European strategies for sustainable flood plain management to reduce flood risk

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Abstract

Floodplains are manifold landscapes where various requirements with an increasing competition can be observed. The loss of natural floodplains through urban development, flood defence, land drainage and agricultural improvements has led to a dramatic decline in habitats and wildlife. - Between 1998 and 2004, Europe suffered over 100 major damaging floods, including the catastrophic floods along the Danube and Elbe Rivers in summer 2002. These recent major flooding events in Europe have raised awareness of the need to restore and manage our floodplains for – inter alia – decrease of flood risks. One of the key hydrological functions of floodplains is that of floodwater detention. In Europe several activities were started to reduce the risk of flooding. The most important piece of recent legislations that affects the restoration and conservation of floodplains is the European Water Framework Directive (WFD) (adopted in 2000) and the Directive on the assessment and management of floods which was adopted in 2007.With the Floods Directive a three-stage process is proposed:

1. preliminary flood risk assessment
2. the development of flood hazard maps and flood risk maps, and finally
3. flood risk management plans which should include inter alia protection measures such as restoring flood plains and wetlands.

Besides these legal instruments on European level other tools were developed and implemented in several European countries. There are approaches like Guidelines for land use planning in flood prone areas in Norway, a Strategic Flood Risk Assessment (SFRA) for England and Wales or the Act to Improve Preventive Flood Control, which was implemented in 2005 in Germany. The different characteristics and pros and cons of different approaches towards a coherent development and land use planning are discussed in the paper. There is a great potential for coherent approaches – current implementations are still poor.

Key words: flood plain management, reduction of flood risk, land use planning, instruments

1 Introduction

Between 1998 and 2004, Europe suffered over 100 major damaging floods, including the catastrophic floods along the Danube and Elbe Rivers in summer 2002. More often and more intensive flood events are predicted by several simulations (e.g. IPCC 2007).

Flood risk is understood as the hazard multiplied with vulnerability. These terms are defined according to EEA (2007b):

Vulnerability: The degree to which a system is susceptible to, and unable to cope with, injury damage or harm.

Hazard: A threatening event, or the probability of occurrence of a potentially damaging phenomenon within a given time period and area.

Risk: Expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability.

During the last centuries floods have been managed mainly by technical measures like dams, levees, and straightening channels. The same 'trend' can be observed for rivers and brooks. Mostly, these regulations were not only intended for flood protection but also to reclaim land for agricultural use on fertile soils in the flood prone areas. Although these measures may reduce floods with local effects, they can cause unforeseen and even greater effects along the watercourses, and then not only downstream but upstream as well.

Floodplains are often cheap as building land in rural areas, attractive (being near a river), and easy to develop (being level). Floodplains are particularly advantageous for commercial and industrial facilities that need a large amount of space (sport arenas) and sometimes use river water as process or cooling water (nuclear power plants). Larger rivers offer the possibility of freight transport by ship. Towns and cities are interested in further development. They have to make land available for development or for commerce and industry. Many owners are either not aware that there is a danger of flooding because they do not come from the region and assume that if land is released for development it will not be unsafe, or they ignore the danger (MunichRe 2006).

The dimension and implication of floods can be considerably influenced. Flood-intensifying conditions include a range of factors. Nagle (2003) names the following human-related causes for the intensification of floods and its consequences:

- More rapid discharge in urban areas due to impermeable surfaces and increased number of drainage channels;
- Floodplain developments (increasing risk of damage/increase in exposed values);
- Urbanisation and urban growth (increase of impermeable surfaces);
- Bridges, dams, obstructions;
- Changes in vegetation cover, e.g. agriculture;
- Human-induced climate change(e.g. sea level rise and increase of heavy rainfalls);
- Deforestation (causes the increase of flood runoff and a decrease in channel retention capacity);

The following reasons for flood risk can be added:

- Failure of flood protection systems;
- Shortage of watercourses and expanded drainage systems to establish more agricultural land which causes a reduction of flood retention capacities;
- No or wrong information;
- Little or no risk perception;

River engineering measures such as canalisation and reduction of retention potential in the floodplain increase the velocity and therefore flood risk for downstream areas. In 1995, the peak of a flood wave in the river Rhine needed 65 hours from Bale to Karlsruhe; nowadays it only needs 24-28 hours (Dister 2002).

Increasing pressure on land for human settlements often leads to a drastic loss of natural riverbed areas and fails to take into account exceptional events. Flood disasters usually result from a lack of appropriate planning of human infrastructure.

Flood plains are diverse landscapes. They can be defined as the lowland areas alongside rivers and streams which are more or less regularly inundated by floods (Dister 1994). Water-related biotopes, and especially flood plains, are not only extremely important but also rich ecosystems with a huge variety of species and functionalities. 'Freshwater ecosystems, when scored on the area they cover and the number of species they harbour, are in fact the most species-diverse habitats on Earth' (IUCN, 2005). The most important natural influencing parameters for flood plains are the flood dynamics and gradual processes. The preservation of riparian landscapes, but also of extensively used pastures and meadows in flood plains (the cultural landscape) is of great interest.

The loss of natural floodplains through urban development, flood defence, land drainage and agricultural improvements has led to a dramatic decline in habitats and wildlife.

In terms of flood risk reduction it is a crucial point to optimize the retention potential of the river basin. This depends mainly on:

- The expansion and the size of the effective flood plain or retention areas (e.g. polders), respectively;
- The land use of the effective flood plain;
- The land use across the whole catchment area;

Figure 1 shows the impact of land use on the discharge for different precipitation rates and types of land use. It is obvious that particularly for extreme rainfalls (here 100 l/m^2) the land use patterns have a major impact on the discharge (forest 30% of the discharge for impermeable areas such as streets or other sealed areas). Infiltration is the major process (beside precipitation) for recharging groundwater (Symander 2004). If the infiltration rate is low or zero (as for impermeable surfaces), there is poor or no infiltration, and a rapid runoff. This situation has consequences for groundwater recharge.

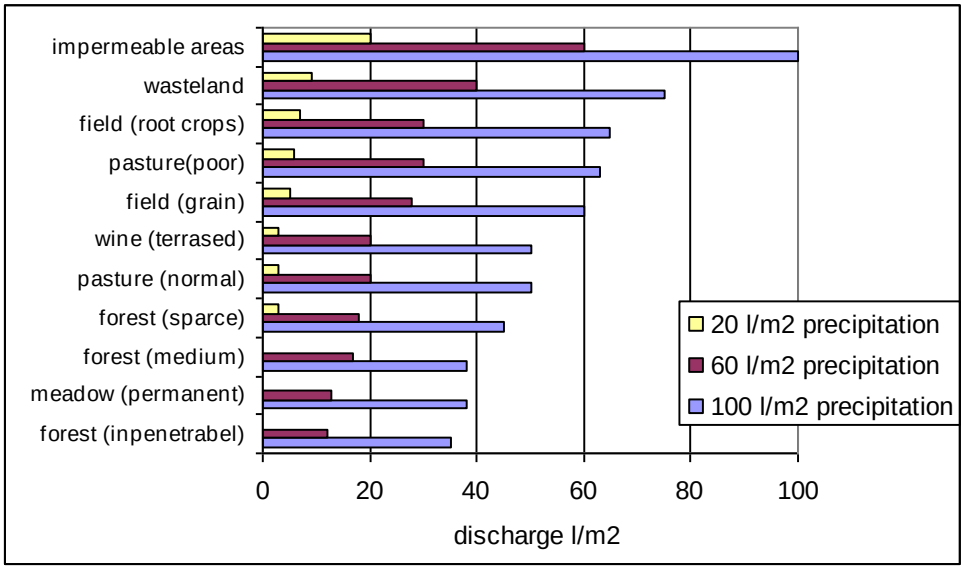

Figure 1: The impact of land use on the discharge (adapted from UBA 2006).

Table 1 shows possible natural flood risk reduction measures. A wide range can be considered, all having positive effects on flood risk reduction and potentials for an enhancement of the (human-social) value of floodplains. Dister (1992) claimed that dike shifting is the best solution for solving problems of flood risk from an ecological perspective.

However, every single measure has to be considered in the local context in terms of whether it is an appropriate measure for that particular place. The nature of the vegetation in floodplains is important because of the type of friction effects it has. Trees create more of a barrier than bushes since the latter flatten during high flows. Other factors are the smoothness of trunks, tree size, the spatial design of floodplains etc. They all affect the degree of friction and water retention. However, it is very hard to measure and to quantify the impacts of all these factors. In general, floodplain forests should be seen as being potentially useful in flood impedance. They lead to lower flood peaks, but of longer duration. (Blackwell and Maltby 2006, Patt 2001). Many analyses show the negative impacts of floodplain destruction on flood risk in downstream areas. Therefore, it is a consequent idea to re-establish retention areas by natural flood risk reduction measures which are described in Table 1.

Table 1: Natural flood risk reduction measures. After Blackwell and Maltby (2006).

Measure	**Qualitative description of the measure**
Protection of existing naturally functioning river and floodplain systems	The existing storage capacity of the river system is maintained and valuable ecosystems are protected.
Flood bypasses	New river bypasses, including new floodplains with wetland or floodplain ecosystems. Also called green rivers.
Removal/lowering of minor embankments	Enlarges the effective river floodplain.
Setting-back of embankments	Enlarges the storage capacity of a floodplain and leads to enlargement and restoration prospects for a floodplain.
(Re)construction of stagnant water bodies such as isolated channels and oxbows in the (former) floodplain	Increases the storage capacity of a floodplain.
Development of manageable flood detention polders which should preferably be used as extensive grassland or floodplain forest	Increases the storage capacity of a floodplain.
Floodplain excavations	Enlarges the effective river floodplain.
Changes in land use in the catchment area (for example reforestation)	Promotes retention of water in a catchment area
Restoration of floodplain vegetation	Increases the storage time of water on a floodplain.
(Re)construction of meanders	Increases the storage capacity of a river channel, decreases a river's slope.
(Re)construction of flowing side channels	Increases the storage capacity of a channel area and increases the water conveyance capacity through a river section.
Re-meandering the river course or allowing spontaneous river morphological development	Increases the storage capacity of a river channel. Removal of flow restrictions
Alleviation of unwanted flooding in some areas and purposefully relocating this to designated areas.	Increased river flows downstream with managed storage areas used for habitat creation
Rejuvenating or removing vegetation with a high hydraulic roughness	Only ecologically beneficial if the management of the vegetation supports the development of a stable and viable ecosystem.
Removal or lowering of groynes and other hydraulic obstacles in the river channel	Allows more dynamics in water level fluctuations, decreases a river/valley roughness coefficient.

Examples from the river Rhine give ideas of possible measures in the floodplain, flood protection and other effects, and costs (Table 2).

Table 2: Measures in the floodplain: Action plan on flood defence on the River Rhine – overview of activities 1998-2020 - effect and costs. Own compilation following Disse and Engel (2001).

Activity category	**area**	**Flood protection effects**	**Other effects**	**Cost estimate (million €)**
Reactivation of inundation areas	160 km^2	Water level reduction; 14-25 cm	Groundwater recharge, restoration of aquatic & terrestrial habitats	1,450
Tech. flood retention like polders	364 m^3	water level reduction; 45-60 cm	new habitats	960
Restoration of rivers	11.000 km	Few close-range effects	Restoration of aquatic and terrestrial habitats	1,160
Extensification of agriculture	3.900 km^2	Few close range effects	Groundwater recharge, new habitats	1,705

This summary illustrates that flood defence activities have different effects on:

- Water level decrease
- Ecological functioning of the ecosystem and
- Costs.

Regarding a sustainable land use planning for flood plains in order to reduce flood risk there are two aspects/strategies: (1) the protection of flood prone areas and secure the level of retention potential and (2) reclamation and restoration of (former or degraded) flood plain areas. These two aspects are ana-

lysed and evaluated for several European instruments in the field of land use planning and environmental planning.

2 National flood risk management strategies

The extreme increase in flood events and flood damage during recent decades makes it obvious that an integrated approach is crucial to flood protection. Many issues such as technical measures, spatial management, retrofitting, raising risk awareness and also environmental and land use management have to be incorporated into the complex field of integrated flood management (IFM).

The German Laender (Working Party on Water) divides the areas of integrated flood management into three main pillars (LAWA 1995):

- Technical flood protection (dikes and levees, water reservoirs, clearing the discharge profile, flood protection walls, protection of objects, creation of polders);
- Spatial or land use management (flood mapping, restriction of land use/building in the flood prone area, suitable/sustainable use, conservation and development of flood prone areas, natural river/stream courses, adapted land use, retention of water in the catchment);
- Flood prevention (information, forecasting, retrofitting, rising awareness);

Several programmes and instruments have been established to come closer towards an integrated spatial or land use management on a national and international level. Meanwhile, many different legal and managing frameworks have become operative in Europe or were developed further or were adapted.

Besides legal instruments on European level other tools were developed and implemented in several European countries. There are approaches like Guidelines for land use in flood prone areas in Norway, a Strategic Flood Risk Assessment (SFRA) for England and Wales or the Act to Improve Preventive Flood Control, which was implemented in 2005 in Germany.

Each country has its own approach to the implementation of flood risk management in its administrative system and to improving integration of flood risk issues into land use planning. A comparison and evaluation of these approaches was conducted in 2006; an overview of the main features of these instruments is given in Table 3. All information is based on an evaluation conducted in the context of the European project FLOWS (Evers and Gusky 2005). The evaluation results show different requirements, approaches and instruments used in handling and coordinating flood risk and spatial planning.

Germany

After the major floods in Germany in 2002, a range of flood risk management initiatives was started. First of all, the government passed a 5-point-programme. The first and most important point is that rivers should be given more space, namely natural floodplains, for example by dike shifting, establishing of polders or restoration of watercourses. Another aspect is the coordination and financing of transboundary activities, planning and management. The subject of transboundary spatial planning was stated as important and all projected constructions along the main rivers at that time were to be checked carefully with respect to their flood impacts. The last item was a new framework for improved catastrophe management. All in all, it was the beginning of a broader discussion about integrative management of flood risk and the starting point for the Federal Act for the improvement of preventive flood protection (Flood Control Act) of May 3rd 2005 (Bundesgesetzblatt 2005).

The new German Flood Control Act lays down uniform and stringent legal provisions for the prevention of flood damage on a nationwide level. Waters and water segments with high flood risk have to be identified. The federal states (Laender) are obliged to inform the general public about the identified areas. For areas with a high potential of damage, floodplains have to be designated by 2010. The inundation areas in potential flood areas in the form of defended areas, e.g. areas which are flooded if a dike breaks or is overtopped, have to be designated by 2012. These areas have to be mapped and shown in land use plans and development plans so that this information can no longer be easily ig-

nored for development purposes. The chance that flood issues will be considered at an early stage of the planning process increases. The public has to be included in the initial process of designating/identifying the inundation areas. The basis for designating floodplains is the so called 100-year flood, an event that statistically occurs every 100 years.
With the new regulation, new housing areas in floodplains are prohibited by federal law. Exceptions are possible if nine closely defined requirements are met, all of which have to be fulfilled completely in every individual case. Some of these requirements are: the municipality has absolutely no alternative for human settlement development, no lives are at risk and no significant property damage is to be expected, and the structure of new buildings is to be adapted to flood events. In the case of agricultural land use, the Laender have to ensure that soil erosion and pollution of water bodies are prevented or reduced. If no flood protection plans exist, the Laender have to draw up plans co-ordinating flood protection along the rivers within four years after implementation of the act. In the set up process of flood control plans the interests of upstream and downstream riparian regions have be co-ordinated. Furthermore, the federal states are required to designate more areas as floodplains by restoration or dike shifting or other possible measures.
The German approach seems to be strict and in case of flood risk definition inflexible (100-year flood is the ultimate measurement requirement). The only flexibility is given by the regional flood plans which have to be developed for water segments which are identified by each federal state. A stringent implementation of the legal regulations is not obligatory. Concrete goals for a certain flood risk level or the increase of flood plain area are not required to be defined.

England and Wales

For England and Wales, the Planning Policy Guidance Note: 25 (PPG25) 'Development and Flood Risk' gives guidance to Local Planning Authorities (LPAs) when considering planning and development in areas at risk from flooding. Local Planning Authorities are required to ensure that flood risk is properly taken into account in the planning of developments in order to reduce the risk of flooding and the potential damage which floods cause. The LPAs are required to follow the principles of the sequential test to carry out allocation of land for development. There are three categories of flood risk zones: Zones of little or no risk, Zones of low to medium risk and Zones of high risk or more. These categories of flood risk zones are determined on the basis that no flood defences exist, i.e. they are theoretical and not based on actual risk. Therefore PPG25 Flood Risk Zones provide only a starting point for consideration of flood risk.
LPAs have found it necessary to have Strategic Flood Risk Assessments (SFRAs) carried out, based on actual flood risks, taking into account all potential sources of flooding and the existence of flood defences in drawing up development plans and policies and considering proposals and applications for development. SFRAs should be produced by all LPAs as essential advisory documents which will enable flood risk management to be taken into account in sustainability appraisals (possibly via mandatory Strategic Environmental Assessments). Initially, potential hazards should be identified by collecting and analysing relevant available data sets. These will generally fall into three categories: Potential source of flooding, pathways for flooding routing and receptors of potential flooding. Also an element of the SFRAs is to define the flood risk for people in defended areas. The Environmental Agency is obliged to provide LPAs with basic information concerning flood risk on a catchment level. A general basis for flood risk consideration is provided by three flood risk zones which give orientation based on general flood information. The advantage is that this information – provided by the Environment Agency (EA) – exists everywhere and that potential risk areas are known. However, for SFRAs the real flood risk has to be ascertained. With an SFRA there is more local flexibility for planning, which can be both an advantages and a disadvantage.

Norway

In Norway, a commission on flood protection measures was established by Royal Decree after the large flood in 1995. The commission produced an official Norwegian Report. The report was followed up by a White Paper (No.42, 1996-97). The White Paper can be regarded as a national action plan for Norway and presents several measures, such as improved flood forecasting, a flood inundation map programme and guidelines on land use planning in flood prone areas. As a result of the report and the White Paper a major research programme (HYDRA) was initiated.
According to the Planning and Building Act, the municipalities are responsible for taking natural hazards into account in land use planning, and could be liable if damage occurs. The "Guideline on plan-

ning and development in flood prone areas" (NVE, 1999) defines differentiated safety levels along two dimensions: type of flood and type of asset. The responsibility of making guidelines according to these natural hazards lies with the Norwegian Water Resources and Energy Directorate (NVE). Together with detailed maps of inundation areas it was implemented in the municipality planning procedure. The NVE considers this approach as an efficient tool in improving safety against floods. An important instrument and the legal background to all planning activities in Norway is the Planning and Building Act. According to § 2 PBA, the Act is intended to facilitate the coordination of national, county and municipal activity and provide a basis for decisions concerning the use and protection of resources, and development, and to safeguard aesthetic considerations. It is the local authority (municipality) in the first instance which, through the planning process, shapes the physical environment and ensures that the standard of construction and the application of conservation measures according to local conditions and requirements.
Most of the work in the planning process involves dialogue and negotiation. By centralising the planning consent process, national government is in a position to oversee a comprehensive solution and to help reconcile opposing views in all counties. In strengthening the regional planning process, the government seeks to encourage the local councils to take more responsibility for regional development – in collaboration with the local authorities, other public bodies, and commercial and private organisations in the county. The municipalities shall use the guidelines as a basis for municipal planning and for consideration of individual cases in relation to the plans. To aid municipalities in identifying flood risk areas the government decided to finance a programme aimed at producing flood inundation maps for the areas along rivers in Norway with the greatest damage potential – the flood inundation mapping programme. The maps are produced digitally, which is important for integrating these data into land use and urban development planning. The digital spatial data follows national standards so that exchange and integration can be taken for granted.

These three kinds of flood risk management instruments have different levels of legally binding provisions. The requirements of municipalities and counties vary considerably between these countries:

In Norway, the NVE offers detailed inundation maps for the rivers with high flood risk. In England, the LPAs are required to follow the principles of the sequential test (PPG25) when allocating land for development. Some general information is provided by the EA. In Germany, the Act has to be implemented into the federal legal system of the Laender. However, it is not intended that the government should provide additional financial support or that federal authorities should give assistance with information and data. In Norway, the Guideline defines the classification of risk which is divided into 3 categories, depending on flood risk and type of development. In England, the LPAs have to follow a sequential test (PPG25) to carry out allocation of land for development. In Germany, the risk of flooding is separated into ‘flood risk areas’ and ‘potential flood risk areas‘ of a ‘100-year flood’. The identification of potential 100-years-flood-areas means no identification of risk but of certain probabilities. The definition of risk is made on the regional level for every river system Länder-wise. There is no common methodology to define flood risk. This relatively inflexible framework does not encourage public discussion about tolerable risks. For the ‘100-year flood’, defended areas seem to be safe even if potential flood areas/inundation areas have to be described in land use maps.

From the integration aspect of river basin elements and diverse management fields, the German Flood Act includes an interesting instrument: The flood control plan (§ 31d), which ‘shall include in particular measures to preserve or restore retention areas, to flood and discharge the water from these retention areas according to the requirements of an optimised floodwater run-off in river basin units, to relocate dykes, to preserve or restore alluvial meadows and to retain precipitation water’. Furthermore, cooperation in river basin districts (§ 32) is required: ‘Federal state law shall stipulate cooperation in flood control within the river basin districts of the relevant Laender and states, particularly the coordination of flood control plans and protection measures’. Because the implementation phase has only just begun, it is not yet possible to assess whether or how these requirements will be realised. However, whilst the Act requires some cooperation on a catchment level, there is no implementation strategy proposed which can help to realise this. The implementation of the Act has to be made Laender-wise, no general information or data on the catchment level are provided and so forth.

The SFRA in England and Wales provides information for identification of potential hazards by collecting and analysing relevant available data sets to classify potential sources of flooding, pathways for flooding routing and receptors of potential flooding. So the catchment aspect and elements such as land use and hydromorphology can be, or have to be, considered. How the identified and designed measures might be implemented in the catchment is not known. At least there has to be an exchange of information and planning proposals on the level of river basins.

Within the Norwegian approach the hazard related to new development areas have to be identified and if safety is not at an appropriate level, the area cannot be developed or protection measures must be installed (which are then more or less obligatory for land use planning). There is a clear coordination of activities on a higher level by the national authority NVE, so that catchment approaches are easier to realise. There are also legal instruments available for catchment based planning, but they are hardly used.

The most integrative aspect in Norway is that a geodata concept is developed and implemented so that an exchange of geodata e.g. with spatial planning is easy to handle. All approaches have in common that data, models, and economic data are required for flood risk analysis and flood risk mapping. The crucial instruments for implementation of measures are instruments of spatial and land use planning such as regional development plans. Therefore, close coordination between flood management and spatial planning is essential.

However, to not only prevent a decrease of flood plain areas but to increase the retention potential by giving the rivers more space a close link and cooperation with nature conservation is crucial to realise. Nature conservation and landscape planning provides a broad range for "pro-active" and sustainable management of floodplain to reduce flood risk.

Table 3: Comparison of different flood risk management instruments in Norway, England/Wales and Germany (Evers und Gusky 2005).

Category	**Norway**	**England and Wales**	**Germany**
Responsibility for flood risk management instrument	Norwegian Directorate for Water and Energy (NVE)	Environment Agency (EA) Policy guidance (national level) PPG 25	Federal Ministry (adoption: national level, implementation: Laender Level)
Sphere of action Implementation	one guideline for all municipalities	SFRA for every local planning authority (LPA)	Law for all relevant levels, development of plans for rivers with high risk of flood
Classification of risks	3 land use and building categories	3 zones of risk (high risk area again differentiated into 3 further levels)	flood risk areas (100-year flood) and potential flood risk areas/flood prone areas
Consideration of flood risk issues in land use planning	flood risk issues are taken into account in municipal master-, zoning- and building development plans	LPAs should take account of resulting level of actual risk in drawing up development plans	flood risk areas have to be registered in land use plans, building development plans
Some key characteristics	- Same guideline for all, but not legally binding - Are revised after some years of implementation - Consideration of different flood risk/vulnerability levels - Technical standards for inundation maps are existent - Geodata concept is developed - Support for LAs by NVE - No pro-active support of flood plain management and restoration	- One generic approach SFRA - Adaptable to regional/local situation - General flood information maps provided by EA - Detailed maps only for high risk areas - Consider different flood risk/vulnerability levels - Standards for inundation maps - Geodata management and info are provided by EA - pro-active support of	- One act for all but regional implementation in the Laender (legally binding) - Strict restrictions for development in floodplains - Consideration of potential flood areas/defended areas - No differentiation of vulnerability - No data/information support for implementing authorities - No geodata concept - No standards for inunda-

		flood plain management and restoration is possible but not required	tion maps (orientation 'Laender-wise') - pro-active support of flood plain management and restoration is possible but not required

3 European Directive on Flood Risk Management

On the European level several activities were started to reduce the risk of flooding. The most important piece of recent legislations that affects the restoration and conservation of floodplains is the European Water Framework Directive (WFD) (adopted in 2000) which influences flood plain management since hydromorphology has to be considered and in case of bad condition to be improves along rivers and in flood plains to meet the good ecological status. The second even more important instrument is the Directive on the assessment and management of floods which was adopted in 2007. This legal framework will be adapted to the WFD structures and timelines. With the Floods Directive a three-stage process is proposed:

1. preliminary flood risk assessment
2. the development of flood hazard maps and flood risk maps and finally
3. flood risk management plans which should include inter alia protection measures such as restoring flood plains and wetlands.

The WFD does not include explicit flood risk management aspects; thus, the necessity for such requirements has been evident for several years. Subsequently the European Commission proposed a Directive on the assessment and management of floods. Its aim is …

> *…' to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community'* (EC 2007, Article 2).

The central characteristics of this Directive are, first of all, a transboundary approach and secondly flood management on a river basin scale and thirdly an integration of other developments in the catchment in relation to flood risk and its assessment with regard to the potentials of reduction. The drafted Directive has to be seen in close connection with the WFD (ibid).

Under the Directive member states would first have to carry out a preliminary assessment to classify and identify the river basins and associated coastal areas at significant risk of flooding (Article 4). For such zones they would then need to draw up flood maps and flood risk maps (Article 6). The flood maps shall show flooded area subject to high flood probability, medium probability (100- year flood or larger) and a flood with low probability or extreme event. Given the fact that they are produced for 3 floods, one might say it leads to at least 3 flood risk classes.

Even more interesting from a point of view for sustainable flood plain management is the need for flood risk management plans (Article 7) as an important instrument for integrative flood (and river basin) management. It is required that a flood risk management plan at the level of river basin district or sub-river basin has to be developed which should address all phases of the flood management cycle focusing on prevention, protection and preparedness. For the preliminary flood risk assessment and as a preparation for the flood risk management plan, it was stated that for all catchments the land use plans and development plans have to be examined for their impact on future flood risk in an upstream/downstream context.

The Floods Directive provides an instrument which can not only react to other development planning purposes, but other planning purposes must also be integrated and coordinated on the catchment scale. Relevant aspects of cost and benefits (which are not explained), spatial planning, and agriculture and nature conservation have to be included. It should be easy to realise pro-active coordination and collaboration with other planning and working areas.

With limitations this applies to both the WFD and the FD, but perhaps necessary to limit this to water-relevant issues. In such a context the WFD/ FD relation is an example of the integration of environmental and risk related issues. The FD makes coordination between different water related policies within catchments mandatory, but what measures to implement to reduce risk is basically left with the nations/ regions in question.)

A difficult point is that the timescale with the WFD action programmes can not truly be coordinated because in the current period WFD measures have to be set up and appointed by 2009. The environmental objectives have to be met in 2015, when the flood risk management plan has only to be designed but not yet implemented. However, in the second round this can be realised. The Floods Directive says nothing about when the flood risk management plan has to be implemented. Only the terms of controlling the plans are mentioned (Article 14).

4 Other Planning and implementation instruments

Instruments of spatial planning and land use planning

In Europe, spatial and land use development is normally controlled by spatial planning and development plans which are organised on different levels of detail (e.g. national level or state/Laender-level and local level of municipalities). The influence of spatial planning on river basins and flood plains is manifold. Spatial planning can influence the degree of sealing, which has consequences for water quality and quantity. It can reduce pressure on floodplains and riverine areas or river or lake shores because of development restrictions. It can also (partly) influence the type of land use (e.g. main precedence areas for nature conservation, flood protection, re-creation of retention area, forestry).

Many people want to live by rivers and to account for changing demographics, space is required to build houses. A crucial aspect in spatial planning is to derive a balance between the restrictions of flood risk areas and flood-adapted constructions.

Spatial planning has to be considered as preventive planning. In general, management with realisation of tangible measures like restoration of rivers or desealing of district and actions is not possible with the instrument of spatial planning. This is somewhat different with sectoral planning instruments.

Sectoral planning/Environmental impact assessment (EIA)

Almost all biotope types of floodplains are protected by laws like the European Natura 2000 Directive and national laws like the Federal Nature Conservation Act (BNatSchG) in Germany. Some are additionally Ramsar Sites registered in the list of international important wetlands. What is missing is a comprehensive and mid- or long-term strategy for sustainable protection and development. This is also required by the strategy plan of Ramsar. All these jurisdictions are not really conflictive, but the interlinkages can be considered as poor. It should be taken into account that there is some overlap in the legal foundations for every work area. There are global frameworks such as conventions, European frameworks such as directives, national laws, regional and local laws and regulations. The overlapping does not inevitably create problems but makes coordination complicated and time-consuming.

Sectoral planning, such as landscape planning, could support the targets of flood plain restoration by assessments and developing measures. Information which is included in landscape plans can be used for management plans and programmes of measures and the scale and the contents are adequate for its integration. For instance, assessment instruments of urban or landscape planning can support the protection of special areas for specific land use purposes and the controlling of land use. This can be used

for protection of flood prone areas or for restoration of rivers or lakes e.g. in the context of arial pools. Landscape planning can contribute via instruments of protection of undeveloped space, development goals or the direct establishment of nature protection zones (as in independent landscape planning) or as primary or secondary integration into the spatial planning process. Compensation measures, identified by Environmental Impact Assessment) can be earmarked or pooled for e.g. river restoration or floodplain restoration projects.

Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is a system of incorporating environmental considerations into policies, plans and programmes. It is sometimes referred to as Strategic Environmental Impact Assessment. SEA is a legally enforced assessment procedure required by Directive 2001/42/EC (known as the SEA Directive) (EC 2001). The SEA Directive aims at introducing a systematic assessment of the environmental effects of strategic land use-related plans and programmes. It typically applies to regional and local development, waste and transport plans within the European Union. Some plans, such as finance and budget plans or civil defence plans are exempt from the SEA Directive, it also only applies to plans that are required by law, which interestingly excludes national government's plans and programmes, as their plans are 'voluntary', whereas local and regional governments are usually required to prepare theirs. This EU Directive also includes other impacts besides the environmental, such as material assets and archaeological sites. In most western European states this has been broadened further to include economic and social aspects of sustainability. SEA should ensure that plans and programmes take into consideration the environmental effects they cause. If these environmental effects are part of the overall decision making, the process is known as *Strategic Impact Assessment*. This instrument can play an interesting role for sustainable development and also for sustainable flood plain management due to the pro-active management character since a lot of aspects can be integrated in planning processes beforehand.

5 Summary

It became clear in this paper that a close link and connectivity between land use planning and flood risk management is crucial for a sustainable flood plain management in order to reduce flood risk. A coherent approach of spatial planning instruments on the one hand and water management on the other hand is mandatory. The different characters and pros and cons of different approaches towards a consistent development and land use planning are discussed in the paper. There is a remarkable variety of instruments with regard to flood risk management in Europe. The majority of instruments concentrate first of all on the preservation of flood plains by land use planning and related planning instruments such as guidelines or assessments. Instruments which might also have a relevant positive impact on the retention potential and the increase of flood plain areas are, however, singular. For this approach a pro-active management which includes land use planning, nature conservation, agriculture and other issues have to be realised on a catchment level. This is intended to be realised with the European Directive on Flood Risk Management and also with the German Flood Control Act. There is a significant potential for coherent and coordinated approaches for sustainable flood plain management in order to reduce flood risk. However, the level of obligation in both mentioned legal regulations is not very strict. An evaluation of these instruments was not yet possible since the implementation has still to be started or has only started recently. Future will show how effective these instruments will improve the flood risk situation by non-structural measures in the flood plains in Europe.

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