundation for legal binding detailed development plans (cf. Axelsson and Nordahl, 2015: interview). Interestingly, Arvika is not part of the 18 areas with significant flood-risk in Sweden. This is a result of the method used[65] to determine these areas since flood-risk in Arvika was seen as too small to be in the highest league. (cf. Gustavsson, 2015: interview)

However, flood-risk issues are also an actual topic within the municipality, which "(...) is focused to the surroundings of the lakes Glafsfjorden and Kyrkviken", in that case "land-use planning indicates that Arvika and the surroundings is to be secured against high water levels with a dam in the strait between Glafsfjorden and Kyrkviken." (cf. Axelsson and Nordahl, 2015: interview)

About two years ago also a land-use plan for an area southwest of Arvika (Västra Sund) was completed. This area is located at shores of the two lakes, which is seen as flood-hit area. Due to that, consideration of flood risk was necessary for different parts of the area. One example is the minimum floor height of + 49.5 m above sea level, which might be adopted when new embankments are finished. "According to detailed planning -— the flood risk is always a topic in the flood-hit areas of the municipality as well as during the process of applications for building permits." In the development of this land-use plan, guidelines "for building permits and planning with a respect to high water levels around the lake Glafsfjorden" were implemented in the planning process. (cf. Axelsson and Nordahl, 2015: interview) These guidelines were published in 2007 and include recommendations relating to a centennial flood and an extreme event at lake Glafsfjorden (cf. Arvika Kommun, 2007: 4ff.).

[65] This method included statistic data about lives, health, environment, economy, etc. which would be affected of floods of different levels (cf. Gustavsson, 2015: interview).

On request the municipal actors stated that "property owners/developers around the lakes Glafsfjorden and Kyrkviken are aware of where flood-risk is an issue as many properties were affected or damaged during the flood in year 2000" (Axelsson and Nordahl, 2015: interview).

7.2.3 Flood issues in the comprehensive plan of Kristianstad

Kristianstad, a city in southern Sweden "is possibly the most flood aware" city "in Sweden as its low-land location on a flood plain means that it regularly faces flood risk". In the "recent years there have been near disastrous floods in 1980, 1995 and 2002, which had recurrence intervals of 50 – 100 years" (cf. Thorsteinsson et al., 2005: 1). The city has about 35 500 inhabitants in the inner city and about 79 500 in the whole municipality (cf. Kristianstads kommun in Johannessen and Hahn, 2012: 374) and is "very vulnerable to flooding, because low lying land for agriculture and housing was acquired through building of embankments and lowering of lakes in the 19th century" (Kristianstads kommun in Johannessen and Hahn, 2012: 374). One of the largest embankments was built in 1868 and keeps, together with six large pump stations, the water out of the city. (cf. Johannessen and Hahn, 2012: 374)

In the last comprehensive plan, which dated back to 1990, there was no specific mention that the old bay is subject to flooding, but it was "clearly stated that the city is at risk to flooding when the River Helgeå runs high" and that climate change and a "subsequent sea level rise will increase" the flood risk in the future. It is also recommended that "long-term investments in low-lying areas for example below 5 meters[66] above mean sea level" should be avoided. (cf. Thorsteinsson et al., 2005: 4) The new comprehensive plan – of 2013 – "(...) recommends avoiding urban development in flood-prone areas and, if this is not possible, promotes related adaptation measures" (Stadsbyggnadskontoret, 2013 in Wamsler et al., 2014: 196). The comprehensive plan also mentions that embankments and pumps are necessary due to the location at former wetlands and the lake bottom. For the design/dimension of the embankment a combination of unfavourable conditions, e.g. rainfall, snowmelt and ground water conditions and consideration of future climate change (2 m above present mean water level), were used.
(cf. Stadsbyggnadskontoret Kristianstad, 2013: 82f.)

"An important issue in the municipality's on-going comprehensive planning is the protection of existing development in the area" (Mohlin and Lanné-Hagentoft, 2013: 296). Since "the older building stock, which was constructed without taking into consideration rising sea levels, will persist for a long time to come" (Mohlin and Lanné-Hagentoft, 2013: 296). However, concrete measures how to deal with these existing buildings within areas of residual risk are not named yet. However, options beside protection by the help of structural measures and relocation of buildings seem very limited.

[66] These "restrictions on land use to avoid or reduce potential hazards (...)" or the "establishment of a minimum height above sea level for new buildings" are also seen as climate change adaption measures (cf. Wamsler and Brink, 2014: 1366).

7.2.4 Flood issues in the comprehensive plan of Norrköping

Norrköping does not belong to the 18 areas with significant flood risk. That is because only lakes and waterways have been included in the analysis from MSB and coastal flooding has not been analyzed. (cf. Norrköping Kommun, 2012: 36) However the extent of climate change and flood-risk issues within the municipal comprehensive plan — in the risk appendix of the comprehensive plan — is relatively large and it refers to the regional recommendations of 2006. (cf. Norrköping Kommun, 2012: 43) In this appendix it is stated that about 2800 buildings in Norrköping are located at flood-risk areas (cf. Norrköping Kommun, 2012: 39), and due to climate change and a followed sea level rise of 1 m in combination with a 100-year flood "the sea level in the inner Bråviken bay" would raise "estimated 2,38 m above the current average." This leads to the recommendation "that new settlements should be located 2,5 m above the current average." (cf. Norrköping in Storbjörk and Hjerpe, 2014: 2277) However, the "risk appendix also contains an exception, permitting the practical and concrete outcome of climate adaptation in waterfront spatial planning to be negotiated case by case" (Storbjörk and Hjerpe, 2014: 2277).

7.2.5 Flood issues in the comprehensive plan of Falun and Borlänge

The latest comprehensive plan for Falun was created as corporate comprehensive plan with the municipality Borlänge in 2014. Within this plan the areas which are especially flood vulnerable are named and the plan also states that when planning new settlements flood-risk has to be considered. Since Falun is also one of the 18 areas with significant flood risk, flood hazard and risk maps exist. Beside a notice about the relevance of stormwater floods, general recommendations to reduce flood-risk (no buildings, except simple buildings as garages, etc. in centennial flood areas, risk assessments in areas endangered by 10 000 year floods, no important buildings, e.g. hospitals etc. in flood endangered areas) are part of the planning document. (cf. Falun-Borlänge, 2014: 70f.)

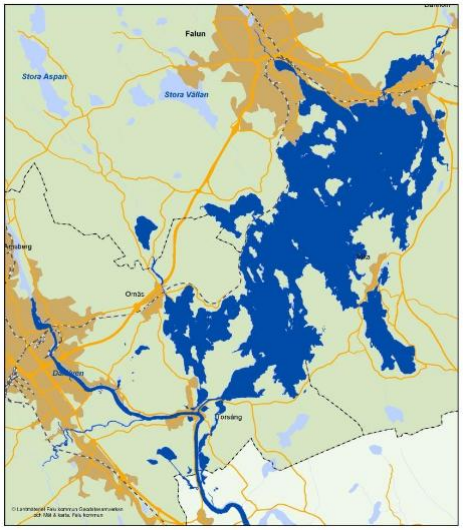

Figure 54: Lake Runn and river Dalälven at Falun and Borlänge (Falun-Borlänge, 2014: 72)

Furthermore, there are special terms for buildings endangered by floods of the lake Runn and river Dalälven (regulations for single-family houses, minimum floor levels and obligatory risk analysis in frame of a building permit) (cf. Falun-Borlänge, 2014: 74). In the following map the endangered areas (100, 200 and 10 000 year flood) at lake Runn in Falun are shown.

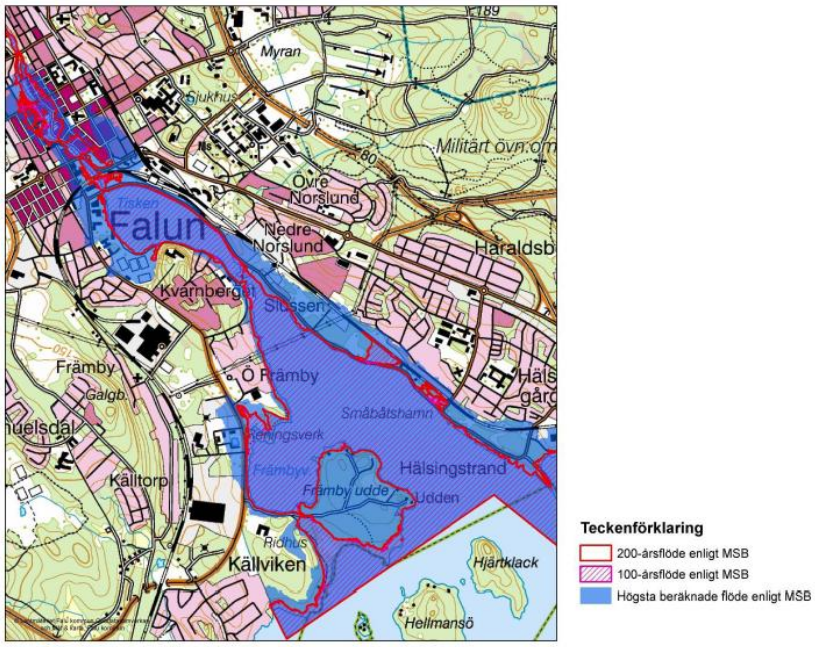

Figure 55: Flood-risk lake Runn in Falun (MSB in Falun-Borlänge, 2014: 74)

7.2.6 Flood issues in the comprehensive plan of Ockelbo

The comprehensive plan of Ockelbo mentions flood risk in relation to future climate changes, especially areas endangered of floods or landslides require special attention (cf. Ockelbo Kommun, 2012: 2) In the map, the flood lines for a design event and a centennial flood, as well as landslide areas are visualised.
(cf. Ockelbo Kommun, 2012: 159f.)

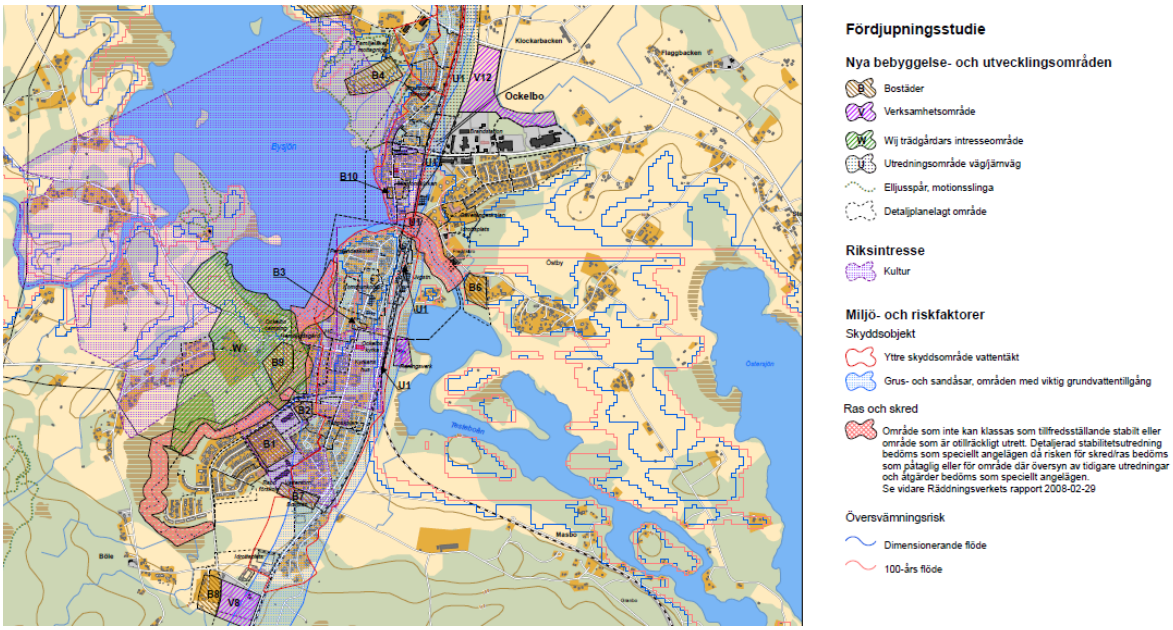

Figure 56: Unscaled cutting of the comprehensive plan Ockelbo (Ockelbo Kommun, 2012: 160)

7.2.7 Flood-risk issues in detailed development plans

Since it is not obligatory to implement flood-risk issues in the detailed development plan, although the municipalities have to consider flood-risk issues and land must be suitable in that way, it could be interpreted that flood-risk issues should be included in the detailed development plan if a flood-risk is existing in that area. In practice, this happens on a case by case basis, because general regulations or guidelines are lacking, and for example in Stockholm there are "no recurring restrictions and the issue is handled specifically in each case where an increased risk is identified. Regulation comes in the form of specific requirements for new development in flood-prone areas, such as necessary mitigation and security measures for buildings and public space" (Elgström, 2014: interview). In Falun (see the previous chapter) implementation of flood risk issues on the level of the detailed development plan is "quite new" and "except for not allowing buildings under the levels in the comprehensive plan" regulations have not used yet in detailed development plans. Discussions about "how to implement" these issues in the detailed development plans are still ongoing. (cf. Perols, 2015: interview)

One example for the implementation of flood-risk issues — which is more an adaptation to flood-risk than a complete building prohibition — is the development project Lillviken in Kalmar, where new residential buildings will be built within the floodplain. (cf. Kalmar Kommun in Boverket, 2009 b: 10)

Figure 57: Detailed development plan Lillviken in Kalmar (Kalmar Kommun, 2009, 1)

The detailed development plan states, that in case of a flood event the water can rise up to 1.4 m and due to that the floor level of buildings closest to the water may not be less than + 2.5 meters. The garage ramp and entrance should be also protected from floods. The plan also states that further investigation should be made for expected levels and frequencies of future floods before planning. (cf. Kalmar kommun, 2007: 11)

As a result, the "buildings closest to the water will stand on pillars, so that high water levels will not affect the building foundations" (Kalmar Kommun in Boverket, 2009 b: 10). However, there was no regulation within the detailed development plan that the buildings have to be on pillars, but due to the lowest floor level of 2.5 meters over sea-level in the detailed development plan — today the lowest building level is 2.62 meters over sea-level — actions were necessary and the pillar solution seems to be a suitable solution for the developer and the municipality. (cf. Vikman, 2015: interview)

In the current comprehensive plan of Kalmar — of 2013 — minimum floor levels due to flood-risk and sea-level rise are also mentioned. (cf. Kalmar kommun, 2013: 38) This lowest building level of 2.62 meters over sea-level is always considered within the planning process and within the development process of the detailed development plan, thereto a flood simulation is made, which includes rain and existing water- and sewage system. Due to that, current regulations are depending from case to case. For future planning also a new climate-adaption plan was designed, which will work as a guideline for detailed development plans, but the municipality has not started to use these guidelines yet. (cf. Vikman, 2015: interview)

Other approaches beside minimum floor levels are for example regulations for the technical supply system, which should be either placed at a minimum level or must be waterproof. Furthermore, in Kristianstad consideration of avoidance of bedrooms and spaces for disabled people is a current issue.(cf. Mohlin and Lanné-Hagentoft, 2013: 292ff.)

7.3 Actions relating to flood-risk in Austria

Simultaneously to the previous examples about flood-risk issues within local spatial planning this chapter points out examples of actions (on the municipal level) in Austria as well as their connection and interference with political interests.

7.3.1 Municipal recall by the supervising government of Lower Austria to act responsible due to legal requirements

Due to the legal basis of the spatial planning laws municipalities have to designate flood-prone areas and also have to reallocate endangered building land or decree building bans, if the legal requirements demand such measures. In December 2005 the supervising authority — the government of Lower Austria — sent some kind of reminder to all municipalities and cities, which named all necessary parts of the legal basis and the necessary approach. (cf. Government of Lower Austria, 2005: 1ff.) It was also stated that municipalities have been confronted with claims for damages after floods due to spatial planning or building regulation neglects and in a second recall the supervising authority reminded the municipalities about the legal requirements and their liability. (cf. Government of Lower Austria, 2008: 1ff.)

7.3.2 Information about flood-risk in Perchtoldsdorf

In the municipality Perchtoldsdorf (Lower Austria) published information about necessary actions relating to flood-risk — which was also presented in information events — on the internet. (cf. Perchtoldsdorf, 2015: online). Firstly, general information about flood related terms and explanations of occurrence probability, as well as legal requirements (visualisation of the run-off area of a centennial flood in the local development concept, building bans, etc.), as well as information about measures for flood protection are available for the public (cf. Hohenauer, 2012, 7 — 21). Secondly, actions within the hands of local municipal spatial planning, as hazard zone maps (e.g. an overview about endangered areas within the municipality is given) and their relevance for spatial planning — which is noticeable in building prohibitions and building bans — are available in a short overview for the public (cf. Perchtoldsdorf, 2012 a: 2 — 10). And thirdly, also the decrees of building bans (cf. Perchtoldsdorf, 2012 b: 1f.), information about run-off analysis — done within the municipal area — and the inundated areas[67] and also recommended measures[68] (cf. Papay, 2012: 9 — 22) are available.

By the help of this information (flood-) risk awareness and acceptance for necessary actions can be generated on the one hand, and on the other hand, it also shows that the municipality itself is aware of the flood-risk and deals with flood-risk and implement the legal regulations.

7.3.3 Missing building bans in Achau

As previously mentioned, the local development concept of Achau (Lower Austria) takes flood issues into account. However, more general relations are made, like the creation and preservation of flood run-off areas within and outside of the settlement area of Achau. (Örtl. ROP Achau 2003)

The existing recommendations in the local development concept of Achau and regulations in the spatial planning laws are contrary to the current situation — at the moment there is still not built-up building land available within risk areas without a building ban (cf. BMLFUW, 2015 a: 9). The endangered not built-up areas within the municipality were identified and the next steps (e.g. a building ban) behoves the municipality (cf. Siegl, 2015: interview). This matter of fact was also confirmed by the municipal chief officer. Due to political differences within the municipal council the building ban was not decreed and another examination of the supervisory authority — the government of Lower Austria was demanded (cf. Weber, 2015: interview). The rejection of the building ban can be also reviewed in the minutes of the municipal council meeting (cf. Achau, 2013: 4f.). In February 2015 elections for the municipal council took place within the municipalities of Lower Austria. It was stated by the municipal chief officer that, decision regarding the building bans in Achau should be possible in Spring 2015,

[67] At the stream Dürre Liesing and Petersbach inundations within the built-up and building land zoned area are possible (cf. Papay, 2012: 9 — 12).

[68] Structural measures, like retention basins, linear measures, adaptation of bridges and protection measures on the buildings are named (cf. Papay, 2012: 15 — 22).

when the new municipal council is in office (cf. Weber, 2015: interview). However, this inactivity of the municipality — especially the municipal court as a decision maker — can be a problem in the future.

However this way of acting cannot be seen as typical situation in Austria. Furthermore, it was named as an exception, especially in regards to the existing standards/regulations within the spatial planning law and in case of liability it was seen as problematic practice. (cf. Obkircher, 2015: interview) Furthermore Siegl stated, that Achau cannot be seen as a municipality with a big problem of endangered not built-up building land[69], since only limited areas within the closed residential area, where a building ban must not be decreed, are concerned. (cf. Siegl, 2015: interview)

However, in practice one can say, that the issue of building bans and reallocations more or less only concern areas not part of the closed residential area, since legislation include exception rules and only oblige building bans and reallocation for areas not seen as closed residential area. (cf. Siegl, 2015: interview)

7.3.4 Building bans as a consequence of new flood-risk information

Leopoldsdorf

Usually after a change of flood-risk related information like run-off analysis or the creation of a hazard zone map, reallocations or building bans should be decreed if endangered building land exists. An example for actions including of building bans after the development of flood-risk information[70] is the municipality Leopoldsdorf (Lower Austria).

As part of a study, made for the realisation of a flood protection project at the creek Petersbach, information about flood endangered areas was developed. As a result of legal regulations the municipality had to visualize the endangered areas within the land-use plan and furthermore, the mayor of Leopoldsdorf demanded the decree of a building ban for the endangered not built-up building land. (cf. Leopoldsdorf, 2013: 1)

Within the decree of the building ban, the municipal court also made clear the case of municipal liability[71], based on two decisions ruled by the Austrian Surpreme Court. In these terms it was stated, that actions relating to flood-risk issues are necessary. Subsequently a building ban for the endangered areas was decreed by the municipal council. (cf. Leopoldsdorf, 2013: 1f.)

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[69] In lower Austria municipalities with endangered not built-up building with the size of a few hectars exist (cf. Siegl, 2015: interview).

[70] Another example is the municipality Perchtoldsdorf, in Lower Austris, where also run-off analysis were developed, in consequence of this flood-risk information building bans — with reallocation advises for certain areas or regulations within the building regulation plan — have been decreed for the areas which would be inundated in case of a centennial flood. (cf. Perchtoldsdorf, 2012 b: 1f.)

[71] If endangered areas are not shown within the land-use plan, or if the authorities do not point out the flood-risk within the building procedures, the planning decision makers are liable in case of a flood damage (cf. Leopoldsdorf, 2013: 1f.).

Leobersdorf

Another example for building bans after the creation of new flood-risk information, in this case run-off analysis, is the municipality Leobersdorf (Lower Austria). The new run-off analysis, done in 2010, pointed out that large areas of building land within the municipality Leobersdorf are located within the run-off area of a centennial flood at the river Triesting and Neubach. However, at these areas also flood protection measures were constructed, in this relation the building ban has been decreed for a unlimited time for the not built-up building land located in the current hazard areas. In addition it is also mentioned that constructions, which can proof by the help of an expertise[72], that a flood-risk is exclusionary, are not opposing the building ban. (cf. Leobersdorf, 2010: 1) This municipal action was approved by the government of Lower Austria, as supervising authority (cf. Landesregierung Niederösterreich, 2011: 1).

7.3.5 Flood protection as an indirect effect of other actions in Salzburg

Due to the determinations within the spatial development concept of the city of Salzburg (Salzburg) — as well as due to the regulations within the spatial planning law — no new building land zoning took place within endangered areas and also no existing not built-up building land exists within red hazard zones. Areas around some smaller creeks in the North and East of Salzburg — where extensive building land was zoned in the 1960s — were reduced in the 1980s to the existing built-up plots and after that, no building land zoning in these outskirts took place. (cf. Schmidbaur, 2015: interview)

Another relevant factor in case of a limitation of soil sealing and conservation of retention areas is the green-land-declaration[73] (*Grünlanddeklaration*), which regulates the conservation of 3500 hectare zoned green-land[74] (cf. SalzburgWiki.at, 2007: online). This declaration focused on an inner- instead of an external-development and also a development border of the city was drawn, which is binding for the next ~ 30 years. Due to the regulations within the spatial development concept in combination with the green-land-declaration, the question of development within endangered areas is more or less non-existent and also the "legal durability" is higher than in other cities or municipalities. (cf. Schmidbaur, 2015: interview)

Furthermore, due to ecological aspects, 5 meter wide green-land zoning was done beside smaller creeks within the whole city area, which also prevents damages due to small-scale overflowing (cf. Schmidbaur, 2015: interview).

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[72] In this term the current state of the flood protection has to be considered (cf. Leobersdorf, 2010: 1).

[73] Due to the reformation of the green-land-declaration, changes of the determinations are just possible if a "citizens' vote" — which is binding for the municipal council — took place, as well as a 3/4 majority of the municipal council decided about the change. (cf. Stadt Salzburg, 2014: online)

[74] Changes are just possible — under the amending provisions — if compensation with a reallocation of ecological equivalent zoned not built-up building land takes place as well as if public interest obliges the change. (cf. Schmidbaur, 2015: interview)

7.3.6 Adaptation in Salzburg regarding climate change ensuring future flood-protection

Flood protection for the city of Salzburg — the constructions started in 2004 and should be finished by 2022 — is planned with a protection aim of a centennial flood + 50 cm freeboard (*Freibord*) (cf. Land Salzburg, 2012: 8f.). This freeboard can be also seen as a consideration of aspects of future climate changes, as well as the zoned green-land beside creeks which might prevent future damage due to an increasing flood-risk at these smaller watercourses. Beside these measures also the negative attitude relating to buildings on the open countryside (*auf der grünen Wiese*) can be seen as a measure for the conservation of water retention areas as well as a prevention of increasing soil sealing. Furthermore, strategies for a prevention of soil sealing, like roof greening and more frugal constructions of underground car parks — which reduce the water retention of the soil — are seen as "small adaptation" measures referring to future climate changes, e.g. heavy rain events. (cf. Schmidbaur, 2015: interview)

Under aspects of living with floods, in particular regulations with respect to allowance of adapted constructions/buildings within endangered areas, Schmidbaur stated that these questions about building within endangered areas are not relevant for the city of Salzburg, due to existing regulations and strategies. (cf. Schmidbaur, 2015: interview)

7.3.7 Reallocations of endangered building land

As previously mentioned, a measure — possible also subsequently to building bans — to prevent future damage and risks is the reallocation of building land, which is regulated in the spatial planning laws. But this is sometimes seen as a kind of expropriation and due to that the responsible decision makers execute that inherently (cf. Rammler, 2015: interview). The supervising authorities (government of Lower Austria) stated, that this argument does not apply and it is a protection of land owners of themselves, if they are interested to build in endangered areas and would accept future damage of their property (cf. Stellner-Bichler, 2015: interview).

Hadersdorf-Kammern

An example for extensive reallocation is the municipality Hadersdorf-Kammern (Lower Austria). Due to reservoirs at the river Kamp, a flood was not expected and at the time the land-use plan was developed, run-off analysis was not available for the whole municipal area; since new research results and the experience of a big flood event in 2002 (which could be analysed with aerial pictures) reallocations were essential. (cf. Pomaroli, 2015: interview) Due to the new knowledge about flood-risks within the municipality and the experiences in 2002, building bans and reallocations have been discussed were decreed in 2005. (cf. Hadersdorf-Kammern, 2005 a: 2ff. and 2005 b: 1f.)

However, the legal regulations make it clear that a reallocation in the case of flood-risk is without compensation, though the property owner of one of the reallocated plots (industrial land) caused a remonstrance at the constitutional court demanding financial compensation. On the basis of the spatial planning laws the demanded compensation was rejected by court. (cf. VfSlg 18.470/2008)

Salzburg

Another example of remonstrance at the constitutional court regarding reallocation took place in the city of Salzburg (Salzburg). In this case the land owner meant the reallocation was illegal, since in Salzburg direct reallocation regulations due to flood-risk do not exist within the spatial planning laws.

However, the constitutional court also decided that a reallocation, based on red zones in the hazard zone map is legally permissible, since the law does not allow land-use as building land in flood endangered locations. (cf. VfSlg 16.286/2001)

Gutenstein

In Gutenstein (Lower Austria), as a first step, building bans have been decreed, because a flood protection project in the alley of the river Piesting is planned, but only in areas where red hazard zone risks already existed or flood-risk in fringe areas of the building land reallocations took place. (cf. Fleischmann, 2015: interview).

7.3.8 Trans-municipal matters — flood protection in Altenmarkt im Pongau and Flachau

Trans-municipal matters in terms of flood endangered areas are also the case for some areas in Altenmarkt im Pongau, neighbouring municipality of Flachau (Salzburg). In certain flood endangered areas urban development is not possible and structural measures are necessary to protect the existing buildings and infrastructure. (Steiner, 2015: interview) For flood-protection measures in Altenmarkt im Pongau and Flachau the necessary areas for the retention basin are located within both municipalities, but Altenmarkt im Pongau is seen as the main beneficiary. The acceptance of the flood protection project, by the land-owners in Flachau was relatively low. The separate consideration of both municipalities within the realisation of this flood measure does not allow to align advantages and disadvantages beyond municipal borders. (cf. Winter, 2012: 92f.) The acceptance by the land-owners was not only low because the profiteers was the neighbour municipality, furthermore they wanted adequate compensation for the loss of value and for the provision of the flooded zone. In case of future developments of Flachau, the options are limited, but as mentioned before the areas which are used for the retention basin have not been regarded as possible building land within the spatial development concept. (cf. Oberreiter, 2015: interview)

Options for trans-municipal co-operation or trade-off of assets and drawbacks would be not only useful for the development of structural measures, e.g. retention basins, but also for prevented development options of upstream residents in favour of downstream municipalities, since flood protection should not only be considered on the level of municipalities, since it concern a greater area. Accordingly, consideration of flood-risk in upstream and downstream municipalities[75] is necessary, since measures have external effects on other municipalities. If all municipalities consider these regional matters the overall situation will not get worse. (cf. Oberreiter, 2015: interview)

However, in practice trans-municipal co-operation and trade-offs would be needed. Oberreiter stated that these co-operation and spatial planning co-ordination should be done by the province as supervising authority even if the municipalities are already obliged to inform the next up- and down-stream municipalities about the spatial effects of flood related developments. (cf. Oberreiter, 2015: interview)

7.3.9 Trans-municipal co-operation — Waterboard Triesting

As already mentioned, co-operation of municipalities regarding flood-risk issues is key. The example of the waterboard Triesting (Lower Austria) shows that municipal co-operation is possible and that certain technical measures, such as retention basins[76], have to be considered when it comes to spatial planning.

In the past run-off analysis for the Triesting alley have been developed to localise the ideal locations for retention basins. Within the waterboard the realisation of basins at certain locations was decided. Some were already realised while others are still in the planning process. (cf. Fischer, 2015: interview)

To enable a co-ordination within the waterboard, run-off analysis had been developed within the whole waterboard area to visualise the measures (retention basins) and their consequences on the municipalities. In this context also linear measures, e.g. dikes and building bans for inundation areas were taken. In addition, an information system about water levels[77] was created to enable fast responses in case of a flood within the waterboard. (cf. Fischer, 2015: interview)

Since only a single retention basin is operating yet — located upstream in Weissenbach[78] — flood protection for all downstream municipalities is not possible. In order to grant protection for all municipalities involved in the waterboard, all planned protection basins have to be realised. (cf. Fischer, 2015: interview)

[75] Upstream municipalites are not allowed to increase downstream flood-risk with measures within the own municipal areas (cf. Oberreiter, 2015: interview).

[76] Some areas are particularly suitable for the realisation of retention basins.

[77] The municipalities can look at the water levels of the whole river-basin area within the waterboard area (cf. Fischer, 2015: interview).

[78] This basin is just one of many, which should enable flood protection for all municipalities within the waterboard (cf. Fischer, 2015: interview).

However, the basic requirements are fulfilled: the waterboard acquired all necessary properties and for the financing a financing key based on the size of the population and the municipality area (share of building land, etc.) had been developed. (cf. Fischer, 2015: interview)

7.3.10 Revision of hazard zone maps after the development of flood protection measures

Building bans in Lower Austria are unlimited, but they would end if the site is not longer endangered by a flood, for example if flood-protection has been developed. However the revision of hazard zone maps is seen as a problem in case of residual risk[79]. Furthermore flood protection measures should provide protection primary and should not be used to enable building land zoning. (cf. Rauter 2001 in Seher, undated a: 8) Seher stated that land owners expect the revision of the hazard zone maps to build within formerly endangered areas. (cf. Seher, undated a: 8) In this case a visualisation of residual risk areas in case of HQ300 or another extreme event allows — as it is done in the hazard zone map of the BWV[80] — a differentiation of flood-risk areas and of flood endangered areas in case of an extreme event or in case of a failing flood protection. This information can be used further in planning decisions.

7.3.11 Extension of building prohibitions to areas with residual risk

In the current draft for the amendment of the spatial planning law of Upper Austria[81] building prohibitions for flood endangered areas are planned to be extended. At the moment areas which are not suitable due to natural conditions, especially areas located within the run-off area of a flood with a thirty years occurrence probability and endangered by centennial floods[82] are not allowed to be zoned as building land. (cf. OÖ ROG § 21 subsection 1 and 1a) The amendment plans to extend the building prohibition to areas with residual risk[83], e.g. red hatched areas (hazard zone map BWV) and raised areas within the red hazard zones. (cf. Land Oberösterreich, 2014: 29) This strategy is an important additional step, since developments in former endangered areas can increase the (residual) risk in respect of overflows or failure of protection measures (cf. Neuhold, 2015: interview).

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[79] As mentioned in chapter 7.1. the residual risk/damage potential increases if developments "behind the dikes" take place.

[80] The area with residual risk in case of failure of the flood protection or in case of an extreme event (HQ300) are visualised (cf. Bmlfuw, 2011 c: 6).

[81] Upper Austria is not directly part of this analysis, however this planned amendment would be also possible in other provinces in Austria.

[82] In this case (HQ100) exception rules are existing, e.g. if retention and run-off areas are not substantially affected and compensation-areas are established or if building land is not expanded with areas with a significant higher risk potential (cf. OÖ ROG § 21 subsection 1a clause 1 and 2).

[83] At the moment the hazard zone map WLV does not include areas with residual risk. However the law amendment also takes the option of future residual risk areas within these maps into account. (cf. Rudolf-Miklau, 2015: interview)

7.4 Actions relating to flood-risk in Sweden

Precautionary measures for natural hazard prevention or mitigation can be taken within local spatial planning. (cf. Swedish Rescue Services Agency 2000 in Gullstrand et al., 2003: 245). The following examples show actions in terms of flood-risk Swedish municipalities are taking as well as actions which can be seen as contradiction to successful flood-risk implementation.

7.4.1 Allowed flooding of "less important" uses

Previous in this thesis it seemed questionable if certain land-uses could be endangered by floods and if it is better if an industrial area is inundated or a settlement area. In general one can say that certain land-uses are more flood sensitive uses than others, and also the damage potential is different.

In the two Swedish municipalities Lomma and Vellinge the municipalities "made agreements with nearby golf-clubs to allow the golf course to be temporarily flooded to protect the city" (Wamsler and Brink, 2014: 1366). Agreements like in Lomma and Vellinge might be possible in many locations and these agreements could be connected to building-permits or regulations in land-use planning to allow future (not flood sensitive) developments in floodplains or at retention areas while the risk-potential of the city stays the same.

7.4.2 Additional measures: urban drainage

"City planners as well as developers are often lacking insight in issues concerning urban drainage", but the "importance of highlighting stormwater issues at a very early stage of the planning cannot be enough emphasized", because "the drainage of stormwater from new developments sometimes can influence the planning" (cf. Stahre, 2006: 67). Due to matters of urban floods caused by strong rainfall and increasing soil sealing the issue of how to deal with and how to drain storm water is also an important issue within (local) spatial planning that should be concerned within development projects: it not only affects the development and its direct surroundings but can also have (downstream) effects on other actors/municipalities.

7.4.3 Temporary flood protection to protect inappropriate land-use in Falun

"In Falun the safety vs. scenery conflict relates to the tricky balance of, on the one hand, the need to consider flood risks by avoiding building houses in risky areas and, on the other, the political ambition to build new settlements and facilities with proximity to water" (Storbjörk, 2007: 461). In the recent past, the dependency on temporary embankments for flood protection increased due to lowland localizations of settlements. Even if the general management strategy "strives to" minimise risks with temporary embankments, this does not have to lead to a decrease of the overall vulnerability "which stems from the choice of where to build in the first place." (cf. Storbjörk, 2007: 462)

However, Falun is one of the areas with significant flood risk in Sweden, and also the strategies within the comprehensive plan (see chapter 7.2.5) as well as possible implementation of flood-risk regulations in the detailed development plan (see chapter 7.2.6) indicate that there is a likelihood that in the future long term prevention strategies are very likely to be in the focus of the municipal decision makers.

7.4.4 Important infrastructure endangered by floods in Kristianstad

In Kristianstad the hospital, the headquarters of the Fire and Rescue Services, the main municipal waste water treatment plant (cf. Thorsteinsson, 2005: 4), "(...) works, settlements, day care centres, schools and eldercare run the risk of being flooded due to their lowland location" (Storbjörk, 2007: 460). Up to 12.000 people — depending on the risk scenario — are endangered in this area, which is protected by an embankment, that almost cracked in the flood of 2002. (cf. Storbjörk, 2007: 460) At the moment a new 10 km embankment is built and will be finished by 2020. Additional mobile/temporary flood protection is used to protect the city from floods. (cf. Inero, 2013: online)

On the one hand the flood protection for the existing town and infrastructure is necessary and understandable since relocation measures would not be possible. However a strategy to prohibit especially sensible uses, as important vulnerable infrastructure like hospitals, within the endangered area might be an useful long-term strategy.

7.4.5 Continuation of waterfront developments in Norrköping

Due to the municipal planning monopoly, it is up to each municipality to decide about spatial planning issues. The former chair of the town planning committee in Norrköpping stated "We need to complement Norrköpping with (...) waterfront housing, and here we have discussions (on what is appropriate)." The municipalities want to be as attractive as possible and plans on demand are often made. As a consequence, buildings in certain waterfront locations are possible, since sometimes decision makers act too nice and say "yes that should be possible" as another committee member in Norrköpping stated. (cf. Storbjörk and Hjerpe, 2014: 2275)

"Several politicans also emphasized the need to withstand pressures for inappropriate waterfront housing" and that the committee should have "(...) a long-term (...) responsibility" and ensure that there are long-term ideas and to withstand pressure when it is clear "(...) that building won't be sustainable in the long run." (cf. Storbjörk and Hjerpe, 2014: 2276)

This case is particularly important in case of liability of decision makers, because "once a local development plan is approved, politicians take responsibility for the appropriateness of the location, according to the Swedish Planning and Building Act." (cf. Storbjörk and Hjerpe, 2014: 2276)

However, a committee member in the study made by Storbjörk and Hjerpe stated "We are not elected to tell people where to live and not (to live). Then they will vote for someone else next time (...) but we do need to be clear about what areas are inappropriate or what technical measures can be used to avoid problems" (cf. Storbjörk and Hjerpe, 2014: 2276) Another committee member noticed a gap "gap between the detailed thinking of the town planning committee and the strategic thinking in comprehensive planning—which is unfortunate", as well as "(...) poor communication with the construction and environmental protection committee, which deals with planning permits, meaning that some areas are developed based on kind-hearted dispensations" (cf. Storbjörk and Hjerpe, 2014: 2281). This poor communication and a lack of interaction between different political committees involved in spatial planning activities was also shown from other actors within this study. Some areas which would be appropriate in terms of flood-risk were seen as bad alternatives in frame of public transport issues. (cf. Storbjörk and Hjerpe, 2014: 2281)

This example shows that also a case by case basis which allows planning flexibility, can cause problems and that exceptions that, for example, allow waterfront developments "(...) could end up with a situation in which the exception becomes the rule" (cf. Storbjörk and Hjerpe, 2014: 2280).

8 Core issues of the implementation of flood-risk in land-use planning

Measures within spatial planning can prohibit constructions or other measures which reduce the capacity of flood retention to preserve areas with a high retention capacity (cf. Seher and Beutl 2004 in Seher, 2008: 46), on the other hand water management "(...) usually provides 'lines of defence', boundaries that separate wet and dry areas. The lines result from accurate calculations of water engineers on design levels such as centennial floods. Often this separation is done with technical construction such as dikes. These lines enable planners to draw land-use plans on dry land" (Hartmann and Juepner, 2014: 1).

8.1 Limits of technical protection measures and residual risk

Technical protection measures, as dikes are an option to protect constructions located at former flood plains, but the dike is only constructed to protect for a certain event — for example a centennial flood — but not for bigger floods. As a result, smaller flood events will be prevented, but the vulnerability in case of a large flood — bigger than the design event still exists.

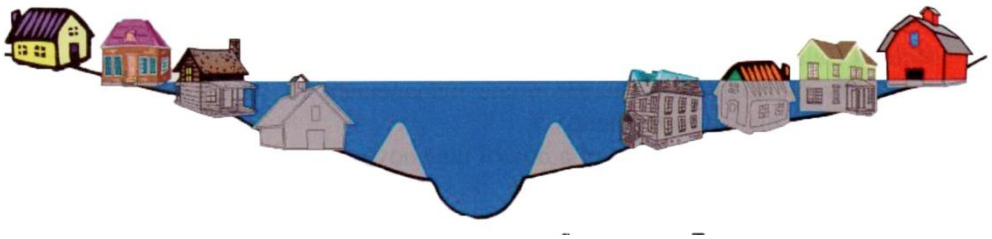

Figure 58: Dikes do not guarantee complete flood safety. The damage potential behind the dikes is large and generally growing as a result of the defences. (Kundzewicz et al., 2012: 20)

Developments, e.g. buildings in areas behind protection structures e.g. dikes, gain economical benefits but, as previously stated, it also increases the flood-risk — due to that these areas are seen as areas with residual risk — if the structures fail, or if the extreme event overflows them. (cf. Seher, 2013: 6)

Even if building prohibitions in areas with residual risk would be useful, but it is quite hard to realize. Since in some locations — e.g. in alpine locations — big areas are located within zones with residual risks Nachtnebel stated that a prevention of all (settlement) developments is not enforceable and other interests are predominant. (cf. Nachtnebel, 2013: 14f.)

Furthermore, Nachtnebel also stated that an indicator for the available not flood endangered areas, the share of inundated (in case of a flood with a low occurrence likelihood) permanent settlement area in comparison to the whole area which is suitable for permanent settlement can be used. If the share is high, it can be assumed that the settlement pressure[84] and furthermore the interest to construct building within endangered areas is high, because a small amount of areas without flood-risk exists. (cf. Nachtnebel, 2013: 14f.)

Another way to achieve a reduction of this residual risk is the improvement of the protection measure, e.g. adapted to a bigger design event, but "strengthening dikes encourages more intensive land use behind the dikes, hence, when there is an incident, there is more damage and society has a strong feeling of being at risk. This provides an impetus to raise and strengthen the dikes again" (Wiering and Immink, 2006: 430).

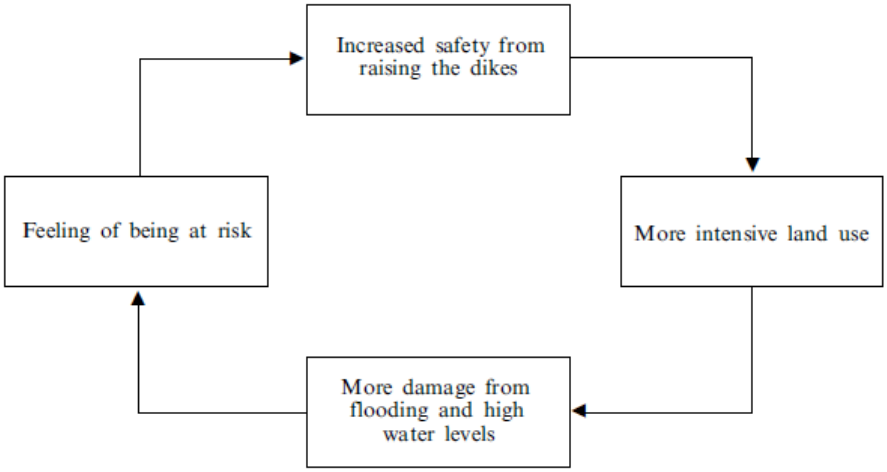

Figure 59: The control paradox (Remmelzwaal and Vroon in Wiering and Immink, 2006: 430)

"This strategy is thus a vicious circle, because the measures to reinforce the dikes do not, in fact, take away the cause of the problem and, in part, create new risks." This effect is known as "the control paradox" (cf. Wiering and Immink, 2006: 430).

Actually, this reaction is not really a paradox, it is rather a reaction to protection measures, such as dikes. After the construction of these structures the areas — which were endangered of a flood before — are safe. This safety leads to new developments, and a more intense land-use in the safe areas — as a reaction to the protective construction — increases the damage potential. A sore point of an adaptation/improving of dikes or other measures is that protection by these measures is not always possible, especially from an economical viewpoint. However, the fact that safety is improving and at the same time, due to the new developments in the area with residual risk, the overall risk increases can be seen as a paradox. Consequently, beside technical measures flood-risk adaptation within spatial planning is growing in importance.

[84] Another factor for a high settlement pressure is an increasing population (cf. Nachtnebel, 2013: 15).

8.2 Options to deal with flood-risk issues within spatial planning

Different options to deal with or to implement flood-risk issues within spatial planning exist. This part points out the core issues of spatial planning approaches respecting flood-risk.

8.2.1 Prohibition vs. adaptation of buildings in endangered areas

The Swedish Rescue Services Agency (SRSA) stated that there is a need existing within municipalities to take action to prevent or mitigate natural hazard events and that the "easiest way for municipalities to do so is to stop the exploitation of potential flood risk areas" (cf. Swedish Rescue Services Agency in Gullstrand et al., 2003: 245), this might be the easiest way, but in some municipalities there is "simply no land left that is not exposed to some kind of risk or environmental issue[85]" (Elgström, 2015: interview). In other municipalities large areas are affected by floods — some towns are located completely within flood-risk areas — does future development options in these towns or municipalities stop or has to be forced to stop totally? (cf. Pomaroli, 2014: interview)

On the one hand, regulations to prohibit buildings in endangered areas[86] are an option to prevent flood damages, and on the other hand, "local solutions to adapt new buildings and infrastructure to local conditions" (Elgström, 2015: interview) are possible for flood protection and allow future developments.

"For a municipality like Stockholm, with an intensive demand for new housing and new land designated for development, it is not an easy solution to just prohibit exploitation in these areas as this has significant political and economic consequences" (Elgström, 2015: interview). But adaptation to flood-risk is not possible to an unlimited extent and municipalities also have to face the fact that developments in certain areas are not possible due to flood-risk.

However, in practice, prohibition of certain areas as well as flood adaptation, resulting from exception rules to building prohibitions in Austria, are necessary measures for flood protection within spatial planning.

8.2.2 Relevance of land-use categories for flood protection

The object of spatial planning is the planned overall design of a certain area. With the instruments of spatial planning spatial demands and spatial use should be distributed according to the suitability of the location. As mentioned before natural hazard endangered zones reduce the use possibilities, but the consideration of these risks can help harmonize the different aspects of danger/risk and use-interests of the land owner. (cf. Weber and Seher, 2003: 71)

[85] However in the Austrian province Vorarlberg with a limited suitable area for permanent settlement, due to the alpine location, a building prohibition in HQ300 endangered areas is existing within the spatial planning laws (cf. Neuhold, 2015: interview).

[86] One Austrian example is the province Upper Austria, where a building prohibition for HQ30 is existing, while in HQ100 exemption rules for buildings are existing. However even there a change to a total building ban in HQ100 is recommended. (cf. Nachtnebel, 2013: 14)

Hence, land-use planning can also deal with flood-risk on a differentiated level, e.g. which kind of function requires which level of protection? "Might a commercial area be inundated more often than a residential area?" (cf. Hartmann and Juepner, 2014: 1)

Seher stated that not the whole flood run-off area is endangered to the same extent and not every building is flood prone to the same extent. The existing regulations within the Austrian spatial planning laws more or less do not know a differentiation, although in areas with smaller risk potential or for areas with residual risk building with consideration or uses with a low vulnerability is possible. (cf. Seher, 2013: 7) In comparison, the case by case basis in Sweden can have benefits in this way.

However, it is to say that the best behavioural precautions are to avoid endangered areas (cf. Bmlfuw, 2011 a: 8), which might not be possible due to spatial circumstances, as geographic conditions and subsequently very limited areas which are suitable for permanent settlements. Due to that adaptation and the allowance of floods in certain (used) areas might increase in importance.

It is necessary to say that adaptation strategies which allow "living with floods" are useful, but areas which are especially important for flood retention or suitable for flood protection measures should be kept free from other conflicting uses.

8.2.3 Preservation of areas with a high flood retention capacity

Recovery of original natural flood run-off and flood storage areas and the production of new retention areas as well as a reduction of the vulnerability of settlements is a main aspect of flood protection, therefore measures on the municipal level come to the focus. (cf. Kötter, 2011: 231f.) Designation of flood run-off and retention areas and land-use categories can prohibit uses which reduce retention capacity and could ensure (new) retention areas. In Austria there are no specific land-use categories for flood issues, but within regional planning, settlement borders or regional green areas can be marked (these instruments could be also used for flood issues). Subsequently, local land-use planning zoning as green area could preserve retention areas. However, the spatial planning instruments in Austria are only suitable in a limited extent to precipitate a certain use. (cf. Seher, 2006: 5)

However a problem is that it is not possible to force (Austrian) municipalities to zone areas as green areas which must be kept free for flood retention (cf. Pomaroli in Bmlfuw, 2009 b: 27). Furthermore, flood retention areas are often not only relevant for a single municipality and municipalities are often not willing to provide areas for flood-retention for other municipalities (cf. Mair in Bmlfuw, 2009 b: 25).

8.3 Municipal co-operation and upstream/downstream relations of flood-risk

Floods do not know municipality borders, but flood-risk measures within the hands of spatial planning are usually limited to local spatial planning of the municipalities (cf. Seher, 2012: 53) and the "risk for strong floods due to global climate change has received an increased importance. There are urgent needs for these issues to be handled in physical planning of land and water use within a river basin" (Gullstrand et al., 2003: 245).

Actions on a regional level are not really performed, but the different location of municipalities at a river (upstream or downstream resident) offers different actions. On the one hand upstream a technical measure for flood protection can affect the downstream municipalities and on the other hand retention areas within the upstream area reduce the development potential of the upstream municipalities. (cf. Seher, 2012: 53) "Potential negative consequences like an increased risk of flooding are for the account of downstream communities (negative external effects)" (Seher, 2011: 259).

Floods have a regional dimension. This also calls for corresponding approaches on this regional level, but a regional approach causes an overlapping of political and administrative areas and the catchment area/the river basin. (cf. Seher, 2011: 259). Larssons holds a similar opinion on a needed regional approach: "Since fluvial (river) flooding depends on conditions in the whole river basin, it is necessary to think and act basin wide" (Larsson, 2015: interview). However, water does not know municipal borders and a large physical planning framework would be needed to provide space for the river, which is missing in Sweden. "Also, socio-economic objectives may take precedence at the local level, and upstream or downstream management of water resources may not be a priority for the concerned municipality." (cf. Johannessen and Granit, 2014: online)

Hence, planning on the base of river basins "opens up a gap between this newly-defined administrative area and existing territorial institutions and stakeholders (communities)" (cf. Seher, 2011: 259), but river "(..) basin management is a classic example of responding to problems of spatial fit" (Moss, 2004: 87). "By managing water resources according to the territorial unit of an ecosystem rather than political-administrative boundaries, river basin management is designed to address the interdependencies between, in particular, upstream and downstream effects, water quality and water quantity, and water and adjacent land-use resources" (Moss, 2004: 87).

A lack of municipal cooperation in Austria was also recognized within the flood risk II report of the Ministry of Agriculture, Forestry, Environment and Water Management, because often a co-operation of municipalities is needed in order to achieve effective measures (cf. Bmlfuw, 2009 a: 13).

This problem was also noticed by Evers et al., who stated "flood and planning issues are not regarded and handled on the level of river basins but on administrative areas" (Evers et al., 2012: 2).

Beside waterboards or co-operations for the creation of technical measures regional co-operations hardly exist in Austria and in practice an approach based on river basin districts is not supposable in Austria, because flood risk prevention is just a part in (local) spatial planning; certainly, in some cases a consideration of the whole river basin would be useful, but due to many other aspects — e.g. economic co-operations — a treatment within municipal borders is the more practical approach. For example, in cases of strategic environmental assessments a regional consideration as well as in some cases of regional cooperation, in frame of water boards or water cooperatives for the realisation of flood protection measures, exists. (cf. Pomaroli, 2015: interview)

However, even if there are river basin district authorities[87], as well as ideas for a co-operation on the level of river basins[88], exists. In practice planning on the level of river basins within spatial planning is not existing and no legislative implementation[89] has taken place so far.

8.3.1 Downstream effects of upstream floods

In Summer 2009, the upper part of the river basin of the Swedish river Svartån received about 120mm of rain and 40 mm later that day. The heavy precipitation caused a fast rising of water levels and about 600 ha of agricultural land was flooded after a levee broke. As a result of the upstream flooding the city of Västerås, which is located downstream at the river Svartån was not affected in the same extent[90] as without the upstream flood. (cf. Hjerdt, undated: 8f.)

[87] For example in Sweden Authorities, based on the water framework directive, exist (cf. Vattenmyndigheterna, 2009: 2).

[88] E.g. the integrative river basin management plan (IRBMP) for the river Ilmennau in Germany in frame of the flood related project SAWA (cf. Evers et al., 2012: 3) or the protective water management spatial development plan for the river Möll in Austria (SREP) (cf. Manhart, 2012: 96).

[89] E.g. of plans like the protective water management spatial development plan.

[90] The peak flow was just about twice the average discharge (cf. Hjerdt, undated: 9).

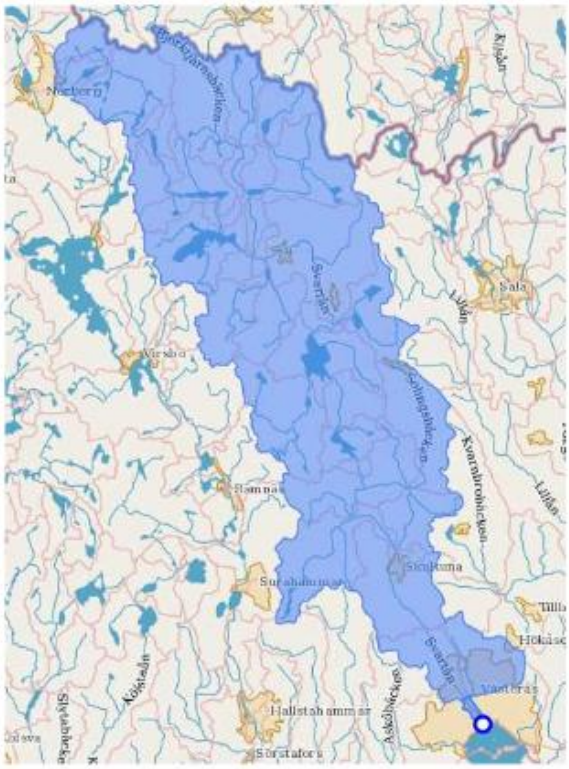

Figure 60: Svartån river basin (Hjerdt, undated: 8)

However, the question of the reasonability of allowed/planned flooding in upstream rural areas to protect downstream urban areas arose. Low lying fields could be converted to wetlands easily. (cf. Hjerdt, undated: 9) This example shows upstream-downstream dependencies of municipalities. However, "socio-economic objectives may take precedence at the local level, and upstream or downstream management of water resources may not be a priority for the concerned municipality" (Johannessen and Granit, 2014: online).

8.3.2 Parochialism of municipalities

Hans Peter Köck of the Institute of Spatial Planning and Living in Salzburg mentioned that a major problem in Austria is that the sovereignty of spatial planning is based within municipalities. Due to that the planning authority — the mayor — focus on his sphere of action. Köck also emphasises, that the municipalities should considerate more carefully where constructions should be prohibited. (cf. ORF, 2012: online) Contradicting is the point of view of M. Mödlhammer, the president of the municipal association, who mentioned that there was no spatial planning decision within Salzburg that was not approved by the provincial supervising authority (cf. ORF, 2012: online) and in this term everything was planned on a legal basis. In this context, some municipalities with development potential (in terms of growing population, etc.) have to face the problem of missing development opportunities, because the necessary areas are endangered by natural hazards. (cf. Winter, 2012: 89)

Improvements of this situation may only happen within regional spatial planning, but this requires professional competence and the ability to communicate, as a spatial planner stated. Therefore, the province or the regional administrative authorities have to take actions to motivate or support municipalities as well as active interventions on a regional level. However, this requires intense discussions and a focus on the best overall solution as well as regional compensations — which might be of financial nature. But despite all efforts in that direction there will be always cases where regional coordination will not work. On the level of single municipalities, the options are very limited, which is why a coordination for example within the regional level should be aimed at. (cf. Fleischmann, 2015: interview)

Nevertheless, there are examples of regional cooperation or solutions within water boards or similar organisations within Austria and another option for regional co-operation would be within the frame of small-scale regional concepts, if it concerns waters of a medium size (cf. Siegl, 2015: interview). Which would be useful regarding the different requirements within the river basin. Also Obkircher stated, that municipal co-operation could be possible on the a small-scale regional level. (cf. Obkircher, 2015: interview) However, yet there are no best practice solution as regards spatial planning matters.

8.3.3 Options for zoning of retention priority zones

As mentioned before the share of endangered areas of the whole area suitable for permanent settlement, as well as increasing population are indicators for conflict potential of flood-risk areas and building land/settlement areas. (cf. Nachtnebel, 2013: 14f.) Furthermore Nachtnebel stated within a project in Upper Austria, that the focus on preservation of retention areas should be located in municipalities without a high conflict potential. Due to that, within the catchment area, first of all the necessary important retention areas should be localised and as a second step, the focus should be set on areas within municipalities without a high conflict potential[91]. These areas should be kept free of constructions and building land zoning. The loss of land could be compensated with inter communal compensation payments. (cf. Nachtnebel, 2013: 20)

8.3.4 Options for municipal compensation

A model for municipal compensation was developed within the Austrian project FloodRisk II, and its practicality was tested in three municipalities at the river Traisen. Hereby, the compensation for the reduced economic development potential of the upstream municipalities in consideration of socioeconomic links of the municipalities and hydraulic dimensioning of compensation area was calculated. (cf. Seher, undated b: 13ff.)

[91] In terms of the two indicators mentioned above.

This was done by implementing opportunity costs (e.g. missed revenues due to not realised industrial area), opportunity revenues (e.g. infrastructure costs which would be necessary), the project realisation likelihood, transaction costs, benefits for the upstream municipality (e.g. revitalisation of alluvial forests, creation of recreation areas) as well as links within the municipalities (e.g. commuters). (cf. Seher, undated b: 14) In this case the model — which uses all necessary parameters and was already used in some municipalities (cf. Seher, undated b: 15) — shows that planning within observation areas bigger than a single municipality, can work and how compensation payments could be calculated.

Measures to enable such a compensation are needed, since Seher stated in a previous publication, that the municipalities are an insufficient level of planning because they are competing against each other in terms of direct municipal tax revenue and without compensation upstream municipalities would not abstain development options and financial revenues in favour of downstream municipalities. (cf. Seher, undated a: 8)

8.4 Local decision makers and flood-risk implementation

In Sweden as "a result of increased interest in lakeside and coastal living flood prone areas have been more developed during the last decades" (Näslund-Landenmark, undated b: 2). Storbjörk also mentions that in some municipalities a strong political pressure to attract new citizens and change former trends o population decline by, (...) providing desired settlements with proximity to water" and so in the last decades built up areas located in lowland areas and close to water have increased. (cf. Storbjörk, 2007: 460). Such strategies — to "vitalize the city by improving aesthetic values in areas close to water", to make the city more attractive — create "an advantage in the general competition of attracting new residents and tax-payers" — which can be seen as economic values — are conflicting with risk reduction strategies to avoid buildings in endangered areas. (cf. Storbjörk, 2007: 461) Another factor is that "many municipalities are in practice dependent on private investments to ensure new settlements. The trend toward plan making on demand suggests a transformation where planning risk being less regulating with respect to private actors and more growth oriented" (Madureira 2013 in Storbjörk and Uggla, 2014: 3).

This conflict also lead to questions if it is "(...) reasonable to invest all this money in protection to be able to place buildings close to water?" and if it necessary to "(...) take the risk of flooding every tenth year or build somewhere else?" (cf. Storbjörk, 2007: 462) A statement by an interview in the study of Storbjörk and Uggla is that waterfront areas are often wanted by developers and these needs on the market are contradicting the intentions to build flood-proof and to avoid buildings in lowland waterfront areas. Due to that "dealing with flood risks can end up being at odds with local planning strategies aimed at developing attractive waterfront areas. (cf. Storbjörk and Uggla, 2014: 8)

This ongoing development of waterfront areas and coastal infrastructure and changes in rainfall patterns as well as rising sea levels — especially in the southern part of Sweden — "mean that Sweden is becoming more vulnerable to floods" (cf. Johannessen and Granit, 2014: online).

However, there are also problems to implement flood-risk issues. Sometimes scenarios which are the basis for the calculation of flood-risk are not seen as the truth and officials try to avoid the risk of being blamed if scenarios prove insufficient (cf. Storbjörk, 2007: 465), or the development pressure and demand to build in attractive — but vulnerable — coastal zones or floodplains "make it difficult to adopt a preventive approach that recognizes that water flows and floods need space", even if "municipal planning experts are aware that development should be avoided" in these sensitive areas. (cf. Johannessen and Granit, 2014: online) In other cases, scenarios were seen as unrealistic[92] (cf. Winter, 2012: 90), inundation was seen as impossible due to dams and reservoirs[93] (cf. Pomaroli, 2014: interview) or no consent of involved parties to construct protection measures made it impossible to realise them (cf. Loizl, 2012: 11). In other cases in Sweden officials were "consciously avoiding showing citizens maps of flood prone areas upon which local guidelines are drawn in order not to end up in the role of determining what is safe or not" (Storbjörk, 2007: 465).

Due to "strong local stakeholder interests (e.g. in agriculture) flood risk reduction in Sweden is not prioritized, and is often strongly challenged" (Johannessen and Granit, 2014: online). Also Storbjörk and Uggla state that "some planners see it as their role to make sure that waterfront planning meets the local strategic guidelines whereas others, particularly those facing population decline and weak economies, state that they want to be attractive for private developers rather than putting pressures on them to fund expensive protective measures" Storbjörk and Uggla, 2014: 8). Some planners also mentioned that in "retrospect many problematic waterfront areas have been built and are still increasingly planned for" (cf. Storbjörk and Uggla, 2014: 8). Another example for Austria, for making an inconsequential behaviour of municipal decision makers possible is the exemption for building land zoning within a closed residential area (see chapter 6.1.2), many municipal decision makers are often not willing to explain their voters why reallocation and building bans are required while new zoning as building land within closed residential areas is possible. Another reason is the interpretation of legislation as they "have to" enact a building ban instead of that they "must" enact a building ban. (cf. Scherz, 2012: 87) Another problem is the obligatory reallocation of endangered building land, when a building ban was enacted; after five years— if the risk is not removed — this should not be necessary for endangered building land within closed residential areas, since the authorities are allowed to zone new building land in this areas even if a risk is existing. This issue should be clarified. (cf. Obkircher, 2015: interview)

[92] E.g. at the river Enns in Altenmarkt in Salzburg (cf. Winter, 2012: 90).

[93] E.g. reservoirs at the river Kamp in Lower Austria (cf. Pomaroli, 2014: interview).

On this basis, one can say it can be hard to implement flood-risk issues in political motivated and steered processes as land-use planning, where many different actors and interests are involved. But there can be situations which make it easier to address and implement these issues.

Land-use planning is strongly connected to political structures — which also include legislative periods—and political authorities. Storbjörk mentions that "no politician wins an election by investing tax-payers' money in risk management related to dangers that either occurred a few years back or may potentially occur in the future. Political realities mean that to succeed in politics and gain public support, core issues are schools, eldercare and medical services, not risk management. The exception to the rule is of course if flooding has recently occurred" (Storbjörk, 2007: 462). Due to that there is a lack of preparedness and sufficient risk management existing and national authorities have stated that this vulnerability and "risks are like ticking bombs", but they "do not cope with or take responsibility for" (Storbjörk, 2007: 463). The consequence of this is initiatives dealing with flood-risk, e.g. trans municipal cooperatives are often "disaster driven". This means actual problems caused by flooding in the recent past and the followed increasing risk awareness can be a driving factor to implement flood-risk issues in physical planning or to realise protective measures. (cf. Seher, 2012: 57) These "windows of opportunity" have to be used to realise flood protection as well as to generate inter-communal co-operations, e.g. a trans-municipal co-operation of up- and downstream municipalities. (cf. Bmlfuw, 2009 a: 152)

One could say that it is necessary to realise strategies, which might be hard to be accepted by the general public in the right moment, but for that purpose it is also necessary to have strategies "prepared in the drawer", because otherwise awareness could decrease until the strategy is ready for a realisation.

Some Swedish municipalities mentioned "We already have much existing settlements in waterfront areas so there is no point in saying no to further waterfront planning. We cannot move the whole city." And "If we would take all matters into consideration in planning we wouldn't be able to build anything. Planning is all about finding compromises." (cf. Storbjörk and Uggla, 2014: 8)

These perceptions are contradicting with the current roles and functions of spatial planning — relating to climate change adaptation — which were outlined by Hurlimann and March 2012. They state planning has to" coordinate matters of collective concern or public good" as well as the ability to "manage and facilitate the consideration of competing interests" and "can reduce or modify uncertainty and provide new mechanisms to deal with changing circumstances" and "is oriented to the future and has the potential to coordinate the activities of a range of actors to achieve long term benefits" (cf. Hurlimann and March, 2012 in Storbjörk and Hjerpe, 2014: 2272).

The decision to postpone flood-risk related decisions which can be influenced by future climate change can cause "a future large-scale urban security concern" (cf. Storbjörk and Uggla, 2014: 8), and also Larsson stated "inevitably the ambitions and quality of work in a municipality depends on the individual officers/bureaucrats and politicians. Therefore someone has to make sure that all those individuals fully understand the importance of flood risk. Then there has to be a combination of carrot and stick in order to get results" (Larsson, 2015: interview). It was illustrated in a similar way in Austria, and it was stated that the implementation of flood-risk issues and their achievements depend very strong on individual officers and decision makers within the municipality (cf. Obkircher, 2015: interview).

However, this wait and see or "it-won't-happen-here mentalities"(Storbjörk, 2007: 461) — studies about climate change adaptation "document that municipalities tended to adopt wait-and-see approaches with (...) event-driven adaptations relying upon technical measures (...) focusing on climate variability and current weather extremes (...)"(cf. Storbjörk and Uggla, 2014: 1f.) — and the lack of awareness of their responsibility of decision makers within the municipalities can cause trouble in terms of their liability if they do not take actions or — in the worst case — ignore risks.

8.5 Liability of land-use decision makers

Implementation of flood-risk issues — and also other issues e.g. relating to climate change — in spatial planning is on the one hand important to not "lock future generations into development pathways that increase vulnerability" (cf. Rayner, 2012, Pielke et al., 2007 in Storbjörk and Uggla, 2014: 1), and on the other hand, the acting of decision makers can have (negative) consequences for them or for the municipalities if they do not act responsibly.

As previously mentioned, within the land-use planning process — in both of the sample countries, Austria and Sweden — risk due to natural hazard or unsuitable soil conditions, has to be considered by the decision makers and if the consideration of these issues is inadequate, municipalities might have to deal with legal actions not only by property owners but also insurers (cf. Thorsteinsson, 2007: 486).

If flood-risk had been ignored or not considered in an adequate way, according "(..) to the Planning and Building Act (*Plan- och bygglagen*, PBL) the municipality is liable during the implementation time of the detailed development plan, which can be up to 15 years. After that period the property owner is to be liable" (Carstens, 2015: interview). Storbjörk and Uggla also mention in their study that due to the responsibility for a "consideration of risks of flooding and erosion" and that they have "to plan for new settlements with respect to climate change", the "main locus of responsibility lies with municipalities who can be held liable for bad decisions up to 10 years" (cf. Storbjörk and Uggla, 2014: 3).

On request at county administrative boards, the case of compensation and liability has never been tested in court, but Carstens mentioned that it "is possible that the municipality's liability would be extended in case of testing" (cf. Carstens, 2015: interview). Thorsteinsson et al. also mentioned that "insures have sought and received compensation from municipalities in cases where the physical planning has been less than satisfactory in the flooded area" (Thorsteinsson et al., 2007: 499), because "under Swedish law, inadequate attention to flood risk when issuing permits may leave municipalities open to legal action from property owners and insurers upon flood damage" (Thorsteinsson, 2007: 486).

In Austria, there is no general flood liability of municipalities which obliges protection of buildings or property of land owners within the municipality (cf. decision OGH 1Ob24/12d), but municipalities have to visualize flood endangered areas like hazard areas (cf. NÖ ROG § 15 subsection 2 and Slbg ROG § 43 subsection 1).

In this relation the Austrian supreme court stated that land owners can count on zoning decisions as part of the land-use plan in case of the building potential of these plots and furthermore municipalities have to visualize existing hazard zones and flood run-off areas within these documents. If these areas are not visualized the municipality acts culpable. (cf. decision OGH 1Ob158/06a) Furthermore, the Austrian supreme court stated that, municipalities have to consider known risks when they issue a building permit. (cf. decision OGH 1Ob178/06t)

In general, if Austrian municipalities ignore flood-risk or if the consideration of these risks is inadequate, e.g. if a building ban or reallocation would be necessary due to the spatial planning laws, the supervising authority does not have legal means to enforce them. However, consequences according to civil law for the municipalities are possible. Therefore it was mentioned, that the mere existence of a risk cannot cause any consequences, but in the event of damage or loss, civil liability of the municipal decision makers becomes effective. (cf. Stellner-Bichler, 2015: interview)

With this in mind, inactivity, i.e. wait and see instead of declaring a building ban or reallocation of the municipality, can be a problem in case of their liability.

Public liability of municipalities in relation to natural hazard is also possible — due to the regulations within the Act on the Public Liability (*Amtshaftungsgesetz*) — in case of wrong actions, inactivity or wrong information. Examples therefore would be wrong information about hazard zone maps (e.g. necessary building requirements due to the location of the building plot within a hazard zone) or issuing of a building permit despite municipal knowledge or recognisability of the flood-risk. The federal province is liable in case of the approval of illegal land-use plans and if the authority does not overrule illegal building permits. Beside that a liability of technical experts (e.g. the WLV and BWV) — if an expert statement is wrong or incorrect — is also possible. (cf. Bmlfuw, 2009 a: 169f.)

8.6 Future flood-risk

Management of future climate risks, such as extreme weather events and increased preparedness, is often discussed in studies about future climate change adaptation. (cf. Storbjörk, 2007: 458). Urban extreme rainfalls, and their consequences at bottlenecks in urban hydrology as well as adaptation of streets and neighbourhood drainage systems are factors which increase general flood-risk (cf. Johannessen and Granit, 2014: online). But also smaller creeks, which are not seen as areas with significant flood-risk, which are now confronted with a development pressure — partly based on the use restrictions caused by flood endangered areas — as well as surface water/run-off[94] are increasing general flood-risk in the future (cf. Pomaroli, 2015: interview).

These additional factors show that action relating to flood-risk issues as well as general strategies like minimising soil sealing to prevent urban floods are important aspects of spatial planning and therefore actions of responsible decision makers are necessary.

Beside climate change also development of flood-risk information is able to affect flood endangered areas. Due to legal regulations today flood-risk has to be considered within the planning process, but in the past because of various reasons e.g. missing information, risk- and run-off-analysis, etc. development in floodplains took place. Insurances and financial support in case of a flood-event are useful and important instruments for affected property owners, especially if decision makers have to balance interests and risks. E.g. If they should "(...) take the risk of flooding every tenth year or build somewhere else" and if it is "(...) reasonable to invest all this money in protection" (cf. Storbjörk, 2007: 462).

Yet "flooding is the leading cause of losses due to natural phenomena in Europe, and is responsible for a greater number of damaging events than any other type of natural hazard" (Kron, 2012: 459), but due "to its economic situation Europe is far more capable of protecting itself against natural disasters than less wealthy and less developed countries and emerging nations" and therefore, "losses from extreme events tend to be monetary rather than in terms of human lives" (cf. Kron, 2012: 466). Efforts on flood-control can "explain why flood losses do not show distinct upward trends", but as mentioned before beside flood protection, these measures "encourage (..) development in the areas protected" and the overall risk might increase (cf. Kron, 2012 466f.). For that reason flood insurances become more and more important within the discussion of flood-risk relevance within spatial planning. Sweden and Austria are located in different sub-regions of Europe, but in "particular, the number of flood events is increasing in each region, but at different rates" (cf. Kron, 2012: 462).

[94]Floods without a river, which are caused by extreme rainfall (cf. Pomaroli, 2015: interview).

The actual losses caused by floods is seen as "realised" risk and the most costliest floods in Europe happened in 2002 in Central, southern and eastern Europe with overall losses of € ~ 22 billion, of which merely 16 percent had been insured; in comparison the flood in Switzerland, Austria, Germany, Hungary and Slovenia in 2005 lead to losses of € 1.4 billion and 53 percent were covered by insurances. (cf. Kron, 2012: 459ff.) An increase in losses can be explained on the one hand, by more settlements in flood-prone areas and increasing values within these areas and on the other hand, by a "greater susceptibility of values to water" (cf. Kron, 2012: 476), while the difference of the insurance coverage can be based on damaged public infrastructure objects — usually not insured — or also on obligatory insurance schemes[95]. In general, in developed countries about 10 to 30 percent are insured. (cf. Kron, 2012: 460) However, in "Sweden (...) flood insurance is voluntary and policies are issued and managed by private companies. The State does not offer insurance itself nor financially back the insurers" and "mortgage lenders require borrowers to insure buildings, resulting in penetration rates above 90%" (cf. Centre for Climate Change Economics and Policy, 2014: 8). In comparison, the insurance density in Austria is relatively low and the coverage level is also limited, but the state is compensating losses by means of catastrophe funds[96] (cf. Hlatky, 2007: 53ff.), which support affected property owners and municipalities, etc. — after a hazard event took place — to support reconstruction of properties and infrastructure[97] (cf. BMF, 2012: 3).

Due to the high coverage level in Sweden, "(...) 2011, the insurance companies paid water damages in the amount of" € 400 million "of which the compensation of damages related to flood or heavy rain amounted to" € 35 million (Nordic insurance associations, 2013: 10) and at the moment "(...) insurance coverage for water damage is still available for all" (Nordic insurance associations, 2013: 16).

However, the circumstances for the insurance system could change in the future. This can be based on an increased knowledge of flood-risk and other natural hazards, e.g. improved mapping of endangered areas which mean hazard risks are better known. As a result, it is "conceivable that the insurance companies will introduce differentiated premiums and excesses, with the consequence that properties in areas with a proven high risk of a particular natural peril will be subject to sharply increased insurance costs or will quite simply no longer be insurable." (cf. Swedish Commission on Climate and Vulnerability 2007 in Centre for Climate Adaptation, undated: online)

Furthermore, flood hazard maps and its information"(...) on (changed) risk levels might, for instance, make people's houses unsellable, while insurance cover does not apply to damage that has not (yet) occurred" (Wamsler and Brink, 2014:1368).

[95] As it is the case in Switzerland or France (cf. Kron, 2012: 460).

[96] Which is financed by shares of the corporate and income tax. (cf. Bmlfuw, 2004: 7)

[97] As well as support for fire brigades, construction of structural measures, etc. (cf. Bmlfuw, 2004: 11), due to the construction of protection measures the catastrophe fund in Austria is also important for hazard prevention (cf. Bmlfuw, 2004: 71).

Therefore one has to say that the demand for insurances in general is high for floods of a high occurrence probability and insurance offers are not available for these floods, but instead for floods of a low occurrence probability, where the demand for insurances is low. (cf. Hlatky, 2007: 65)

As a result "alternative of government re-insurance may then need to be examined" (Swedish Commission on Climate and Vulnerability 2007 in Centre for Climate Adaptation, undated: online). Other options are obligatory flood insurances, as the UNIQA insurance in Austria demanded (cf. Uniqa Group, 2014: online) as well as financial support. Therefore, it is not only necessary to provide insurances for existing structures (which might be a result of inadequate planning decisions too) but also to reduce new flood-affected developments to minimise the risk in the future.

8.7 Difficulties/differences in terms of flood-risk implementation

In Austria legal regulations for the visualisation of flood-prone areas exist, but "Swedish municipalities often rely on a priori knowledge. The rarity of large floods has meant that many municipalities either do not include flooding in their plans or lack the ability to assess flood risk" (Thorsteinsson, 2007: 486). "Obviously, the importance varies greatly depending on the context. Some exposed municipalities (...) are very affected and concerned" (Hjalmarsson, 2014: interview).

Due to the question if legal binding regulations concerning flood-risk are needed, from the point of view of a city planner from Stockholm, the "current legislation is sufficient for regulating land use with regards to a changing climate" (Elgström, 2014: interview).

"Flood risk plans and work are not as comprehensive as in Austria. The case is rather different, (...) almost none of the areas in Sweden, would qualify as a targeted area in an European perspective, with the possible exceptions of Göteborg, Kristianstad and perhaps Uppsala and Karlstad. Örebro is a specific case where the highest calculated flood could be severe but no historical records indicate flood even near that discharge (..). In (...)Floods have occurred historically (...), the effects in an European perspective were rather small. (...) There are several reasons for this, the most prominent is probably geomorphological, Swedish rivers are simply not very old and floodplains are generally relatively small and steep. Furthermore, due to the relative low population density, settlements have historically been located in flood secure places" (Carstens, 2015: interview). However, Axelsson and Nordahl stated that "National and regional guidelines which can be implemented at the local level in the municipality according to the specific conditions in each municipality" could be a possible addition to the current state, but "it is sufficient if they are guidelines as the municipality can adopt their own policies through policy decisions" (cf. Axelsson and Nordahl, 2015: interview).

Storbjörk and Hjerpe also mentioned a "(...) current lack of general political statements on and guidelines for climate adaptation" — where flood risk issues are often included — but this lack "(...) instead helps maintain flexibility in planning." (cf. Storbjörk and Hjelpe, 2014: 2281)

In Austria, there are general guidelines or legal within the (spatial planning) legislation, but some regulations are not a 100 per cent concrete and leaves room for interpretation. Due to that the Austrian Conference on Spatial planning recommended that, e.g. the protection aims within the spatial planning and building laws should become more precise and that the hazard zones of the hazard zone maps should be implemented in the legislation. (cf. Austrian Conference on Spatial planning, 2005: 14f.) On the one hand the spatial planning laws are concrete enough to enable exact actions for municipal actions (cf. Obkircher, 2015: interview) but on the other hand, i.e. the undefined formulation of danger zones in spatial planning laws enable a functional view for a case by case basis instead of a strict focus on hazard zones or inundation areas. (cf. Loizl, 2015: interview).

National strategies and guidelines or recommendations dealing with flood-risk issues in particular or climate change in general are useful to enable a consistent approach. At the moment there is no national strategy in Sweden to implement environmental issues (cf. Wamsler and Brink, 2014: 1376) and "Swedish regulations about planning only give general support for authorities and municipalities" and this opens possibilities "for risky planning" decisions "and small possibilities for authorities to stop" these. Furthermore, "21 regional authorities and 290 municipalities have to" decide on their own about what is safe and which areas are endangered. (cf. Gustavsson, 2015: interview) However, on request regarding the responsibilities, "the current system (where the municipality is responsible and the CAB has a monitoring/supervising function) has turned out to be good" (Hjalmarsson, 2014: interview).

In comparison, in Austria, due to the legal basis of spatial planning within the competence of the federal provinces, there is neither a uniform and overall law for the whole country nor the handling of flood-risks and endangered areas is uniform. One might consider that as a problem and a nationwide spatial planning law would make some things easier but to this end specialised local knowledge would be necessary and local conditions must be considered. As a result an overall law could lead to a law with many exemption rules (cf. Neuhold, 2015: interview). Thus, one could say that the implementation of flood-risk issues within the local level e.g. within Austrian municipality or within the Swedish municipal planning monopoly is the right approach. Since, planning actors and decision makers have the necessary knowledge, but due to the conflict with other economic interests, guidelines on a higher level are necessary. In Sweden guidelines by Boverket/MSB could be suitable to channel municipal actions in one direction (cf. Elgström, 2015: interview) and often could "be more effective to handle specific issues than regulations by law" (cf. Hjalmarsson, 2015: interview).

Also Gustavsson from the County Administrative Board Värmland stated that Boverket should regulate at which level of risk (e.g. occurrence probability of 100 years) certain buildings are allowed to be constructed or not (cf. Gustavsson, 2015: interview). However, whether to use regulations in the Planning and Building Act "or on 'authority level' depends on the issue and how that specific issue fits in the existing framework" (cf. Hjalmarsson, 2015: interview). With this in mind also in Austria a pro-forma harmonization of the nine spatial planning laws could be done with some kind of "best practice" recommendation list of flood-risk handling within (local) spatial planning. However, the national flood-risk management plan can be regarded as something similar with its trans disciplinary measures and aims to reduce the risk — for the areas with significant flood-risk in all 9 states — within the planning period 2016 — 2021. (cf. Bmlfuw, 2014: 1) The flood-risk management plan also shows the different existing legislation, e.g. for reallocation or relocation as well as the relevance and actuality of this measure in the states during the planning period. (cf. Bmlfuw, 2014: 87ff.)

9 Summary

Floods are the most widespread natural hazard within Europe. Inundation zones interfere with different land-uses, for example settlement, industrial or agricultural areas as well as infrastructure. In case of agricultural land, which is flooded every now and then, the negative effects are minor compared to the damage potential within a dense city area. From an ecological viewpoint, floods can even improve agricultural land. However, in many areas within Europe a shift from rural to urban land-use is taking place. In certain areas — e.g. in densely populated areas or in parts of Austria, where the area which is suitable for permanent settlement is limited, due to the alpine location — the competition for attractive locations is increasing. Furthermore, waterfront locations or areas in alleys at former flood plains are seen as attractive development areas, which leads to intermingling of flood endangered areas and settlement areas. Furthermore the amount of these overlapped areas can change increase or also change in terms of location, due to circumstances, often associated with a future climate change.

Spatial planning with its land-use plans and zoning decisions is a predominant aspect as regards flood-risk areas. Accordingly, certain measures have already been taken, but new strategies and/or actions are needed respective spatial planning to prevent future damages and to reduce risk and damage potential. In this term zoning possibilities and the steering of development is an important aspect of land-use planning. However, spatial planning is not the only responsible sector within these natural hazard issues. Furthermore many different actors, i.e. water engineers are involved.

To enable actions, within spatial planning, information on flood-risk is needed. Existing knowledge about floods, their extent and the endangered areas are key aspects for a well founded and successful prevention strategy.

The European Union recognized the actuality of flood-risk and flood protection within Europe as well as the need for developments or improvements of an interdisciplinary approach. On these grounds in 2007, the floods directive — which obliged actions within the member states — was published. However, this directive can be seen as an obligatory guideline, because the details of the implementation on a national level is up to the member states. But with is compulsory actions, e.g. breakdown of areas with significant flood-risk, development of flood hazard and risk maps up to the future flood-risk management plans, the floods directive is nonetheless an important starting point for a flood prevention approach.

The relevance of flood-risk varies significantly across the member states of the EU. Nevertheless, in some countries the relevance of flood-risk was high and relevant instruments already existed, while in other countries the flood-risk as well as the relevant knowledge was low or was just focused on certain areas.

By using two sample countries, Austria — exemplified by the provinces Lower Austria and Salzburg — and Sweden, this thesis wants to highlight this varying significance and the resulting difference in implementing the floods directive. An analysis of the relevance of flood-risk issues within spatial planning and how flood

endangered areas are handled within land-use planning decisions has been provided.

Research on the topic of flood-risk within spatial planning makes a basic knowledge of flood occurrence as well as the respective terminology necessary. Firstly, the general relevance in terms of spatial planning objectives and aims are illustrated. Secondly, information about floods, which existed before the floods directive was implemented as well as maps obliged by the floods directive was analysed. Thirdly, the relevance of flood-risk within spatial planning and how flood-risk knowledge is considered within spatial planning (instruments) is pointed out.

The research has shown that spatial planning legislation and their instruments as well as the legal character of planning instruments are quite different within the sample countries. These differences can be partly explained by different topographic and geographic circumstances — which includes the availability of land as well as the existing flood-risk — in Austria and Sweden.

Due to the differences in relevance of flood-risk, information about flood endangered areas and its quality — in terms of coverage rate and resolution as well as the included contents —and consequently, the importance within the spatial planning legislation, are not directly comparable.

This becomes apparent when the handling of flood endangered areas and the actions of decision makers were analysed. In Austria zoning and building prohibitions are typical approaches, while in Sweden flood-risk issues are processed on a case by case basis, which leads to various implementation possibilities.

Beside the analysis of legislation, flood hazard and risk maps also key aspects problem fields difficulties regarding the implementation of flood-risk within spatial planning are illustrated.

10 Recommendations and conclusions

Based on the previous analysis regarding the relevance of flood-risk in spatial planning recommendations to planning actors and decision- and law makers will be given to enable an optimisation of flood-risk implementation within the different levels of spatial planning in Austria and Sweden.

10.1 Recommendations regarding spatial planning legislation

Flood-risk is an issue within the spatial planning laws both of Austria and Sweden, but the relevance within the legislation is different. In Austria consequences for areas which might be inundated, e.g. zoning building prohibitions, are part of legislation. In contrast, Swedish legislation only obliges a consideration of flood-risk. However, in Austria the laws in the provinces deal with flood-risk in a different manner, to enable the consideration of local circumstances, which hinder an uniform handling of flood-risk areas. But the underlying information about flood endangered areas are regulated by federal laws.

In terms of flood-risk an Austrian federal spatial planning law seems not recommendable, since this might lead to a multiplicity of exception rules, which could not be seen as an improvement.

Since a consideration of flood-risk is obligatory in Sweden one could say that the legislation is sufficient in respect of inundation areas.

A specification[98] of Swedish legislation including more detailed consideration of flood-risk, e.g. building bans for areas endangered by floods with a high occurrence probability, seems necessary.

Legal certainty of the comprehensive plan and obligatory contents could help to implement flood-risk issues successfully in Swedish spatial planning practice.

If flood-risk areas exist within the municipality the visualisation of the endangered areas within the comprehensive plan should be obligatory.

Precisely because flood hazard maps are the most relevant information for spatial planning decision makers, a legal basis for these documents is necessary, even if the information itself must not be legal binding.

The legal basis for flood-risk related information should specify the aims, basic contents (e.g. water depth, basing scenarios, etc.) and suitable scale(s) of these documents should be set within a legal base, to achieve usable information which can be further used within spatial planning.

It was noticed in general that flood-risk is not a present issue within regional planning, both in Austria and Sweden. Since river-basins are named as a suitable observation area, co-operations within this area seem necessary, particularly because co-operations at Swedish lakes to develop common guidelines are in place.

[98] However, it was also stated, that guidelines by MSB or Boverket could be more effective, since it depends how the specific issue fits in the legal framework (cf. Hjalmarsson, 2015: interview).

Consideration of important flood-risk areas should be enabled and accelerated within regional spatial planning instruments to set a legal basis for river-basin oriented approaches and trans-municipal co-operation.

In some cases, new instruments are developed or introduced instead of using and optimising already existing tools. However, the already existing tools could suffice to enhance the handling of flood-risk issues. Still, in Austria new instruments (e.g. water management regional programmes) are created.

This increasing amount of tools (e.g. regional programmes, small-scale regional development concepts, etc.) makes it not only more difficult to keep an overview, but also to reach the respective aims.

Instrument which are already in place should be optimised to be suitable for an implementation of various issues, e.g. flood-risk, instead of developing new tools. Only if the existing instruments do not suffice, additional instruments should be created.

10.2 Recommendations for regional planning

At the present stage, flood-risk is implemented to a very limited extent within the level above municipal spatial planning, e.g. at the regional level. Since floods and flood-risk does not know municipal borders, a consideration of these issues within regional planning, for example a localisation of important run-off or retention areas would be desirable to illustrate the areas which are especially important and/or have a supra-local relevance for flood protection. In these terms the regional interest or a public concern to preserve these areas would be shown to the actors on the local level. However, a mere visualisation of these areas does not ensure that these sites are actually available or not already used. Due to that, also the availability has to be verified.[99] If the areas are available, local planning could be steered in the desired way — as it is possible with nature protection areas or supra-local settlement boundaries, etc. — by regional planning, which might not easily be put into practice because it limits the local planning possibilities and would need a legal basis.

Informal visualisation of important flood retention areas with a regional relevance within regional planning documents/instruments should be realised/enabled.

Procedures for the compensation[100] of municipalities which abstain from development possibilities due to flood retention preservation — in terms of upstream downstream locations — should be practically enabled.

[99] Testing of relocation possibilities — if just isolated buildings are affected — could be possible in a following step on the local level, but it is necessary to state that relocation measures are a very sensitive field.

[100] Uniform procedures and calculation methods (as shown in chapter 8.3) seem necessary to enable an effective and successful approach within more than one municipalities on a river basin level.

10.3 Recommendations for local spatial planning

Flood-risk issues are very focused on the level of local spatial planning. However, in some cases flood-risk is seen as an issue among others, i.e. economic benefits caused by developments — within local spatial planning. Due to the spatial planning legislation in Austria and Sweden the municipalities are an important actor or decision maker within local spatial planning. However, there are predominant — economic — factors which influence land-use decisions, e.g. a planned industrial area or other development projects, which generate municipal tax income, can be seen as an issue facing flood risk-risk in a process of consideration. In this context it is important to oblige the municipalities and particularly the decision makers to consider flood-risk adequately. However, this analysis of spatial planning legislation found out that flood-risk has to be considered by the municipalities of both sample countries, but the regulations within Austria are much stricter than in Sweden.

A higher valuation of flood-risk issues, which have long term consequences within the process of consideration within land-use decisions is needed.

The best possible consideration of existing (local) flood-risk knowledge like hazard maps, inundation maps as well as experiences within past flood events in land-use decisions is necessary.

Exceptional rules, e.g. in Lower Austria, make building land zoning despite flood-risk within closed residual areas possible. As a consequence also building bans and reallocation are not obligatory within this area, which enables endangered municipalities to develop new buildings within existing structures, since these areas might be the only development potential within the municipality.

Municipalities should not insist on the development of flood endangered areas within closed residual areas if other possible more suitable locations are available.

In terms of development of flood endangered areas within the closed residual area the extent of flood-risk (e.g. water depth) should be of major importance. Moreover, the effects of constructions on other buildings must be considered.

Another important aspect within local spatial planning is residual risk. Even under economic considerations a densification and use of areas protected by dikes or other structural measures might be advisable due to the costs of such measures, but the residual risk should not be unnecessarily increased. However, due to local circumstances, e.g. limited available space these areas with residual risk might be the only existing development opportunities.

Thus, areas with residual risk should be kept free from sensitive uses, e.g. hospitals, etc. and furthermore adaptation of constructions within these areas to resist floods should be pointed out.

However, to achieve that, an awareness of the limits of structural measures as well as for floods bigger than the design event has to be generated. This is particularly important, since climate change might intensify flood events in the future. Furthermore, political or even personal interests can contradict spatial planning aims or the implementation of flood-risk issues within spatial planning.

(Political) decision makers should not postpone or neglect decisions due to political reasons.

(Political) actors, which are involved in land-use planning decisions should distinguish personal from public interests.

10.4 Recommendations in terms of uncertainty of future flood-risk

Consequences on flood-risk and further on spatial planning due to future climate change are uncertain. This uncertainty makes it necessary that flood-risk issues have to be taken much more into account than it has been the case so far. Measures and adaptation strategies must be combined to enable protection of current flood-risk areas and climate change adaptation have to be commenced now.

Current flood-risk and damage potential should be reduced or at least not increased.

Sea-level rise, as an effect of future climate change should be considered at coastal areas.

Structural flood protection should include measures within spatial planning, e.g. safeguarding of retention areas and constructions should be avoided within flood endangered areas.

Residual risk should be considered in planning decisions and should be visualised within planning documents/instruments to raise flood-risk awareness.

Maps about flood-risk areas should be continuously created and kept up to date to pay respect to changes in flood-risk.

10.5 Conclusions

Firstly, the regional and spatial circumstances within the countries are important factors for the occurrence of floods, the vulnerability of dwellings, cities and infrastructure and furthermore the relevance of flood-risk in spatial planning.

Existing river regulations and hydropower plants were named as reduction of flood-risk within Sweden, but examples of floods, e.g. at the river Kamp in Austria — which were not expected for the same reasons — showed that these structures do not make floods impossible[101].

Secondly, the availability of land is an important factor. In Sweden the availability of land within the country made it possible to avoid settlements in flood prone areas right from the start. This is contrasted with the limited suitable area for settlements — due to the alpine location — in Austria. However, a increasing demand for housing and designated developments within the urban agglomerations in Sweden — for example in Stockholm — shows that on a more local scale the limited available area is nevertheless an important factor within spatial planning. In respect to that hazard endangered areas and the relevance of flood-risk within spatial planning in Sweden is also given, even if — compared to the total size of the country — the problem field is focused on a smaller area of the country than in Austria.

Thirdly, this is also reflected by the fact that areas suitable for permanent settlement — which are calculated and mapped in Austria — are presently not mapped in Sweden. That might change in the near future due to the competition between the need for dwellings and need for agricultural land as well as existing natural conditions, e.g. soil stability, existing flood-risk, etc. within Sweden.

Moreover, this thesis pointed out two different models of spatial planning legislation. Beside the similarity of the municipality as the main authority of spatial planning the handling and instruments of spatial planning are quite different in Austria and Sweden. While in Austria — even with different laws in the federal provinces — spatial planning is strictly regulated through different layers of legally binding instruments, in Sweden just the most detailed level of spatial planning — the detailed development plan —is legally binding, while the other layers — e.g. the comprehensive plan — are merely seen as information or recommendations instead of a hierarchical higher ranking determination of spatial planning aims. In comparison, the Swedish comprehensive plan — from an Austrian perspective — is more a development concept than a land-use plan with detailed zoning regulations, as it is the case with the Austrian land-use plan.

The detailed development plan in Sweden and the building regulation plan in Austria are more easily comparable. But the Swedish detailed development plans are more focused on specific areas and projects, while the building regulation plan in Austria regards a bigger area.

[101] Furthermore, storage power plants are not built for flood protection.

Another big difference dealing with flood-risk issues is the obligatory visualisation of flood-lines or hazard risk zones in the land-use plan, while in Sweden the legally binding detailed development plan should not include more regulations than those that are necessary to achieve the purpose of the plan and also in the comprehensive plan it is not obligatory to show flood-risk measures. However, it was stated, that the Swedish legislation should be interpreted that if a flood-risk is existing in the certain area, it should be considered within the detailed development plan, but it was also stated that the different actions of Swedish municipalities or unawareness to sort out how to implement flood-risk issues within the detailed development plan exist.

Overall, it is evident that flood-risk issues are conflicting with other factors within the fields of spatial planning. Economic interests and the need for housing and other developments hinder an avoidance of flood-risk areas within (local) spatial planning. On the one hand, municipalities want and need development within their municipal borders, and on the other hand, (attractive and) available locations can be endangered by floods. This leads to developments within endangered areas in Sweden and in Austria reallocations or building bans are not decreed if they are not obliged by legislation. Furthermore, spatial planning is affected by political actors, which tend to prefer actions which showing results within an election period instead of promoting long-term strategies. Moreover, a necessity of strategies to oblige actions to reduce negative effects of floods — which might increase in relation to climate change —within the own competences of the municipalities exists.

In terms of flood awareness and individual responsibility, a significant difference within Austria or Sweden was not found within the research of this thesis. Interests by land-owners or developers to build-up endangered areas exist in both countries, whereby in Austria, on the whole, these difficulties might be more relevant due to the limited area which is suitable for permanent settlements. Whereas in Sweden, the same issue is more relevant within agglomerations with higher densities, where land is also limited and the demand is high. The assumption that in general interests to use endangered land are higher in Austria could be more or less confirmed by the existing regulations within the spatial planning laws, which show stricter regulations in Austria than in Sweden. But the stricter regulations in Austria also show that within the lawmakers flood awareness exists and due to extensive flood-risk strict regulations are needed to control the demand for building land, etc. within the limited suitable settlement area and simultaneously keep the level of protection high.

However, examples within Sweden have also shown that in certain areas the flood-risk is high as well as the intended use of flood prone areas, e.g. waterfront locations. Due to that stricter regulations, as a next step of the current flood-risk consideration could make sense in Sweden too.

To achieve aims in respect of flood-risk, information about flood endangered areas and other in-depth analysis about risk scenarios and (negative) effects on a detailed scale is necessary to be able to use this information in planning/zoning decisions and furthermore to implement flood-risk issues in spatial planning instruments.

In this regard it is particularly important how the information about flood-risk is presented, since for example flow velocities and its consequences are much harder to understand for "laymen" than water depths.

The Austrian approach is to derive hazard zones from the intensity of floods (product of water depth and flow velocity) which are visualized in flood hazard zone maps. This approach seems to be much more understandable and also usable for spatial planning decision makers than the basic data of run-off analysis, etc.

Another relevant factor is the choice of design events. Even if Sweden uses the highest standards with a flood of a 10 000 years occurrence probability, these events do not seem suitable for spatial planning decisions, since it might not be feasible to offer protection for a rare flood event like that, especially from an economic point of view. It might be an interesting information about the largest imaginable event, but to consider residual risks and to implement them in planning decisions by using an extreme event with a lower occurrence probability (e.g. 200 — 300 years) seems more suitable.

In this term one could say, beside the point of risk awareness, the implementation of flood-risk issues in spatial planning also depends strongly on the availability and quality of flood-risk related information.

In this respect, with the aim to reduce negative effects, the floods directive can be seen as a success in terms of either setting a starting point for implementation of flood-risk issues in national legislation and furthermore in spatial planning or can help to proceed and extend strategies and measures which were already in place. In addition this directive can help creating awareness of responsible actors as well as raising the awareness of (affected) citizens and land-owners.

In both sample countries information about certain flood endangered areas as well as a consideration of flood-risk issues within spatial planning existed. However, it is noteworthy that the quality of these maps and the actions within spatial planning legislation in Sweden was very limited in comparison to Austria. The implementation of the floods directive, in general, can be seen as a success. Additional or updated information, e.g. about areas with residual risk in case of floods with a low occurrence probability, as well as new instruments like the flood-risk management plan, which will include measures within different scopes can be seen as the output of this directive. However, within the fields of spatial planning the directive did not cause direct impacts yet and furthermore the existing (spatial planning legislation in terms of flood-risk is seen as sufficient.

Additionally, it is important to emphasize that there is also a demand, either for stricter regulations in Sweden, or for an optimisation of the realisation of existing regulations in Austria. This demand could be noticed within the different actions, respecting flood-risk, of Swedish municipalities or the negligent actions of some Austrian municipalities when it comes to reallocations and building bans.

However, the comparison of the two sample countries and the different approaches dealing with flood-risk showed that also the Swedish approach has its advantages in terms of "living with floods". These adaptations can be possible additions to strict building prohibitions in certain areas.

To sum up, a big part of flood-risk related strategies in Austria and Sweden are focused on technical flood protection measures instead of safeguarding strategies within the hands of spatial planning. This might be on the one hand the easier strategy, which also offers areas for future developments beside the protection of already existing settlements, but on the other hand, both in Austria and in Sweden, the beneficiaries of these measures, e.g. land owners usually do not have to pay the whole necessary investments., because financial support exists. However, it is necessary to state that this thesis does not want to question technical flood-protection measures in general, but to balance them with other possibilities within the hands of spatial planning. Since, technical measures should be seen as the whole, including the areas with residual risk.

Another key aspect is municipal co-operation, since flood-risk does not end at municipal borders and the handling of flood endangered areas, e.g. technical protection measures, affect other municipalities too. A regional consideration of flood-risk could help to keep important areas free of other uses and could enable trans-municipal or regional approaches which could be much more effective than actions within single municipalities.

To put it in a nutshell flood-risk is a factor beside others within the decision making process of land-use planning and how, or in how far, these aspects are taken into account depends on the local circumstances as well as on the responsible actors who balance the interests. An additional factor of uncertainty which will affect planning in the future is the aspect of future climate change. If present endangered areas are not taken into account within planning decisions yet, how it will be possible to adapt to possible extensions of flood endangered areas due to climate change in the future.

11 List of abbreviations

BMLFUW	Ministry of agriculture, forestry, environment and water management
B-VG	Federal constitutional law
BWV	Federal water engineering authority
CAB	County administrative board
ForstG	Forestry act
MSB	Swedish civil contingencies agency
NÖ	Lower Austria
HORA	Flood-risk zoning in Austria
HQ30	Flood with a 30 year occurrence probability
HQ100	Flood with a 100 year occurrence probability/centennial flood
HQ150	Flood with a 150 year occurrence probability
HQ300	Flood with a 300 year occurrence probability
HQ10 000	Flood with a 10 000 year occurrence probability
Slbg	Salzburg
SMHI	Swedish meteorological and hydrological institute
SRSA	Swedish rescue services agency
ÖÖ	Upper Austria
OGH	Austrian supreme court
Örtl. ROP	Local spatial planning programme
ÖREK	Austrian spatial development concept
ÖROK	Austrian conference on spatial planning
PBL	Planning and building legislation/Planning and building act
REK	Spatial development concept
ROG	Spatial planning act
RUFS	Regional development plan for the county of Stockholm
WBFG	Waterworks promotion act
WISA	Water information system Austria
WLV	Torrent and avalanche control
WRG	Water rights act

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14 References

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Sweden

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14.4 Interviews

ANDERSSON, Ida: security coordinator, municipality Arvika

ÅSTRÖM, Daniel: responsible for the implementation of the floods directive, county administrative board Stockholm

AXELSSON, Hilde: head of urban planning, municipality Arvika

BAUER, Thomas: department regional planning, government of Lower Austria

CARSTENS, Christoffer: coordinator climate change adaptation, community development & civil contingencies, county administrative board Gävleborg

ELGSTRÖM, Ludvig: urban planner, city planning department, city of Stockholm

FISCHER, Stefan: building authority deputy, municipality Leobersdorf, manager waterboard Triesting

FLEISCHMANN, Michael: spatial planner, RaumRegionMensch, Sulz im Weinviertel

GAUFFIN, Johanna: urban planner, county administrative board Stockholm

GINZINGER, Winfried: legal expert, section 10 housing and spatial planning, spatial planning, government of Salzburg

GUSTAVSSON, Leif: preparedness director, risk and security, department infrastructure planning, county administrative board Värmland

HJALMARSSON, Johan, department health and social affairs, planning, building and housing unit, Swedish governmental office

LARSSON, Rolf: water resources engineering, Lund university

LAGERBLAD, Lovisa: unit for climate change adaptation, county administrative board Stockholm

LIDINGÖ STAD: department support, environment and city Planning

LJUNGLUND, Eva-Karin: planning unit, county administrative board Dalarna

LOIZL, Robert: head of department, 7/02 water management and flood protection, department 7 water, government of Salzburg

LUNZ, Stefan: department of plant, environmental and water Rights, government of Upper Austria

MOSTRÖM, Jerker: senior advisor, regions and environment department, statistics Sweden

NÄSLUND-LANDENMARK, Barbro: expert natural disasters, risk- and vulnerability reduction department, Swedish civil contingencies agency (MSB)

NEUHOLD, Clemens: department IV/6, federal water engineering authority,the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management

NORDAHL, Anna: security coordinator, municipality Arvika

NORLANDER, Anna: climate change adaptation and land-use planning, natural hazards & critical infrastructure section, Swedish civil contingencies agency (MSB)

OBKIRCHER, Erich: head of building authority, municipality Langenlois

PEROLS, Anna: head of sustainability and planning authority, municipality Falun

PFEIFFER, Christian: head of department, building authority, municipality Mittersill

PICHLER, Andreas: department III/5, torrent and avalanche control, the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management

POMAROLI, Gilbert: department land-use planning and local development concept, government of Lower Austria

RAMMLER, Heidemarie: department land-use planning and local development concept, government of Lower Austria

RUDOLF-MIKLAU, Florian: deputy head of department, torrent and avalanche control, the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management

SCHMID, Franz: department IV/6, federal water engineering authority, the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management

SCHMIDBAUR, Andreas: head of department, spatial planning and building authority, city of Salzburg

SIEGL, Karl: spatial planner of Achau, RAUMPLANUNGSBÜRO DI KARL SIEGL, engineering office for spatial planning, Vienna.

SIGL, Martin: spatial planner of Altenmarkt im Pongau, allee42 landschaftsarchitekten gmbh & co kg, engineering office for landscape-and spatial planning

STEINER, Georg: head of building Authority, municipality Altenmarkt im Pongau

STELLNER-BICHLER, Anna: department building- and spatial planning law, Government of Lower Austria

VIKMAN, Malin: analyst, planning unit, planning office, city of Kalmar

VON SYDOW, Karin: unit for climate change adaptation, county administrative board Stockholm

WEBER, Gertrude: chief officer, municipality Achau

WINKLER, Bernd: head of the water management department, department water management, government of Lower Austria