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The European Floods Directive and Opportunities offered by Land Use Planning

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The European Floods Directive and Opportunities offered by Land Use Planning

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Abbreviations

CC	Climate Change
EEA	European Environmental Agency
EC	European Community
EU	European Union
EU-FD	European Floods Directive
EU-WFD	European Water Framework Directive
FRM	Flood risk management
FRMp	Flood risk management plans
IPCC	Intergovernmental Panel of Climate Change
RB	River Basin
RBMp	River Basin Management Plan

Acknowledgments

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Decision makers and those in the chain of accountability in local governance are in contact with territorial choices, from river basin scale to municipality. For this reason, the report would be a contribution to spread knowledge and encourage greater hydrological risk sensitivity in land use planning.

This can be made possible towards prudent choices in planning, updating of practices in those territories that are always in contact with the river and get them to be visionary, considering the scenarios of climate change, the present population growth and needs of future generations.

"Modern society has distinct advantages over those civilizations of the past that suffered or even collapsed for reasons linked to water. We have great knowledge, and the capacity to disperse that knowledge to the remotest places on earth. We are also beneficiaries of scientific leaps that have improved weather forecasting, agricultural practices, natural resources management, disaster prevention, preparedness and management…But only a rationale and informed political, social and cultural response – and public participation in all stages of the disaster management cycle – can reduce disaster vulnerability, and ensure that hazards do not turn into unmanageable disasters"

Kofi Annan
Message on World Water Day, 2004

Abstract

There is no doubt in the scientific community that man-made change of land use, such as urbanization or deforestation, increase flooding. Projections show that we can expect more extreme weather events, such as flash floods, that will become more frequent and intense. The European Floods Directive is introduced as a reference framework for the prevention of flood risk. The aim of this report is to raise the awareness towards the potential of spatial planning for water-related natural hazards and, at the same time, contribute to the development of a culture of risk prevention rather than relying on post-disaster response and recovery. For this purpose, five best practices from Germany, Italy and Switzerland are presented as examples that give more attention and importance to spatial and urban planning practices and approaches. Land use planning has long been recognised as a potentially valuable tool in the long-term (non-structural) reduction of human vulnerability to natural hazards and increase the preparedness of the population.

Summary of the report

The frequency and intensity of floods in Europe have clearly increased in the last few years (EEA, 2010a). Between 1950 and 2006, there have been 12 flood events in Europe (flash floods and river floods) with the number of fatalities exceeding 100 in each case (Barredo, 2006). The severe floods in Europe in the first part of this century were mostly caused by heavy rain events. The year 2002 proved to be a record year with major flood events in six EU Member States (Austria, Czech Republic, France Germany, Hungary and Romania). The total number of deaths was 78 with material damage rising to more than USD 21 billion (Genovese, 2006; Barredo, 2006 and 2009).

One reason for high flood damages is that people have often settled along rivers because flood plains provide fertile farmland, resource for economic development and drinking water, and they act as corridors for transport. Today, "…man has increased the level of valuable assets in the vicinity of water bodies and has created the potential of damage; if we want to limit flood damage consistently and quickly, success is better guaranteed by regulating land use alongside water bodies..."(LAWA, 1995).

Part of the observed upward trend in flood damage can be attributed to 1) socio-economic factors, such as increases in population, wealth and urbanisation in flood-prone areas, as well as to 2) land use changes, such as deforestation and loss of wetlands or natural floodplain storage for example via dike construction, river straightening and floodplain sedimentation (Feyen at al., 2009). Considering the uncertainty of future conditions shaped by main drivers such as climate change and rapid urbanization, the situation is getting even more severe. Where defences exist, the residual risk will increase as the probability increases that they fail or be overtopped by severe floods. In this unfavourably changing environment, a substantial rethinking of the existing strategies and a paradigms shift from traditional approaches is required in order to cope with future flooding in an adequate way.

Experiences show that flood risk reduction must be considered at a range of scales, starting from the river and water catchment as a whole and linking cities to the river basin system in a strategic plan, avoiding single sectorial solutions.

Europe is one of the most urbanised continents with around 75 percent of its population living in urban areas. By 2020, that percentage will increase to 80 or even 90 percent in some member states (EEA, 2006). The EEA report 2012 (EEA 2012) shows that roughly one fifth of European cities with over 100.000 inhabitants are very vulnerable to river floods and extreme rainfall such as "flash floods". In fact, for decades urban drainage systems have been optimised to drain a rain shower with a particular return period. Considering future climate and on-going urbanisation, this 'carrying capacity' has already turned out to be inadequate in a number of cities (EEA, 2012).

Flood risk management aims to minimise the risks arising from flooding to people, property and the environment. Minimising risk can be achieved through structural measures that block or restrict the pathways of floodwaters, such as river or coastal defences, or non-structural measures that are often aimed at reducing the vulnerability of people and communities, such as flood warning, hazard-zoning and flood-adapted spatial planning.

While some activities can be designed to mitigate the effects of flooding, many current practices and structures have unwittingly increased the flood risk. Spatial planning with respect to agriculture, forestry, the protection of natural areas and the development of settlements play an important role in the process of flood plain management (Friesecke, 2004), in particular ensuring that future development needs avoid or minimise future increases in flood risk. The preventative risk reduction by spatial planning process therefore constitutes a parallel, but inter-dependent process to that of flood risk management.

Flood management has shifted from protection against floods to managing floods risk. In Europe, this shift is reflected in the Floods Directive (EU-FD) of October 2007 (EU, 2007). The EU-FD shall be carried out in coordination with the European Water Framework Directive (EU-WFD), notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. All assessments, maps and plans prepared shall be made available to the public. The EU-FD introduces new instruments to manage risks from flooding, and is thus highly relevant in the context of adaptation to climate change impacts (EEA, 2009).

The report describes and compares several instruments and best practices for flood prevention through risk reduction by spatial and land use planning in Germany, Italy and Switzerland. For flood prevention there is a strong need to cooperate not only across different disciplines but also over several levels or scales of planning and decision making. This includes different administrative levels (state (Bundesland) planning, regional (province) planning and local and urban development planning) as well as various types of organisations (governmental, public, municipal, private).

As a result, there is currently great public and stakeholder interest in this issue and it is necessary to intensify research activities in order to understand natural disasters better and to reinforce flood risk management.

1 Main drivers of flood events

The frequency and intensity of floods in Europe have clearly increased in the last few years, affecting millions (EEA, 2010a) and causing an increase in economic losses (Barredo, 2009). Over the past ten years, Europe has experienced more than 165 major floods. An extreme natural event becomes a disaster when it has a large impact on human settlements and activities. Flood hazard increases for different reasons and several of them are correlated (Genovese, 2006) as a result from the confluence of both meteorological and hydrological factors, exacerbated by human actions (WMO, 2012).

Meteorological factors include rainfall frequency and intensity, storms and temperature. Hydrological factors include existing soil moisture, groundwater levels, extent of impervious surface, natural channelization of water courses, and tidal impacts on runoff. Human actors complicate matters through land use changes, occupation of the flood plain, inadequate maintenance of drainage infrastructures, and obstruction of drainage channels (WMO, 2012). According to Kötter (2003), it could be summarized that the two main drivers of flood events are extreme precipitation and increased vulnerability to natural disasters due to growing urban population, environmental degradation and a lack of planning, land management and preparedness. Some climate projections point to more extreme flooding as a consequence of extreme weather events in the future (IPCC, 2007 and Aerts et al. 2009). Furthermore human encroachment into unsafe areas has increased the potential for damage and for that societies become more exposed, developing flood-prone areas (maladaptation).

Background

Flooding is the most widespread natural hazard in Europe in terms of economic loss (CRED, 2009). In the last decade Europe has experienced a number of unusually long lasting rainfall events that produced severe floods (Fig. 1), e.g. in the Netherlands, Belgium, France and Germany in 1993 and 1995, the Czech Republic, Poland and Germany in 1997, in northern Italy (in 1994 and 2000), in the UK (e.g. in 1998, 2000 and 2007), Tisza (in 2000 and 2001), in the Elbe and Danube in 2002, and in 2005 in Romania and the northern Alpine region (Austria and Switzerland), in Ireland (2009), France, Italy and Poland (2010), and in Germany and Italy (2011).

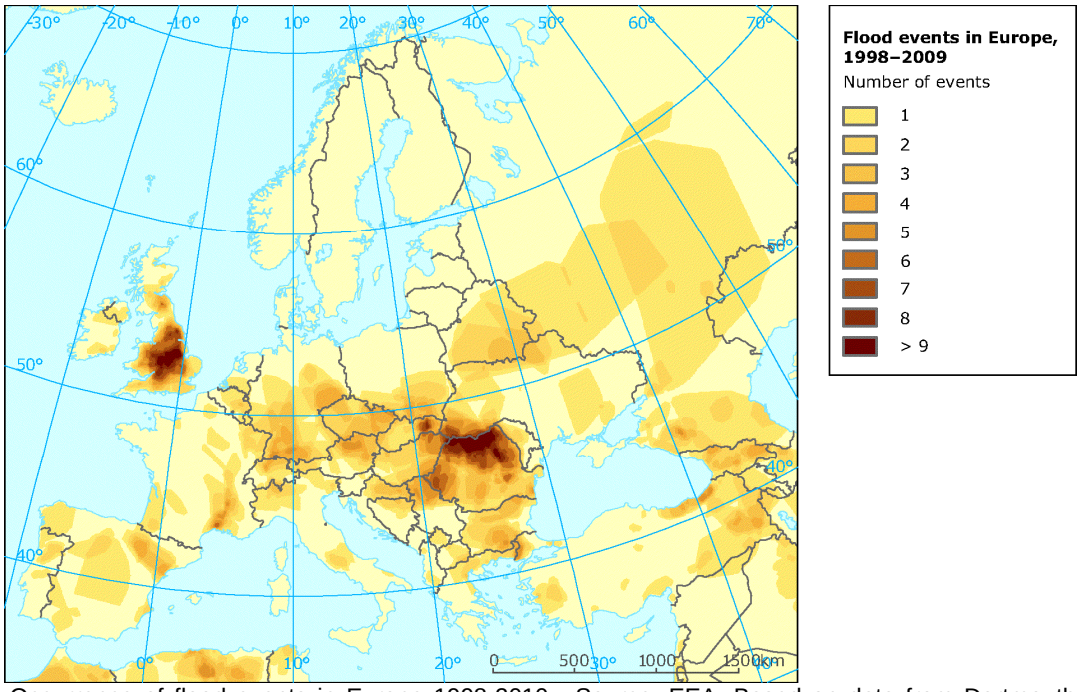

Fig. 1 Occurrence of flood events in Europe 1998-2010. Source: EEA, Based on data from Dartmouth Flood Observatory.

1.1 Extreme precipitation: past trends and climate change projections for Europe

Past trends

The number of extreme precipitation events has increased over most of the European land area, linked to warming and increases of atmospheric water vapour. For Europe as a whole, also the intensity of extreme precipitation such as heavy rain has increased in the past 30 years, even for areas with a decrease in mean precipitation, such as central Europe and the Mediterranean. In particular, the contribution of heavy rain to total precipitation has increased (Fig. 2) and is projected to continue to become more frequent.

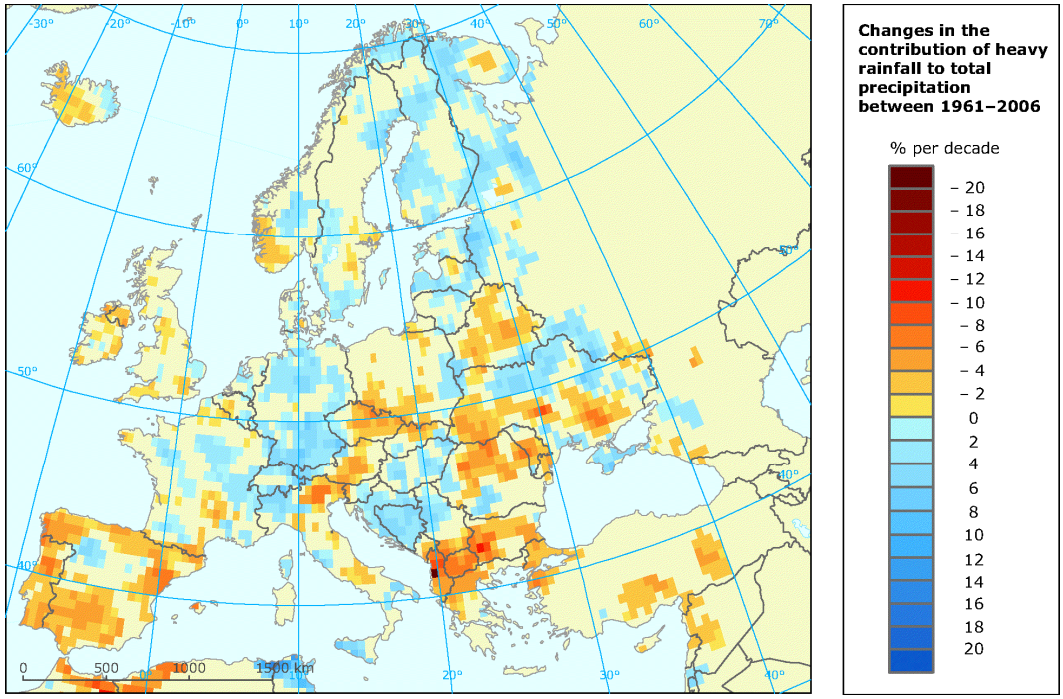

Fig. 2 Changes in the contribution of heavy rainfall to total precipitation 1961-2006. Source: The climate dataset is from the EU-FP6 project ENSEMBLES (http://www.ensembles-eu.org) and the data providers in the ECA&D project (http://eca.knmi.nl).

Changes in Climate Extremes and Climate Variability

Changes in climate variability and extremes of weather and climate events have received increased attention in the last few years. Understanding changes in climate variability and climate extremes is made difficult by interactions between the changes in the mean and variability (Meehl et al., 2000). Such interactions vary from parameter to parameter depending on their statistical distribution. For example, the distribution of temperatures often resembles a normal distribution where non-stationarity of the distribution implies changes in the mean or variance. In such a distribution, an increase in the mean leads to new record high temperatures (Fig. 3a), but a change in the mean does not imply any change in variability. For example, in Fig. 3a, the range between the hottest and coldest temperatures does not change. An increase in variability without a change in the mean implies an increase in the probability of both hot and cold extremes as well as the absolute value of the extremes (Fig. 3b). Increases in both the mean and the variability are also possible (Fig. 3c), which affects (in this example) the probability of hot and cold extremes, with more frequent hot events including more extreme high temperatures and fewer cold events. Other combinations of changes in both mean and variability would lead to different results.

Consequently, even when changes in extremes can be documented, unless a specific analysis has been completed, it is often uncertain whether the changes are caused by a change in the mean, variance, or both. In addition, uncertainties in the rate of change of the mean confound interpretation of changes in variance since all variance statistics are dependent on a reference level, i.e., the mean. For variables that are not well approximated

by normal distributions, like precipitation, the situation is even more complex, especially for dry climates. For example, changes in the mean total precipitation can be accompanied by other changes like the frequency of precipitation or the shape of the distribution including its variability. All these changes can affect the various aspects of precipitation extremes inclusive the intensity of precipitation (amount per unit time), (IPCC, 2001).

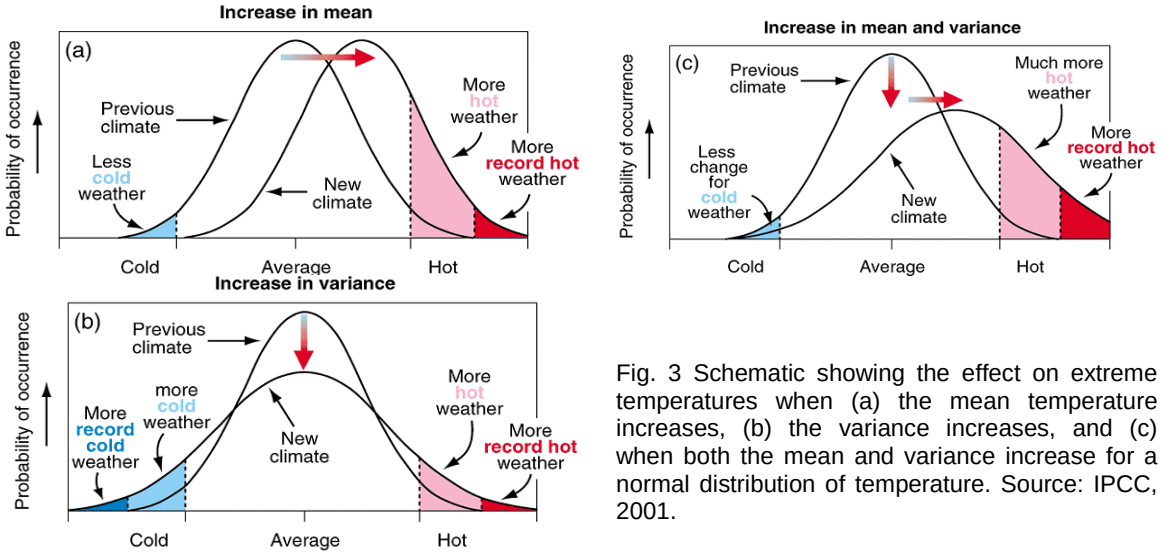

Fig. 3 Schematic showing the effect on extreme temperatures when (a) the mean temperature increases, (b) the variance increases, and (c) when both the mean and variance increase for a normal distribution of temperature. Source: IPCC, 2001.

Projections

Projections of statistical aspects of weather and climate extremes can be derived from climate models representing possible future climate states (Meehl et al., 2000). For the coming decades, it is projected that global warming will increase the magnitude and frequency of intense precipitation events in most parts of Europe, especially in the central and northern parts (Semmler & Jacob, 2004). For Europe as whole it is likely (66 % probability) that heavy precipitation events will continue to become more frequent (IPCC, 2007). In summer, the frequency of wet days is projected to decrease, but the intensity of extreme rain showers may increase. In addition, the frequency of several-day precipitation episodes is projected to increase. Geographically, there is considerable regional differentiation in the projections. Extreme precipitation events are projected to increase by 17 % in northern and 13 % in central Europe during the 21st century, with no changes projected in southern Europe (www.climateadaptation.eu).

BOX 1 Climate Change and Extreme Events in Europe – Key Points of Floods

- The main driver of floods and droughts is extreme precipitation linked to regional soil moisture and atmospheric temperature.
- Changes in extreme climate are likely to have a greater impact on society than changes in mean climate.
- Flood magnitude and frequency are likely (a 66-90% probability) to increase in most regions of Europe.
- Expected climate change will intensify the hydrological cycle causing dislocations and high costs in agriculture and urban areas.
- The European summer climate will affect the incidence of heat waves and droughts in the future.
- Today's climate models are not (yet) adequate at projecting extreme climate events in local areas such as flooding in a given river basin, but climate change analysis on water resources needs to be done at the river basin scale.
- With a rising likelihood of extreme weather conditions and resulting floods and droughts, the areas prone to these risks should be carefully mapped.

Source: Eisenreich et al., 2005.

1.2 Human action increases vulnerability

Historically, people often settled along rivers because flood plains provide fertile farmland, resources for economic development and drinking water, and they act as corridors for transport (Smith & Ward 1998). Due to population growth, the rapid changes in land use in the last decades from forest to agriculture and settlement, and also river straightening, detention and other flood protection measures are examples of human impacts that influence the run-off regime in the river basin system. The latest Corine land-cover inventory for 2006[1] shows a continued expansion of artificial surfaces, such as urban sprawl and infrastructure development, at the expense of agricultural land, grasslands and wetlands across Europe. The loss of wetlands has slowed down somewhat, but Europe had already lost more than half of its wetlands before 1990 (EEA, 2010a, Cap.6).

The River basin is a system

On a river basin scale the upper catchment part is linked to the lower system via hydrological processes and the river system. River basins[2] are dynamic systems constituted by a complex arrangement of fluxes between the land and water environment (WMO, 2007). John Wesley Powell, scientist geographer, put it best when he said that a watershed is: "*that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community*." (http://water.epa.gov/ , United States Environmental Protection Agency).

The hydrograph (Fig. 4) illustrates storm water peak discharges in an urban watershed (red line) and a less developed watershed (yellow line). In watersheds with large amounts of impervious cover, there is a larger volume and faster rate of discharge than in less developed watersheds, often resulting in more flooding and habitat damage.

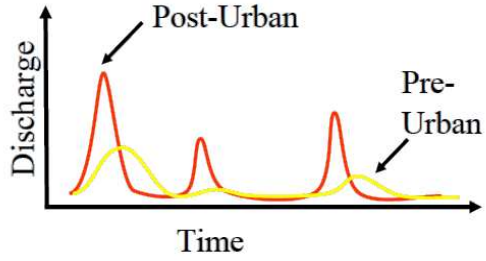

Fig. 4 Storm water peak discharges in an urban and less developed watershed. Source: Santa Clara Valley Urban Runoff Pollution Prevention Program Hydromodification Management Plan, 2005. Posted at: http://ci7e.securesites.net/hmp_final_draft/

The type and density of vegetation cover as well as the changes in land use associated with urban development (geographically and demographically), help to increase flooding in many ways: the flood hazard and risk increase partly because there is more exposure, but also because the process of urbanization itself alters local hydrologic characteristics (Montz, 2000) and disrupts the natural water balance and water storage capacity (WMO 2007). Flood risk reduction, for urban areas as political or economic units, must be considered at a range of scales, including the river and groundwater catchment as a whole.

The River basin is shared between undeveloped and urban areas

In undeveloped areas such as forests and grasslands, rainfall and snowmelt are retained on vegetation, in the soil column, or in surface depressions. When this storage capacity is filled, runoff flows slowly through soil as subsurface flow (Fig.5). With natural groundcover, 50% of rain infiltrates into the soil and only 10% ends up as runoff. As imperviousness increases, less water infiltrates and more and more runs off. In highly urbanized areas, over one-half of

[1] Based on EEA Corine land-cover data for 2006. Data coverage is for all 32 EEA member countries — with the exception of Greece and the United Kingdom — and 6 EEA cooperating countries. Source: Corine land cover 2006 raster data (version 16, 04/2012). www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster.

[2] Other terms that are used to describe a drainage basin are catchment, catchment area, catchment basin, drainage area, river basin and water basin. In the United Kingdom and Australia, a watershed refers to a divide that separates one drainage area from another drainage area, while in North America, it means the drainage basin or catchment area itself.

all rain becomes surface runoff, and deep infiltration is only a fraction of what it was naturally (Chester et al., 1996). Thus, urban areas, where roads and buildings cover much of the land surface, have less capacity to store rainfall and snowmelt (Konrad, 2003). In the linked environment of a river basin, upstream actions can influence downstream stakeholders, therefore, a better understanding and assessment of land use change impacts on the watershed hydrologic processes, is of great importance for the prediction and mitigation of flood hazards, and also for the planning, sustainable development and management of the watershed (Chen et al. 2009).

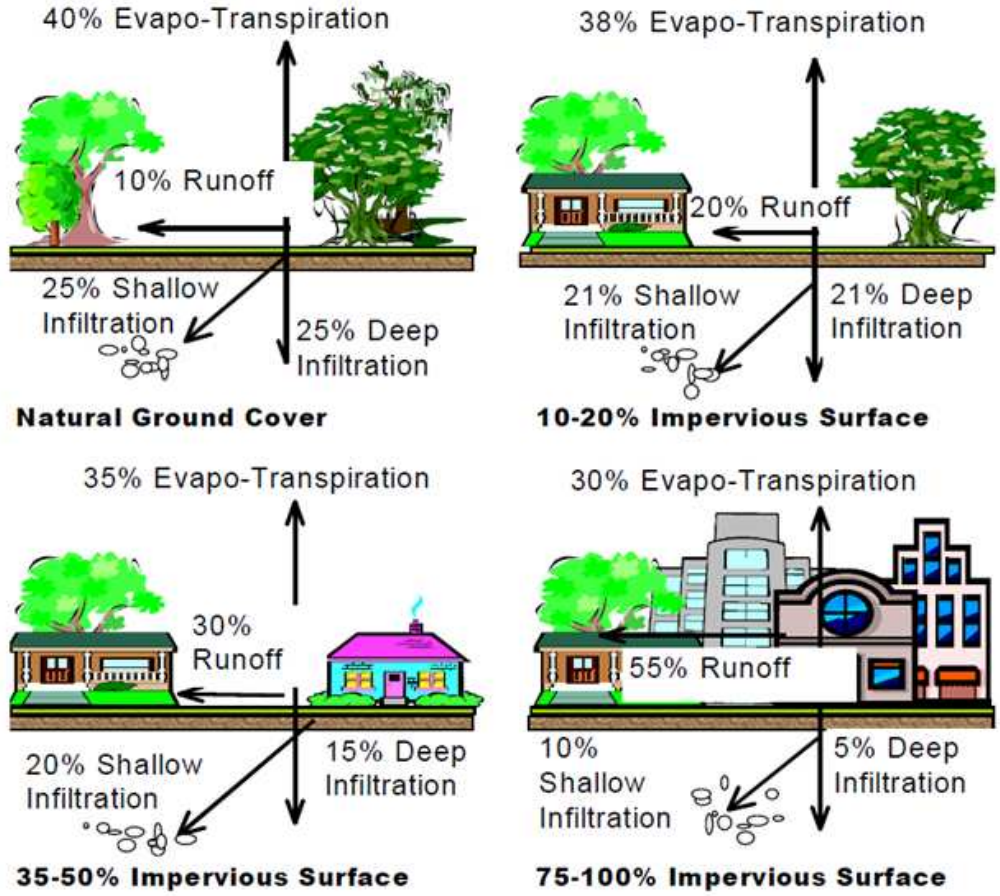

Fig. 5 Water cycle changes associated with urbanization. Image from: http://www.swrcb.ca.gov/rwqcb2/water_issues/programs/stormwater/ISDC/Nemo_Fact_Sheet.pdf

Undeveloped areas: forest, flood plain and soil

Forest

Forests play a vital role in the sustainability of clean and reliable water supplies and in the alleviation of the accelerated sediment release that could clog reservoirs and exacerbate floods (Haigh et al, 2004). Recent findings have provided correlations between forest loss and increase in flooding, e.g. the work of Bradshaw et al. (2007), considered 10 years of data from 56 countries. The study concluded that a decrease in natural forest area of 10% resulted in an increase of flood frequency from 4% to 28%. In addition, the same 10% decrease in forests in the surveyed countries resulted in a 4% to 8% increase in total flood duration.

Forest has the natural ability to absorb water when it rains, and to release that water slowly into rivers. Thus, deforestation is a cause of increased flooding because the water moves more quickly from the land to the rivers, causing erosion (raindrop splash) and stripping the soil. However, the impact of forestry on peak flows depends on the different stages of forest growth, forest types, climatic zones, soil types, morphology and general land management practices (EEA, 2001).

Floodplain

Floodplains are hotspots of biodiversity and central elements of an ecological network. They are also flood protection areas, greenery of waterways, and areas of agricultural as well as urban use (Follner et al, 2010). Floodplains, as wetlands and brush lands, are therefore "flood-prone" and are hazardous to development activities.

In Germany, the Federal Agency for Nature Conservation funded several research projects, which compiled an inventory of the former floodplain area for the larger rivers, the remaining active floodplains and their status (Brunotte et al. 2009), to contribute to the implementation of synergies between nature conservation and flood protection measures. The survey of the floodplain areas was conducted for sections of the rivers with a catchment area of at least 1,000 km^2. Tidal waters were excluded. Remaining active and former floodplains were assessed. Together they form the geomorphologic floodplain which is defined in this case as the area which could be inundated, if there were no man-made dikes. For each 1-km section of the rivers, separately for the left and the right side, the active and former floodplain areas were assessed and land use, nature conservation value, and protection status were documented. The data base of the floodplain assessment consists of several digitally available georeferenced data (GIS) provided by German administrations.

The final report shows that in the past floodplains of larger rivers covered about 15,000 km^2, which corresponds to 4.4% of the German territory, of which two-thirds were lost by embanking. Less than 10% of the active floodplains fully provide their ecological functions. The remaining near-natural hardwood forests cover only about 1% of the active floodplain area (Fig.6). This situation is a result of the intense agricultural use and the former importance of rivers as routes for transport and trade as well as the arising settlements and infrastructure. In the former floodplain areas, a small percentage (4%) of “slightly modified” floodplain sections are left, which apparently still maintained “floodplain-like” without being inundated (Follner et al., 2010).

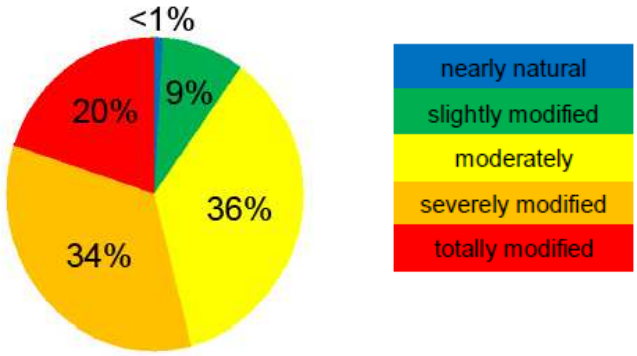

Fig. 6 Distribution of the floodplain status classes for all assessed sections of active floodplains in Germany.
Source: Follner at al. 2010

Top soil is a non renewable resource

“Il suolo minacciato[3]” (literally: “The threatened soil”) is an Italian documentary describing the soil consumption and sealing in the Parma Food Valley. According to Mercalli (1st part of the documentary) “*top soil is a non renewable resource…It is the life support system for humans and all the form of life*”. Top soil, the uppermost layer of soil, has a thickness from 2 inches (5.1 cm) to 8 inches (20 cm). It has the highest concentration of organic matter and microorganisms and is where most of the Earth's biological soil activity occurs (Millennium Ecosystem Assessment, 2005). Top soil sealing occurs when agricultural or other rural land is built on and all soil functions are lost. In Europe, on average, built-up areas take up around 4 % of the total area of Member States, but not all of this is actually sealed. In the decade 1990–2000, the sealed area in the EU-15 increased by 6 %, and the demand for new construction sites for urban sprawl and for transport infrastructures is continuing to rise (EEA, 2010b).

[3] http://www.ilsuolominacciato.it/film.html , by Nicola dall´Olio , only in Italian language.

1.3 Urbanization and cities

Urbanization

Urbanisation reduces the retention area available for natural flood prevention or increases the number of homes and businesses actually in flood-prone areas (EEA, 2012). The impact of man-made changes on the hydrology of developing watersheds can be measured in terms of the ratio: flood peak after development to flood peak before development over a range of return periods (Kibler et al., 2007). Urbanization increases the frequency of high-flow discharges and reduces the time to reach peak discharges because of soil sealing and increased run-off (Saghafian et al., 2008). Heavy rain falls in cities cause surface flooding because the capacity of the sewage system is temporary not be able to cope with the high run-off of water. Indeed, much of the flooding in England in the summer of 2007 was due to surface water (Pitt 2008). The areas with the highest increase in urbanization tended to match those more prone to floods. However, the analysis of urbanization effects on flood frequency seems to be a vexing problem, because of a lack of flood data in urban areas and of nonstationarity/dynamic development processes (Suriya et al. 2011).

The construction of urban transport infrastructure contributes to a constriction of floodplains and an increase in the area of impermeable (or “sealed”) surfaces. Linear features, such as roads and railway lines, which do not have sufficient or adequate drainage works, may divert flows to other areas or increase water levels upstream. Hence, the construction of road and rail networks can intensify floods and their catastrophic effects (EEA, 2001).

With urban sprawl, a greater number and proportion of watersheds are affected by concrete, buildings, and other impervious surfaces which impede the rapid infiltration of precipitation (Roy et al., 2005). These changes to the natural patterns of runoff have resulted in increased risk to human health and safety, as well as hydrological, geomorphic, and ecological impairment of receiving stream ecosystems (Allan, 2004). In the following Figure 7, Andjelkovic (2001) gives a generalized view of the interlocking problems brought on by urbanization. If the amount or intensity of precipitation is higher than the capacity of the system, or if parts of the system do not function properly, floods are the result.

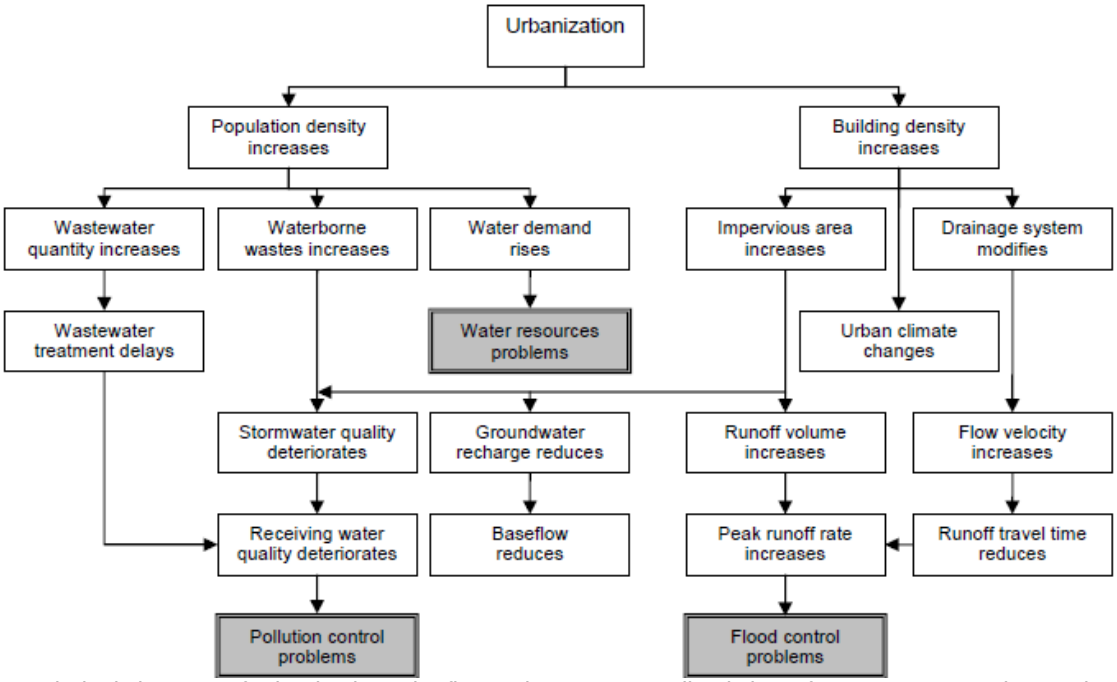

Fig. 7 Hydrologic impacts of urbanization. The figure shows a generalized view of water movement in an urban environment. Source: Andjelkovic, (2001).

Andjelkovic (2001) also identifies a “minor” system– consisting of sewers, curbs and gutters, open channels, and swales – and a “major” system– consisting of natural and man-made pathways for excess water to flow overland to a receiving water body. Floods in urban areas result from the interactions between these minor and major systems. Many communities did not know that the system “major” existed until they found water coursing through their basements, industrial parks, and commercial buildings.

Cities and floods

Differences in urban design and management make cities vulnerable to flooding in different ways, even those situated in the same geographic region. Excessive amounts of rain water cannot drain into the ground where a high share of the city's area is imperviously sealed and thus generate or worsen floods (EEA, 2012). Flooding in urban areas can be caused by flash floods, coastal floods, or river floods, but there is also a specific flood type that is called urban flooding. Urban flooding is specific in the fact that it is caused by a lack of drainage in an urban area. As there is little open soil that can be used for water storage nearly all the precipitation needs to be transported to surface water or the sewage system. High intensity rainfall can cause flooding when the city sewage system and draining canals do not have the capacity to drain the amounts of rainwater. The very same can happen in rural areas and is then called “ponding” (www.floodsite.net).

Rivers have historically been and continue to be important transport routes. Therefore, most of Europe's large cities and conurbations are located along major rivers. The EEA (2012) report shows that roughly one fifth of European cities with over 100.000 inhabitants are very vulnerable to river flooding (Fig. 8) and “flash floods” from extreme rainfall events.
The map in Fig.8 indicates if a city has a large share of depressions, which can be flooded. It indicates the risk of considerable damage throughout Europe in particular deltas in the Netherlands (Rhine-Meuse) and northern Italy (Po). However, the map should be interpreted with caution, since neither coastal floods nor flood protection measures are considered in the calculations.

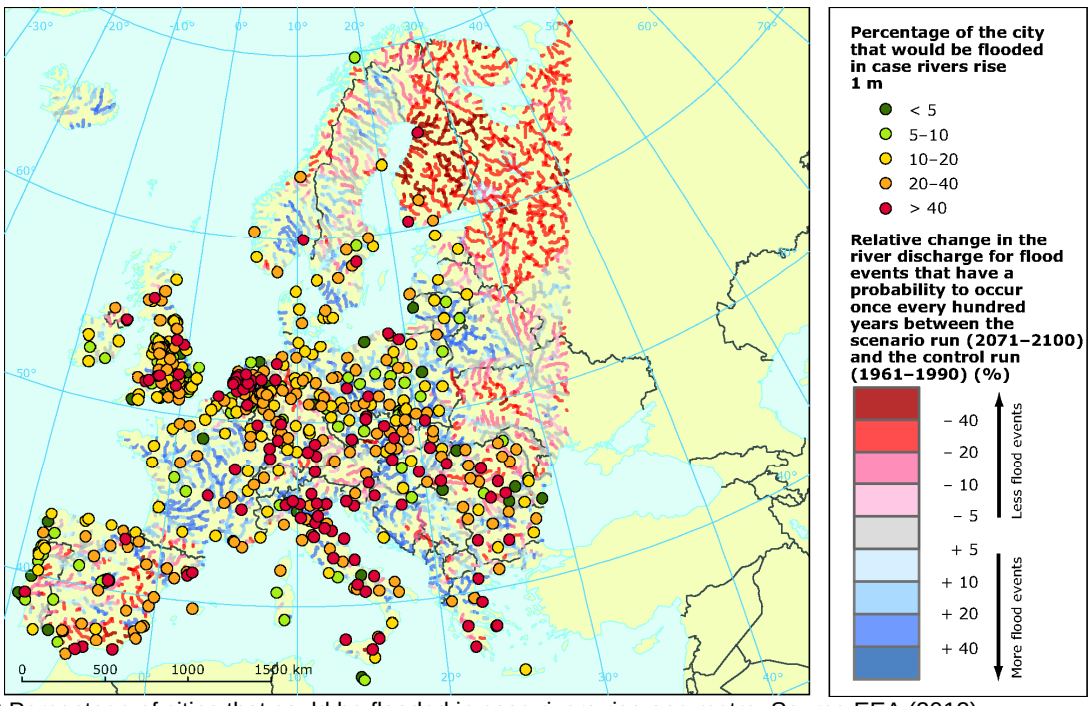

Fig. 8 Percentage of cities that could be flooded in case rivers rise one metre. Source EEA (2012)

Barredo (2006) reports a catalogue of the major flood events since 1950– 2006 in the European Union and he characterized major floods in terms of casualties and direct damages. Twenty-three out of the forty-seven events listed in the catalogue are classified as

flash floods. They are mainly localised in Italy, Spain and southern France. Flash flood events are also reported in Germany, Belgium and UK.
The high economic losses caused by floods include damage to infrastructure, public and private property due to the flooding itself, erosion or landslides, indirect losses in or beyond the flooded areas such as interrupted power generation and deteriorated groundwater quality caused by pollution or salinization in coastal areas. Socio-economic challenges in the form of lower productivity, failure of services, loss of jobs and income sources pose additional problems (EEA, 2012).

A city's weakness does not depend solely on soil sealing but also on rain water management. For decades urban drainage systems have been optimised to drain a rain shower with a particular return period. Considering future climate and on-going urbanisation, this 'carrying capacity' has already turned out to be inadequate in a number of cities (EEA, 2012). One example was the extreme rainfall that took place in Copenhagen in 2011. The city centre was flooded when over 150 mm of rain fell during a two hour period on 2nd of July 2011. Insurance damages alone were estimated at 650 to 700 million EUR. After the flood event, there was a governmental decision to change the planning law, for new buildings with flat roofs. Since then all of these buildings have to be greened.

2 The role of land use planning in flood risk management

Introduction

The way land resources are utilized has a decisive influence on development prospects of societies. Land Use planning[4] is the process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses (http://preventionweb.net/go/492).

Flood risk management (FRM) aims to reduce the likelihood and/or the impact of floods. By the end of 2013, all EU Member States have to complete the Flood Risk Management Plans (FRMp) that should focus first on prevention then on protection and preparedness (EU, 2007). Prevention will be possible through an appropriate land-use practice that prevent floods damage by avoiding construction of houses and industries in present and future flood-prone areas and by adapting future developments to the risk of flooding (EC, 2004).

The EU Water Framework Directive (EU-WFD) and the EU Floods Directive (EU-FD) strongly emphasise the need for closer ties between river basin management and land use planning. At the same time, European guidance on spatial planning promotes the idea of incorporating wider social and environmental objectives within planning decisions. Therefore, these two drivers should promote greater integration between spatial planning systems and the river basin planning system associated with the EU-WFD (Blackstock et al. 2011) and EU-FD. Flood prevention in the major European river catchment areas can only be made effective through the imposition of clear conditions and intervention in land-use (ESDP, 1999). An integrated and holistic[5] approach to flood risk management set within LUp processes is now seen as an effective way of minimising risk (URS, 2002 and EGLI, 2002). Although this has not always been recognised in practice and empirical guidance on its implementation, which is still lacking (e.g. DCLG, 2009 and Carter at al. 2005).

It is increasingly recognised that the management of land and water are inextricably linked (Defra, 2005) and most human effects on flood risk have rather long time scales: land use change and urbanisation develop with time scales of decades and centuries and short term corrections are not possible (Merz et al., 2010). The water management policy and spatial planning efforts in the long run must concentrate towards attaining an equilibrium stage between economic development and urbanisation on the one hand and the needs to allocate more space to water for flow retardation and water retention on the other hand – space that must be earmarked now. The exigencies of flood prevention must become one of the guiding principles in spatial planning (EU Water Directors, 2003). Naturally, since these processes are better understood for a couple of decades, calls have been that planning practices in the different sectors and groups dealing with land use planning, flood protection or flood risk management should be interlinked or harmonized and carried out in a coordinated way throughout a catchment (Greig, 2010).

The human response to the prevailing flood hazard has in most cases been based on the construction of flood defences, especially levees, storage reservoirs, floodwalls, and diversions. Contrary, the approach of land use planning should be largely recognized as the way forward, where development decisions are based on the knowledge of the prevailing and expected future risks. This is the key to develop planning strategies referring to faced risk and to gain credence from the society (WMO, 2007).

[4] Other Europeans call it *Raumordnung, aménagement du territoire, or town and country planning*.

[5] A holistic approach must take into account all individual factors of influence and all the usages of water within a catchment area. It is after all a question of reconciling the various competing demands made on a body of water, and this includes the economic and social needs of people in the region as well as ensuring an ecologically intact environment.

2.1 Preventive land use planning

Amongst the non-structural responses (see paragraph 2.4), land use planning is considered as one of the more crucial components in managing flood risks (Wheater & Evans, 2009), especially as a preventive measure. Preventive land use means stopping building development in flood basins (LAWA, 2010) and discourages any construction or works likely to form an obstacle to the natural flow of waterways that cannot be justified by the protection of densely populated areas (EU Water Directors, 2003). Planning measures can reduce the costs of flood risk by excluding some activities from the floodplain and by providing conditions under which particular developments would be allowed at locations with given flood risk. Planning measures are generally not aimed at existing buildings (except for buildings delocalization) and therefore do not directly reduce the risks of households or business already located on the floodplain (URS, 2002).

Indirectly planning measures could decrease the total water run-off for example designing water holding areas in parks and ponds at city level or through an integrated spatial plan with the main objectives of flood protection, master landscaping and the improvement of overall environmental conditions of a river at the catchment level (for more examples see Fig.9).

The general driving principle in preventive land use planning is that the development of urban and industrial areas has to be kept out of main risk zones. It is better to have the land zoned and used for purposes such as cities and landscapes than to try and ensure that future development is flooding proofed (Friesecke, 2004).

The European flood action programme emphasises the importance of damage prevention by appropriate Land Use planning (EC, 2004). Important aspects include:

- avoiding construction of houses and industrial buildings in current and future flood-prone areas;
- adapting future developments to the risk of flooding;
- appropriate land use, agricultural and forestry practices.

At the regional or river basin level some transnational prevention programmes exist. Examples include the Rhine across France, Germany, the Netherlands and Switzerland and the Meuse across Belgium, France and the Netherlands. Wider transnational cooperation is stimulated by macro-regional strategies of EU regional policy, for example, for the Baltic and the Danube (EC, 2009b; EC, 2010a; EC, 2010b).

2.2 Prevention is cheaper than aftercare measures

In natural environment, there is no flood damage. The general increase in damage caused by natural disasters is related to the number of people who live in exposed areas and accumulate value there (Münchener Rück 2003). The more intensively and the less suitably the flood basin is used, the greater is the potential for damage and the actual damage when the flood occurs (E.U., 2003, p. 19).

In Europe, the number of disasters attributed to flooding is on the rise. Since 1998, over 100 major damaging floods have caused 700 fatalities, the displacement of about half a million people and at least € 25 billion in insured economic losses (EEA, 2003). Examples are the winter Storms Joachim and Dagmar (12/2011) resulting in insured losses of close to USD 0.7bn in Germany, Scandinavia, France, and Switzerland. Windstorm Friedhelm (12/2011) battered the UK with hurricane-force winds, destroying vehicles, damaging offshore facilities, blocking roads, and leading to USD 0.4bn in estimated losses. Hurricane Katia (08/2012) developed over the Cape Verde Islands and made landfall in Scotland, giving rise to USD 0.2bn in damage. Meanwhile, a slow-moving extra-tropical area of low pressure (named “Rolf”, 11/2011, the first low pressure system over the Mediterranean to be categorized as a tropical storm) caused torrential rains and widespread flooding in southern France and northern Italy, claiming the lives of eleven people and leading to insured losses of USD 0.6bn (Swiss Re, 2012).

The extreme consequences of the recent catastrophic events have highlighted that risk prevention still needs to be improved to reduce human losses and economic damages. For instance, it is interesting to note that from 2002 to 2008 the European commission Solidarity Fund has financially supported eight countries to help them recover from flood events, with about 150 million Euros of funding. Hence, it is essential to investigate and disseminate the benefits of prevention measures compared to traditional post-disaster recovery.

Prevention means both:

- preventing disasters from happening (when this is possible);
- taking measures to reduce their impacts.

The development of a culture of risk prevention requires the improvement of our:

- Memory and knowledge of past disasters;
- Communication and understanding capacity of current and future hazards;
- Awareness of risk;
- Preparedness for future events.

The EU KULTURisk project (http://www.kulturisk.eu/home) aims at developing a culture of risk prevention by evaluating the benefits of different risk prevention initiatives. This evaluation will be carried out by developing a novel methodology and referring to different types of water-related catastrophes, such as river inundations, urban flash floods, storm surges, rainfall triggered debris flows and landslides. The Work Package 3 (WP3) is related to "mapping, planning and risk transfer". The first Report on WP3 is available at http://www.kulturisk.eu/results/wp3 and provide a comprehensive and critical review of: i) the recent development of hydrological and hydraulic models used for mapping flooding and debris-flow hazards, ii) deterministic and probabilistic methodologies to map water-related risk, iii) land-use and urbanisation planning as well as risk transfer (insurance policy) practices in water-threatened areas.

In order to demonstrate the advantages of prevention options, an original methodology will be developed, applied and validated using specific European case studies, including transboundary areas. The benefits of state-of-the-art prevention measures, such as early warning systems, non-structural options (e.g. mapping and planning), risk transfer strategies (e.g. insurance policy), and structural initiatives, will be demonstrated in the project.

KULTURisk is initially focused on water-related hazards as the likelihood and adverse impacts of water-related catastrophes might increase in the near future due to of land-use and/or climate changes. In particular, a variety of case studies characterised by diverse socio-economic contexts, different types of water-related hazards (floods, debris flows and landslides, storm surges) and space-time scales will be utilised. Finally, the applicability of the KULTURisk approach to different types of natural hazards (e.g. earthquakes, forest fires) will also be analysed.

2.3 Multi-scale approaches to manage flooding

In each country, community and city, there are different situations and different answers to problems with respect to flooding and living in cities prone to flooding. Flood risk reduction must be considered at a range of scales, including the whole water system (Fig.10). Also, experience has shown that local flood protection measures can have negative effects both downstream and upstream. According to Shaw et al. (2007) and Jha et al. (2012), there are different approaches to manage the risk of flooding focusing on three (or four) spatial scales: the conurbation/catchment scale, (the city scale) the neighbourhood and the building scale.

The following diagram (Fig.9) illustrates the actions and possible techniques which have to be considered to create an integrated flood risk solution. It summarized the range of actions and techniques available using practical examples to managing the risk of flooding and it is

promoted by the United Kingdom's Town and Country Planning Association (TCPA) in the third “Design Guide for Sustainable Communities”, Shaw et al. (2007).
At the catchment scale the main goals should be to integration of green and the establishment of retention rooms (e.g. sports fields and car parks) to increase the temporary water storage capacity during flood events, which helps to reduce peak flows.

At the neighbourhood scale, efforts should focus on understanding and managing flood pathways and protecting areas at risk. Well designed adaptation can have additional benefits for water quality and resource management, and enhance public spaces. Similar solutions from catchment flood risk management strategies can be applied at the neighbourhood level and include, for example, the replacement of impermeable surfaces by Sustainable Drainage Systems (SUDS), such as permeable pavement, gravel or grass so that water can soak away.

The aim at building scale should be to minimise the exposure to flooding whilst incorporating structural solutions, which help to reduce the vulnerability. New developments need to be carefully assessed to ensure that they are built to cope with flood risks as they change over time and that risks in adjacent areas are not exacerbated. Existing buildings can take advantage of new materials and products to minimize flood risks. Though it must be stressed that these strategies do not always make new development in the floodplain acceptable in flood risk terms – they are aimed to protect existing development.

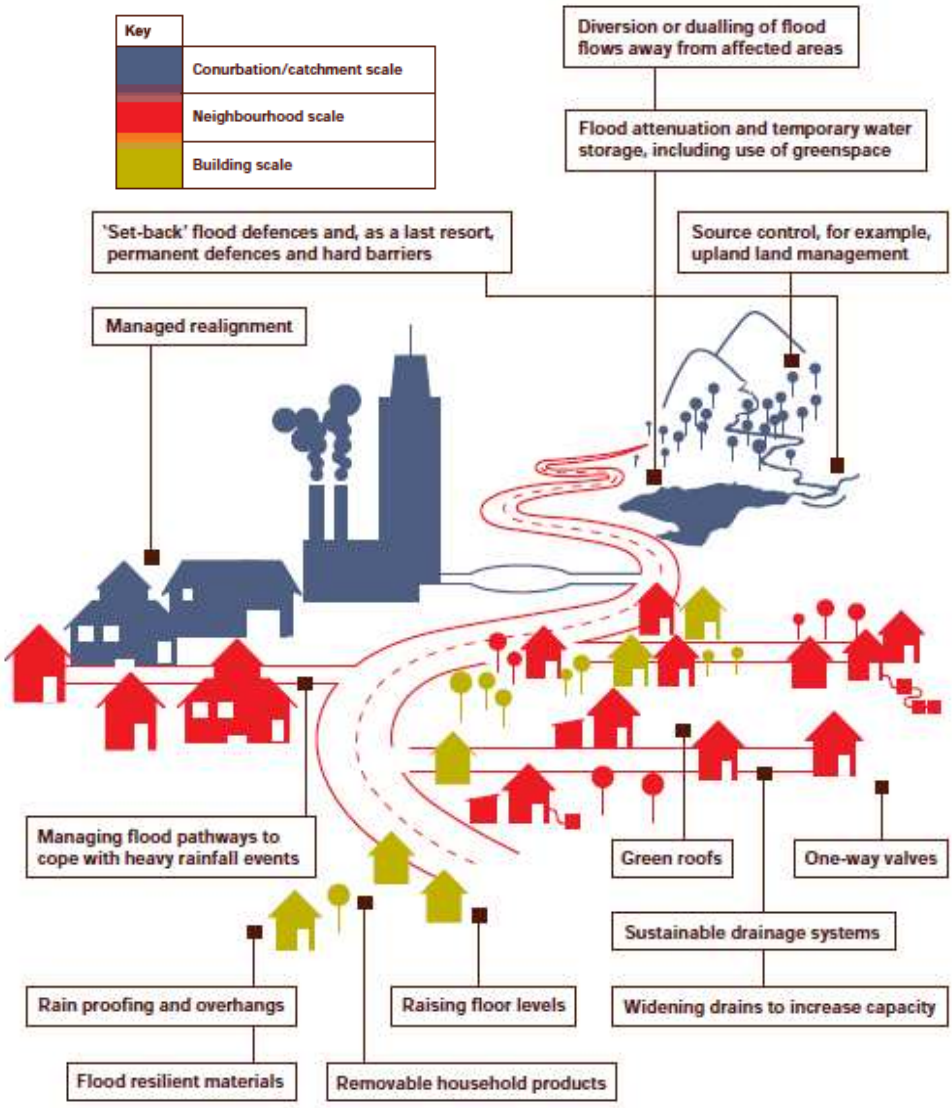

Fig. 9 Multi-scale approaches to manage flooding. Source: Shaw et al., 2007.

2.4 Structural and non structural approaches: finding the right balance

Traditionally, flood risk reduction has been concentrated on the construction of embankments and retention by reservoirs. Such measures, also called flood control strategies, aim at reducing the flood hazard, i.e. the probability of hazardous flooding. Attempts to decrease vulnerability, i.e. the other aspect of risk, have been of minor importance (Merz et al., 2010). Meanwhile, it is well recognized that structural flood control alone does not solve the flood problem and countries are moving towards more integrative practices (Alphen & Bourget, 2010) that recognize the importance of a coherent set of flood risk management measures.

Flooding is controlled by a combination of structural and non-structural measures enabling the riverside population to minimize its losses and continue to live in harmony with the river. These include engineering, social, economic and administrative measures. Planning of protection against flooding and its effects involves research into the ideal combination of these measures (Tucci, 2007, Mambretti et al., 2008). The paradigm shift from "providing the safe level of protection" to "reducing the risk to the acceptable level" is possible only through wide acceptance of the fact that absolute safety is impossible to achieve and that every individual, community and state must adapt to a certain level of flood risk (Anzeljc, 2010). There is no single response that will reduce flood risk substantially and that is completely sustainable. Different response measures will vary under different scenarios, and the Government needs to support the concept of a portfolio of responses to decreasing flood risk, which should include structural and non-structural solutions (Evans et al. 2008). Measures which can be implemented more quickly (such as operations and maintenance, greening of urban areas, improved drainage, building design and retrofitted protection measures) can also enable occupation of flood risk areas while minimizing the expected damage from flooding (Jha et al., 2012).

Structural flood management measures often are not an adequate answer. The disadvantage of this strategy is its finiteness of effectiveness. Recently, levee systems have been built along Mississippi and Sacramento Rivers in the United States and Rhine, Loire, Vistula, Scheldt and Danube Rivers in Europe. Examples for the non-effectiveness of existing structural measures are the recent flood events (Serbia, Romania and Bulgaria 2006, New Orleans 2005, Bangladesh 2004). In light of this there is a growing realisation that various flood mitigation measures exist – and not only structural measures such as dams and dikes – and must be combined in an integrated approach to flood management (Friesecke, 2004).

Structural measures

Structural flood management measures are any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems (http://www.preventionweb.net). Avoiding the impacts of flooding will continue to imply the use of protection structures such as dikes and embankments, a fact also recognised in current flood management plans such as the Bavarian Plan for Flood Protection (Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz, Bayern 2005).

The 100-year flood event on the lower Danube in 2006 caused suffering and even loss of life: 10 people were killed and ca. 30.000 people displaced; damage was estimated at more than half a billion Euro. In Romania alone, agricultural polders, which provide livelihoods for local people, were heavily impacted during the floods: an area of 70.000 ha was flooded affecting 10.000 people. In Serbia about 240,000 ha of agricultural land was flooded, approximately one half by rivers and the other half by groundwater. 2000 houses in 30 communities within unprotected areas were flooded. Civil Defence evacuated about 1000 residents. Water management companies reported flood defence costs of approximately €10 million. Damage was initially estimated at roughly €40 million. The Danube floodwater also resulted in bank overflow on the Bulgarian side and seriously affected an area of several hundred kilometres along the Danube River: It was necessary to evacuate over 2000 people (ICPDR, 2008).

In 29 August 2005 there were over 50 failures of the levees and flood walls protecting New Orleans, Louisiana, and its suburbs following passage of Hurricane Katrina and landfall in Mississippi. The levee and flood wall failures caused flooding in 80% of New Orleans and all of St. Bernard Parish. Tens of billions of gallons of water spilled into vast areas of New Orleans, flooding over 100,000 homes and businesses (ASCE, 2007).

The Afsluitdijk (lit. Closure-dike) is a major dike in the Netherlands with a length of 32 km and a width of 90 m, at an initial height of 7.25 m above sea-level. The Netherlands has become prosperous due to its favourable position in the delta of several large rivers. But without strong flood defences two-thirds of the country would be under water. Nine million people live in this vulnerable area of the Netherlands where 65% of the gross national product is earned. Monitoring the condition of the flood defences is therefore absolutely vital. The condition of the "primary flood defences" is particularly crucial. They protect the land from water from the sea, the major rivers and from the IJsselmeer and the Markermeer lakes.

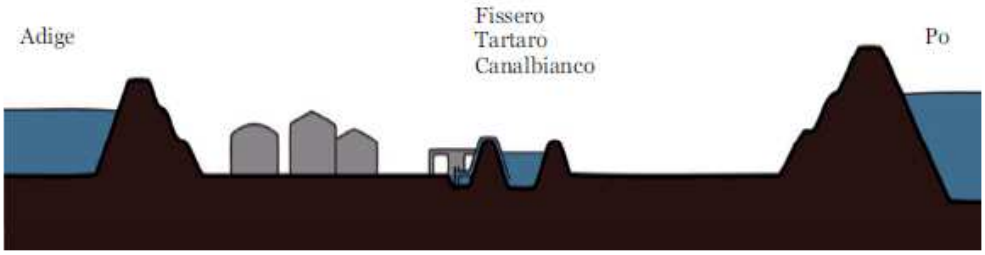

Fig. 10 Section of Polesine. graphic of Maurizio Conci.

Polesine is a wide plain located between the lower portion of the rivers Adige and Po (Fig. 10), with many areas below sea level; thus the mechanical drainage of land allows the maintenance of this area.
The only structures that rise are the manmade channel's embankments (Santato, 2011).

The project MOSE in Venice (Fig.11) is a system of tidal regulation works that can cope with a difference in level between sea and lagoon of as much as two metres. MOSE has been designed on the basis of a precautionary criterion to cope with an increase of up to 60 cm in sea level, in other words, higher even than the latest estimates from the 4th IPCC report which projects an increase in sea level of between 18 cm and 59 cm during the next 100 years. So even in the worst possible scenario of that time, Venice and other built up areas in the lagoon would be protected.

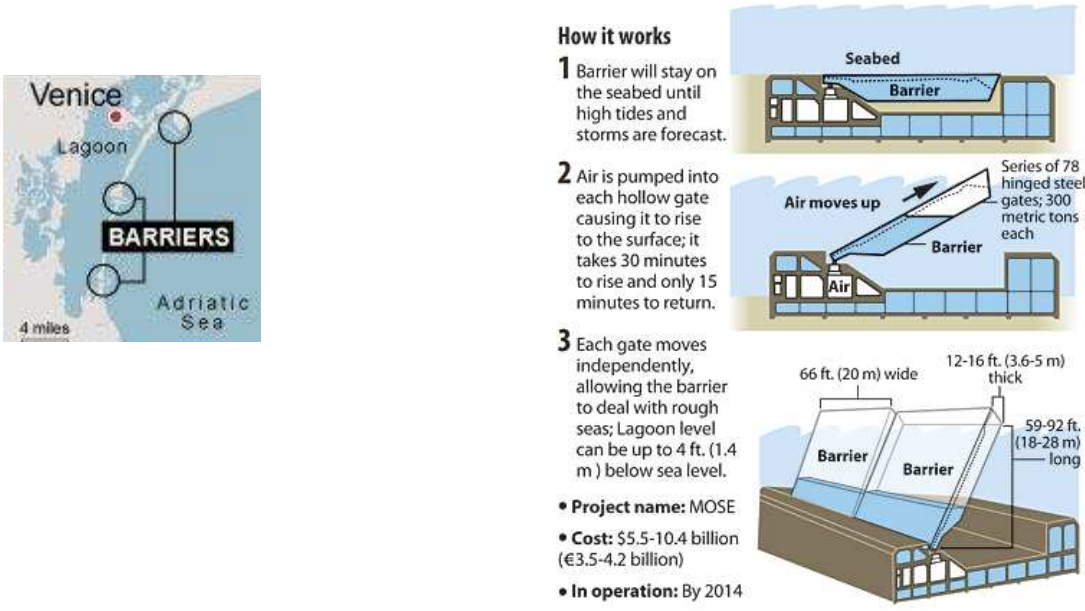

Fig. 11 Project MOSE in Venice. Source: http://www.salve.it

Non structural measures

Non Structural Measures (NSMs) are any measures not involving physical construction that uses knowledge, practice or agreement to reduce and prevent risks and impacts, in particular through policies and laws, public awareness raising, training and education (http://www.preventionweb.net). Regulations, such as city codes and subsidies, should promote implementation of non structural measures such as means for rainwater storage, infiltration and runoff control in an integrated manner at the urban and basin basin scale (WMO, 2011a).

The neighbourhood of Augustenborg (Malmö, Sweden) has experienced periods of socio-economic decline in recent decades, and has frequently suffered from floods caused by overflowing drainage systems. Augustenborg underwent significant regeneration between 1998 and 2002. The main drivers for this regeneration initiative were the difficult social and economic situation in the neighbourhood, flood risk management, waste management, and biodiversity improvement. The significant change was the creation of sustainable urban drainage systems (SUDS), including ditches, retention ponds, green roofs, and green spaces. The project has resulted in a successful outcome as the rainwater run-off rates have decreased by half, and the increase in green space has improved the image of the area. (malmo.se/sustainablecity).

Green roofs act as a natural storm water management device by using vegetation and soil to slow down and reduce runoff response. More than reducing the flood risk, green roofs also clean and filter the air and rain water. Not only are green roofs able to filter contaminants out of rainwater they can also degrade contaminants, either by direct plant uptake, or by binding them within the growing medium itself.

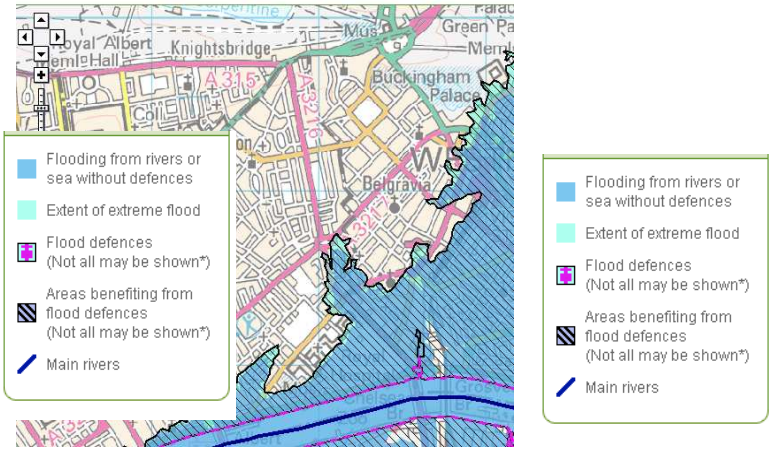

Fig. 12 Environmental Agency's Flood Map, snapshoot from the city of London. Source: www.environment-agency.gov.uk

The Flood Map is a multi-layered map which provides information on flooding from rivers and the sea and also has information on flood defences and the areas benefiting from those actions. The Flood Map is designed to increase awareness among the public, local authorities and other organisations of the likelihood of flooding, and to encourage people living and working in areas prone to flooding to find out more and take appropriate action. It can also be used by those people who wish to apply for planning permission in England and Wales (Fig. 12) to see whether the site they plan to develop is in a flood risk area

Fig. 13 Website of the “Flood partnership” in Baden-Württemberg. Source: http://wbw-fortbildung.net/wbw/

Flood partnerships are an integral part of the flood prevention in Baden-Württemberg (Fig. 13). The overall objective is to increase hazard awareness, to network with affected residents and stakeholders and to initiate and implement flood prevention actions. The first foundation was in November 14, 2003 in the city of Ravensburg. Now it is being adopted by Rhineland-Palatinate, Saarland and Luxembourg as a means to facilitate the process of establishing flood risk management plans (M. Heintz et al. 2012).

The evacuation map for the Netherlands for polders along the Rhine river near Germany (Fig. 14) shows clearly the mandatory evacuation routes, including indication of one-way converted roads, closed entrances and exits, and it is easy to interpret by the general public.

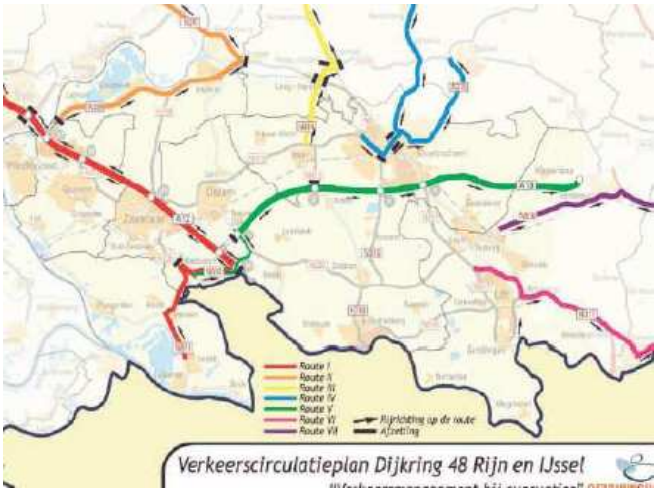

Fig. 14 Evacuation map for the Netherlands. Source:http://ec.europa.eu/environment/water/flood_risk/flood_atlas/

Hazard zoning provides a detailed overview of the hazard situation and a basis for communal and cantonal spatial planning processes in Switzerland (Fig. 15). Hence it serves as a basis for identifying hazardous zones and determining conditions for use (e.g. definition of hazard zones in development plans and formulation of building regulations).

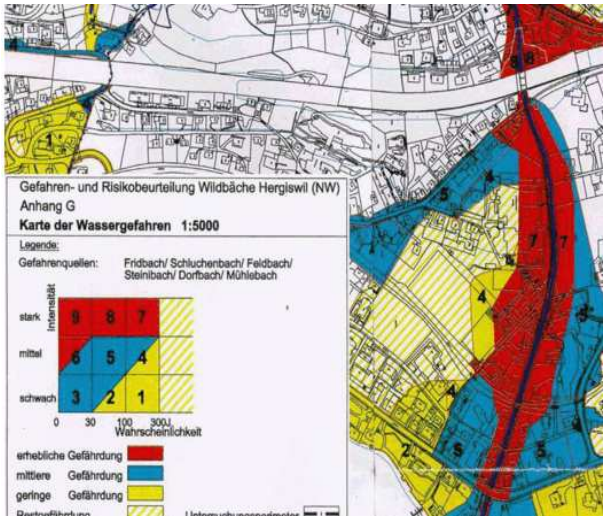

Fig. 15 Hazard zoning and land use planning in Switzerland.
Source: FOEN et al., 2006.

Flood peaks reached very high levels due to the reduced discharge capacities of the floodplains: restoring floodplain areas along the middle and lower stretches of the Danube River (Fig. 16) will yield multiple benefits not only in terms of enhanced flood protection, but also for local livelihoods. The so-called "Lower Danube Green Corridor" is an initiative that aims to protect and restore precisely these areas in Bulgaria, Moldova, Romania and Ukraine, who all signed the agreement in 2000.

Fig. 16 Lower Danube Green Corridor Programme. Source: http://www.deltanet-project.eu/.

2.5 Mitigation under climate change

Structural measures must not collapse and fail and cause the sudden uncontrolled proliferation of damage when exposed to extreme volumes of runoff, bed load or physical stress. However, old protective structures (such as dikes or embankments) often fail to fulfil this requirement or flood defence failure data is or was not considered in hydrological modelling (Santato, 2011).

Many protective structures which originate from the 19th century no longer fulfil the technical and ecological requirements applicable today. These include important river engineering measures, (for example on the Rhone in the Rhone Valley in Switzerland or the lower portion of the Adige and Po rivers in Italy). Numerous smaller structures (for example canals and pumps for water draining in lower land) also require renovation and upgrading to fulfil today's requirements. Their design is often based on experience gained at a time when extraordinary natural hazard events were comparatively rare and were not taken into account in planning as extreme event (FOEN, 2011).

It has conventionally been assumed that the natural resource baseline is constant. Traditionally, hydrological design rules have been based on the assumption of stationary hydrology, tantamount to the principle that the past is the key to the future, and this is no longer valid under the ongoing global change (Lindenschmidt et al., 2007). Probably, many existing protection systems designed to protect against a flood with a certain statistical return period will fail more frequently under climate change conditions. With this evidence it is the challenge for the designer to provide a concept for a general robust layout of hydraulic schemes to cope with overloaded or under-designed hydraulic structures (Zenz, 2009). These are for example special measures for debris management, additional dam overflow sections with erosion protection or partially improved dam cross sections with seepage prevention or filter sections. Entrapped by the present practice, water authorities react on this increasing residual flood risk with the intention, for example, to raise the height of the dike. But dike rising is not flexible enough to cope with the uncertainty of climate change because dike rising can also be:

- ✓ cost intensive,
- ✓ needs space,
- ✓ needs long implementation periods,
- ✓ has a strong impact on ecology,
- ✓ and the projections of climate change are too uncertain for deriving assured design high water levels.

On the other hand, keeping water out of urban areas is mostly not the perfect solution; accepting and preparing for some degree on flooding will in many cases be a more sensible solution..

BOX 2 Terminology: Mitigation and Adaptation in the flood context.
In the engineering and hydrological context, MITIGATION refers to methods of reducing the effects of floods. These methods may be **structural** solutions (e.g., reservoirs, levees) or **non-structural** (e.g., land- use planning, early warning systems) (Glossary of Meteorology, AMS - American Meteorological Society http://amsglossary.allenpress.com/glossary).

It should be noted that in climate change policy, “mitigation” is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change. (Source: Annex II, 4SR, IPCC 2007).

In climate change policy, the MITIGATION action is combined with the ADAPTATION action defined as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Glossary of UNFCCC: http://unfccc.int/essential_background/glossary/items/3666.php).

In this context, ADAPTATION includes both **structural** and **non structural** measures to adapt (reduce the risk, find opportunities) a community to the future CC impacts. It should be kept in mind that protection and prevention from flooding is an adaptation work to climate change.

The effects of urbanization on runoff are well known. Without mitigation, urbanization increases flood risk. The key issue is the extent to which mitigation measures are implemented, either at catchment or local scale. So the effect of this driver is heavily dependent on socio-economic scenarios (Wheater & Evans, 2009), and for this reason, mitigation strategies are urgent, with or without CC.

The safest and most sustainable way to deal with this increased risk is to reduce vulnerability and exposure by moving settlements and assets out of the flood plains, flood prone areas behind protection constructions and by giving rivers their natural room for flooding. However, for many settlements and land uses this is not a feasible option and more integrated approaches are needed to come up with realistic and tailor-made solutions (EEA, 2009).

2.6 Examples of flood prevention from different countries

At the national level, Japan appears to have devised a balanced approach by stressing the importance of protective measures combined with alternate solutions, such as evacuation planning and land use management policies. Regulations and codes can, and should, be harnessed to the effort to develop and implement adaptive strategies in urban flood management and integrated flood management. The Government has established a subcommittee on climate change adaptation for flood control under the Ministry of Land, Infrastructure, Transport and Tourism. Their adopted strategy has a prominent place for adaptation through control and guidance of community development.

The Netherlands have a rich history of relying primarily on structural solutions to managing the various risks posed by floods and coastal storms, as evidenced by its Delta Works network (www.rijkswaterstaat.nl). In the 19th century, they developed dredging technology to provide a coordinated and interconnected dike and drainage system that influenced the spatial organization of their cities. Dams were built, a traffic network was conceived, and dike belts with safety norms were created. Much of this infrastructure was built underground, so in the 1970s the government decided on another approach of flood control. *"We are trying to work with Nature instead of fighting against it,*" said V.J. (Han) Meyer, professor of urban design at Delft University of Technology. *"This has caused us to re-vision how we deal with water in urban areas. It has led us to a new program called Vision 2053."*

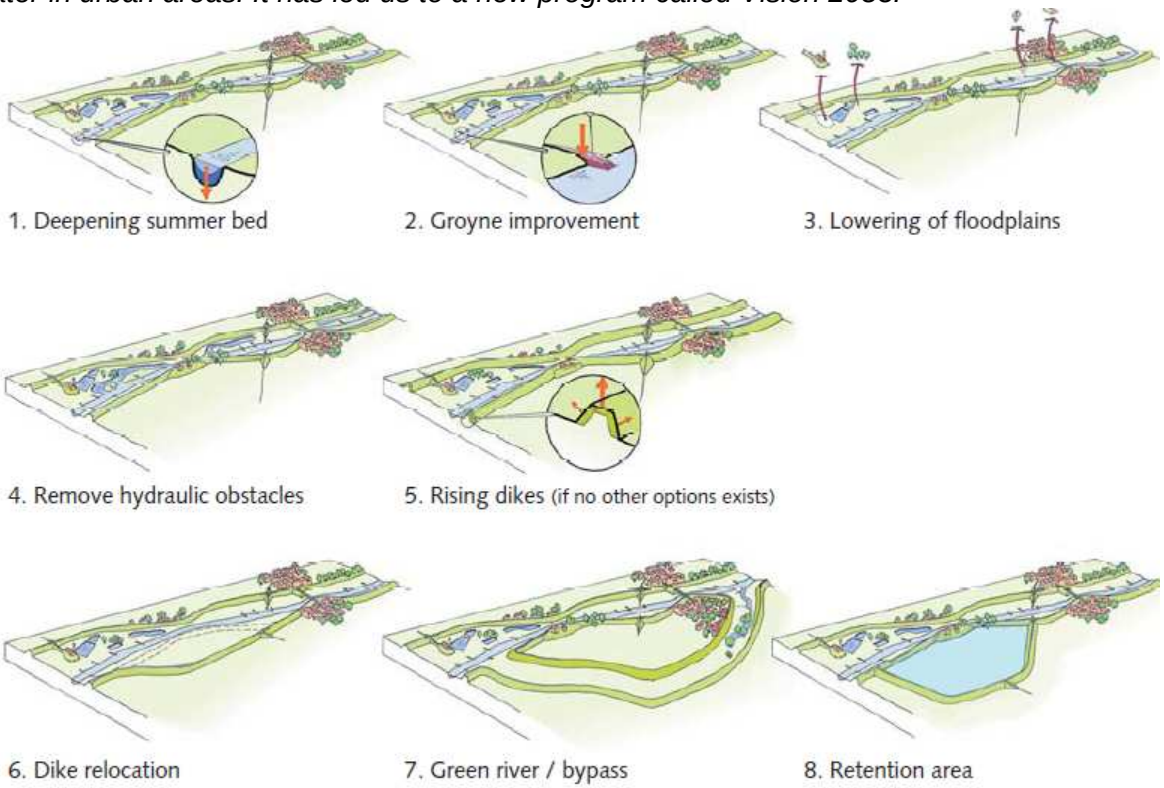

Fig. 17 Overview of possible spatial measures in the riverine area. Source: www.ruimtevoorderivier.nl

Vision 2053 approaches flood defence in new ways, for example building earth dunes and beaches in front of the existing coastline instead of construct higher dikes that can be weakened against the power of sea waves (Fig.17). All together more than 300 in practice possible applications of these measures were evaluated for the most optimal feasible combination, from both technical and economical point of view. Two types of analyses were carried out. The first type of analyses focuses on the effects of the different types of measures along the branches as a whole. The second type considers the evaluation of certain combinations of measures, as desired by stakeholders.

The Dutch cabinet recently proposed a Spatial Planning Key Decision in which the spatial planning for the entire area related to the Rhine delta is laid out. The document presents an integrated spatial plan with the main objectives of flood protection, master landscaping and the improvement of overall environmental conditions. Completion of a basic package of about forty projects (that will greatly influence urban design and architecture) is foreseen for 2015, with a budget of €2.3 billion. The new project called "Room for the Rivers" will create more space for river water to go in times of high discharge. Further information is available in English version at: http://www.ruimtevoorderivier.nl/.
There it is indicated that the Dutch strive for a three-layered approach to flood control: concern over the urban life of the city, infrastructure, and the underground. This approach aims to protect and deal with the environment and it shapes the look and functioning of cities.

For 2050 measures will be taken anticipating the climate changes with a river discharge of 16,000 m³/s. This project has also identified measures to adapt to climate change in 2100 with a river discharge of 18,000 m^3/s. Spatial developments in the region (present and future) have been taken into account. For the most part, however, the responsibility for land use planning continues to reside at the local governmental level.

The French government is slowly putting in place nationwide risk prevention plans governing land use called "Plan de Prévention des Risques". They will establish areas of the country where there is the risk of a natural or industrial disaster. The risk plan divides the area into three planning zones:

- ✓ Red Zone – No planning permission permitted
- ✓ Blue Zone – Planning permission subject to conditions
- ✓ White Zone – Planning permission subject to local planning regulations.

Australian Government uses a Planning Matrix for flooding risk by applying graduated controls. The matrix method was identified in the Hawkesbury- Nepean Flood Management Advisory Committee's report "Land use Planning and Development Control Measures" (HNFAC 1997) as an appropriate means of implementing the outputs of a floodplain risk management plan through land use planning. The matrix approach provides the opportunity to recognise that different land uses, densities and forms of development have different vulnerabilities to flood hazard. Land use can be planned in various ways to achieve risk levels which meet the expectations of both existing and future communities. Fig.18 illustrates the distribution of land uses within the floodplain using graduated controls (HNFMSC, 2006).

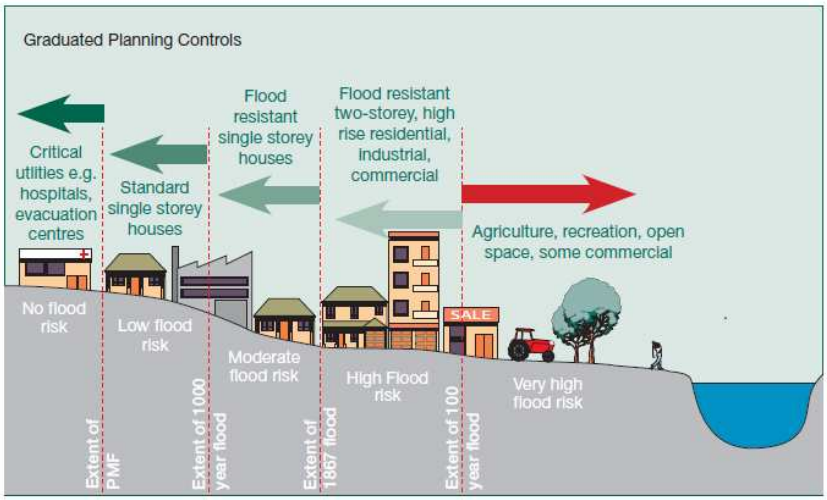

Fig. 18 Distribution of land uses on the floodplain to reduce risk (note: the number of risks bands may vary between floodplain areas depending on the range in depth of flooding above the flood planning level). Source: (HNFMSC, 2006)

In Germany, the Bundesland Bavaria is planning to implement a number of measures for flood protection between 2012 and 2020 (Hochwasserschutz-Aktionsprogramm 2020) for a total of 2.3 Billion Euros, including:

- measures to renaturalise the river landscape, and thus increase the retention and discharge capacity of rivers and streams;
- infrastructural measures to protect the area against 1/100-years floods;
- measures to reduce the damage by floods (spatial planning, building regulations, reliable flood warnings) and to insure the damage.

In the Bavarian Alps programs are started to improve flood protection facilities like dams, floodplains, and keep areas with high risks for flooding clear from housing and constructions.

The use of insurance as a flood mitigation tool is a clear work in progress. In the US, UK and Switzerland, the insurance industry plays a critical role in reducing the flood risk. In the case of the US, the Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP).

Switzerland adopted a strategy of integrative risk management. In this way more measures will be taken in future to limit the damage caused by natural hazard events. For example, hazard potential will be reduced through spatial-planning measures, based on which areas at risk from natural hazard will not be subject to development and open space will be created or conserved for watercourses and water bodies. Hazard maps provide the basis for the assessment of the hazard risk that exists in certain areas. If these measures are insufficient, up-to-date technical measures (e.g. channel improvement and water retention measures) will be taken to reduce the hazard potential.

European countries should trend towards more integrated flood management practices, balancing structural and non structural approaches and this requires understanding where and when flooding could happen and how serious it might be. Such assessments are a crucial undertaking on which all the other measures depend. Doing this it is necessary to involve modelling the behaviour of the river basins in different weather and tidal conditions, and matching this to knowledge of land topography to see where floods are likely to arise and how often.

3 Specific European policies on floods

Introduction
Traditionally, European flood control has focused on reactive practices. The initial interventions have largely relied on control of floods through structural measures, later supported by certain non-structural measures. These approaches have been ad hoc and essentially mono-disciplinary in nature. For quite some time now there has been a growing realization that the flood control strategies adopted to date have fallen short of expectations (WMO, 2011a).

Structural measures have generally disturbed the ecological balance and rather than mitigating flood risks have largely succeeded in only shifting them. It is widely recognized that a paradigm shift is required to move from defensive to proactive action – towards a culture of prevention by managing risk of, and living with, floods. Flood management has shifted from protection against floods to managing floods risk. In Europe this shift is given by the European Floods Directive 2007/60/EC. General objectives for an integrated and sustainable management of floods are defined within the European Spatial Development Perspective (ESDP) and the Council of Europe Conference of Ministers Responsible for Spatial/Regional Planning CEMAT[6] guidelines. The EU-FD specifies these objectives and defines requirements of each member state to produce flood hazard maps, flood risk maps and flood risk management plans according to specified minimum recommendations.

Background
The term "risk prevention" could be considered not very accurate since risks cannot be prevented but only reduced. Most accepted terms are "risk reduction and management": risk reduction, as the policy objective, and risk management, as the set of tools and mechanisms to achieve such objective, which encompasses three types of actions aiming at avoiding (prevention) or limiting (mitigation and preparedness) the negative impacts of natural hazards. However in many European and national documents, the term risk prevention is commonly used referring either to risk reduction or risk management. Prevention is generally considered as a phase of the disaster risk management cycle (Campostrini et al. 2011). In the United Nations International Strategy for Disaster Reduction[7] (UNISDR) definition, the risk management aims at both avoiding/minimizing impacts. In the European perspective the risk management cycle has been defined in the communication of the EC concerning flood risk management (COM(2004) 472 final). This communication constitutes the basis upon which the Floods Directive (Directive 2007/60/EC), was built.

3.1 The European Floods Directive

The EC states that the most effective approach in flood risk management is through the development of flood risk management programmes which encompass both pre and post disaster phases, classified as: Prevention, Protection, Preparedness, Emergency, Response, Recover and lessons learnt. The EU-FD states that "flood risk management plans should focus on prevention, protection and preparedness" (EU-FD, 2007).

Catastrophic floods endanger lives and cause human tragedy as well as heavy economic losses. Floods are natural phenomena but through the right measures we can reduce their likelihood and limit their impacts. In addition to economic and social damage, floods can have severe environmental consequences, for example when installations holding large quantities

[6] The CEMAT Guidelines form a link between global objectives of the UN Commission on Sustainable Development and the European Spatial Development Perspective (ESDP).

[7] The United Nations International Strategy for Disaster Reduction Is a strategic framework, adopted by United Nations Member States in 2000, aiming to guide and coordinate the efforts of a wide range of partners to achieve substantive reduction in disaster losses and build resilient nations and communities as an essential condition for sustainable development. At international level it is the most influential voice regarding disaster risk reduction, as its aim is to put together the National governments of the United Nations and share a common vision and strategy for reducing disaster losses.

of toxic chemicals are inundated or wetland areas destroyed. The coming decades are likely to see a higher flood risk in Europe and greater economic damage (www.streamproject.eu)
The EU-FD is focused on all kinds of floods, including river, lakes, flash floods, urban floods, coastal floods, storm surges and tsunamis. It requires Member States to assess if rivers and coasts are at risk and to take adequate and coordinated measures to reduce this risk.

BOX 3 Terminology: prevention, protection, preparedness
It is necessary to provide some preliminary definitions, because of a certain lack of uniformity in the use of terms:
• Prevention: preventing damage caused by floods by avoiding construction of houses and industries in present and future flood prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land use, agricultural and forestry practices;
• Protection: taking measures, both structural and non structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
• Preparedness: informing the population about flood risks and what to do in the event of a flood;
Source: (COM(2004) 472 final)

3.2 European Floods Directive and European Water Framework Directive

The Floods Directive has to be coordinated with the European Water Framework Directive and takes place within the River Basins as well (ANNEX 2). One key reason for this close coordination with the WFD is that physical flood protection infrastructures are some of the key drivers for determining ecological status of waters with regards to hydro-morphological quality elements. There are also many measures with the aim of reducing flood risk which can have multiple benefits for water quality, nature and biodiversity, as well as in terms of regulating water flows and groundwater restoration in water scarce areas (Brättemark, 2010).

The EU-FD aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity through involvement of the public participation procedures in the preparation of these plans (for which the second cycle plans are also due in 2015). To meet the demands of the EU-FD in coordination with the WFD, an integrated approach (integrated flood risk management) will be imperative. A conceptual example of such a modelling configuration is given in Fig. 19 where climate and land-use change, river flow, flood risk and economic and social impacts are intimately connected and have to be jointly taken into consideration.

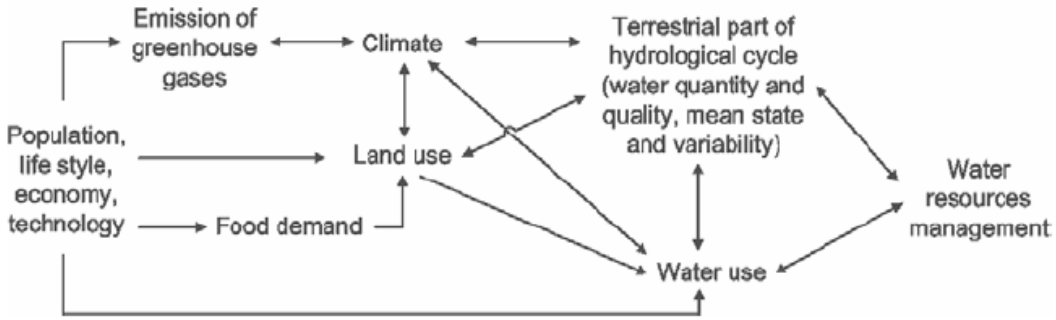

Fig. 19 Conceptual example of an integrated modelling system to help fulfil the requirements of the EU Floods Directive. Source: concept of Taikan Oki, cf. Kundzewicz & Mata (2007).

The Directive therefore suggests that catchment use could potentially have an important role to play in flood risk management but it does not state how it should be planned or implemented or how effective land management can be (Johnson, 2008).

3.3 The three step approach of the European Floods Directive

The EU-FD prompted member states to review their current flood risk management in a three step approach (Fig. 20), to be coordinated with the WFD implementation cycle.
At first, member states were required to carry out a preliminary flood risk assessment by 22 December 2011 of their river basins and associated coastal zones to identify areas where potential significant flood risk exists. Since measures cannot apply everywhere at the same time, this instrument allows to define those river sections which are currently regarded as flood-prone and need further risk appraisal.

Secondly, member states have to provide flood hazard maps and flood risk maps for the previously defined zones until 22 December 2013. Flood hazard maps show the flood extent, water depths and flow directions/velocities for three different probability scenarios (high-, medium- and extreme events), whereas flood risk maps should contain information about the number of inhabitants, economic activity, industries, potential source of pollution, cultural heritage and nature protection areas potentially affected by flooding in the simulated inundation area through the three scenarios mentioned above.

The third step of the directive is the preparation of FRMP which consist of objectives and measures that shall be identified by the responsible institutions until 22 December 2015. All steps have to be reviewed and updated in a six-year cycle (EU, 2007).

Flood risk management can be defined as the “continuous and holistic societal analysis, assessment and mitigation of flood risk”. The regular review cycle (every 6 years) is very important because flood risks tend to change over time for two principal reasons: 1) Land use changes, such as urban sprawl in flood plans with potential increase in flood related damage as one result, but which may also reduce the natural capacity to retain flood water, and, 2) Climate change is highly likely to change the magnitude and frequency of floods in the EU, therefore regular reviews of flood risk assessments, maps and management plans to adapt to changed flood risks will be crucial.

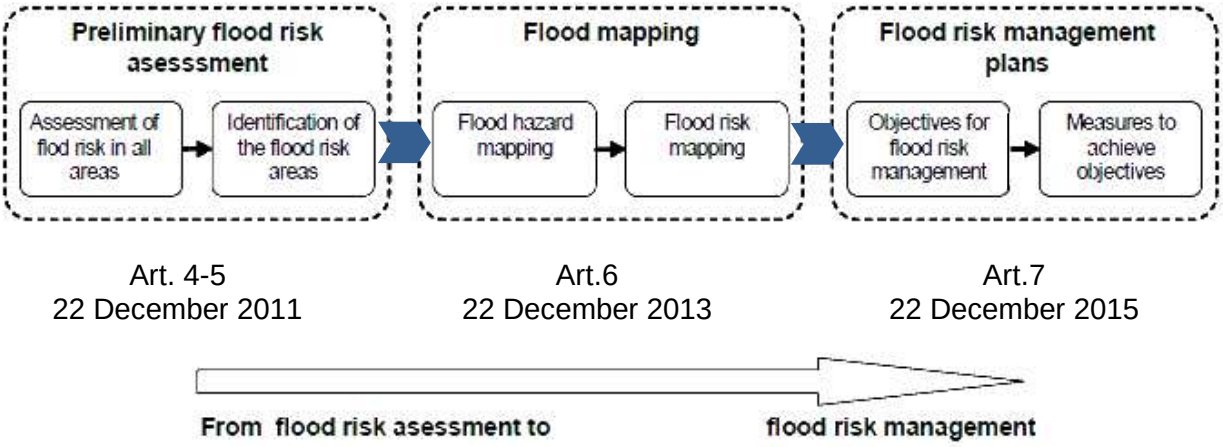

Fig. 20 The three implementation steps of the European Floods Directive.

The EU-FD underlines that the FRMP may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event (EU, 2007).

Sustainable flood risk management has been incorporated into recent European legislation and planning guidance. The lack of a detailed explanation of what it means however has hindered its development and application. The sustainability of the approach should mean that it integrates a range of flood management requirements using best practices with good planning. Sustainability has to involve the economics of a scheme, good planning, understanding flood generation processes, protecting natural environments and working with communities. Sustainable flood management is therefore an integrated set of procedures

linked into a physical catchment. The component of natural flood management has recently been developed as that procedure which involves working with rivers using natural processes with systematic land use planning (Johnson, 2008). An example of a sustainable flood (risk) management approach for a city context is given in Fig. 21.

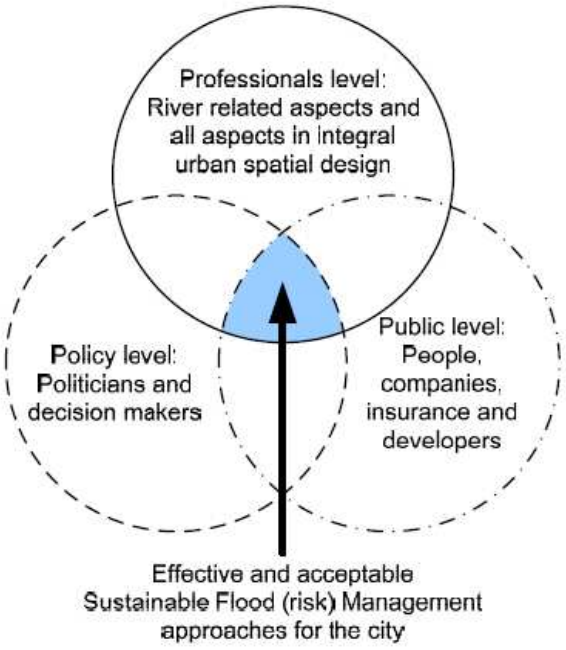

Fig. 21 Sustainable city flood (risk) management. Source: Johnson (2008)

Flood risk maps and management plans

This Directive requires EU Member States to develop and implement flood risk maps and management plans (de Moel et al., 2009; EEA, 2010), a necessary step for developing flood risk management strategies (Merz et al. 2007) and a valuable basis for spatial planning and further technical, financial and political decisions. EEA is including the flood risk map uploading process from each EU Member State into the Water Information System for Europe[8] (consult the WISE-RTD Water Knowledge Portal: http://www.wise-rtd.info/en). The Flood Map is for use by property owners and local authorities and shows where floods may occur and how severe they could be. It is a map of natural floodplains showing areas which can be flooded without protection. Its data contributes to local planning authority decisions. It also helps property owners recognise risks in the area they live in and prepare for floods (EA, 2009).

The main approach covering flooding from rivers (and the sea) is the Flood Map which shall show the potential adverse consequences associated with the flood scenarios and expressed in terms of (EU-FD, Art.6)

- the indicative number of inhabitants potentially affected;
- type of economic activity of the area potentially affected;
- installations which might cause accidental pollution;
- other information which the member state considers useful such as the indication of areas where floods with a high content of transported sediments and debris floods can occur and information on other significant sources of pollution.

The implementation of the Floods Directive in the mountain context requires consideration of aspects that do not take place in the plain, such as debris flows. Debris flows (also referred to as mudslides, mudflows, or debris avalanches) are a common type of fast-moving

[8] WISE is a partnership between the European Commission (DG Environment, Joint Research Centre and Eurostat) and the European Environment Agency, known as "the Group of Four" (Go4); is a gateway to information on European water issues. It comprises a wide range of data and information collected by EU institutions to serve several stakeholders

landslide that generally occurs during intense rainfall on water-saturated soil. The major problem related to debris floods is the uncertainty in the triggering condition and in the determination of concurrency probability. Debris flow often hit unexpectedly densely populated areas with huge solid and liquid volumes and discharges.

The need for a closer integration or coordination between flood management plans and land use plans has been recognized for a long time. However, many countries are struggling to devise appropriate policies and administrative mechanisms that would facilitate such integration (WMO, 2007). A reliable hazard and risk zoning for land use planning and development is, therefore, an urgent need, as is clearly stressed by the United Nations (2004).

The basic guide for spatial planning should improve drainage through decentralised rainwater soak-away facilities. Renaturation of rivers and lakes, reforestation and adapted agriculture promote localised retention of water and increase groundwater recharge at the same time (BMU, 2009). The “give back space to river” approach seems to be the most effective in terms of hydrological risk, but considering the mountain context and debris floods phenomena, the defence strategy could include different measures, for examples:

- Maintenance of water: obtaining the discharge capacity and the existing protective structures: e. g. maintenance of the embankment and the canal bed, emptying debris collectors or fix damage to barriers. Here, take into account the concerns of nature conservation and fisheries.
- Spatial planning measures: avoidance of risk areas (e. g. ban on construction in high risk areas), creation of risk registers and risk maps.
- Structural protection measures in waters: where additional protective measures are necessary (Fig.22), this must be undertaken as natural and landscape needs.

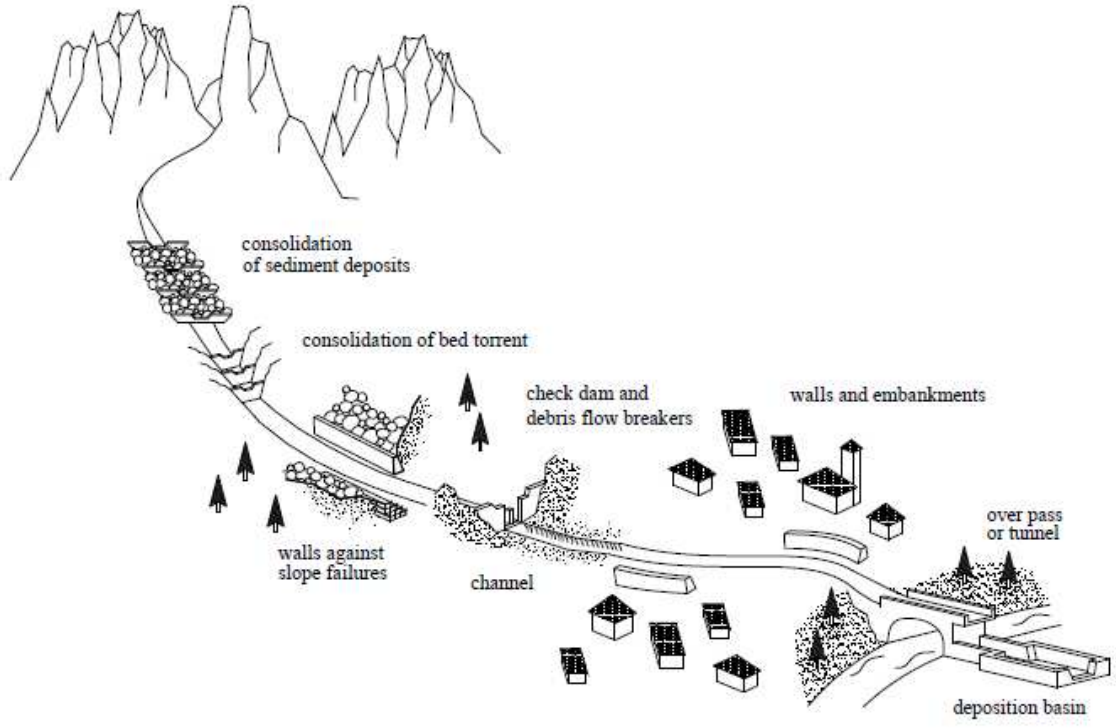

Fig. 22 Defence strategy from debris flows. Source: A. Armanini, presentation at the conference: “Methodologies and best practices for the participation of the stakeholders involved in flood risk prevention” Trento 3-4 October 2011.

3.4 The importance of stakeholder's participation in the risk mapping process

Flood risk maps are certainly excellent tools for risk assessment and planning, but they can also be valuable tools for public education and awareness. Properly presented, flood maps allow urban residents to see exactly where and how they may be impacted by flood waters. They can also see who in the community is vulnerable to flooding and who is not. Since concise visual information is often more compelling than reams of text, residents may be thereby induced to take a more active, personal part in community and to hold their elected officials more accountable for effective flood planning and management (WMO, 2011b).
Recent paradigms call for a participatory process in which the different stakeholders are involved early in the assessment procedure. On the one hand, the knowledge of the research community has to be communicated to users and the uptake by end-users has to be facilitated. On the other hand, the expertise, the perspectives and values of the stakeholders need to be taken into account (Merz et al., 2010). Following this change, the potential users of flood maps, as land-use planners, should be involved in the process of flood mapping. In land use planning, the hazard map serves as a foundation for the delineation of hazard zones (or analogous measures).

3.5 State of the art on the implementation of the European Floods Directive

As part of the Common Implementation Strategy (CIS) a Working Group on Floods (WGF) has been set up to support the implementation of the Floods Directive, and to provide a platform for information exchange on flood risk management. The CIS Work programme for 2010-2012, including the mandate to WGF, is available at:
http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm
As a result of this information exchange of current practices different documents have been developed by the Member States and stakeholders taking part in this WGF[9]. A number of WGF thematic workshops on different themes related to the implementation of the Floods Directive have been organised by the WGF and its members.

In order to monitor and inform about how well member states follow the reporting obligations (ANNEX 2) an informal Floods Directive scoreboard has been developed by the EC (DG Environment, Joint Research Centre and Eurostat) and the EEA. The scoreboard (available at: http://ec.europa.eu/environment/water/flood_risk/timetable.htm) shows if notifications or reports have been submitted (green face), not submitted (red face) or are incomplete[10] (orange face). The notification of the EU-FD transposition (Art. 17, deadline 26.11.2009) and the indication of the competent authorities /units of management (Art. 3, deadline notification 26.5.2010) have been submitted from all the EU Member States. With respect to the third deadline of the EU-FD regarding preliminary Flood Risk Assessment (Art. 4&5, deadline reporting 22.3.2012) the report of information appear not submitted from Bulgaria, Hungary, Italy, Malta, Portugal and Slovakia and partially fulfilled from France, Greece and Slovenia. The other EU Member States have submitted the preliminary flood risk assessment.

EC and EEA are currently developing an electronic data and information system on water called WISE (Water Information System for Europe http://water.europa.eu/). The WISE portal now includes a Floods Directive Viewer (Fig. 23), available at:
http://www.eea.europa.eu/themes/water/interactive/floods-directive-viewer.

[9] The documents are:
- Good Practice for Delivering Flood-Related Information to the General Public, 2007.
- A "Handbook on good practices for flood mapping in Europe" 2007, including the "Atlas of Flood Maps, with examples from 19 European countries, USA and Japan.
- A CIS Guidance document N°24 entitled "River basin management in a changing climate" (2009), includes a chapter on how to take into account climate change throughout the different stages of implementation of the Floods Directive.

[10] The table does however not give any indication on if the notified legislation is conform to the requirements of the Directive, or if the reported information fullfils all requirements of the respective articles.

Like FLOOD-WISE (http://flood-wise.eu/elgg/), many European projects in essence aim at collecting and dissemination existing know-how and experiences between regions in Europe (a list of the EU projects on floods is available at: http://ec.europa.eu/environment/water/flood_risk/links.htm#fundinglinks) and, related to urban areas (see the ANNEX). For this purpose good practice web portals are often being set up during a project. In the case of FLOOD-WISE a suitable database structure is WISE-RTD (http://www.wise-rtd.info/en).

Information on the competent authorities for implementation of the Floods Directive in the different river basin districts/units of management is now available here and more information on Floods will also gradually be made available on WISE as the Directive is being implemented (http://ec.europa.eu/environment/water/flood_risk/timetable.htm).

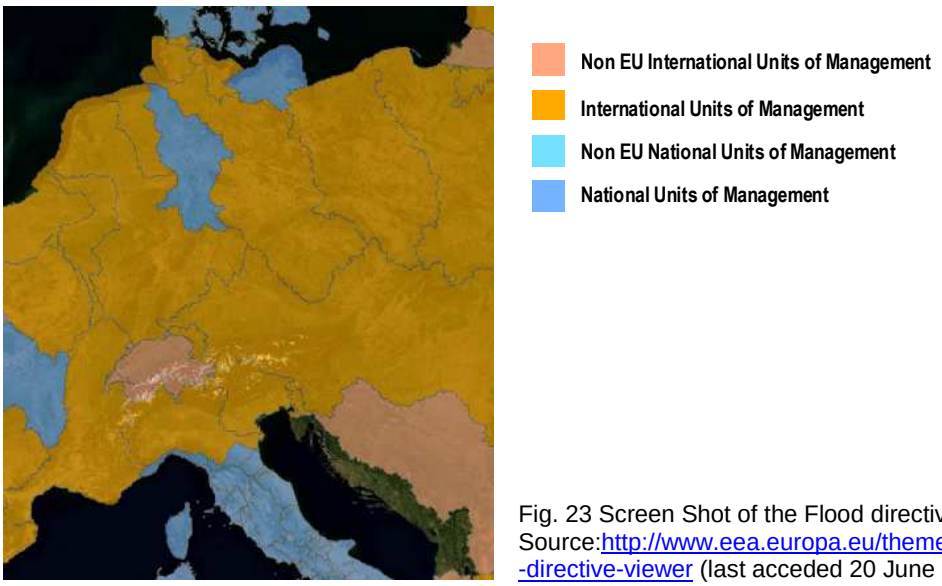

Fig. 23 Screen Shot of the Flood directive viewer portal. Source:http://www.eea.europa.eu/themes/water/interactive/floods-directive-viewer (last acceded 20 June 2012)

Information on Flood Risk Management is also available on CIRCA[11]. This summary provides background information and links to key deliverables of the Water Framework and Floods Directive Common Implementation Strategy (CIS) in relation to Flood Risk Management. A specific folder in the public part of CIRCA containing key documents is available at: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/flood_management&vm=detailed&sb=Title
For more detailed information on other specific topics consult other summaries at: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/directive_directive&vm=detailed&sb=Title

3.6 Integrating adaptation to Climate Change in European flood policy

The management of flood risks is a crucial component of climate change adaptation, and the EU-FD requires that EU Member States take climate change into account in the preliminary flood risk assessment and develop appropriate adaptation approaches to reduce impacts of flood events in Europe, depending on their specific needs. The EU-FD introduces new instruments to manage risks from flooding, and is thus highly relevant in the context of adaptation to climate change impacts (EEA, 2009).

[11] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/directive_directive/management_2012-05pdf/_EN_1.0_&a=d

In April 2009, the European Commission published the White Paper (EC, 2009a), which introduced a framework for adaptation measures and policies to reduce the EU's vulnerability to the impact of climate change. For flood management, the paper focuses on the importance of integrated basin approach and risk assessment through existing Directives. The WFD and EU-FD require Member States to apply integrated approaches based on existing river basins (European Commission, 2009) and the white paper states that adaptation should be integrated into the implementation of these directives.

As the knowledge about the impact of climate change on the frequency and intensity of hazardous events is still fragmentary, adaptation strategies on the European level are focused on the reduction of vulnerability of society and infrastructure. In other words, adaptation strategies aim at the improvement of resilience and flexible response to risks caused by natural hazards, as flooding.

For the first RBMP, a "climate check" is suggested in order to ensure the adaptiveness of the Programmes of Measures (CIS, 2008). Climate change impacts are to be taken into account in the identification and appraisal of measures, in order to ensure that no action is taken that would in the longer term reduce resilience or adaptive capacity. The potential benefits of measures for adaptive purposes might also be used as criterion for their prioritisation. A preference for win-win situations and no-regret measures is expressed in the policy documents. Action that cannot or only at high costs be reversed should be avoided (EEA, 2009).

"Progress and Challenges in Urban Climate Adaptation Planning: Results of a Global Survey" is said to be the first systematic study at this scale of adaptation initiatives and challenges and was carried out by JoAnn Carmin, Associate Professor of Environmental Policy and Planning at the Massachusetts Institute of Technology (MIT) with research assistants, Nikhil Nadkarni and Christopher Rhie. It was presented in May at the 2012 Resilient Cities Congress in Bonn by Prof. Carmin.

Among the 19% of cities who had assessed climate impacts, increased storm water runoff (65%) and storm water management (61%) are the top two concerns. Many cities are taking measures to mainstream adaptation into disaster risk reduction and land use planning but globally they report three top challenges: 1) securing funding for adaptation; 2) communicating the need for adaptation to elected officials and local departments; and 3) gaining commitment and generating appreciation from national government for the realities of local adaptation challenges.

4 Flood management and land use planning in selected countries

The flood risk management plan on river basin district level is based on the flood hazard maps and the flood risk maps It contains common objectives for flood risk management (prevention, protection and preparedness, including land use planning, flood forecast and early warning systems). Measures must be planned to achieve these goals. They will take into account costs and benefits, extent of flooding and overflow channels and areas potentially apt for flood retention, e.g. natural flood areas, land use and water management, regional planning, etc. Land use planning which integrates flood risk management is a key requirement because it provides an opportunity to develop new settlements that incorporate integrated flood management at the outset. Specific flood prevention policies exist in many European countries. Especially the ones that have frequently been exposed to natural hazards often have well developed management plans and the institutional capacity to reduce and remediate the impact of natural hazards. Others are just at preliminary stages of building up their response capacity (Alfieri at al. 2012).

Various surveys and reports provide information about the availability and use of flood maps in European Countries. For example the European exchange circle on flood mapping has compiled a handbook and atlas on flood mapping in Europe, containing examples from 19 European countries, USA and Japan (EXCIMAP, 2007). The information from EXCIMAP (2007) and other sources are combined in the research of de Moel et al. (2009), which gives an overview of existing flood mapping practices in 29 countries in Europe and shows what maps are already available and how such maps are used. Very few countries have developed flood risk maps that include information on the consequences of flooding and the available flood maps are mostly developed by governmental organizations and primarily used for emergency planning, spatial planning and awareness rising.

4.1 Flood mapping in selected European countries and connection with land use planning

According to de Moel et al. (2009), a distinction can be made in spatial planning between countries where flood maps serve an advisory purpose, and countries where there is a binding legislation to use flood hazard or risk information (Table 1). Flood zones delimited on flood maps mainly serve as guidelines and are not binding for the following countries: Great Britain, Hungary, Ireland, Finland, Austria, Luxembourg, Norway, Portugal, Sweden and Latvia. Countries that have a binding flood zones for spatial planning are: Switzerland, Germany, Italy, Spain, Romania, Lithuania, France and Poland.
However, binding legislation does not seem to guarantee effective flood risk management in practice. The full potential of regulating land use in flood-prone areas is often not reached because in many countries flood zones only serve as guidelines or there are practical problems related to the implementation of binding rules (de Moel et al. 2009).

Tab. 1 Overview of the government use of flood maps in selected countries.
Source: extract from the table 1 in de Moel et al 2009, p. 295

	Emergency planning	Spatial planning (advisory)	Spatial planning (binding)	Construction	Awareness	Insurance	Flood assessment/ management
Switzerland	**X**		**X**	**X**			
Germany			**X**	**X**			
Italy			**X**				

Selected countries in this report are Italy, Germany and Switzerland because they have a binding legislation with respect to restricting or prohibiting developments in flood-prone areas. In these countries flood maps are produced by the regional government. They cover the entire territory in Switzerland and selected regions in Germany and Italy.

The governmental levels are different in each country. Europe is the upper level for Germany and Italy but not for Switzerland. The lowest level in all the three countries is the municipal level.

In Italy spatial planning is essentially led by the regions, with the central government providing financial support and providing advices, including coordination. The urban policies of Italy are characterized by local level planning led by the regions. River Basin Authorities have the competence of hydrological risk assessment and management and civil protection forecast and prevents natural and anthropoid hazards (emergency planning).

In Germany spatial planning is based on cooperation between the federal government and the different states (Bundesländer). A state has its own sub national plan. The most detailed description of land use in Germany is at local or city level. This plan has to be approved by the superior government. Effective flood risk management is hampered by the decentralised structure of the Bundesländer and many different entities (which can differ between the Bundesländer), who have to cooperate and agree (Samuels et al. 2005).

In Switzerland practical planning implementation was to remain essentially a matter of the Cantons, which in turn often delegate a number of tasks to the communes (local authorities). In addition to this federal framework legislation, the Swiss Confederation promotes and co-ordinates the spatial planning of the Cantons and also takes into consideration the "demands" of spatial planning in its own activities. In Switzerland regional governments can decide for themselves how strictly flood zones are incorporated into their spatial planning policies (Zimmerman et al., 2005). Recommendations are made by the central government regarding flood zones, which are usually followed.

4.2 Overview of the stakeholders' interviews and introduction to case studies

The following overview is the result of interviews with stakeholders from three selected European countries that took place during the internship. It gives a general introduction on the responsibilities and land use aspects of flood risk management in Germany, Italy and Switzerland.

The workshop "Hydraulic risk assessment in the mountain context and implementation of the European Floods Directive", Free University of Bozen (Italy), 3-4 May 2012 gave a chance to get directly in contact with the authorities involved in the implementation of the EU-FD in Italy and flood risk management in Switzerland, respectively with Ms Giuseppina Monacelli (ISPRA, Italy) and Mr Roberto Loat (FOEN, Switzerland). The interview to Ms Meike Gierk (BMU, Germany) took place the 19 of March 2012 via phone at the Climate Service Center in Hamburg, Germany. All interviews are reported in ANNEX 3.

Related flood risk management and similar questions were asked to stakeholders and were functional to introduce case studies from each of the selected countries. To facilitate the reading, the main interesting information emerging from the interviews is listed below in different sections, including: responsibilities, international cooperation, monitoring and public information, climate change. Case studies are generally introduced in this context and elaborated in the next paragraphs.

Responsibilities
The interviews show that there are big differences due to the different internal organisation. Italy is a country organized with regions, but Germany and Switzerland consist of different states with their own freedoms in legislation and planning systems.

Flood management in Italy follows a subsidiary approach. The responsibility for the implementation of the EU-FD is with the River Basin District Authorities and the different regions in coordination with the Civil Protection Department for the emergency plans, explained Ms Giuseppina Monacelli. Administrative or legal boundaries often fragment river basins, so the risk management authorities are developing collaboration with other governance levels (see paragraph 4.4).

Ms Meike Gierk explained that in Germany there are 16 Länder and each has a Ministry for the environment with different organization: at this level the discussion of measures is taken and every federal state has its modus operandi. In fact each of those ministries has a different name and is differently organized: sometimes they have two levels of hierarchy and other times they have three. Administrative regions, districts, municipalities are responsible for the implementation of flood risk management at local level and direct responsibilities for all matters involving risk management.

In Switzerland, Ms Roberto Loat illustrated that the 26 Cantons and municipalities are responsible for the flood risk management. Catchments are always bigger than the Canton and this means that flood issues must be addressed among them.

International cooperation
The Italian State has exclusive legislative power, as well as the guiding, coordinating and substituting power for the local authorities. At national level the Ministry of Environment, Land and Sea, the Institute for Environmental Protection and Research (ISPRA) and the National River Basin Authorities (coordinating the River Basin Districts) are the main stakeholders involved. Together they are responsible for providing a national framework with regard to the protection of the environment. Considering international river basin cooperation, Italy has eight river basin districts, from which two are international sharing water courses with France to the west (river Rhone), Switzerland and Austria to the north (Rhine, Danube and Po rivers) and Slovenia to the east (river Vipacco). The international sharing water courses in Italy are quite negligible because they include just a small part of the river basins.

ISPRA is involved in the Danube Flood risk "Stakeholder-oriented flood risk assessment for the Danube floodplains" project, a European transnational project promoting the cooperation between spatial planning and water protection in the Danube river basin. Then, there is for example collaboration in the Vipacco river basin, shared between Italy and Slovenia, the "Vipacco Laboratoy", a participatory project to implement innovative approaches for the hydraulic risk prevention and perception in the context of KULTURISK research project[12] (see paragraph 2.2).

At international level Germany cooperates with its neighbouring countries in seven transboundary international river basin commissions (Danube, Rhine, Elbe, Oder, Mosel/Saar, Maas, Ems) which are subdivided into different working groups (e.g. on hydrology, flood protection, water quality etc.). One example is the case study of the "*flood action plan"* for the entire Rhine catchment area because it provides interdisciplinary and cross-border flood protection (International Commission for the Protection of the Rhine, ICPR); the Emscher case study will focus more on the role of land use planning in integrated river basin management with an ecological approach. Additionally there are also bilateral

[12] The main goal of KULTURisk is to develop a culture of risk prevention in Europe and demonstrate its advantages over traditional post-disaster recovery approaches. Seventh Framework programme of the European Commission.

working groups, the so-called Boundary Water Commissions which are split up into different task forces dealing with specific aspects (management, maintenance etc.).

Switzerland adopted several bilateral (e.g. with Italy or Austria) and multilateral agreements (e.g. International Commission for the Protection of the Rhine) with its neighbouring countries (Fig. 24) addressing mainly transboundary water issues. For example, the four INTERREG IIIA EU projects with Tyrol (Austria) and Autonomous Province of Bozen (Italy) aimed at creating a new information system for hydrological risks (IHR).

Fig. 24 International Partnership between Tirol (Austria), Grigioni Canton (Switzerland) and Autonomous Province of Bozen (Italy).
Source: www.provincia.bz.it/opere-idrauliche

Furthermore, there is also close cooperation with the European Union to address the implementation of the European Floods Directive. In 2012, Switzerland holds the chairmanship of the UNECE Task Force Water and Climate which is also dealing with transboundary flood management issues and the impact of climate change.

The European Union's new Floods Directive will oblige all member states to produce flood hazard maps for high risk areas. France and Switzerland are joint directors of the European Exchange Circle on Flood Mapping (EXCIMAP 2007), with the objective to formulate a recommendation incorporating good-practice methods for high-quality hazard maps. There is also an agreement with China on cooperation in the field of water resources.

Monitoring and public information

In order to monitor the implementation of the risk management at the federal state, Germany and Switzerland introduced different national reporting portals, also in English. Public information in Italy is available in River Authorities and regions web sites (sometimes in English).

In Germany, the www.wasserblick.net hosts the internet portal for competent authorities. The subject site is used primarily for information and communication within the government and the Federal States, but there is also a selected content of information available to the public in the section "Public Forums". This web site contains the "MapNavigator" tool that gives an overview of the relevant technical data processed in various thematic maps. This information is also available as shape-files for download. The freely accessible maps and data services can be found in the repository. Then, every Bundesland has a web site and most of the information is also available in English. Here it is possible to take a look and check the work in progress on the EU-FD implementation.

In Switzerland, the Federal Office for the Environment's (FOEN)"*ShowMe*"database (available in: http://www.bafu.admin.ch/naturgefahren/11421/11423/index.html?lang=de) provides an overview of the current status of the hazard mapping process: the Cantons have implemented 80 percent of the hazard maps. Missing maps have to be submitted according to the planning of the Cantons by 2013 (ANNEX 4). Information in the internet portal is available in German, French and Italian (some part are also in English). For the first time in Switzerland there is a nationwide survey of the endangered areas including precautionary protective measures for example with the controlled flooding of selected areas of spatial

planning and control systems corridors of runoff, at the river Engelberger Aa (Canton Nidwalden)..

In Italy, there is not a national portal that provides information on the implementation of the EU-FD. Consultation on some of the regional water protection plans (PTA_piani di tutela delle acque) is ongoing or has been completed. Is it possible to read more about the regional water protection plans, which are currently available, and their consultation on the specific pages of the relevant regions[13]. Consultation on the draft River Basin Management Plans (Italian) are ongoing in Eastern Alps, Po, Northern Appenines, Central Appenines, Southern Appenines, Sardinia, Sicily and Pilot River Basin District Serchio and implementation of the EU-FD could be checked in the River Authorities web-sites[14].

Transfer of information

In September 2008, the LAWA adopted a strategy for the implementation of the EU-FD in Germany which contains basic positions and practical guidance. Due to determined administrative responsibilities in the past, the Bundesländer already were in charge for all flood protection issues. Concerning the new directive they have to elaborate the flooding management plans in line with the directive. In light of this, the LAWA-AH committee elaborated two papers available also in English at http://www.lawa.de/Publications.html that provide a practical guidance for organisational issues, e.g. for the spatial delimitation of areas for processing flood hazard- (FHM) and flood risk maps (FRM) and for the elaboration of Flood risk management plans (FRMP). In particular, the recommendations describe how the Federal Länder should implement the EU-FD. They also show the way for establishing appropriate methods and approaches for these actions, for analyzing the existing situation, the deficits and provide the measures for achieving the objectives. In this way there is a basis for the implementation of a standardised water management system within the Federal Länder which works in administrative borders.

Natural hazards such as avalanches, floods, and mass movements in Switzerland should be recognized, recorded, and presented spatially by unified criteria. For this purpose the federal government has published various recommendations and guidelines in recent years especially with a focus on spatial planning tools, available in German, Italian and French at http://www.bafu.admin.ch/naturgefahren/.

At national level, the Institute for Environmental Protection and Research (ISPRA) designed, realized and installed the SINTAI - Information System for the Water Protection in Italy available in Italian at http://www.sintai.sinanet.apat.it/ that manages data channel according to the EU directives and national legislation where objectives and technical issues are established on protection of inland and marine water. In Italy the river basin plans for the management of flood and landslide hazard/risk are intended as a superior-ranking system for urban development, land use, water resources use, etc. Therefore a dialogue between River Basin Authorities and Municipalities is requested under maps revision; they must respect constraints and prescriptions on land use in flood-prone areas. The information is transferred through consultation forums, web site and publications.

[13] For example in the following regions:
Emilia Romagna: http://ambiente.regione.emilia-romagna.it/acque/ ,
Marche: http://areeurbane.regione.marche.it/tra/pta/index.htm,
Veneto:http://www.regione.veneto.it/Ambiente+e+Territorio/Ambiente/Acqua+e+difesa+del+suolo/Acqua/Ciclo-Acqua/Pianificazione+Regionale/Piano+di+Tutele+delle+Acque.htm,

[14] For example:
Autorità del bacino del fiume Adige: http://www.bacino-adige.it/
Bacini idrografici delle Alpi Orientali: http://www.alpiorientali.it/

Climate change
The management of flood risks is a crucial component of climate change adaptation. The EU-FD requires that member States take climate change into account in the preliminary flood risk assessment, depending on their specific needs. Ms Meike Gierk said (see question 2, in ANNEX 3) that Germany has already begun to consider the implications of climate change explicitly. In flood management for example the design flood magnitudes are proposed to increase by a certain factor, e.g. by 15% or similar. The scientific world and the Confederation were occupied mainly in the causes of climate change and disaster reduction. In the field of natural hazards, various studies have been developed, especially measures and strategies of coordination such as the strategy of the National Platform for Natural Hazards (PLANAT_ http://www.planat.ch).

In September 2007, the Italian Ministry for Environment, Land and Sea organized a National Conference on Climate Change in Rome. The main result of this conference was a call for the preparation of national, regional and local adaptation strategies. The Conference was the start for several activities that were beginning by basin/district authorities and regions taking into account the climatological/hydrogeological conditions of the territory. Different approaches come into practice at local level and the town planning regulations from which the Faenza case study gives an example: while the town planning regulations were driven by energy efficiency, aesthetic qualities and quality of life, they are likely to bring climate change adaptation benefits in terms of reducing the impact of high temperatures and lessening flood risk.

4.3 Geographical context and law in force dealing with floods in selected countries

In this part geographical context and law in force dealing with floods in the three selected countries are presented; also more specific information about responsible authorities dealing with floods risk management is added.

4.3.1 Germany

Geographical context
Topographically Germany may be roughly divided into three basic forms: the North German Plain, the uplands and the Alpine region. The surface waters in Germany are characterized by six river systems, i. e. the rivers Rhine, Ems, Weser and Elbe are draining into the North Sea and the Odra into the Baltic Sea. The Danube discharges into the Black Sea. The rivers are interconnected by various canals for navigation.

Law in force dealing with floods
The EU-FD was transposed into German national law by means of the Federal Water Act (*Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz) – WHG*) of 31 July 2009 (Federal Law Gazette (BGBl.) I p. 2585). The Act entered into force on 1 March 2010 (LAWA, 2010). Section 72 of the Act defines the term “flood” as follows: “Flood means the temporary inundation of land not normally covered by water by surface waters or influx of sea waters in coastal areas”. The transposition of the Floods Directive into the Federal Water Act (Wasserhaushaltsgesetz) in Germany leads to a focus “only” on riverine and coastal flooding, excluding floods from sewerage systems (as permitted by Art. 2, No. 1 of the EU-FD) and free run-off due to torrential rain and flooding caused by groundwater (Heintz at al., 2012). Section 75 of the Act contains provisions on the establishment of flood risk management plans (FRMp). In September 2008, the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA) adopted a strategy for the implementation of the FRMp in Germany which contains basic positions and practical guidance.

Following the flood events (Danube and Elbe in 2002), the German Federal Government drew up a 5-point plan for improving preventative flood protection (BMU, 2003a). On this

basis a draft for an *Artikelgesetz* (a law that applies to several different laws or contains very different contents) was drawn up (BMU, 2003b). The *Artikelgesetz* proposes the correct approach towards strengthening risk reduction through spatial planning as an instrument for flood risk reduction. The efforts of regional spatial planning authorities to define areas prone to flooding are simplified and supported on a nationwide basis. Another positive approach is the proposal to integrate flood protection, flood-related construction and flood risk reduction in one law (BDLA, 2003). Currently these are anchored in different laws independently of each other (DKKV, 2004).

Responsible authorities
In Germany, responsibility for flood management is mostly at the state level (Bundesländer). The federal government enacted the Federal Act in their Bundesländer laws, obliging federal governments to include floodplain management, designation of floodplains and implementation of regulations designed to protect against the risk of flooding. The Bundesländer are also in charge of developing flood control plans to help minimize damage. Plans should include preservation or restoration of retention areas, relocation of dikes, preservation or restoration of alluvial meadows and retention of precipitation water (BMU, 2002).

All information about water and floods are available on LAWA website http://www.lawa.de/, the German Working Group on water issues of the Federal States and the Federal Government represented by the Federal Environment Ministry. The aims of the Working Group of the Federal States on water issues are to discuss in detail questions arising in the areas of water management and water legislation, to formulate solutions and to put forward recommendations for their implementation. In addition however, topical questions in the national, supranational and international sphere are also adopted, discussed on a broad basis and the findings submitted to the relevant organisations.

4.3.2 Italy

Geographical context:
One of Italy's main geographical features is the prevalence of hilly and mountainous land. Out of a total land surface area of about 30 million hectares, only 23% is lowland in the North, 18% in the South and 9% in Central Italy (Table 2).

Tab. 2 Italy surface according to the land elevation (ha 000)Source: http://www.icid.org/i_d_italy.pdf

	North	Centre	South	Italy
Mountain	5,532	1,576	3,503	10,611
Hill	2,273	3,724	6,548	12,545
Lowland	4,187	536	2,255	6,978
Total	11,992	5,836	12,306	30,134

Law in force dealing with floods
In Italy the Floods Directive was implemented with the Legislative Decree (D.Lgs) 49/2010 *"Attuazione della Direttiva 2007/60/CE relativa alla valutazione e alla gestione dei rischi di alluvioni"*. The Decree came into force on April 17, 2010. Article 2 of the D.Lgs defines the term "flood" as follows: "a temporary flooding, with transport or mobilization of sediments also at high density, of areas that are not normally covered by water. This includes floods from lakes, rivers, streams, mountain torrents, possible artificial drainage networks, and any other surface water body, also with a temporary regime, natural or artificial, flooding of coastal and marine areas and excludes flooding not directly attributable to weather events".

In Italy, preliminary Hazard/Risk maps were produced already in the nineties following the L. 183/89 law on the implementation of hydrogeological protection. The Italian land protection

legislation is defined by the regional Authority by means of the Hydrogeological System Management Plan (PAI). The primary objective of the PAI is to reduce the geological risk within values compatible with the uses of the land, so as to protect the personal safety and minimize damage to the goods on display. The contents of the plan are divided into structural interventions (works), relating to the design structure of riverbeds, hydraulic and slope critical nodes, actions and non-structural measures (land use regulations and rules of conduct). The PAI often include only the major plain river system and do not consider the drainage networks or debris flows (Rusconi, 2011). With the EU-FD the PAI have to consider also the flooding from secondary or minor river system (i.e. drainage networks) that has not been up to now considered.

The legislative part of the PAI regulates the conditions of land use in a way compatible with risky situations and it lays down provisions for planning the implementation of the Plan itself. The regulatory apparatus of the PAI is represented by the implementing rules, which contain addresses, instructions and directives. The government draws a directive on the establishment of an integrated warning system at the national and regional level. It includes, for example, the monitoring of hydro-pluviometric data and water availability as well as the implementation of a network of centers for data processing, supporting decision-making for civil protection and warning for hydro-geologic and hydrologic risk. Fig. 25 represents a scheme for band limitation and shows that while within the limits of the bands “A” and “B” the urbanization is ruled by the “River Authority” (and strictly prohibited or limited to necessary maintenance of existing building), the activities within the “C” band have to be ruled by the Municipalities. The “C” band is divided in different regions with a different degree of hazard (and so with different rules related to the possibility of urbanization), because they are usually very large and the impediment of using that large areas would bring an economic loss.

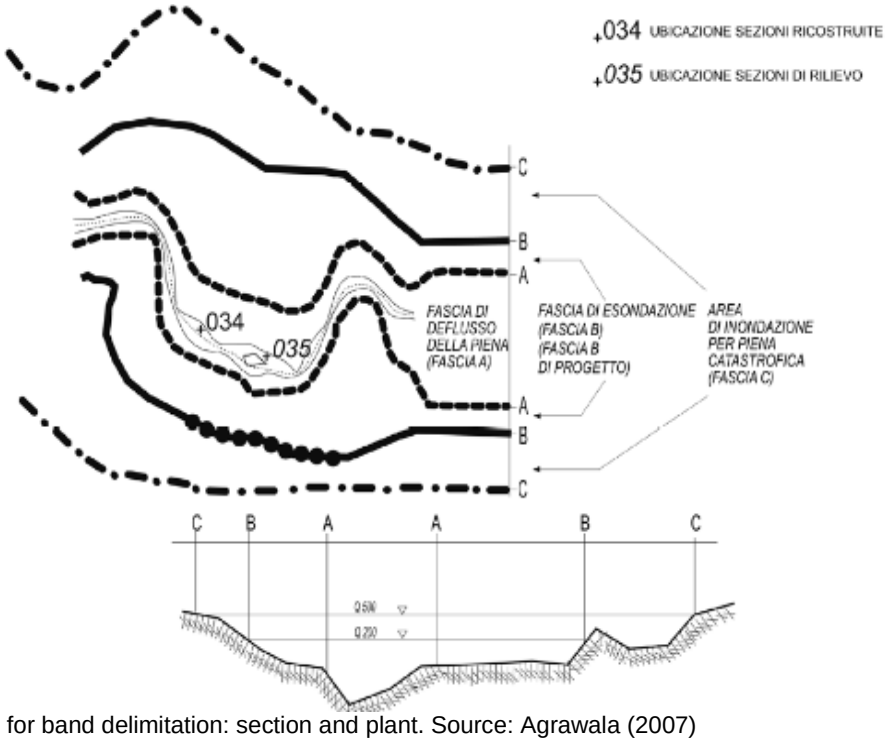

Fig. 25 Scheme for band delimitation: section and plant. Source: Agrawala (2007)

Responsible authorities

The fundamental step on Italian water management is represented by the law 183/1989 that established the hydrographic basin as the environmental reference system within which all regulatory actions concerning soil protection, water pollution abatement and water resources management had to be coordinated for the purpose of rational economic and social development and the protection of the environment. For the nationally significant basins the law set up Basin Authorities.

Basin Authorities are collegiate bodies in which state and regional authorities are represented and are headed by the Italian Ministry for the Environment and Territory. The regions and the River Basin District Authorities are responsible for planning at regional and at river basin scale. This legislative decree 152/2006 sets up a unitarian frame for environmental matters, which has not yet finished its institutional course. A part of the decree takes in the European Water Framework Directive, which imposes to member states the institution of River District Authorities, thus expanding to the rest of Europe the Italian "river basin" approach to water resources management. Therefore Italian national River Basin Authorities are going to be transformed into River District Authorities.

4.3.3 Switzerland

Geographical context
More than two thirds are mountainous areas, with the Alps in the south (60% with 3,000 km^2 of glaciers) and the Jura (10%) in the north-west. The area in between these two mountain ranges forms the so called Swiss Plateau. Many of the European rivers have their origin in the Swiss Alps. Examples are Rhine, Rhone and the Inn, this latter as the major tributary to the upper Danube. In the Southern Alps, the Ticino is a major tributary of the Po River.

Law in force dealing with floods
Everything related to the flood risk and risk in general is based on the Federal Law on Forest (Key legislation: 1876, 1902, 1991; SR 921.0) and on the Federal Law on Water Protection (Key legislation: 1955, 1971, 1991; SR 814.20) and Flood Protection (Key legislation: 1991; SR 721.100). By these laws Cantons have to work following the decisions on risk and hazard given by the confederation strategy.

Responsible authorities
The main authority for the prevention of natural hazards is the Federal Office of the Environment (FOEN), which is part of the Federal Department of Environment, Transport, Energy and Communications (DETEC). FOEN is responsible for a number of recommendations concerning hazards associated with mass movements, floods and earthquakes including the compilation of hazard maps and micro-zoning. The objective of the Federal Office for Spatial Development (ARE), which is also part of DETEC, is the sustainable development of Switzerland's territory. As part of this task, ARE is interested in the natural hazards associated with spatial development.

A country-wide hazard assessment is currently being carried out for settlement areas in Switzerland, the results of which are being presented in the form of hazard maps for floods, landslides, rock fall processes and avalanches. Hazard maps provide the scientific basis for the implementation of spatial planning measures. The current state of the preparation of the hazard maps in Switzerland is shown in the Annex. Switzerland heavily engages in mapping activities to identify zones that are prone to natural hazards (e.g., Petrascheck 2002). The Cantons are obliged to provide hazard maps and to consider these maps in land use planning. Hazard maps (scale 1:10,000) have been developed for many communities for inundation and erosion. The hazard map (Fig. 21) provides a detailed overview of the hazardous situation at five threat levels (red: substantial threat; blue: moderate threat; yellow: little threat; yellow-white striped: residual threat; white: no or negligible threat). It represents hazardous areas and especially provides the fundamentals for distinguishing hazard zones in land use planning. Comprehensive studies and publications were published by the national platform Planat for natural disasters in Switzerland (http://www.planat.ch/).

An example of sharing hazard zoning between countries
The same approach of hazard zoning from Switzerland is adopted also in different other countries, for example the Autonomous province of Bozen has the same structure related to the Italian law 183/89 (Macconi, 2010). South Tyrol is currently developing risk zone plans (PZP_Piani delle zone di pericolo) for individual river basins. Furthermore, risk identification

maps already exist: in 2010 the “General plan for public water utilization” (PGUAP_Piano Generale di Utilizzazione delle Opere Pubbliche) was approved from the Autonomous Province of Bozen. The PGUAP has River Basin Plan validity (EU-WFD and EU-FD requirements); the PZP (Fig.26) is a sectorial plan of the PGUAP and included in the urban plan (PUC_Pian Urbanistico Comunale): an overview of the municipalities from the autonomous province of Bozen that have already approved the PZP is available in ANNEX 4.

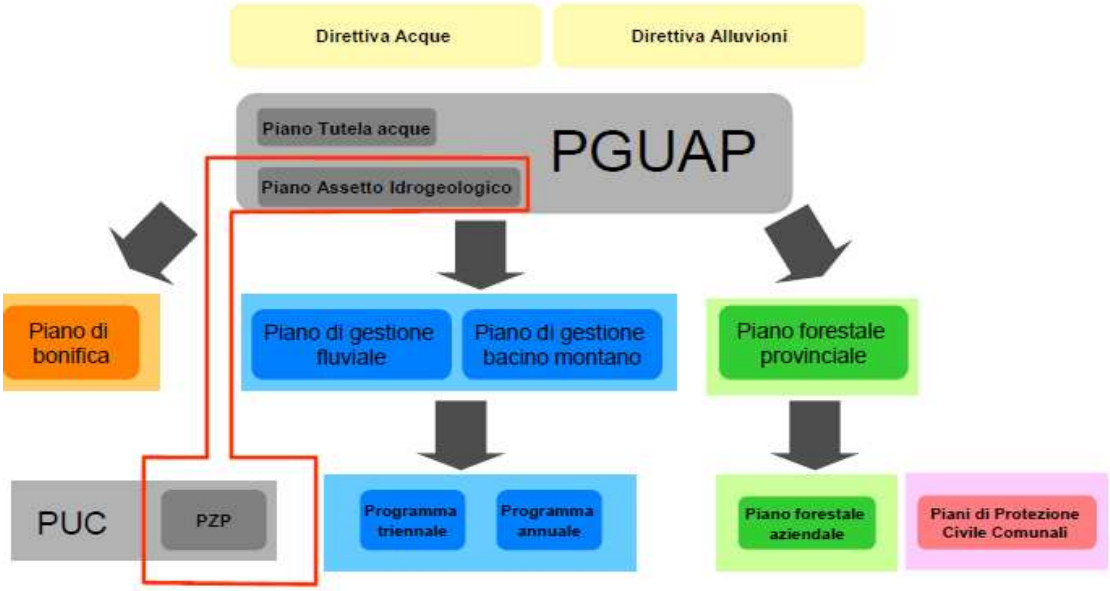

Fig. 26 Planning tools in the Autonomous Province of Bozen. Source: Macconi (2010).

There are four hazard zoning steps in the Autonomous Province of Bozen: 1) the municipality identifies the significant zones (3 levels) afterwards the provincial engineers identify hazard to assess; 2) the municipality organises the competitive tender; 3) the freelancer devises the plan in coordination with the provincial engineers; 4) the PZP follows the same approval procedure of the urban plan (PUC) and approved by the municipality.

4.4 Case studies

4.4.1 Introduction

Absolute safety against flooding is impossible to achieve (Lateltin & Bonnard, 1999). Land-use planning focuses on acceptable risks in areas prone to natural hazards. In some European countries, such as Germany, Switzerland and Italy, land-use planning uses zoning to restrict building construction and for a binding spatial planning (de Moel et al. 2009). The use of maps, but also strategic and city plans and agreements provide information regarding restrictions and negative impacts are considerably avoided. Different case studies are presented in order to emphasize the role of land use planning in flood management at different levels from transboundary river basin to catchment area in Germany, from regional to local in Italy and at city level in Switzerland.

4.4.2 Germany

International commission for the protection of the Rhine and land use aspects in Germany

General description

The Rhine River basin has parts in nine countries. It is the most important waterway for transporting goods in Western Europe. The river basin has a long history of integrated management brought about through its importance for a range of economic activities and, more recently, through the need to improve the natural river environment and protect against

flooding. The ICPR (International Commission for the Protection of the Rhine) is an international body tasked with coordinating national efforts to improve water quality, reduce the impact of flooding and encourage sustainable development of the Rhine. The riparian states of Germany, Switzerland, Luxembourg, France and the Netherlands signed the Convention on the International Commission for the Protection of the Rhine against Pollution in 1963 in response to public pressure to clean up the river that had become known as the "sewer of Europe". Since the establishment of the ICPR, water quality in the Rhine has improved significantly with contaminants. Pollutant levels for a number of substances being reduced by between fifty and ninety percent from the early 1970s to the late 1980s.

Objectives

Due to the focus on water quality, flood management of the Rhine was of limited interest in Germany until the floods of 1993 and 1995 dramatically forced the issue into the public arena. The need for improved flood prevention and protection measures became obvious, thus the responsibilities of the Commission have developed and moved from the prioritisation of water quality improvement towards restoring the river biodiversity and ecosystem as a whole. The ICPR adopted the "Action Plan on Floods" for the Rhine on the occasion of the 12th conference of Rhine Ministers on 22 January 1998 in Rotterdam. It aims at improving flood protection for man and goods by 2020 and to extend and enhance the floodplains of the Rhine. The plan is conceived in phases and will be implemented as part of "Rhine 2020" by all Rhine bordering countries by 2020, entailing expenses of 12 billion Euros.

Objectives for 2020 are (http://www.iksr.org/):

- Damage risks are to be reduced by 25%.
- Extreme flood stages downstream the impounded sections are to be reduced by up to 70 cm.
- The population living in the immediate vicinity of the Rhine is to be made aware of the existing risks by drafting maps of flood danger and risk pointing out the areas at risk.
- Periods of flood forecasting will be distinctly prolonged in order to avoid potential damage.

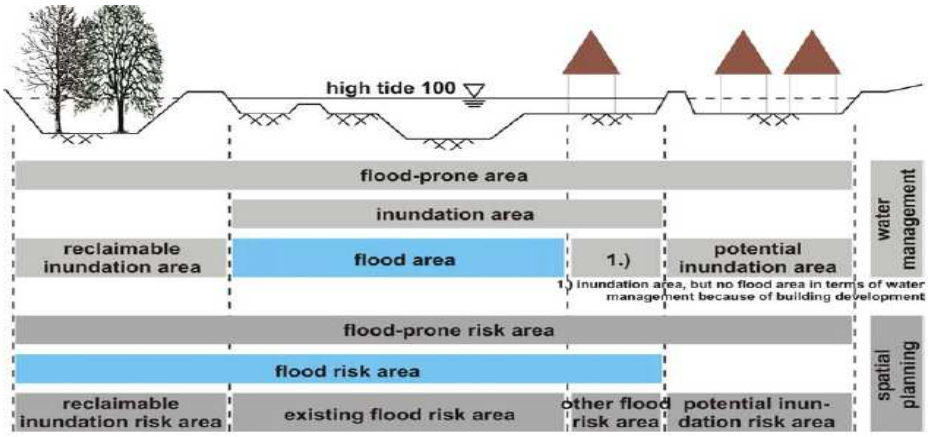

Fig. 27 Overview concerning the different types of flood areas in Germany. Source: North Rhine Westphalia State Environment Agency (LUA NRW), modified and translated by Friesecke 2004.

Furthermore, a "Rhine Atlas" was developed in 2001 in order to highlight areas most at risk from flooding. In Germany, flood management has included Bundesland (federal state) level programmes such as the flood risk and damage limitation strategies developed by the state of Baden-Württemberg which examine flood control measures through the conservation and restoration of the natural river ecosystem (fig. 27).

German interests in the ICPR are represented through the German Commission for the Protection of the Rhine. This is made up of representatives from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the Federal Ministry of Transport, Building and Urban Affairs, the Federal Foreign Office, as well as the LAWA representatives

from the Bundesländer in the Rhine catchment. These are responsible for the planning and execution of the measures agreed upon by the ICPR in Germany. With the amendment of the German Water Resources Act (1996) the objectives of the determination of the flood areas were concretised and their function as a natural retention area included in the regulation. In contrast to flood areas, flood risk areas in terms of spatial planning contain flood-prone, not dike-protected areas as well as sites with existing building coverage. For exact delineation of a flood risk area, there is a need to select a “design” event. Therefore, a specific occurrence probability of a flood event has to be chosen (in Germany generally the 100-year-flood standard that means the flood having a one percent chance of being equalled or exceeded in any given year).

The Emscher conversion

General description

The Emscher is a tributary of the river Rhine catchment, running through the densely populated Ruhr area in Germany. Its catchment covers 865 km². Since the 19th century the Emscher and its tributaries were systematically developed as open wastewater sewers due to industrialisation and extensive charcoal mining. 40% of the area became polders because of heavy subsidence due to mining. The bed of the Emscher and its tributaries were lowered and dikes were built over long stretches, in order to protect the cities from flooding. Now, the integrated river basin management for the Emscher region aims at the revitalisation of the Emscher and its tributaries as a nature-like urban river system (http://www.eglv.de/en).

Regeneration of the Emscher region required a strategic spatial plan and funds to finance the priority work. The aim of all the planning partners in the region was to solve economic and environmental problems not only by re-developing areas, but also by improving the overall quality of the region to make it attractive to investors and businesses. Various actions need to be taken to achieve these improvements. An important factor in creating an attractive environment for business, people and nature was rehabilitation of the Emscher River and re-generation of the surrounding area. Restoration of the Emscher and its tributaries as an urban river system is part of an integrated river basin management plan within the spatial plan for the Emscher Region (Bonn & Raven, 2012)

Objectives

The first step in creating a living river Emscher was to develop the “Emscher Future“ Master Plan (Fig.28). It represents an integrated spatial planning tool for water management, urban and landscape development and river restoration. The main objectives of Masterplan Emscher future are:

- To provide an informal planning mechanism without any formal commitment;
- To set milestones for a long-term process and turn vision into reality;
- To provide a focus for developments and planning activities of various regional and local organizations – a script for joint activities;
- To demonstrate the details of various options;
- To invite the potential partners to cooperate in the work.

The plan is refined and updated as opportunities and needs arise.

Fig. 28 The new Emscher Valley. The "Emscher Future" Master Plan was developed together with Emscher's cities and districts and supported in a unanimous vote by the city and district councils. Source: http://www.eglv.de/en

The spatial planning approach to rehabilitation was based on the availability of space alongside the river channel. In some locations sufficient space should enable an "assisted natural recovery" of the Emscher river-bed, allowing development of features and vegetation typical of a lowland river and its floodplain. These localities, together with confluences where less heavily depredated tributaries join the main river, will provide 'nodes' for flora and fauna to recolonize the waterway system. The main ecological objective is to enable the development of floodplain meadows. Beyond the channel, re-development of floodplain habitats sustained by rain water and streams will supplement the ecological recovery. In densely populated areas where space is very limited, the river profile must be adapted within the constraining factors (Bonn & Raven, 2012).

4.4.3 Italy

Agreement Protocol between Authority of the River Po basin and the Provinces of the River

General description

In Italy, the most vulnerable area is the River Po basin in northern Italy that hosts about 30% of the Italian population and 40% of Italy's total productive activities. The river Po, runs through the Po Plain and flows into the Adriatic Sea, forming a delta and one of the largest wetlands in Europe and in the Mediterranean Sea.

Valorisation and risk reduction in a defined territory can be reached only through an integrated policy in sectors related to landslide – and flood – risks mitigation, water resources protection and environment protection. Moving from this vision, the Po river basin Authority promoted the "Po river valley Strategic Project" (hereafter called Project) to overcome sectorial intervention approaches, and to strengthen the vision at basin scale. The project (www.adbpo.it, only in Italian) is a major national project that embraces the entire plain of the Po, four regions and all the riverine provinces, close to 500 Municipalities. It started with the Agreement protocol to enhance and protect the territory and to promote population safety in the Po Valley signed in Mantova on May 2005 by the Po river basin Authority and the 13 riverine provinces that share the same principles and goals: Alessandria, Cremona, Cuneo, Ferrara, Lodi, Mantova, Parma, Pavia, Piacenza, Reggio Emilia, Rovigo, Torino and Vercelli. In 2007 the Po River Basin Authority technicians started to draw up the Preliminary draft of the River Po Valley Strategic Project (PSS), approved in May 2008.

Objectives
To enforce existing basin plans and European directives concerning the matter (EU Birds Directive, Habitat Directive, Water Framework Directive and Floods Directive), the project has set the following main objectives:

1. to enhance hydraulic safety conditions and recover “room for the river” in the plain territories;
2. to promote the conservation of ecological integrity of the territory alongside the Po river and the conservation of water resources;
3. to increase the natural and cultural heritage value of the fluvial territories, improving accessibility for local population and for sustainable tourism;
4. to strengthen the overall Po river governance system and increase the level of knowledge and participation in order to improve interventions programming and realization ability, under the banner of sustainability.

The actual risk mitigation structural system (especially embankments along the Po and major rivers), even if coherent with the general PAI prescriptions, shows some local critical issues. Furthermore some evolutionary trends, man-induced, let the territory become more vulnerable to hydrological risks. The increasing river channels artificialization and inert-quarrying activities are indeed causing, in some reaches of the Po River, a channel deepening up to 2 meters that produces general damages to navigation and withdrawal works, and to bridge structures. To solve these criticalities the Project aims at:

- solving local problems concerning the embankment system;
- re-balancing the sediment-yield transport;
- deepening the knowledge necessary to manage residual flooding-risk, according to the EU Floods Directive approach, through residual risk mapping and population correct information.

The second objective deals with actions finalized at the strengthening and size-increasing of the ecological network and at a better integrated management of water resources, including environmental uses. Along the Po river many CISs and ZPSs have actually been individualized, belonging to the European Natura 2000 Network. On these aspects the Project aims at promoting the completion and coordination of management plans of Natura 2000 areas, maintaining the vision of the whole river system.

The third objective focuses on the natural and cultural heritage potential value of the fluvial territories and brings actions forth to improve territory attractivity and sustainable economic activities and tourism.

The fourth objective crosses all the other three, and deals with the strengthening of the governance system. Jurisdictions fragmentation between different institutional levels and complexity of communication between different actors, involve the necessity to develop cooperative models to reach effective results (Puma & Simonelli,2010).

Faenza: Extra cubature for developers in return for green space
General description
Faenza is an important historic city situated on the Via Emilia between Rimini and Bologna with a population of around 53,000 inhabitants. It covers an area of 215 km², partly on the plain and partly on hilly terrain. The city centre, dating back to the 18th century, hosts the International Ceramic Museum and other major cultural institutions.

The Municipality of Faenza has implemented a bio-neighbourhood incentive programme for developers, which is included in their Town Planning Regulations. The incentive programme aims to achieve energy and water savings, promote aesthetic qualities of neighbourhoods, and to bring climate change adaptation benefits in terms of reducing the impact of high temperatures and lessening flood risk. The incentive programme allows builders to extend

the cubature of buildings in bio- neighbourhoods in excess of approved standards, if the buildings meet certain criteria of environmental sustainability (Fig.29). These include green roofs, green walls and water retention systems, and also the creation of continuous public green spaces by developers. The unique characteristic of the regulations is that there are no set standards, with the development conditions negotiated on case-by-case basis. The negotiations between town authorities and developers or housing associations significantly shorten the waiting time for building permits and provide an incentive to engage a wider range of stakeholders into the town planning process.

Fig. 29 The river park of Faenza. The river Lamone and its relation with the town of Faenza have a fundamental role within the Town Planning Regulations (PRG). Faenza is the first Italian town planning regulation to achieve such levels of innovation in the field of bio-architecture and environmental protection. Source: http://www.planum.net/cultural-heritage-faenza-italy

Objectives

The prior mechanisms that have set a framework for the bio-neighbourhoods programme include:

- Engagement of Faenza residents in environmental issues linked to economic development:
- "Faenza 2010 - The City We Want", an awareness raising campaign that started in 1998;
- Awarding “Blue stickers” for cars and heating systems, which highlights the adherence to
- fuel- and energy-use standards;
- “City Center by bike” transport initiative.
- Local Agenda 21: In 1999, the Municipality of Faenza joined the national project “Agenda 21” for urban areas: a pilot initiative involving some small-medium sized cities in Italy. This helped to promote development rules and practices based on the direct involvement of developers and citizens in the urban design process.
- Focus on green spaces: During the preparation of the 1999 Town Planning Regulations, Faenza approved a new “Municipal Rule of Green”, which emphasizes the role of green spaces in the improvement of urban quality.

The Town Planning Regulations 1999 (Piano Regolatore Generale) introduced an incentive scheme for developers to incorporate sustainable practices in building design. This approach was confirmed and extended by the Municipal Structural Plan in 2009. The incentive scheme utilizes the principle of “transfer of development rights” (perequazione urbanistica). At the

design stage, the developer is allowed to extend the cubature of buildings (both the number of floors and the size of the buildings), or include more use types (residential, commercial, or industrial etc), if the development is characterized by certain criteria relating to environmental sustainability and aesthetic quality.

4.4.4 Switzerland
Integrated risk management on the river Engelberger Aa (NW)

General description
Since the last Ice Age, the river Engelberger Aa has created the Nidwalden valley plain from millions of cubic metres of bed load. Only extraordinary storm events raise this flood plain through extensive overbank sedimentation, whereas the sediments move a bit further towards the lake. This process continues unabated. The first inhabitants who settled on this flood plain were aware of the risks associated with the location and of their responsibility for their own safety. Thus, they settled on the slopes. In order to gain additional land, the water courses were gradually contained and provided with flood protection structures. These structures and the conversion of the fens into fertilised meadows gave people a sense of security and they started to build on the flood plain.

As a result of economic development and the increasing demand for land, the settlements spread extensively on the flood plain and, hence also, in the hazard areas. The risk reduction achieved by means of protective structures was quickly counteracted by the rapidly increasing hazard potential created by the new settlements. The storms in the canton of Uri and other Cantons in 1987 clearly highlighted the newly created hazard potential and the associated vulnerability of the built structures and previous flood-risk strategy. The realisation dawned that the risk posed by natural hazards could not be overcome through technical measures alone. Land use constitutes the central element of damage reduction. Thus, in accordance with the Swiss legislation, flood protection measures must be implemented primarily through spatial planning. This ranges from the designation of hazard zones with object protection requirements and segregation of non-development areas and river spaces to the designation of drainage and discharge corridors which must be kept free of development.

Objectives
The discharge corridor provided for the case of excess load is safeguarded in the cantonal spatial master plan and municipal land-use planning and underpinned by additional provisions. To ensure that the water courses can guarantee their function in terms of flood protection and ecology, the necessary space is safeguarded through the designation of river space zones and areas. These extend over several generations on the basis of a long-term perspective.
Fig. 30 shows hazard maps of river Engelberger including hazard zones and the corresponding provisions in the construction and zoning regulations. A ban is usually imposed on development in high-risk areas. Risk analysis involves the examination of all relevant hazard processes, the presentation of the various possible scenarios and assessment of the associated risks. The consequences of climate change and the inconceivable (“worst-case” scenario) are incorporated into the considerations.

Object protection requirements are applied in medium-risk areas and for risks of up to medium frequency. In addition, no new zoning is allowed in the medium-risk areas. The regulations apply to all new and replacement buildings and to major conversion projects. The discharge corridor provided for the case of excess load is safeguarded in the cantonal spatial master plan and municipal land-use planning and underpinned by additional provisions. To ensure that the water courses can guarantee their function in terms of flood protection and ecology, the necessary space is safeguarded through the designation of river space zones

and areas. These extend over several generations on the basis of a long-term perspective (TKN, 2009).

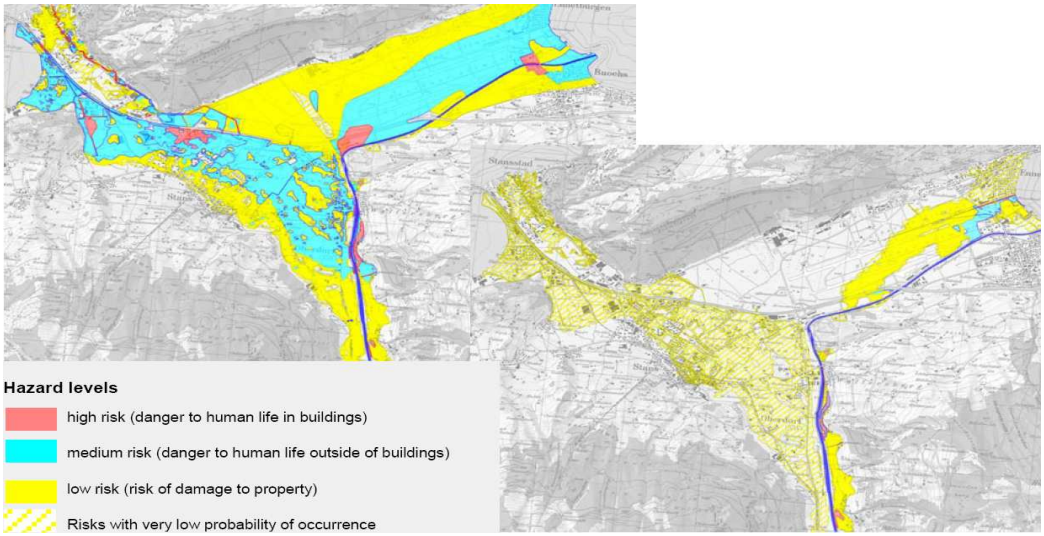

Fig. 30 Hazard map prior to (left) and after (right) the implementation of the flood protection measures. Source: TKN 2009

The flood events of 2005 and 2007 clearly demonstrated that runoff amounts and sediment volumes often exceeded the critical loads for some preventive measures. "Safety valves" are needed which can relieve channels that are overloaded, for example through the gradual and deliberate flooding of prepared areas. Such protection concepts have been implemented on the Engelberger Aa river and have proven successful there (TKN, 2009):

- River engineering measures over a distance of 7.4 km: EURO 22 million (CHF 26 million)
- Passive and planning measures: EURO 3,3 million (CHF 4 million)
- Damage[15] prevented as a result (2007) : over EURO 134 million (CHF 160 million)

The concept of integrated risk management and the measures undertaken as part of the differentiated flood protection project in the Engelberger Aa proved successful and the resulting damages were totally avoided (the estimated cost of the flood of 2005 is in excess of EURO 134 million for the River Engelberger Aa). The investment of EURO 25,3 million more than paid off in the first test case of River Engelberger Aa.

4.5 Considerations on analyzed case studies

The case studies show that even if the various local and regional authorities deal differently with the knowledge about the danger of flooding, it appears, at first, that there are positive synergy effects between flood risk reduction through spatial planning and landscape and nature conservation. Analyzed case studies have shown that land use planning is the most effective means of reducing future risks and damages from flooding at different governance scales. Most important actions are: balancing structural and non-structural measures, involving stakeholders at different governance levels and rising awareness to the population in the flood-prone areas.

Natural hazards do not respect political borders. Pproblems must be solved at the river basin scale: according to the instruments of water management, the flood action plan for the entire Rhine catchment area is a good example to provide interdisciplinary and cross-border flood

[15] The damage figures usually only comprise the direct damages. More details about the damage costs can be found in http://www.wsl.ch/fe/gebirgshydrologie/HEX/projekte/schadendatenbank/download/nhess-9-913-2009_lq.pdf for damages related to single events and in http://www.econome.admin.ch/doku_start.php for theoretical calculations.

protection. An ecological concept for the catchment is helpful for spatial planning of river rehabilitation (see Emscher case study). Exploiting opportunities to allow the river to develop more naturally, such as using natural recolonization sources provided by tributaries, and developing ecological “hotspots” should allow ecological recovery to be maximized, although this will take time to happen.

In Italy, the hydrogeological risk management was always considered as a sector theme of territorial planning with weak results on effectiveness of precautionary actions and ex-ante land use policies. The planning of the river basin is of particular importance to implement the greater integration between land use planning and hydrogeological resources management. In this perspective, the Po river basin Authority has promoted an innovative planning approach. The new plan “Po Valley Special Project” has introduced new integrated and strategic goals.

Faenza represents an emblematic case of "environmental planning", with town planning regulations that go beyond the traditional economic and quantitative approaches (based on the demand for social and economic development, on the production-oriented use of land and on qualitative standards). It is instead based on urban "sustainability" and on a concrete environmental development. The pursuit of ecological aims is inherent to the urban planning of the entire territory and a radical innovation from the point of view of procedures and rules. Only when a risk is recognized effective measures can be taken to prevent it[16] (EU Water Directors, 2003).

The examples from Switzerland show that preventive measures and protection facilities are cheaper than aftercare measures for the damage caused (Hahn, 2006). Prevention is a long-term concept and can be realised only step by step and it will never be complete.

[16] For example improving multipurpose and/or cross-sectoral action such as nature conservation and protection, protection of specific habitats and protection of sources of drinking-water supply.

5 Conclusion and recommendation for land use planners

This report serves as an introduction and guide to assist land use decision makers on how to address flooding from different land use planning scales. The management of land and water are inextricably linked (Defra, 2005) and most human effects on flood risk have rather long time scales: land use change and urbanisation develop with time scales of decades and centuries and short term corrections are not possible (Merz et al., 2010). Land use planning in a river basin system could influence the way in which soil is used, but at the same time is able to connect the macro-scale (city and districts) to the micro-scale (building) through the same prospective.

This report shows, that regional and planning authorities have a key role to play in ensuring that effective policy frameworks are put in place to require that new development is both located and provided in such a manner as to minimise the risk from flooding. Floods Directive (2007/60/EC) requires Member States to develop and implement flood risk maps and management plans thus will have consequences and different opportunities for land use practices throughout a river basin, introduced in the following useful recommendations:

- **The implementation of flood map and flood risk management plans requires multi-stakeholder cooperation.**
- **Communication is necessary to raise awareness and reinforce preparedness.**

Effective engagement with the people at risk at all stages is a key success factor. Citizenship is an active force in defence of the safety but ongoing communication counters the tendency of people to forget about flood risk. Engagement increases compliance, generates increased capacity and reduces conflicts. This needs to be combined with strong, decisive leadership and commitment from national and local governments.

The flood map is designed to increase awareness among the public, local authorities and other organisations of the likelihood of flooding, and to encourage people living and working in areas prone to flooding to take appropriate action. The European Flood Action programme emphasises the importance of damage prevention by appropriate spatial planning — avoiding construction of houses and industrial buildings in current and future flood-prone areas, adapting future developments to the risk of flooding and promoting appropriate land use, agricultural and forestry practices (EC, 2004). This gives the opportunity to investigate and disseminate the benefits of prevention measures compared to traditional post-disaster recovery. There are examples of transnational prevention programmes, for example for the Rhine across Switzerland, France, Germany and the Netherlands (http://www.iksr.org/) and the Meuse across France, Belgium and the Netherlands (www.cipm-icbm.be). Wider trans-national cooperation is stimulated by macro-regional strategies of the EU Regional policy for example, for the Danube (EC, 2010c).

- **An integrated strategy requires a right balance between structural and non-structural measures.**

European countries should trend towards more integrated flood management practices, balancing structural and non structural approaches. Structural and non-structural measures are complementary. Each measure makes a contribution to flood risk reduction but the most effective strategies will usually combine several measures – which may be of both types expecting safety, costs and environmental protection. This requires multi-scale approaches and consideration of long-term developments that take a 50–100 year perspective on the floodplain.

The planning opportunity for a sustainable land-use practice in the context of river-basin management could be the concept of multi-functional land use that would result in a

combination of flood prevention measures with agri-environment practices, territorial planning policies and nature development strategies, including river restoration. This is confirmed by the principle of an interdisciplinary approach to flood-risk management plans, where all relevant aspects of water management, physical planning, land use, agriculture, transport and urban development — the degree of soil sealing — and nature conservation are considered at different planning scales, from national to local levels. Here, the opportunity for land use planning is to maintain and improve the natural conditions of the river network and the expansion areas, also for the benefit of water wildlife providing “room for the river” and going along, where possible, the evolutionary dynamics.

- **Land use planning for flood management must be able to cope with a changing and uncertain future.**

The advent of global climate change also contributed to the realisation that a different strategy is needed and new opportunities for land use planning are coming. De Moel et al. (2009) showed that none of the mapping projects have taken into account the effect of climate change on future flood hazard. Incorporating the effect of climate change as well as the surrounding uncertainties in flood risk management could be an important driver for spatial planners and investors to design more sustainable housing and infrastructure in flood-prone areas. Buildings, roads and water/sewer systems are not currently designed for challenges from future climate changes. Land use planning measures have multiple co-benefits considering flood management and climate change. For example, the greening of urban spaces has amenity value, enhances biodiversity, protects against urban heat islands, and can provide fire breaks, urban food production and evacuation space. Improved waste management has health benefits as well as maintaining drainage system capacity and reducing flood risk.

- **Urbanization requires the integration of flood risk management into regular urban planning and governance.**

Europe is one of the most urbanised continents with around 75 percent of its population living in urban areas. By 2020, that percentage will increase to 80 or even 90 percent in some member states (EEA, 2006). Urban planning and management which integrates flood risk management is a key requirement, incorporating land use, shelter, infrastructure and services. The expansion of urban built up areas also provides an opportunity to develop new settlements that incorporate integrated flood management at the outset. Adequate operation and maintenance of flood management assets is also an urban management issue. The linkages between flood management, urban design, planning, and climate change initiatives are beneficial, for example to develop nature and landscapes with water retention.

- **Always consider social and ecological consequences of land use planning scenarios**.

While costs and benefits can be defined in purely economic terms, decisions are rarely based on economics alone. Some social and ecological consequences such as loss of community cohesion and biodiversity are not readily measureable in economic terms.

Which are the responsibilities of land use planning issues? It is not easy for decision makers to define land use based on risk maps because flood bonds foresee trigger of complex socio-economic phenomena that could compromise the population permanence on the territory or high responsibilities assumptions or unsustainable costs. City managers, communities at risk, urban planners and flood risk professionals should give qualitative judgments on these broader issues.

Some further research connections emerging from the report are about:

- The need for a common glossary that encompasses a shared definition and clear terms and that explain the methodology used in the mapping process from each River Basin Authority;
- Build up a best practices and initiatives network to share knowledge and information from different context: mountain, plain, coast, city, river basin;
- Introduce a “land use dynamic planning” based on current available technologies that refer to the analysis and representation of spatial phenomena. This means a research that focuses on the simultaneous representation on digital territory of the hazardous areas, the development or reduction of urban areas and bringing information from monitoring tools in the same view.

Finally, this report has allowed realizing some of the main critical aspects of EU Floods Directive:

1. The EU-FD considers the hazard and risk from the major rivers at a catchment scale and does not refer to minor and major networks at a neighbourhood and building scale. There are rivers that cross countries and require international cooperation agreements and streams belonging to the so-called “minor and major network” (Andjelkovic, 2001), which should not be forgotten by local government.
2. In the mountain context debris flows are not considered in the EU-FD. Probably the next “soil directive” will introduce more about this natural hazard. As an example, in Switzerland debris flow is included in land use planning.
3. Clarity of responsibility for constructing and running flood risk programs is critical; integrated urban flood risk management is often set within and can fall between the dynamics and differing incentives of decision-making at national, regional, municipal and community levels. Empowerment and mutual ownership of the flood problem by relevant bodies and individuals will lead to positive actions to reduce risk.
4. Risk mapping could be a disadvantage for the economic development of an area because it influences the value and importance of the area at risk.

The European Floods Directive is still in the implementing phase, in which the outcomes of pilot projects and examples from different EU countries provide invaluable insights into opportunities and potential challenges in land use planning.

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http://www.wasserblick.net German reporting portal on water
http://water.europa.eu/ Water Information System for Europe (WISE)
http://www.eddyburg.it Territorial and urban planning
http://www.gruppo183.org Italian association for water and soil protection
http://www.emdat.be/ The OFDA/CRED International disaster database
http://www.nordregio.se/EJSD European journal spatial development
http://www.planum.net/ The European Journal of Planning
http://www.climateadaptation.eu/ European centre for climate adaptation
http://www.jrbm.net/index.asp The international Journal of river basin management
http://www.apfm.info/ Associated programme in flood
http://www.preventionweb.net Serving the information needs of the disaster reduction community

ANNEX

ANNEX_ 1

EU funded research projects on Floods and Urban Areas (adaptation)

Floods

- IMPRINTS (7th FP): Improving preparedness and risk management for flash floods and debris flow events http://imprints-fp7.eu
- FLOODsite (6th FP): Integrated flood risk analysis and management methodologies http://www.floodsite.net
- ALFA (INTERREG): Adaptive land use for flood alleviation http://www.alfa-project.eu
- FLOOD-WISE (INTERREG): Sustainable flood management strategies for cross border river basins http://flood-wise.eu/elgg/
- DANUBE FLOODRISK (INTERREG): Stakeholder oriented flood risk assessment for the Danube floodplains http://www.danube-floodrisk.eu/de http://www.danube-floodrisk.eu

Urban Areas

- PREPARED (7th FP): Early warning systems, short- and long-term response strategies for urban areas pertaining to climate change adaptation
- CORFU (7th FP): Collaborative research on flood resilience in urban areas
- SWITCH (6th FP): sustainable urban water management in the 'City of the Future'
- MARE (INTERREG): Managing Adaptive Responses to changing flood risk in the North Sea Region
- FloodResilienCity (INTERREG): Improved integration of increased urban development and flood risks in major cities
- Future Cities (INTERREG): Urban Networks to Face Climate Change
- C-Change (INTERREG): Changes in attitudes and practical responses to the challenges of climate change in city regions
- MiSRaR (INTERREG): Mitigating Spatial Relevant Risks in European Regions and Towns

Land Use

- WAVE (INTERREG): Climate proofing land use regional water systems

ANNEX_ 2

Floods Directive: timetable for implementation
(Freissinet, 2009)

Directive 2007/60/EC on the assessment and management of flood risks set out clear deadlines for each of the requirements.

The key milestones are listed below.

Issue	Deadline	Reference
Entry into force	26.11.2007	OJ L 288, 6.11.2007 Art 18
Transposition	26.11.2009	Art 17
Reporting format Preliminary Flood Risk Assessment	22.12.2009	Art 11
Administrative arrangements to be in place and to be notified to the Commission	26.5.2010	Art 3
Cut-off date transitional measure (availability of existing tools)	22.12.2010	Art 13
Preliminary flood risk assessment	22.12.2011	Art 4 & 5
Public participation process starts (publication of mechanism and timetable for consultation)	22.12.2012 *	Art 9.3 & 10
Flood hazard and risk maps	22.12.2013 **	Art 6
Flood risk management plans	22.12.2015 ***	Art 7
2nd Preliminary Flood Risk Assessment, specific requirement on climate change Commission's first implementation report due.	22.12.2018	Art 14.1 & 4
2nd Flood hazard and risk maps	22.12.2019	Art 14.2
End of 1st flood risk management cycle 2nd Flood Risk Management Plans, specific requirement on climate change. 3rd Water Framework Directive River Basin Management Plans.	22.12.2021	Art 14.3 & 4

Review /update every 6 years thereafter

Reporting to the Commission: 3 months after

* = coordination with article 14 (WFD) requirements
** = date of 1st review of pressure and impact analysis under the WFD
*** = date of 1st review of WFD river basin management plans

Other information are available at:
http://ec.europa.eu/environment/water/flood_risk/index.htm

ANNEX_ 3

INTERVIEWS

Interview to Ms Meike Gierk (BMU), Germany

1. Which are the responsible institutions for the implementation of the EU Floods Directive (EU-FD) in Germany? Which is the role of the State in the prevention and protection from the flood risk?
Länder, the Federal States of Germany, are responsible for the implementation of the EU-FD. The German Länder and the Federation are coordinating the implementation process within the framework of the German Working Group on water issues of the Federal States and the Federal Government (LAWA).

The federal structure of Germany is consisting of 16 separate Federal States (Länder) and every Land has an own Ministry for environment issues: at this level the discussion of measures are taken and every federal state has its modus operandi. In fact each of those Ministries has a different name and is differently organized: sometimes they have two levels of hierarchy and other times they have three. Administrative regions, districts, municipalities are responsible for the implementation of flood risk management at local level and direct responsibilities for all matters involving risk management. The Federal Government is responsible for the transposition of EU-FD into national law (Federal Environment Ministry (BMU) as well as it has a coordination functions.

2. How is climate change considered in the implementation of the EU-FD in Germany?
Germany already began to consider the implications of climate change explicitly in flood management: for example the design flood magnitudes are proposed to increase by a certain factor, e.g. by 15% or similar.

3. Is there in Germany a national monitoring programme on the implementation of the EU-FD? Is it possible to have the German state-of-the-art on the implementation of the Floods Directive?
The “www.wasserblick.net” (water view) is a national reporting portal on water and hosts the central internet portal of the competent authorities. The reporting portal is inter alia the support of the international reporting requirements of the Federal Republic of Germany. The subject site is used primarily for information and communication within the government and the Federal States, but there are also selected contents available to the public in the section "Public Forums".

For example, in this web site there is the “MapNavigator” tool available that gives an overview of the relevant technical data processed in various thematic maps that are also available as shape-file download. The freely accessible maps and data services can be found in the repository. Every Land has a web site and most of the information is also available in English. Here it is possible to take a look and check the work in progress on the EU-FD implementation.

4. In which part Germany needs more attention and why?
Severe flooding has occurred in Germany over the last few decades, causing loss of life, displacement of people and livestock and heavy financial losses. For example, severe damage was caused in the Rhine river basin in 1993 and 1995, the Odra basin in 1997, the Danube basin in 1999, 2002 and 2006 and the Elbe basin in 2002. Every International River

Basin Commission (Danube, Elbe, Rhine, Oder, Meuse, Moselle/Saar) has an own web page and all information is available in different languages. Saxony and Brandenburg are also interested in flood events. Köln is another city frequently interested in flooding.

If a flood happened and the flood event has been assessed and evaluated, the Länder have a better understanding of what happened and can improve the working structure dealing with floods, rules for sharing responsibilities, or create new subworking groups. Flood events could also happen in areas never flooded before. This depends on the vulnerability of the territory given by the population that lives in the area and the involved houses and buildings.

5. How does the transfer of information take place for the implementation of the EU-FD from the EU to the municipal level? Is there a guideline or recommendation from the BMU to the different government levels?

At national level the implementation of the EU-FD takes place through the joint working group on water issues of the Federal States and the Federal Government (LAWA). The permanent committee of LAWA on "flood protection and hydrology" (LAWA-AH) has the lead responsibility in the working group. It discusses methods and courses of action, serves as forum for an exchange of experience and builds on this to develop joint approaches for the implementation of the EU-FD.

In September 2008, the LAWA adopted a strategy for the implementation of the EU-FD in Germany which contains basic positions and practical guidance. Due to determined administrative responsibilities in history, the Länder already were in charge for all flood protection issues. Concerning the new directive they have to elaborate the flooding management plans in line with the directive. In light of this, the LAWA-AH committee elaborated two papers that provide a practical guidance for organisational issues, e.g. for the spatial delimitation of areas for processing flood hazard- (FHM) and flood risk maps (FRM) and for the elaboration of Flod risk management plans (FRMP) as such as well as for the active involvement of all responsible and interested parties. In particular, the recommendations describe how the Federal Länder should implement the EU-FD and show the way for establishing appropriate methods and approaches for these actions, for analyzing the existing situation, the deficits and provide the measures for achieving the objectives.

In this way, there is a basis for the implementation of a standardised water management system within the Federal States which work in administrative borders. The formulated approaches allow sufficient freedom for taking into account specific regional characteristics within river basins. In fact there are partly considerable distinctions in the implementation between the individual states of Germany that are partly due to regional differences in the flood risk, geomorphologic context and with regard to the existing federal laws.

6. Which are the major issues and opportunities in the international cooperation on flood risks?

At international level Germany cooperates with its neighbouring countries in seven transboundary international river basin commissions (Danube, Rhine, Elbe, Oder, Mosel/Saar, Maas, Ems) which are subdivided into different working groups (e.g. on hydrology, flood protection, water quality etc.). In addition to that there are also bilateral working groups, the so-called Boundary Water Commissions which are split up into different task forces dealing with specific aspects (management, maintenance etc.).

For the preliminary assessment of flood risks (2011) and drawing up of maps (2013) for international river basins or sub-basins jointly managed with other member states, it is necessary to ensure an exchange of relevant information between the authorities responsible in the respective member states. The FRMP (2015) have to be coordinated between EU member states which should also seek to achieve coordination with non-EU member states.

In the interests of solidarity, flood risk management plans established in one Member State shall not include measures which, by their extent and impact, significantly increase flood risks upstream or downstream of other countries in the same river basin or sub-basin, unless these measures have been coordinated and an agreed solution has been found among the Member States concerned in the framework of Article 8, EU-FD. The EU-FD stipulates that all implementation steps mentioned above have to be reviewed every six years.

For example the Rhine commission has already been established many years ago. At the beginning they just worked on the quality of water but later, when there were bigger and major floods, they also created sub-groups about floods protection. Flood protection groups exist in every international river commission.

7. Which are the major issues and opportunities in the implementation of the EU-FD in coordination with the WFD?

The EU-FD requires appropriate steps to be taken to coordinate the application of the EU-FD and that of the EU-WFD. Pursuant to the German Water Act the two directives should be coordinated with a particular focus on improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in the WFD. The flood hazard maps and flood risk maps must be produced in such a way that the information they contain is consistent with relevant information presented according to the WFD. The EU-FD supports the objectives already set in the flood risk protection strategies of Germany's Federal States (Länder) and builds on the wide-ranging preliminary work, both legal and technical, carried out at national and state level. The implementation of the federal states' flood protection concepts and plans should continue without delay during the implementation of the EU-FD.

Concerted and coordinated action within the framework of flood risk management should improve the overall level of flood protection (FRMD, recital 5). This means that all stakeholders and competent authorities within the area covered by a FRM plan should be involved in setting appropriate objectives and devising possible actions, as well as in implementing the relevant measures. The local authorities in particular must set appropriate objectives, to be implemented through actions undertaken within the timeframes stated in the Federal Water Act (WHG).

8. Could it be easier to manage flood risks if the administrative limits corresponded to the river basin limits?

Germany has a federal system and, in principle, it is not appropriate to consider this question in reality. Historically, Germany experienced both responsibility for a management of water at the river basin level (former east part of Germany; e.g. Oder/Havel), and more concerning administrative borders (former western part of Germany).

In general, one could say that from the "flood perspective" it would be easier to manage flood risk if the administrative borders would correspond to river basin borders. But that would require to change the German Constitution, which is not up for debate. For example, Bavaria has already elaborated a Flood Risk Management Plan for the Bavarian river Main.

9. Please give some examples in how it could be possible to reduce the risk of floods through non-structural measures.

Where appropriate, FRMPs should focus on reducing the likelihood of flooding and/or on using non-structural measures, including flood forecasting and raising awareness of flooding.

Interview to Mr Roberto Loat (BAFU), Switzerland

1. Which are the responsible institutions for the risk management in Switzerland? Which is the role of the Confederation in the prevention and protection from the flood risk?

The Cantons and the municipalities are responsible for the implementation of the all effective prevention measures to protect the population against hazards associated with natural disasters and major accidents. They are also sovereigns and dispose of the water resources. Within the limits set by federal law, they can claim charges for water uses.

The federal authorities coordinate the implementation and provide technical and financial support. Several federal offices are responsible to deal with the main natural hazards such as floods, storms, avalanches, landslides and earthquakes. The main authority for the prevention of natural hazards is the Federal Office of the Environment (FOEN), which is part of the Federal Department of Environment, Transport, Energy and Communications (DETEC). FOEN is responsible for a number of recommendations concerning hazards associated with mass movements, floods and earthquakes including the compilation of hazard maps and micro-zoning. The objective of the Federal Office for Spatial Development (ARE), which is also part of DETEC, is the sustainable development of Switzerland's territory. As part of this task, ARE is interested in the natural hazards associated with spatial development.

2. How is climate change considered in the risk management of Switzerland?

Climate change has an impact in the medium and long term in Switzerland. It forces to keep in mind that natural hazards will increase and according to the currently available scenarios, further warming and altered precipitation patterns may be expected. This affects the frequency and intensity of extreme weather events especially in winter and, hence also, the threat posed by natural hazards. So far, the scientific world and the Confederation were occupied mainly in the causes of climate change and disaster reduction. In the field of natural hazards various studies have been developed, especially measures and strategies of coordination such as the strategy of the National Platform for Natural Hazards (PLANAT_ http://www.planat.ch).

3. How does the transfer of information take place from the confederation to the municipal level? Is there a guideline or recommendation about flood risk from the Confederation to the different government levels?

Natural hazards such as avalanches, floods, and mass movements in Switzerland should be recognized, recorded, and presented spatially by unified criteria. For this purpose the federal government has published various recommendations and guidelines in recent years. In order to minimize existing risks, hazard maps are being prepared, and their implementation with spatial planning tools is our top priority at present and in the near future. This aspect is central to the current recommendation. It pursues the goal of pointing out the potential and limitations of spatial planning tools and presents sensible applications from the Confederation's vantage point. Our primary audience are experts involved in implementing principles within the domain of natural hazards.

Today, from the technical point of view everything is known but we should always take in mind that nature always surprises us. What is the available basis for decision makers? How could we implement a decision system useful for governance? The different municipalities have the responsibility to take the decision and the Confederation has to prepare the basis for politics and spatial development. The basis has to be understood from all stakeholders and they should be able to understand the hazard risk in the territory where they live.

4. Is there in Switzerland a national monitoring programme of the state-of-the-art on risk mapping?

Everything related to the risk is based on the Federal Law on Forest and on the Federal Law on Water Protection. By these laws Cantons have to work following the decisions on risk and hazard given by the confederation strategy. This is standardized in Switzerland. One of the Confederation duties is the coordination and the assistance to the Cantons. We are daily in touch with the Cantons and we organize workshops, meetings and working courses.

Since the late nineties the Cantons draw hazard maps, with the support of the Federal State. The maps show that natural hazards such as avalanches, landslides, rock falls or floods can threaten settlements.

The Federal Office for the Environment´s (FOEN) "ShowMe" database provides an overview of the current status of the hazard mapping process: the Cantons have implemented 80 percent of the hazard maps and the missing maps have to be submitted in accordance with the planning of the Cantons by 2013. For the first time there is a nationwide survey of the endangered areas. The threat of natural hazards must be regularly checked and the hazard maps need to be adjusted if necessary.

An important step is the application of hazard maps in spatial planning. About two-thirds of the hazard maps in the municipal land use planning are implemented as binding: precautionary protective measures have been taken and major damage could be prevented.

The gaps in risk bases are closed. The task is therefore to capture additional risks due to exceptional rainfall such as the penetration of water through sewage backflow into buildings or groundwater rise.

5. Which are the major issues and opportunities in the international cooperation on flood risk?

Switzerland adopted several bilateral (e.g. with Italy or Austria) and multilateral agreements (e.g. International Commission for the Protection of the Rhine) with its neighbouring countries addressing mainly trans-boundary water issues. Additionally, there is also close cooperation with the European Union for example to address the implementation of the European Flood Directive. At the moment, Switzerland holds the chairmanship of the UNECE Task Force Water and Climate which is also dealing with trans-boundary flood management issues and the impact of climate change.

The European Union's new Floods Directive will oblige all Member States to produce flood hazard maps for high risk areas. Together with France, Switzerland is joint director of the European Exchange Circle on Flood Mapping (EXCIMAP), the aim of which is to formulate a recommendation incorporating good-practice methods for high-quality hazard maps. There is also an agreement with China on cooperation in the field of water resources (2009).

6. Could it be easier to manage the flood risks if the administrative limits corresponded to the river basin limits?

In Switzerland, the catchments are always bigger than the canton and this means that issues must be addressed among the Cantons. One of the Confederation roles is to "bring to the table" the representatives of the different Cantons to find solutions for the whole catchment and not only for the single canton. To do this it is necessary to have the equivalent bases of decision for all Cantons and available data of hazards and risks. The coordination between Cantons is very important to make decisions and in Switzerland, which is a duty of the Confederation. The Confederation has the faculty to oblige Cantons to make decisions if they are not able to be agreed.

7. Please give some example in how it could be possible to reduce the risk of floods through non-structural measures.
Engelberger Aa (NW) project is a good example. The four flood dikes constitute a central component of the flood protection structures. These were created in locations where, in the case of excess load, the excess water with a low hazard potential can be discharged to the side in a controlled way. The flow path used for the discharged water is called a discharge corridor. Buildings or settlements located in this flow path are protected to the level of their protection objective through local measures. In addition, land use planning measures were taken to keep open areas free for floods and inundation. Furthermore, a comprehensive emergency planning as well as a forecast, warning and alert system was implemented.

Thanks to the flood protection project, large-scale damage in 2005 was prevented in the controlled section of the Engelberger Aa, in the lowest part of the valley floor. The flood protection structures functioned technically as planned. The Confederations' philosophy consists on direct natural hazards to low vulnerability zones for better protect settlements. This means to have spatial planning measures that keep vulnerable areas free of settlements.

Interview to Ms Giuseppina Monacelli (ISPRA), Italy

1. Which are the responsible institutions for the implementation of the EFD in Italy? Which is the role of the State in the prevention and protection from the flood risk?
The responsibility for water management is shared among all the main Italian institutions (central government, regions, provinces, municipalities and agencies) applying a subsidiary approach. The Ministry of Environment is responsible for policy making and drafting new legislation. The regions and the River Basin District Authorities are responsible for planning at regional and at river basin scale. River Basin Authorities draw the River Basin District Plans. Provinces and municipalities, organized in ATOs ("optimal management areas"), are directly responsible for water service management in the household sector.

A Committee for the Surveillance of Water Resource (COVIRI), which refers directly to the Italian parliament, oversees water management implementation in each region and in each ATO. Water in agriculture is managed by local Consortia for Land Reclamation and Irrigation. The Italian Regions and the two Autonomous Provinces cooperate in the elaboration of the District Plans and make all arrangements and provisions necessary to protect the soil, the groundwaters and superficial waters. Municipalities, provinces, consortia and other responsible public associations take part in the execution of the regional tasks for the prevention of the hydro-geological risk.

In particular for the implementation of the "Floods" Directive the responsible institutions are: the River Basin District Authorities (art. 63 D.Lgs. 152/2006) and the afferent Regions in coordination with the Civil protection Department for the emergency plans. The Ministry for Environment, Land and Sea is in charge for the following actions:
- supports the River Basin District Authorities defining acts of instruction and co-ordination for tools drafting/adjournment and identifies potential resources.
- Transfers to the Commission the information received by River Basin District Authorities within the scheduled time

With regard to technical, scientific and operational matters, the Ministry for Environment, Land and Sea is supported by the Institute for Environmental Protection and Research (ISPRA), which is part of the System of Environmental Protection Agencies (EPAs) as the technical steering and coordinating body. Moreover ISPRA, as Italian national node of WISE (Water Information System for Europe), supports the River Basin District Authorities for the data elaboration and transmission in compliance with WISE.

The State has exclusive legislative power, as well as the guiding, coordinating and substituting power for the local authorities. At national level the Ministry of Environment, Land and Sea, the Institute for Environmental Protection and Research (ISPRA) and the National River Basin Authorities (coordinating the River Basin Districts) are the main actors involved. Together they are responsible for providing a national framework with regard to the protection of the environment.

2. How is climate change considered in the implementation of the EFD in Italy?

The management of flood risks is a crucial component of climate change adaptation, and the Directive requires that member States take climate change into account in the preliminary flood risk assessment, depending on their specific needs dealing with climate changes in drafting the Flood Management Plans in the context of the management plans at hydrographic district level. The intent is to incorporate appropriate measures in the basin management plan revisions to be concluded by 2015 for the second cycle and 2027 for the third.

In September 2007, the Ministry for Environment, Land and Sea organized a National Conference on Climate Change. The main result of this conference was a call for the preparation of national, regional and local adaptation strategies. After this Conference many activities were beginning by basin/district authorities and regions taking into account the climatological/hydrogeological conditions of the territory. These activities are supported by the Euro-Mediterranean Centre for Climate Change, *Centro Euro-Mediterraneo per i Cambiamenti Climatici* (CMCC). CMCC is an Italian research consortium consisting of various Italian public and private research institutions and is financially supported by the Italian Ministry for Environment, the Ministry for Education, University and Research and the Ministry for Economy. The CMCC developed advanced, high-resolution climate models taking into account the complex orography and several studies along areas prone to flood and landslide are under way.

3. How does the transfer of information take place for the implementation of the EFD from the EU to the municipal level? Is there a guideline or recommendation from the ISPRA to the different government levels (region-province-municipality)?

In Italy the river basin plans for the management of flood and landslide hazard/risk are intended as a superior-ranking system for urban development, land use, water resources use, etc. Therefore a dialogue between River Basin Authorities and Municipalities is requested under maps revision; they must respect constraints and prescriptions on land use in flood-prone areas. The information is transferred through consultation forums, web sites and publications.

At the national level, ISPRA is responsible for collecting, elaborating, managing, evaluating and disseminating environmental data in cooperation with the Italian regional environmental institutions.

For this purpose, ISPRA designed, realized and installed the SINTAI - Information System for the Water Protection in Italy. SINTAI allows a simple access to the information and to the transmission standardization and certification services through open source technologies, available on the web. SINTAI manages data channels according to the EU directives and national legislation where objectives and technical issues are established on protection of inland and marine water. A restricted area is reserved to the institutional organizations for data download and upload. ISPRA, Ministry for Environment and Territory and Sea, Regions, Provinces, ARPA (Environment Protection Regional Agencies) and APPA (Environment Protection Provincial Agencies) are the authorized institutions.

4. Is there in Italy a national monitoring programme on the implementation of the EFD? Is it possible to have the Italian state-of-the-art on the implementation of the Floods Directive?

A task-force of technical experts composed of the responsible institutions: River Basin District Authorities, Regions, Civil protection Department, Ministry for Environment, Land and Sea, ISPRA keep track of the implementation process of the EFD.

In Italy the Floods Directive was implemented with the D.Lgs 49/2010 in February, the Decree came into force on April 17, 2010. Preliminary Hazard/Risk maps were produced in the nineties, according to three/four scenarios. For each scenario at least flood extent is shown on the map. These maps meet the requirements of the Directive as “preliminary flood risk assessment product” scheduled for 2011.

5. In which part Italy needs more attention and why?

At the present time the attention doesn’t lie as much in the territorial coverage, which seems to have a consistent provision, but rather in the interest for different and lesser known kinds of floods (eg.: flash floods and debris flows).

6. Which are the major issues and opportunities in the international cooperation on flood risks?

Floods do not respect borders, neither national nor regional or institutional. This means flood risk management must be transboundary. The great advantages of transboundary cooperation are that it broadens the knowledge/information base, enlarges the set of available strategies and enables better and more cost-effective solutions. Transboundary cooperation on flood risk management is not only necessary, but also beneficial.

ISPRA is involved in the Danube Floodrisk “Stakeholder-oriented flood risk assessment for the Danube floodplains" project, a European transnational project promoting the cooperation between spatial planning and water protection in the Danube river basin. This is a good experience of methodological transfer and best practices on risk reduction that can only be achieved through transnational, interdisciplinary and stakeholder oriented approaches.

In order to share the experience, knowledge and tools for the information and involvement of stakeholders and end users of products and services developed by the institutions responsible for flood risk management, workshops are organised within this project by ISPRA.

7. Which are the major issues and opportunities in the implementation of the EFD in coordination with the WFD?

Member States shall take appropriate steps to coordinate the application of the Floods Directive and the Directive 2000/60/EC focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC.

In December 2006 EU Water Directors established a Working Group on Floods (WG F), which reports to the Strategic Coordination Group and the Water Directors. Given the strong need for coordination of the implementation between the WFD and the Floods Directive and the important role of floods in relation to other WFD related activities, WG F will coordinate with other activities in the Common Implementation Strategy (CIS).

The importance of close links of the Floods Directive with the Water Framework Directive was emphasised all through the consultation process. The Floods Directive therefore

includes a number of links to ensure close coordination in the two implementation processes. This is important to ensure there is no overlap of procedures and institutions and that the timetables for implementation are such that maximum synergies can be achieved.

In order to facilitate the implementing synergic process of both directives, WG F is drafting a document especially useful in case that involved authorities are not the same and Italy takes part in the team working for the document drafting just for the given importance of the integrated approach of the water management policy.

8. Could it be easier to manage the flood risks if the administrative limits corresponded to the river basin limits?

Administrative or legal boundaries often fragment river basins, so it is important that the risk management authority develops a strong collaboration among national authorities and entities operating on the basin. The Directive aims at achieving a co-ordinated river basin approach to water management even where river basins are divided by national boundaries. For this purpose the Directive requires that a river basin covering the territory of more than one Member State is assigned to an International River Basin District (IRBD) (Article 3.3). The districts establishment, also within the States, facilitates the clearing of the fragmentation when the administrative limits do not correspond to the river basin limits.

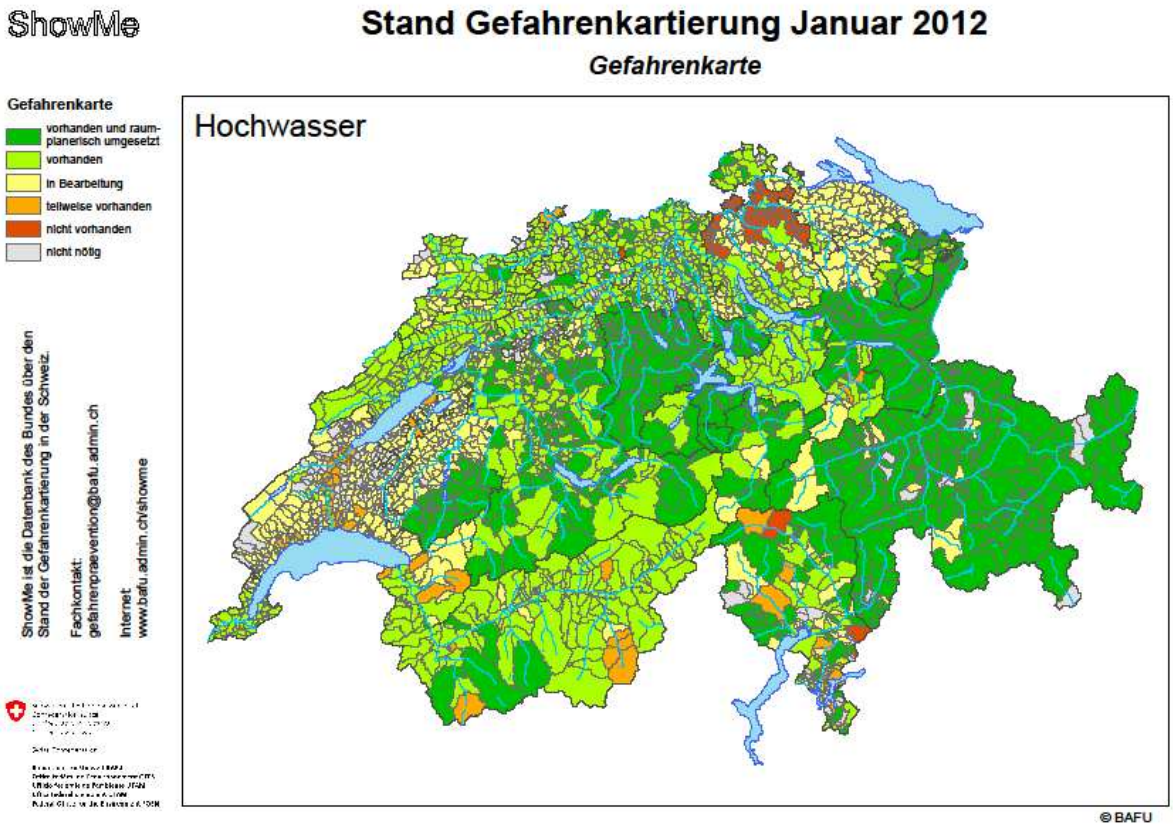
9. Please give some examples in how it could be possible to reduce the risk of floods through non-structural measures.

Many kinds of non-structural mitigation measures can be very cost-effective in reducing risk. Examples include:

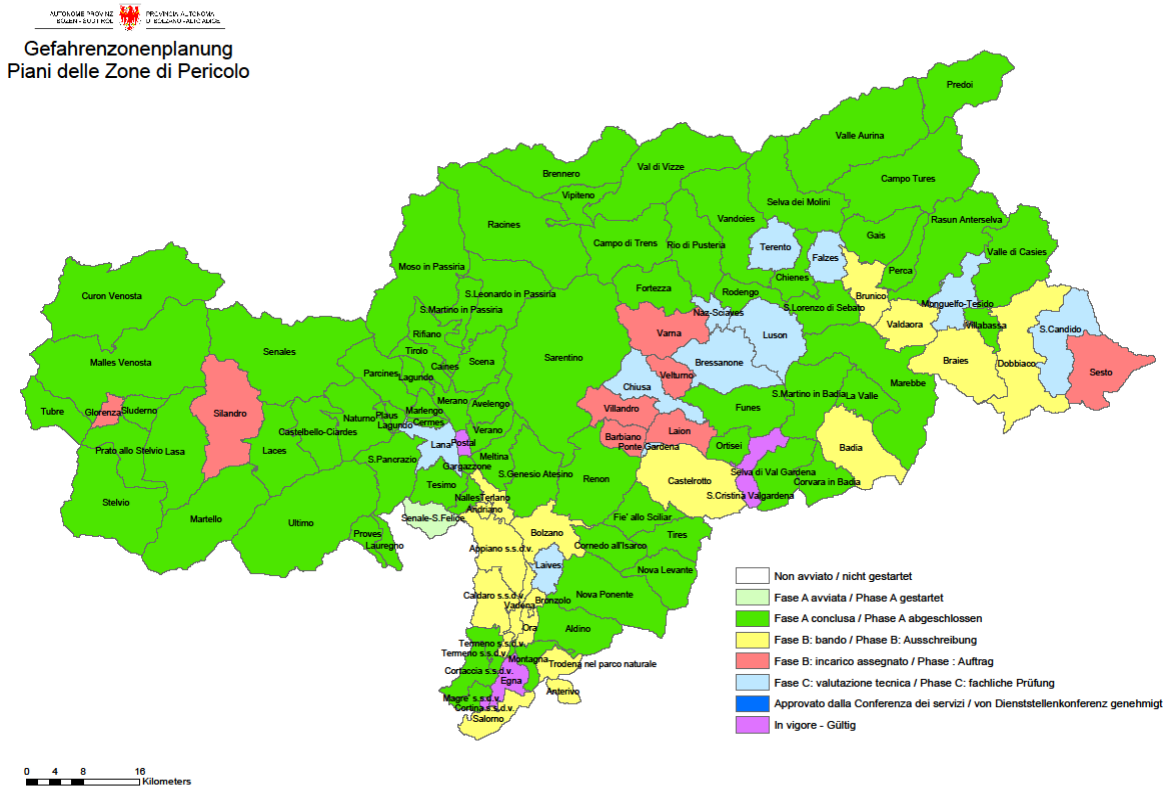
- Detection of natural flooding areas
- Land use limitations in flood hazard areas
- Updating of local plans
- Relocation of elements at risk
- Flood forecasts and early warning systems
- Flood surveillance service

Non-structural measures and flood damage prevention are by now key elements in flood management in Italy. The emphasis is on the maintenance and restoration of floodplains and retention areas. The creation of retention areas in non urbanised areas appears to be successful, often with nature objectives predominating. The direction is mainly decided by the provincial authorities who also finance flood protection considerably.

ANNEX_ 4



Hazard map in Switzerland. Last update 22-05.2012



Hazard Map in the province of Bozen. Last update 17.04.2012

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