Strategic Alliance for integrated Water management Actions

Adaptive Flood Risk Management Planning

Experience from the SAWA Pilot Regions

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Adaptive Flood Risk Management Planning: Experience from the SAWA Pilot regions

A report of Working Group 1 – Adaptive flood risk management
SAWA Interreg IVB Project

Adaptive Flood Risk Management Planning: Experience from the SAWA Pilot regions

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Cover photo: Flood Risk Management Planning in the Wandse Catchment, Hamburg
Photo: TUHH

Summary: This report presents methods for flood risk mapping and flood risk management planning in the sense of the EU Flood Directive (2007/60/EC) in the SAWA pilot regions. The main methods for flood hazard and risk mapping are outlined. For the flood risk management planning the SAWA approach has been introduced. 6 FRMPs and a RBMP have been developed in the partner countries utilising different strategies for stakeholder involvement, depending on the local contexts and methods and tools available. The results are discussed and the recommendations for future work outlined.

Key words: Flood Directive, flood risk mapping, flood risk management plan (FRMP), stakeholder involvement

March 2012

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List of Abbreviations

2000/60/EC	Water Framework Directive
2007/60/EC	Flood Directive
CBA	Cost Benefit Analysis
DTM	Digital Terrain Model
FD	Flood Directive
FPRM	Flood Probability Reduction Measures
FReM	Flood resilience Measures
FRMP	Flood Risk Management Plan
LAA	Learning& Action Alliance
MCA	Multi Criteria Analysis
NSM	Non-Structural Measures
PRA	Preliminary Risk Assessment
WFD	Water Framework Directive

Abstract

The Flood Directive (2007/60/EC) sets clear requirements to the member states regarding flood risk management. It defines steps and actions to be taken in order to shift from mere flood control towards flood risk management. Preliminary flood risk assessment, flood risk maps and flood risk management plans become the key instruments to be implemented for the identified coastal areas or individual river basins (Article (3b)). The implementation of 2007/60/EC, however, faces a number of challenges mostly related to the scarce information contained in 2007/60/EC on which methods and tools to apply in order to fulfil those requirements as well as due to the necessity to coordinate its implementation with the other directives and planning activities, the most significant being the Water Framework Directive (WFD- 2000/60/EC). Integrated strategies are needed to support sound implementation of those two directives in an efficient and effective way and enable involvement of all relevant stakeholders.

Within the EU INTERREG IVb Project SAWA the potential synergies between the two Directives have been explored and the requirements for their coordinated implementation analysed and outlined.

The potential to consider the drivers of future development such as climate change when implementing Flood Directive have been discussed. The aspects of the implementation of 2007/60/EC in the SAWA countries have been presented and analysed within the national contexts and their organisational and institutional structures.

Six Flood Risk Management Plans and one Integrative River Basin Management Plan have been developed during the course of the project in the SAWA partner countries. They are presented in their flood typology and specific flood problems they are addressing, governance strategy adopted for their development, tools and methods applied to assess the efficiency and effectiveness of the adopted measures as well as their contents and level of details.

The legacy of the established networks and alliances used for their development has been discussed.

Lessons learned and recommendations for future work have been outlined addressing the key players of the development and implementation of the flood risk management planning process being decision makers, practitioners/ consultants and research.

Executive Summary

Introduction

The Flood Directive 2007/60/EC sets clear requirements to the member states regarding flood risk management. It defines steps and actions to be taken in order to shift from mere flood control towards flood risk management. Preliminary flood risk assessment, flood risk maps and flood risk management plans become the key instruments to be implemented for the identified coastal areas or individual river basins (Article (3b)). The implementation of 2007/60/EC, however, faces a number of challenges mostly related to the scarce information contained in 2007/60/EC on which methods and tools to apply in order to fulfil those requirements as well as due to the necessity to coordinate its implementation with the other directives and planning activities, the most significant being the Water Framework Directive (WFD- 2000/60/EC). Integrated strategies are needed to support sound implementation of those two directives in an efficient and effective way and enable involvement of all relevant stakeholders.

SAWA has identified the need to link the WFD (2000/60/EC) with the upcoming FD (2007/60/EC).

Thus we have to identify and establish a Strategic Alliance among beneficial partners and fruitful measures to generate sustainable integrated water management actions.

Preliminary Flood Risk Assessment and Flood Risk Mapping

When making the preliminary assessment of flood risk, factors such as experiences from historical events, foreseen impacts of climate change and foreseen social consequences from a flooding should be taken into consideration. The strategy of the different north European countries differs quite a lot due to their very different conditions.

Flood hazard maps and flood risk maps should be produced for the areas that are identified as particularly vulnerable. For all river basins, sub-basins and coastal reaches, flood risk has to be assessed and documented in ***hazard and flood risk maps*** (article 6 (1)). The basis for the assessment will be floods with a high probability of return, a medium probability of return and with a low probability. The consequences of the flood have to be indicated by the number of inhabitants potentially affected, the potential economic damage in the area, the potential damage to the environment, and the technical installations with the potential of pollution and major-accident hazards. The maps should determine specific points with higher flood risk, which have to be taken into account in land use planning. Although 2007/60/EC defines the flood maps as a key instrument, it delivers little or no information about the level of detail, demanding only the "the most appropriate scale for the areas" (article 4 (a)) or methodology to apply in order to derive flood risk maps. Whereby the choice of hydrological scenarios when producing flood and risk maps seems to be more or less comparable between the North European countries, there are considerable differences in strategies to include the aspect of climate change. In the SAWA-pilots only Norway and Sweden have taken climate change into consideration when producing flood and risk maps. The method used is called ensemble analysis, which means using the output of several different global climate models. The variation between the results gives a hint of the uncertainty in the results.

Flood Risk Management Planning

2007/60/EC specifies very clearly the structure and objectives of the flood risk management plan and the favourable measures to be taken for reducing the risk. However little information is given about the strategy to develop and implement this management plan on a local level. Obvious is the need for finding a strategy for stakeholder involvement that supports the planning process best and which will lead to acceptance and proper application of the new paradigm in flood risk management. A fundamental issue that is still to be resolved is how the necessary multi-stakeholder participation in the decision-making process can be carried out cost-effectively and in a timely manner so that the results are not only near optimal but also socially acceptable. The Flood Directive EC 2007/60 does not give any guidance in developing a good governance concept for the implementation of the flood risk management plan. It only requires the participation of the public (Article 10 (2)) in the development and implementation process. "Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans referred to in Chapter IV." Also, Article 10 (2) encourages seeking active involvement of stakeholders in the whole planning process.

Planning Strategies

Within SAWA different stakeholder involvement strategies have been applied in pilot regions. Despite of the initial intensive attempts to find one common strategy for all pilot regions, this approach has been reconsidered. Individual approached have been developed instead. The reason is seen in high diversity of the national contexts in terms of institutional responsibilities and structures, scale of the problem, available data and resources.

Six Flood Risk Management Plans and one river basin management plan (RBMP) have been developed by the partners for the SAWA pilot regions being Wandse River of the Alster catchment area in Hamburg, (urban area, GER), RBMP- River Illmenau in Lower-Saxony, (rural area GER), water systems of Lake Värnen/Göta älv for the cities of Lindköpig and Karlstad, (urban area SWE) River Gaula, (rural area NOR), River Tana, (rural area, NOR) and for the region Hunze en Aa's, (rural area, NL).

In these case studies the flood conditions vary considerably, ranging from pluvial/riverine floods in a small urban catchment (City of Hamburg, Germany), to lake floods affecting the urban environment (City of Karlstadt and Lidköping in Sweden) and riverine floods with land slides (municipality of Melhus/Norway). Riverine floods of predominantly rural areas are addressed in Germany (the ilmenau catchment) and in the Hunze en Aa's area. The experience of extreme floods and their consequences varies considerably. While in the cities of Karlstadt and Lidköping the impact of the recent floods of the lake Vänern is still present in the public awareness, the population in Hamburg did not face a flood hazard in the last decades but is concerned about the consequences of climate change. Great differences between the case study areas exist in the national legislation and in institutional organisation

and responsibilities. The city of Hamburg and the water boards have more sovereignty in water management. Countries like Norway are much more centralised, hampering the flexibility in the development of a FRMP.
All SAWA partners but the Dutch were developing FRMPs during the course of SAWA. The Dutch partners had already set up flood risk management plans but in the context of national water laws. Their interest has been more in finding efficient ways to adapt these plans to the needs of the 2007/60/EC.
It has been assessed that the coordinated activities and contributions of responsible authority, research and consultancy has been crucial for successful design and conduction of the planning process.

Flood risk Management Plans (FRMPs)

The final products of the planning process- FRMP compose of a table with the adopted measures, their short description and the responsibilities and a map indicating the location of the measures to be implemented. FRMP- Wandse, Germany has been structured according to the national LAWA, 2010 guidelines. All plans but the Dutch have a pilot character and will serve as a good practice document on the national level for development of FRMPs. The Dutch plan has been included in the official policy plan “Waterbeheersplan 2010-15, which gives it a high legitimacy.
All established networks should continue their activities. In Sweden, the second part of the two step approach has been planed, extending the existing stakeholder group to additional players whose interests should be considered for the final plans (e.g. traffic and transportation agencies). The same is planned in Norway pilot regions. In Hamburg, the planning activates will be continues addressing the aspect of climate change but building upon the work performed within SAWA.

Lessons learned & Recommendations for Future Work

The lessons learned are related to the experience gained regarding the strategies for stakeholder involvement, process design, methods, tools and resources applied to assess the efficiency and effectiveness of the measures adopted as well as the content of the final FRMP.

It has been assessed as inappropriate to use a common approach for the development of FRMP across Europe due to variety of flood typologies as well as national contexts. Flood risk management planning should be understood as a process and enough time should be allocated for it, involving all key stakeholders.
The quantification of the effect of the adopted measures plays an important role and should be included in the planning process employing the corresponding decision support systems. It also implies the RBMP measures adopted according to 2000/60/EC. Capacity building should accompany the planning process empowering the key stakeholders to make decisions on the adaptive strategies to be adopted. It has been assessed as non-applicable to standardise tools and methods due to differences in the existing experiences and expertise, data availability as well as specific flood problems. Attention should be put to better data management and harmonisation of standards for their cross border management.

The final FRMP should be concise and as specific as possible. Tables containing the list of adopted measures with short descriptions have been assessed as most useful.

Based on the experience gained within SAWA, the main challenges for future activities addressing responsible authorities, research and consultancy are seen as follows:

Responsible Authority (Decision Makers)

- Better integration of the planning activities on a local scale into flood risk management planning on larger scales.
- Providence and management of good quality data (including optimisation of the cross border data) as well as flood hazard and risk maps for reliable FRMP
- Openness to integrate the aspect of climate change

Research

- The governance methods that consider local scale planning into the planning at the larger scales are still matter of research
- The methods to integrate the climate change aspect in the plans
- Further development of the decision support tools in terms of:
    - Improvements of the physical models of the processes described
    - More user friendly of the interfaces and tools in general (easier to use, less time intensive)
    - Methods for capacity building and raising risk awareness
- Appropriate evaluation methods

Consultancy

- Acceptance and utilisation of new tools and methods, mainly DSS or mathematical models mostly related to the efficiency and effectiveness assessment of the planning options suggested

1. Introduction

The SAWA project was launched 1 August 2008, and is part of the INTERREG IVB North Sea Region Programme. Five riparian North Sea Regions have entered this strategic alliance. The regions represent: Germany, The Netherlands, Norway, UK and Sweden. Together the five regions have 22 partners working within the project. The project has a duration time of three years starting in August 2008 and finishing (with an extension) in summer 2012.

1.1 Background

There are three major driving forces, which make regions attractive for people to live, work and invest in. It is a well-balanced combination of thriving local economies, a healthy natural environment and self-sustaining well-established social communities. Over the past decades the North Sea region has been successful in building a prospering setting for this. Nevertheless current threats like depopulation, ageing societies, unemployment, urban and rural inequalities, social segregation, environmental pollution and finally climate change are endangering this complex system. We need innovative strategies and business solutions in the North Sea region to cope with and mitigate or neutralize their negative effects.

One of the major global challenges in this century is without a doubt climate change. The question is not if climate change will take place but rather to what extent it will influence society. The impact of the expected changes is manifold.

The Stern Review (Stern, 2006) was an attempt to address all the issues in terms of future investments real costs. The review states that the increased costs of damage from extreme weather (storms, hurricanes, typhoons, floods, droughts and heat waves) counteract some early benefits of climate change and will rise rapidly at higher temperatures. Based on simple extra-polation, costs of extreme weather alone could reach 0.5 - 1% of world GDP per annum by the middle of the century, and will keep growing if the globe continues to heat up. This leads to the conclusion that the global and regional markets have to withstand a rising economic pressure in the years to come. This prediction is confirmed in the released 4th Assessment Report conducted by the International Panel for Climate Change (M.L. Parry, 2007). The report indicates an extension of intensity and frequency for heavy rains, which leads to higher flood risk in fluvial regions. Also coastal regions are expected to experience a higher flood risk due to sea level rise and the increased frequency of heavy storms. This makes it very clear that societies need to develop long-term strategies to overcome this global challenge.

1.2 Framework for European Actions

Large parts of the North Sea Region are low-lying areas. In many of them the risk of fluvial and pluvial flooding caused by more frequent heavy rainfall is putting high pressure onto regional decision makers and stakeholders. To cope with the impacts from flooding due to climate change we need a strategic alliance of various actors and factors. One of them is water management. On the European level, water policy has been strengthened by the adopted Flood Directive (FD- 2007/60/EC) (European Parliament, Council, 2007).

Its aim is to reduce and manage the risks floods pose to human health, the environment, cultural heritage and economic activity. The Directive requires member states to first carry out a preliminary assessment by 2011 to identify the river basins and associated coastal areas at risk of flooding

For such zones they would then need to draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015. The Directive applies to inland waters as well as all coastal waters across the whole territory of the EU.

It demands an integrated flood risk management on a river basin level with a close link to the Water Framework Directive (WFD- 2000/60/EC) (European Parliament, Council, 2000). The implementation bares great challenges for all, especially knowing the differences in legal, institutional and societal conditions in the member states. Both directives claim an integrated water management approach.

The Flood Risk Management Plans shall be coordinated with the Water Framework Directive River Basin Management Plans (for which the second cycle plans are also due in 2015), and they shall include the flood related measures taken in other legislation. There are a number of 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.

1.3 Scope of the project

SAWA has identified the need to link the existing WFD (2000/60/EC) with the upcoming FD (2007/60/EC). Since each Euro can only be spent once, administrations must optimise their investment to improve water quantity and quality control at the same time. We need to minimize possible economical and ecological impacts due to the legal appointment of flood hazard zones and their level of risk to local business, especially to small and medium size enterprises (SME) and the local community.

Thus a Strategic Alliance among beneficial partner has to be identified and established and fruitful measures to generate sustainable integrated Water Management Actions.

A solid communication and information strategy has to be developed to transmit this new situation properly. This may range from short-term information to active participation in the decision process up to long-term awareness building with a well understood action plan for all affected people and businesses in these risky zones. Set up upon the findings in the INTERREG IIIB projects FLOWS, FLOODSCAPE, FLOOD-SITE, ELLA etc. on how to communicate flood risk in a better way, SAWA wants to build up a North Sea Region network for communicating flood related issues. This will help to give the North Sea Region a common voice and to learn and improve the national communication strategies and public involvement on climate change and flood risk issues.

1.4 General aims and objectives

There is little experience for public authorities to go with on how to apply the new FD in their countries.

Five European countries elaborated recommendations on the most appropriate planning strategy and its problems and advantages during implementation. The SAWA project delivered several pilot Flood Risk Management Plans, which show possible implementation strategies for European countries and prepare local markets for future investments and innovative business ideas to adapt to future flood hazards (e.g. floating homes, retrofitting measures, etc.), including a best practice guideline for integrated water resource management based on experiences in pilot areas (as a part of a book or handout). A various number of DSS-tools have been developed and tested and are finally available as guidance tools in the Flood risk management planning cycle.

The following questions were addressed on a transnational and regional level:

- Who are the strategic partners for the different required actions in a river basin?
- How can the FD and WFD measures be combined and produce synergies?
- What is the best method to define flood areas?
- What does a Flood Risk Management Plan (FRMP) look like and what are the strategies to establish it?
- How can the FRMP be implemented and communicated to the different target groups (politicians, educational institutions, businesses)? Which strategic alliance might be helpful?
- How can we make use of spatial planning and land management for risk reduction on the regional and local level?
- How can we change the paradigm from “Fighting against Floods” to “Living with Floods”?
- What is the societal impact of flooding in low land areas in the light of climate change?
- How can we speak to an "event and action driven" generation to make them sensitive for flood and water management issues?

1.5 Work-Packages structure

Three key areas have been identified in SAWA where water management can be improved supporting a sustainable regional development.

1. *Adaptive Flood Risk Management Plans – FRMPs*

   Integrating the two aspects of flood risks and water quality in one plan creates significant conflicts, but also significant benefits. How can local decision making be an integral part of catchment based planning applying the concept of adaptive FRMPs?

2. *Local Scale Adaptive Measures*

The last decade has illustrated that catchment scale flood defence measures can often be inefficient and un-sustainable. How can measures be more locally adaptive without losing effectiveness on the river basin level?

3. *Capacity building and Education*

Institutional advancement, human resources development and knowledge enhancement for flood risk management are main pillars for implementing an adaptive management structure in any river basin. How must education and communication be improved to optimally integrate stakeholders on all levels?

1.6 SAWA Flood Risk Management Planning (Work package 1)

The work related to flood risk management planning has been performed within Work Package 1. Two main objectives are followed in WP1. These are:

- To improve, facilitate and accelerate the implementation of the new flood directive (2007/60/EC) by developing a planning and implementation strategy based on experience from a number of cases in the North Sea Region (NSR).
- To work out a decision strategy on how to use and prioritize new adaptive measures in FRMPs closely coordinated with the Water Framework Directive (WDF) implementation process to show synergetic potentials.

As a result, Flood Risk Management Plans in the sense of 2007/60/EC have been developed for the following SAWA pilot regions:

- ➢ FRMP Wandse, catchment of River Alster in Hamburg, GER; urban area
- ➢ RBMP catchment of River Illmenau in Lower-Saxony, GER; rural area
- ➢ FRMP water systems of Lake Värnen/Göta älv for the cities of Lindköpig and Karlstad, SWE; urban area
- ➢ FRMP catchment of River Gaula, NOR; rural area
- ➢ FRMP catchment of River Tana, NOR; rural area
- ➢ FRMP region Hunze en Aa’s, NL; rural area

1.7 Guidance to the Reader

This report delivers the results and experience of the three-year work on the development of FRMPs in the SAWA pilot regions. It targets all parties involved in the design and conduction of the flood risk management planning process, being mostly the responsible authorities together with the decision makers, research institutions and consultants.

The overall structure of the report follows the requirements set by 2007/60/EC addressing the preliminary risk assessment (PRA), flood risk mapping and flood risk management planning (FRMP) whereby the focus is put to the planning process.

The contents are given as the following:

Chapter 2 outlines the working approaches in PRA and flood risk mapping in the SAWA countries. The current practices in the partner countries to deal with the uncertainties due to climate change are given.

Chapter 3 introduces the SAWA methodology for the development of FRMPs. The requisites for flood risk management planning together with the national contexts in terms of legal and institutional conditions are analysed

Chapter 4 presents the applied strategies for flood risk management planning and the final results- flood risk management plans. The applied methods and tools in the corresponding pilot regions are given.

Chapter 5 is devoted to the discussion of the experiences and results as well as outlining the lessons learned. Recommendations for future work are given.

This report relates to the outcomes of the other work packages (WP2- Adaptive Measures) and WP3 (Capacity Building) as well as the key issues defined within SAWA being climate change (WP1) and decision support tools (WP1). They are given in separate reports or published within Water Wiki platform (as a part of WP2).

In the report from Lawrence D., Graham Ph., Van den Besten J (2012) "*Climate change impacts and uncertainties in flood risk management: Examples from the North Sea Region"* a thorough analysis on the climate change projections in the partner countries has been presented and current practices have been outlined in its dissemination.

Evers M, Nyberg L (2011) analysed the similarities and dissimilarities of the 2000/60/EC and 2007/60/EC as a part of the SAWA project and the methodology and the main outcomes can be found in the publication: Evers M, Nyberg L (2011): "*Coordination of the Water Framework and the Floods Directives – why a coherent approach is not that simple",* Journal for Water Resources Management

In WP1 several very different DSS-tools have been developed. All DSS-tools are made accessible for the public via Water-Wiki –Database and described in more detail in a separate report Daal D et al. "SAWA Decision Support Systems". DSS-tools developed or applied within SAWA are: Kalypso Planer Client, FLORETO, DSS-High Water, decentralized DSS, 3Di, MDST, Game Theory approach, SFRB. They will be related to the corresponding pilot regions in chapter 4 and summarised in appendix C (Table 5).

2 How to come to a Flood Risk Map

2.1 Summary

The Flood directive (FD- 2007/60/EC) states that every European country should make a preliminary assessment of flood risk to identify the most vulnerable areas due to flooding. When making the preliminary assessment of flood risk factors such as experiences from historical events, foreseen impacts of climate change and foreseen social consequences from a flooding should be taken into consideration. The strategy of the different northern European countries differs quite a lot due to their very different conditions. In the Netherlands, for example, almost every inch of the country is well known and the whole country is densely populated, and therefore the Netherlands has decided to omit the first step in the 2007/60/EC and put their efforts into producing risk management plans. On the other extreme there are Norway and Sweden, which both are sparsely populated and with many rivers and lakes. The Scandinavian countries will most likely only point out very few areas as being in severe risk of flooding.
Flood hazard maps and flood risk maps should be produced for the areas that are identified as particularly vulnerable. The flood hazard map's purpose is to provide a rough picture of which areas will be covered by water under different hydrological conditions. The maps should also illustrate water depth and/or velocity in inundated areas. The risk maps aim to provide a rough picture of the social, economic and environmental impacts that can be foreseen as a result of flooding within an area. It is important to remember the limitations in the flood and risk maps. There are big uncertainties regarding, for example, how water is transported in pipe systems, which might lead to flooding in "safe" low land areas relatively far from the river/lake. It's also important to thoroughly describe the nature of the flood in a particular area in order get the full picture of the flood risks. The duration of a lake flooding is sometimes long and will most likely raise the ground water level considerably, especially in areas built on sand/gravel material. A high ground water level will create problems with technical systems underground long before the water reaches the surface. This might not be a difficulty in areas flooded by rivers that have a faster evolution. Due to these factors the presentation of flood and risk maps is important. The material should be sufficiently detailed so that different parts of the city and its features are easily identifiable, but, at the same time, not so detailed as to misrepresent the state of knowledge to the viewer.

The choice of hydrological scenarios when producing flood hazard and flood risk maps seems to be more or less comparable between the northern European countries Germany, Netherlands, Norway and Sweden. There are however differences in strategies as to whether or not climate change is considered. In the SAWA-pilots only Norway and Sweden have taken climate change into consideration when producing flood and risk maps. The method used is called ensemble analysis, which means using the output of several different global climate models. The variation between the results gives a hint of the uncertainty in the results. The method and results are thoroughly discussed in the SAWA-report Climate change impacts and uncertainties: Examples from Norway, Sweden and the Netherlands, published by NVE and SMHI.

2.2 Preliminary assessment of the flood risk

Article 4, paragraph 1[1] of the Floods Directive (FD) states: "Member States shall, for each river basin district, or unit of management referred to in Article 3(2)(b), or the portion of an international river basin district lying within their territory, undertake a preliminary flood risk assessment in accordance with paragraph 2 of this Article."

The purpose of the preliminary flood risk assessment is to get a good overview of within which areas the risks for and consequences of floods are the greatest within a country. The assessment should be based on information about historical events, predicted possible future events (information about changed conditions due to climate change is crucial) and the consequences' for population, economic activity and cultural heritage. Further analysis will be made within areas that are pointed out as particularly vulnerable.

2.2.1 Germany

The 2007/60/EC was transposed into national law by means of the amendment to the Federal Water Act of 31 May 2009 (WHG). The standard basis for conducting the preliminary assessment in Germany is the recommendation for the "Approach to be used in the preliminary assessment of flood risk under the European Floods Directive 2007/60/EC" (*Vorgehensweise bei der vorläufigen Bewertung des Hochwasserrisikos nach HWRM RL*) developed by LAWA (German Working Group of the Federal States on Water Issues – Bund/Länder Arbeitsgemeinschaft Wasser).

The main objective of this document is to show how the potential significant flood risk may be stated. According to the 2007/60/EC, criteria for human health, for the environment, for cultural heritage and for economic activities are mentioned and detailed. Other criteria are mentioned comprising the number of affected inhabitants, number of affected buildings, expected monetary damage (in Euro), inundation depth and flow velocity, significant infrastructure, already realised precaution measures against floods, existing precaution measures and damage prevented by those measures.

The preliminary flood risk assessment has not been addressed by SAWA, as the pilot areas were selected precisely on the basis of their well known risk.

2.2.2 The Netherlands

As all flood prone areas in the Netherlands are well known, this action would not generate any relevant new information. So it was decided in the Netherlands not to do a preliminary assessment of flood risks.

2.2.3 Norway

[1] Taken from Directive 2007/60/EC on the assessment and management of flood risks

Norway is a sparsely populated country with numerous river basins; the topography is mountainous.

The preliminary risk was in this case seen as an approximation to the potential maximum consequence of the worst-case scenario. A simplified GIS based method was chosen for the predictive modeling. The assessment was based on the assumption that the water level can be derived without use of detailed hydrological calculations. Hydrological data from more than 300 gauging stations and from more than 125 detailed flood map projects were the sources for a statistical analysis, in which the rise of water levels was correlated with discharge and catchment characteristics (size of the area). The method concluded that for catchments smaller than 1 km^2 the water level rises with approximately 2 m and with 8 meters for cathcment areas larger than 500 km^2. For the catchment in between, the water level rise was given as an equation:

$$dH = 0,965\ ln(Area) + 2$$

Within GIS the catchment areas for all raster cells in the Digital Terrain Model (DTM 25 * 25m) were calculated. All rivers and streams from the national river network database were therefore added to the DTM to create a hydraulically-corrected DTM. The statistical relation was then applied to calculate maximum water level rise for raster cells in the DTM that represent watercourses. To calculate the flood level the maximum water level rise was added to the water levels, these were simply derived from the DTM. For all catchments the flood level plain was calculated. For this cross sections were simulated by calculating a runoff pattern on a virtual terrain model based on the buffer distance along the river. The water levels were then applied to the cross sections and inundated areas were calculated by overlaying the flood level plane with the DTM and could be represented on a map as potential flood inundation areas.

Address points were acquired from Statistics Norway and combined with the potential flood inundation area map to estimate the number of residents living within the potential flood inundation area. The building database was combined with an estimate of how many people stay in the building and this was added to include other buildings where people could stay during the day. The results were scaled up, classified and aggregated in order to be more readable. In the figure below the potential flood areas are marked as grey shades, while the flood risk areas that could cause harm to human health can be seen as red, orange or yellow clusters.

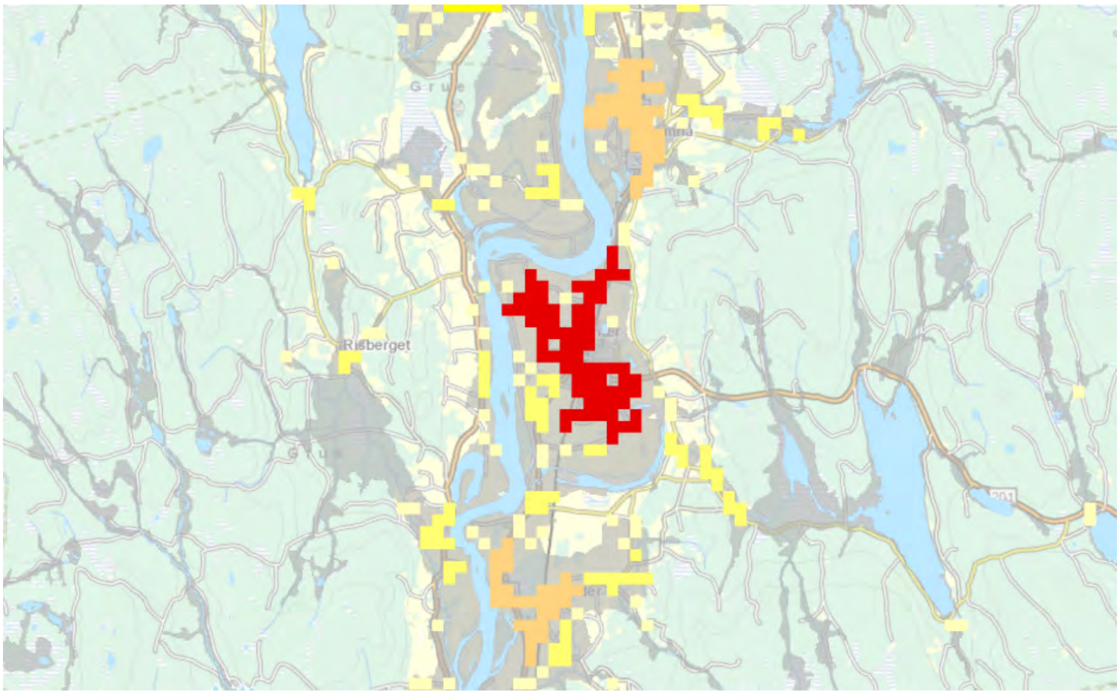


Figure 2-1 The map shows an example of how a risk area can be represented

For the economical aspect, the building database was combined with an estimate of the square meter value. An estimated value of roads and railways was also taken into this analysis.
The preliminary flood risk assessment is not completely finished, and it is recommended that the result from the GIS analysis are evaluated with respect to the uncertainty of the flood extent, the exactness of the building estimate and compared to historical floods.

2.2.4 Sweden

Sweden is, like Norway, a sparsely populated country with numerous river basins. However the landscape is more flat than in the neighbour country.

In Sweden the preliminary flood risk assessment is not completely finished but the overall idea is to mainly use information about historical events when deciding which areas are at risk. The Swedish Civil Contingency Agency (MSB) is in charge of implementing this part of the Flood Directive in Sweden. They have asked the County Administrative Boards to put together information about extraordinary flooding events (extraordinary event is defined as a particularly difficult situation that can not be handled with normal resources) at regional level and out of this material suggest which areas should be pointed out as particularly vulnerable. It's still not clear whether knowledge about climate change will be used in the assessment.

In Sweden this first step in the Floods Directive has not been addressed by SAWA, as the two pilot areas of Karlstad and Lidköping were selected precisely on the basis of their exposed location on the Vänern lake. Both towns also have major river estuaries, which can create problems during the autumn and spring floods. Most likely these areas will be among those vulnerable areas that will be pointed out in Sweden at latest in December 2011.

It should be mentioned that meanwhile some European countries published guidelines on Preliminary Flood Risk Assessment such as the one from the UK http://publications.environment-agency.gov.uk/PDF/GEHO1210BTGH-E-E.pdf or Sweden https://msb.se/Upload/Nyheter_press/Pressmeddelanden/Slutrapport_PFRA_MSB.pdf .

2.3 Maps of Flood Hazard Areas

Article 6[2] states:
"1. Member States shall, at the level of the river basin district, or unit of management referred to in Article 3(2)(b), prepare flood hazard maps and flood risk maps, at the most appropriate scale for the areas identified under Article 5(1).
2. The preparation of flood hazard maps and flood risk maps for areas identified under Article 5, which are shared with other Member States shall be subject to prior exchange of information between the Member States concerned.
3. Flood hazard maps shall cover the geographical areas, which could be flooded according to the following scenarios:
(a) floods with a low probability, or extreme event scenarios;
(b) floods with a medium probability (likely return period ≥ 100 years);
(c) floods with a high probability, where appropriate.
4. For each scenario referred to in paragraph 3 the following elements shall be shown:
(a) the flood extent;
(b) water depths or water level, as appropriate;
(c) where appropriate, the flow velocity or the relevant water flow."

2.3.1 Purpose of the flood hazard maps

The flood maps purpose is to provide a rough picture of which areas will be covered by water under different hydrological conditions. From these different analyses of flood impacts can be estimated. Another purpose is to provide information for flood risk management plans.

In the flood-affected areas, water depth or water velocity should be made clear. Different starting points can be chosen for the subdivision of depth intervals, depending on factors like geographical scale and use of the map. Below you will find two examples of flood hazard maps on different geographical scales. No flood hazard maps showing water velocity have been produced within SAWA.

2 Taken from Directive 2007/60/EC on the assessment and management of flood risks

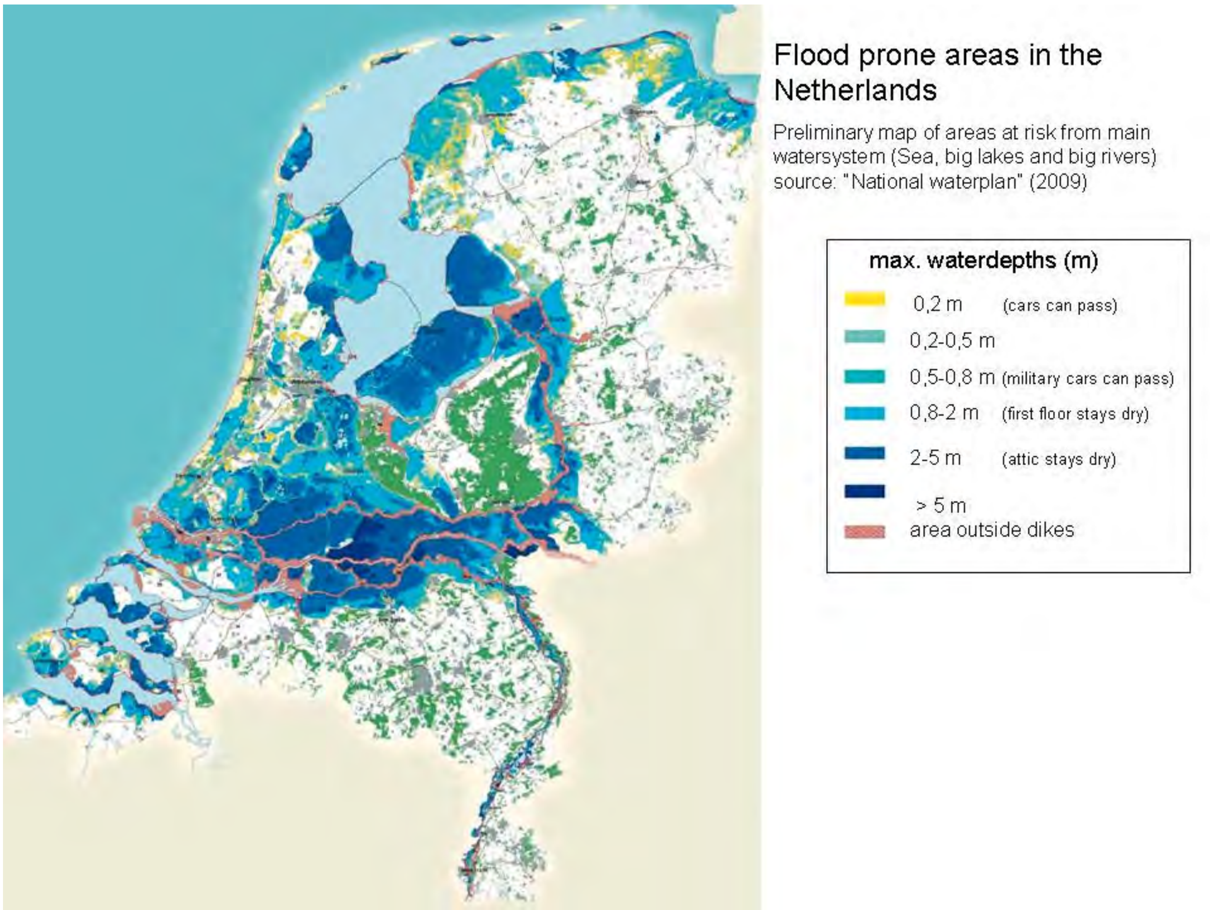


Figure 2-2The picture above shows flooded areas in different places in the Netherlands (regional scale) *Source: National waterplan 2009*

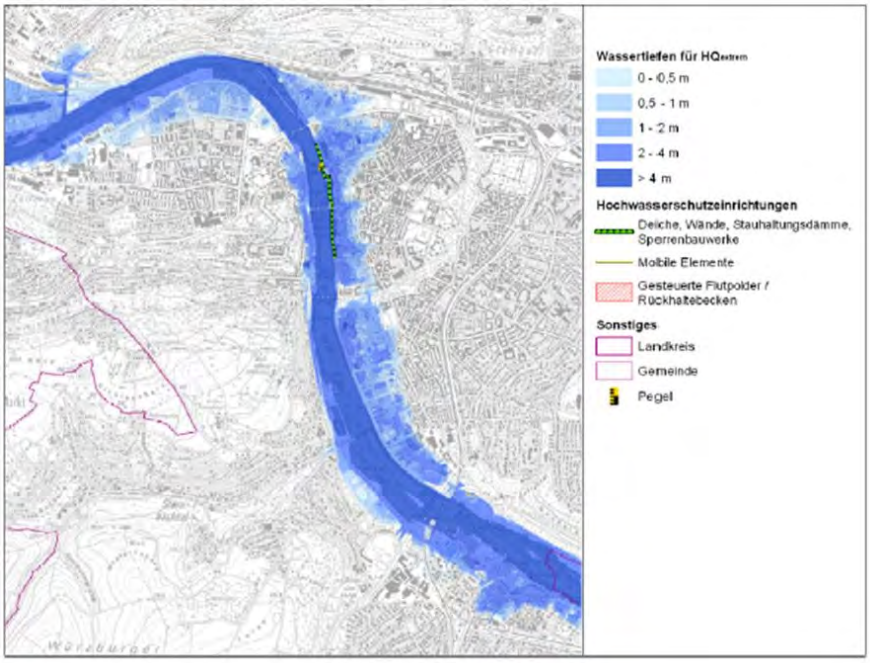


Figure 2-3 The picture above shows a schematic picture of a flood hazard map on a semi-local scale in a major town in Germany (Source: LAWA, 2010)

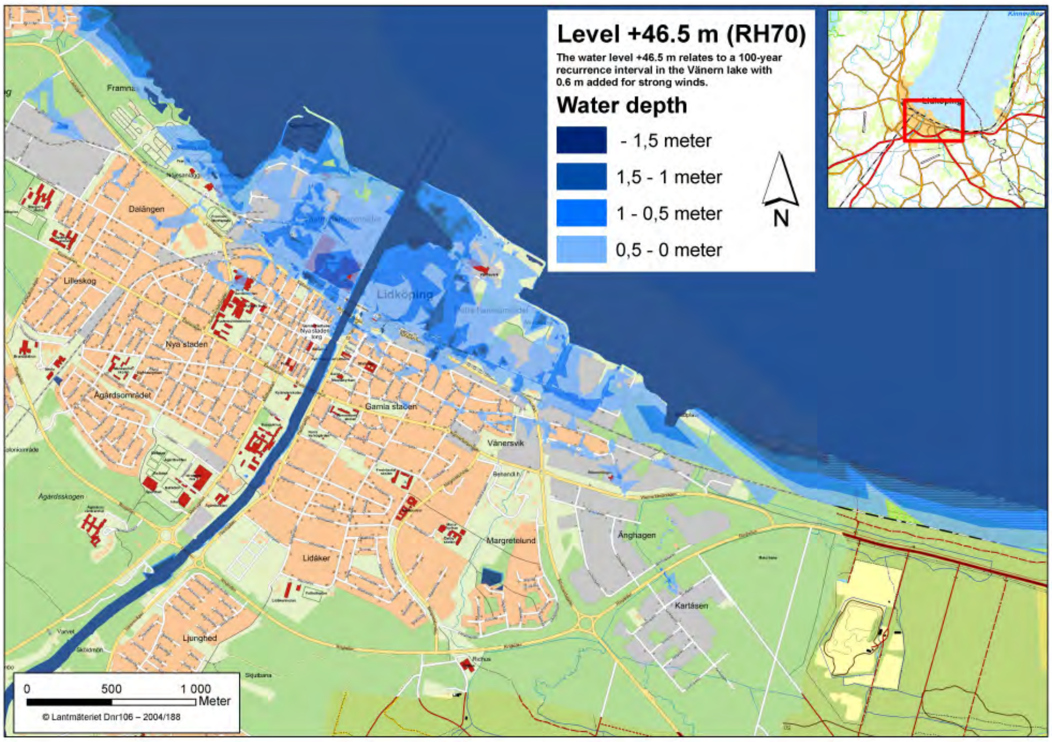


Figure 2-4 The picture above shows an example of a flood hazard map of flooded parts of central Lidkoping in Sweden, local level

2.3.2 Choice of hydrological scenarios

Point 3(b) of the 2007/60/EC text, quoted above, refers to a flood with an approximate recurrence interval of 100 years. However, there is no detailed guidance as to what "low" and "high" probability means in this context.

Which hydrological scenarios that are appropriate to choose for the flood hazard maps depend on factors such as type of water system to be mapped (river, lake or sea) and expected impacts from the flooding on people, economy and ecology.

Flooding by the sea, especially when arising from prolonged low pressure, can often be a very fast process. An extreme high tide usually only lasts a number of hours. Floods in river systems are also often relatively short events, lasting days or, at most, a few weeks. The rapid events mean that there is little room for manoeuvre in the implementation of damage prevention measures. Strongly flowing water can also cause erosion problems and is very damaging to structures including temporary barriers and dikes. Lake floods are a considerably slower process, especially when talking about the larger lakes. Lake Vänern in Sweden is extreme in this context because it is a large lake with a very large storage capacity, which means that floods will occur relatively infrequently. Once they occur, however, the floods last a long time since water loss from the lake is very limited and an extremely large amount must be lost for it to have an impact on the level of the lake. The slower process is a positive aspect, in that it provides plenty of time to implement damage prevention measures but, as flooding could be for a very long time (up to a year is possible), it would also impose other requirements. For example, it is likely that buildings and other structures, which are under water during winter would be subjected to ice loads.

2.3.3 Different approaches in Europe

The different situations in the European countries show that the tradition of how to choose hydrological scenarios varies a lot. In the Netherlands where a large part of the country is located under sea level, a rising sea level is the most important risk. The important dikes towards the sea will therefore be constructed to handle a worst-case scenario (a worst case scenario is equivalent to a return time of 10 000 including factors like a rising sea level due to climate change). Lower return times are used for the inner waterways.

It is important to remember in this context that the Dutch approach of handling risks regarding the dikes towards the sea is not really comparable to the work done in most European countries to prevent damages in cities due to natural flooding events. A breach of a dike at a vulnerable place in the Netherlands can have an explosive and devastating result since it will lead to flooding of densely populated areas located several meters below sea level. This scenario is more comparable to the disaster that would follow a break of a large hydropower dam that could wipe out a larger town within hours. Such dams are found both in Norway and Sweden. For the choice of hydrological scenarios in the context of the flood directive, where the purpose is more to achieve a sustainable spatial planning, the Dutch approach to inner water ways are more representative and comparable to the work in other countries.

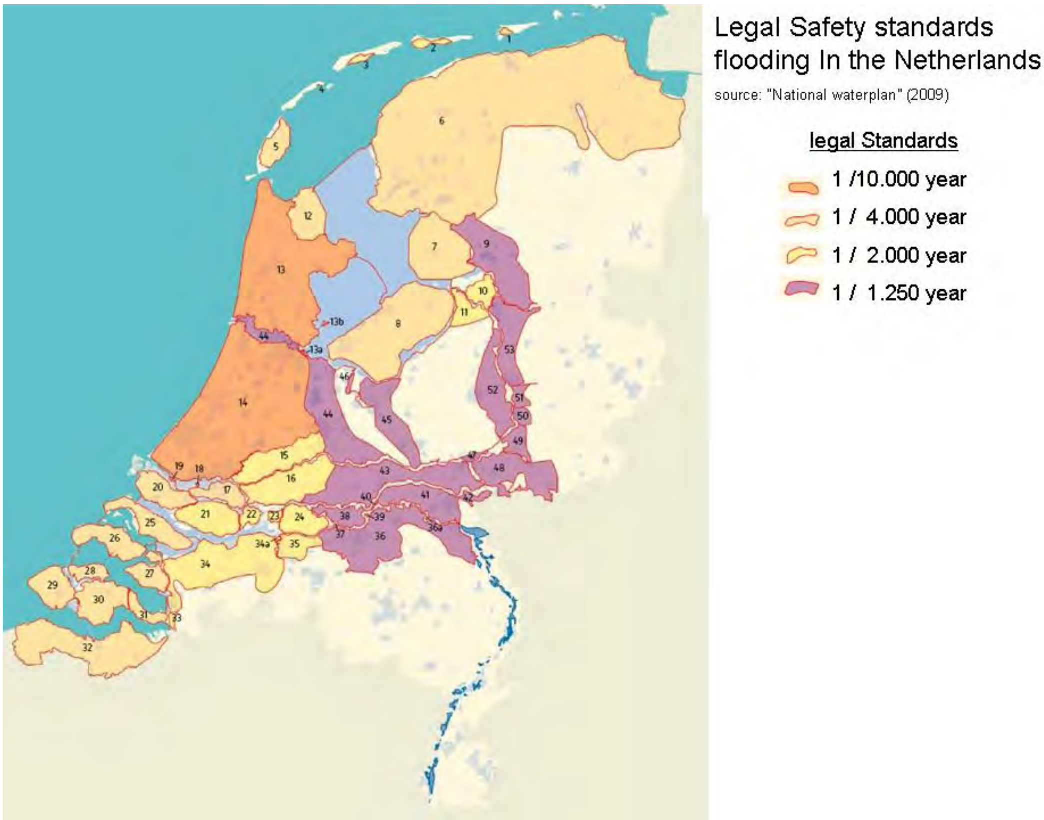


Figure 2-5 Safety standards in different parts of the Netherlands. Source: national water plan 2009

Germany has chosen a recurrence time of 200 years as the extreme event for working with their greatest threat, the rivers. Norway looks at three different recurrence times, 10, 100 and

1000 years not including an effect of climate change. In the Swedish pilots we have chosen two scenarios for Lake Vänern, a 100 years recurrence and a worst-case scenario including a factor for strong wind and a factor for climate change.

Overview

<u>Low probability scenario</u>

Germany
- Normally 1/200 years, in important inner cities areas 1/ 300 years

Netherlands
- 1/1000 years (1/500-1/1000) for low probability
- the most extreme flood possible >1/10.000

Norway
- 1/1000 years

Swedish pilots
- Lake Vänern, worst case > 1/10 000 years
- River Klarälven worst case >1/10 000 [1/200]

<u>Medium probability Scenario</u>

Germany
- Normally 1/100 years,
- 1/200 in important inner cities at highly sealed locations with rapid flooding

Netherlands
- 1/100 years (1/100-1/300)

Norway
- 1/100 years

Swedish pilots
- Lake Vänern 1/100 years
- River Klarälven 1/100 years

<u>High probability scenario:</u>

Germany
- 1/5 - /10 years, still not decided

Netherlands
- 1/ 10 years (1/10 – 1/50)

Norway
- 1/10 years

Swedish pilots
- Lake Vänern, not relevant
- River Klarälven 1/25 years

2.3.4 Hydrological methods to determine extreme floods

Hydrological models are often used for estimating the magnitude of river flows for extreme floods. The HBV hydrological model is typically used in Sweden and Norway. It is a rainfall-runoff model that includes conceptual numerical descriptions of hydrological processes at the catchment scale. HBV can be used as a semi-distributed model by dividing the catchment into sub basins. Each sub basin is then divided into zones according to altitude, lake area and vegetation. The model is normally run on daily values of rainfall and air temperature, and daily or monthly estimates of potential evaporation. Modelled river flows can then be statistically analysed to estimate extreme occurrences at certain return intervals (e.g. 10, 50 and 100-yr floods). Within Sweden, however, additional methods have been developed to estimate maximum probable floods. These are calculated for individual rivers based on a critical combination of unfavourable hydrological conditions, such as high snow build up, high precipitation, and saturated soil conditions. Traditionally, flooding problems in Sweden and Norway occur during springtime when snow is melting at the same time as precipitation is high and soils are saturated.

In the Netherlands different rainfall-runoff models are used to generate river flow. In the regions of the northeast Netherlands two different models are mainly used, Sacramento and SOBEK-RR. Both are cascading reservoir models; the first is a 'black box-model" with two to three reservoirs that have been calibrated for larger sub-catchments. The latter one uses also two to three reservoirs, but it makes calculations per type of land use in the catchment areas. So in principle the effect of land use change can be taken into account. That is not possible with the Sacramento model. In parts where the SOBEK-RR model is not yet well enough calibrated, the Sacramento model will be used when producing flood maps according to the flood directive. In normal basins standard rainfall events with a certain return interval are used to generate extreme flood events. Some basins discharge by spill sluices to the sea during low tide. In such basins strong wind events of a certain direction hamper the discharge capacity. In these cases stochastic methods are used to determine the return period of a flood event as it depends on a combination of return periods of the wind and the rainfall events.

In the Swedish SAWA pilots, the changing climate has also been taken into account using estimates based on different scenarios of world development and the concentration of CO_2 in the atmosphere over the coming century. These were used to run global climate models and regional climate models that represent Europe in more detail. A number of climate model results were used as input into hydrological models for developing scenarios for the future. An example of how estimated future inflows to Lake Vänern in Sweden will affect lake levels is shown in the figure below. Translating results from global climate models into regional hydrological applications was further developed by SMHI and NVE within SAWA, and more detail is presented in a separate report.

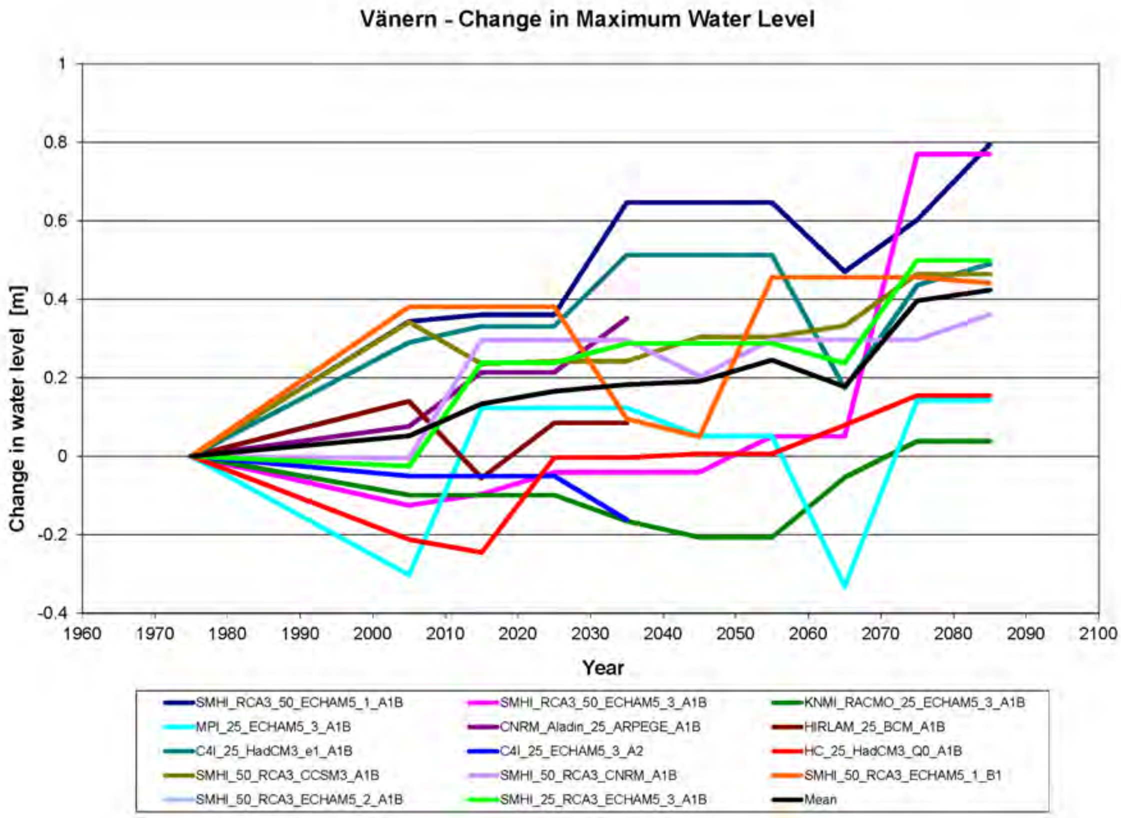


Figure 2-6The changes in maximum water level in Lake Vänern depending on input from different global climate models.

2.3.5 Hydraulic methods to determine inundation and extent of floods

Hydraulic models are used to estimate water levels and the extent of flooding from extreme hydrological conditions. They often use results from hydrological models as input. Two hydraulic modelling systems are widely used in Europe, HEC-RAS and MIKE. Additionally an open source modelling platform Kalypso has been used in some Germany states (including Hamburg) and considered for this analysis. The HEC-RAS (http://www.hec.usace.army.mil/software/hec-ras/) modelling system enables one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modelling. The software was developed by the US Army corps of engineers and is free to download and use.

An open source modelling platform Kalypso (http://sourceforge.net/projects/kalypso/) has been developed in a collaboration between Hamburg University of Technology (TUHH) and the company Björnsen Consulting Engineers (BCE) to offer the whole process chain of Risk modelling, i. e. hydrological, hydrodynamic and risk modelling (Schrage et al., 2009).

MIKE is a similar product developed by DHI (http://www.mikebydhi.com/) in Denmark. MIKE 11 and 12 are, unlike HEC-RAS and Kalypso, not free of charge, but they have the advantage of having a good support section at DHI that can help out when there are errors in a model. This makes the product still competitive. Within the SAWA countries, these three modelling systems are used by Germany, Norway and Sweden. The Netherlands, however, use their own model called SOBEK. The SOBEK modelling system (http://sobek-re.deltares.nl/index.php?option=com_content&task=blogcategory&id=13&Itemid=26) is module based. The quantitative modules allow both one and two-dimensional calculations of non steady flow where one-dimensional calculations are done in canals and rivers and two-dimensional calculations are done for estimating overland flow. Separate modules are available for sediment transport and water quality.

2.4 Development of Flood Risk Maps

Article 6, § 5 of the Floods Directive[3]:

Flood risk maps shall show the potential adverse consequences associated with flood scenarios referred to in paragraph 3 and expressed in terms of the following:

(a) the indicative number of inhabitants potentially affected;

(b) type of economic activity of the area potentially affected;

(c) installations as referred to in Annex I to Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control [9] which might cause accidental pollution in case of flooding and potentially affected protected areas identified in Annex IV(1)(i), (iii) and (v) to Directive 2000/60/EC;

(d) 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.

2.4.1 Purpose of the Risk Maps

The risk maps aim to provide a rough picture of the social, economic and environmental impacts that can be foreseen as a result of flooding within an area. Following the definition of risk being the product of likelihood and consequence of an event, risk maps should also include the impact maps of floods. The maps should be able to identify problematic areas where in-depth analysis needs to be carried out and where action may be needed.

2.4.2 Population

One purpose of the risk map should be to get a rough estimate of how many people will be directly affected in the different flood scenarios.

A scenario such as a large hydro power dam or a dike break can mean a high number of deaths since the event will be so fast that there will not be enough time for evacuation. However, for normal flooding occasions due to high precipitation the effect will mainly lead to people having to leave their homes for a longer or shorter period of time. All presented analyses of the impact on the population so far mainly look at property owners and public registers of inhabitants in different areas in order to get a rough picture of how many people will need a temporary home during a flood. The analyses are therefore not taking into account more indirect effects such as work places, schools, health care centres, important infrastructure, etc whose functions are crucial for society.

In Norway there has been a tradition of making flood hazard maps. The local authorities in the flood risk areas have then managed the objects at risk. In SAWA, the process of making flood risk maps has started. The flood risk maps show the number of people as population

[3] Taken from Directive 2007/60/EC on the assessment and management of flood risks

density. The amount of people is shown for 250*250 m cells within the inundated areas delineated in the flood hazard maps. This way we can still differentiate between settlements and more rural areas within the inundated area.

Economic activity (impact on economic activity is shown in the same map) is defined by the number of offices and shops, industry buildings and tourism buildings within the area. These are shown with different symbols in the map. Community infrastructure is defined by schools, daycare centers, buildings for power supply, buildings for communication, and buildings that are in use by organizations involved in emergency preparedness. All are shown with different symbols. Inundated roads and railways are shown in different colors. The risk maps will furthermore show inundated cultural heritage.

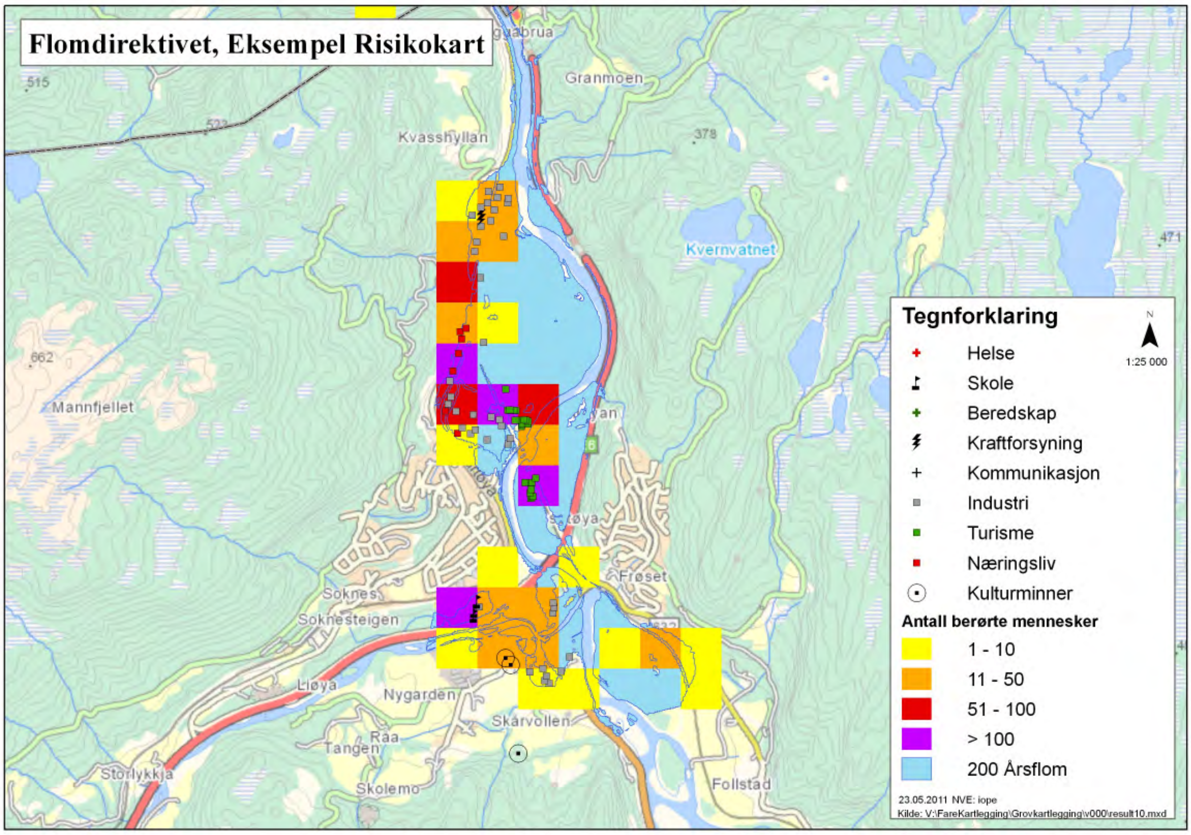


Figure 2-7 An example of a Norwegian flood risk map where consequences for population, cultural heritage, economic activity and social key infrastructure are all shown at the same map.

In Germany, confirmation that the inhabitants will be affected is given if the inundation area overlaps with an area of housing or mixed use. The indicative number of inhabitants potentially affected can be determined by assuming that the inhabitants of a municipality are evenly distributed throughout the specified areas. For those areas which overlap with inundation areas the affected proportion of the total inhabitants within the municipality can then be calculated. If detailed data are available on the number of inhabitants in the inundation areas, these data should be used in preference to the approximate method described above. Effect on economic activity is also shown in the map below as different colours depending on land use.

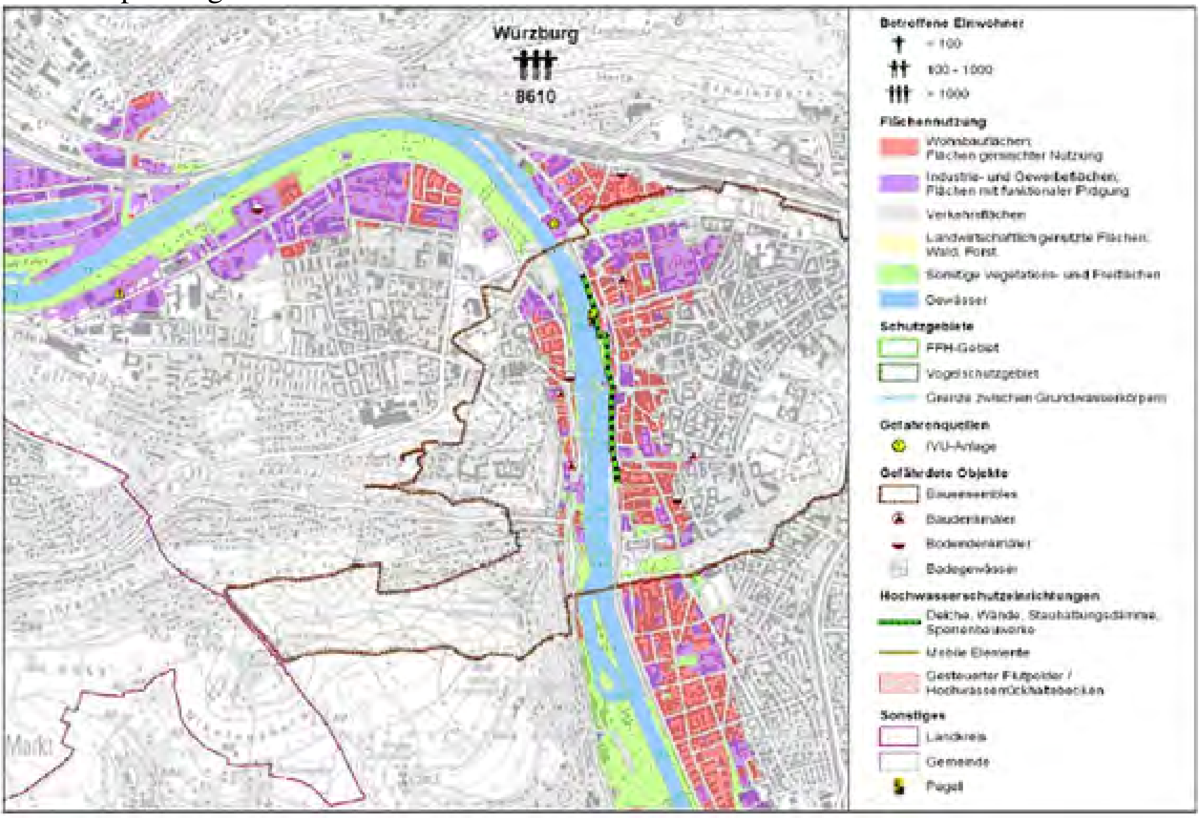


Figure 2-8 An example of a flood risk map of the City of Wurzburg.

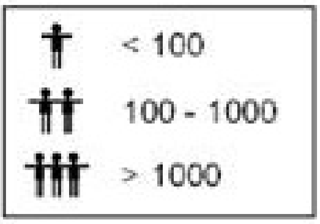


Figure 2-9 The symbol of number of effected people used on German risk maps.

2.4.3 Economic activity

What constitutes economic activity is not clearly defined in the text of the directive SAWA. Sweden interpreted this as meaning various different companies. By cross-referencing addresses and company records in the flood affected areas, the local authority in Lidköping has produced data on how many companies could be affected by a water level of 47.4 m in Lake Vänern. The conclusion, in Lidköping's case, is that almost 550 companies are located in the flood-affected areas. This includes major industries and small service companies in various sectors. For a town with a total population of 25,000 inhabitants 550 companies represents a potentially important economic impact, especially considering that a flooding in Lake Vänern might last for a year.

In the more densely populated areas in Europe like Germany and the Netherlands more sophisticated methods are used to assess impact on economic activity within large areas. This roughly means that different price tags, or water depth related damage functions, are put onto different areas depending on land use. Individual high value objects like hospitals are added. Key infrastructure such as hospitals and power plants is important here. Indirect effects like loss of electricity production for areas outside of the flooded area are therefore pointed out. An example of this is the northeast region of the Netherlands, which in the close future will hold nearly 20-30% of the national electricity production and more than 50% of the gas production. A flooding of this area will have large consequences for the whole country. The estimated economic impact will be a result of the water depth/velocity in the area and the economic value on this particular area.

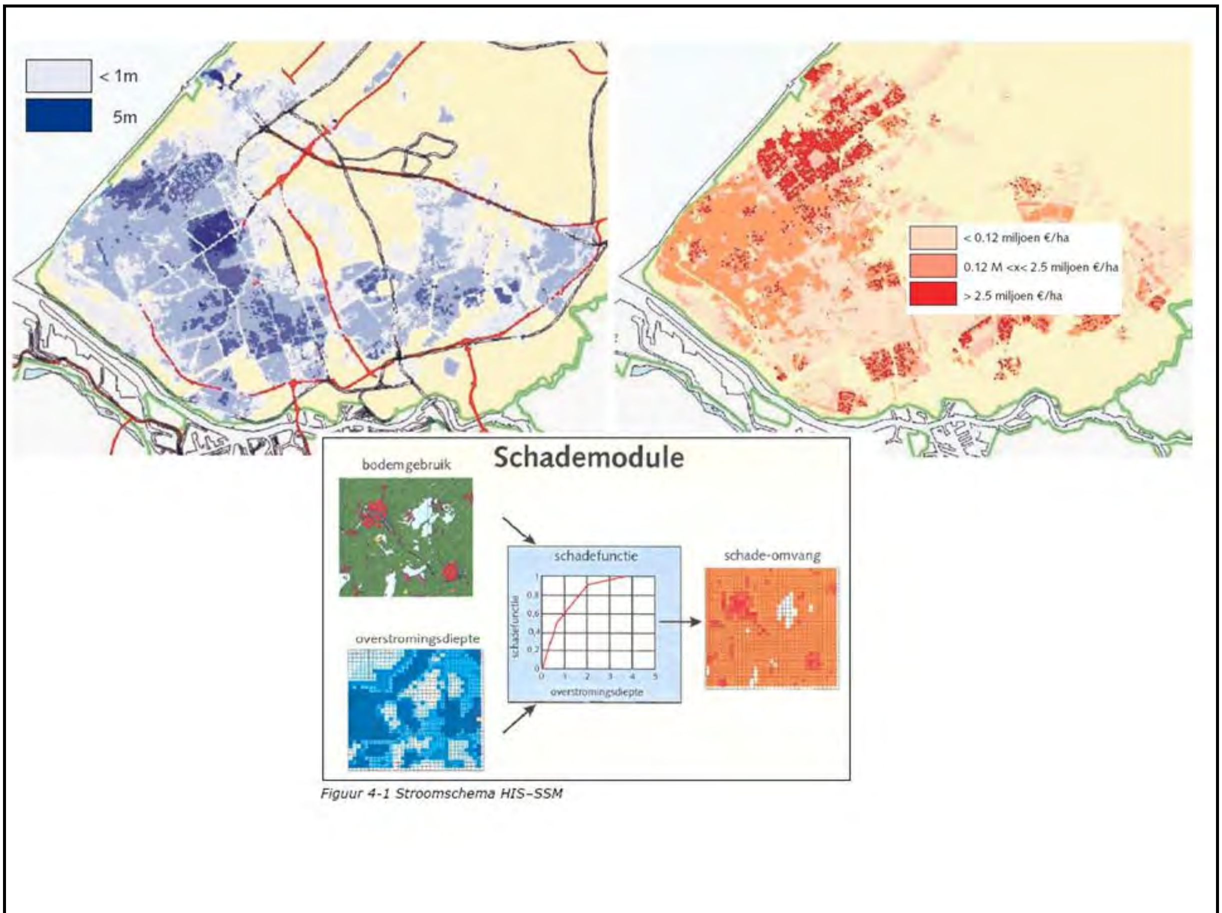


Figure 2-10 A scheme depicting how economic impact in different areas is estimated in the Netherlands.

2.4.4 Environmentally hazardous activities

According to the Flood Directive, the environmentally hazardous activities pointed out in the Council Directive 96/61/EC of the 24th of September, 1996 concerning integrated pollution prevention and control should be listed in the risk maps. In Sweden these objects are relatively few in number. However the SAWA-group in Sweden considered all larger environmentally hazardous objects located in flood prone areas to be of interest. Therefore all of these objects are pointed out at a special risk map.

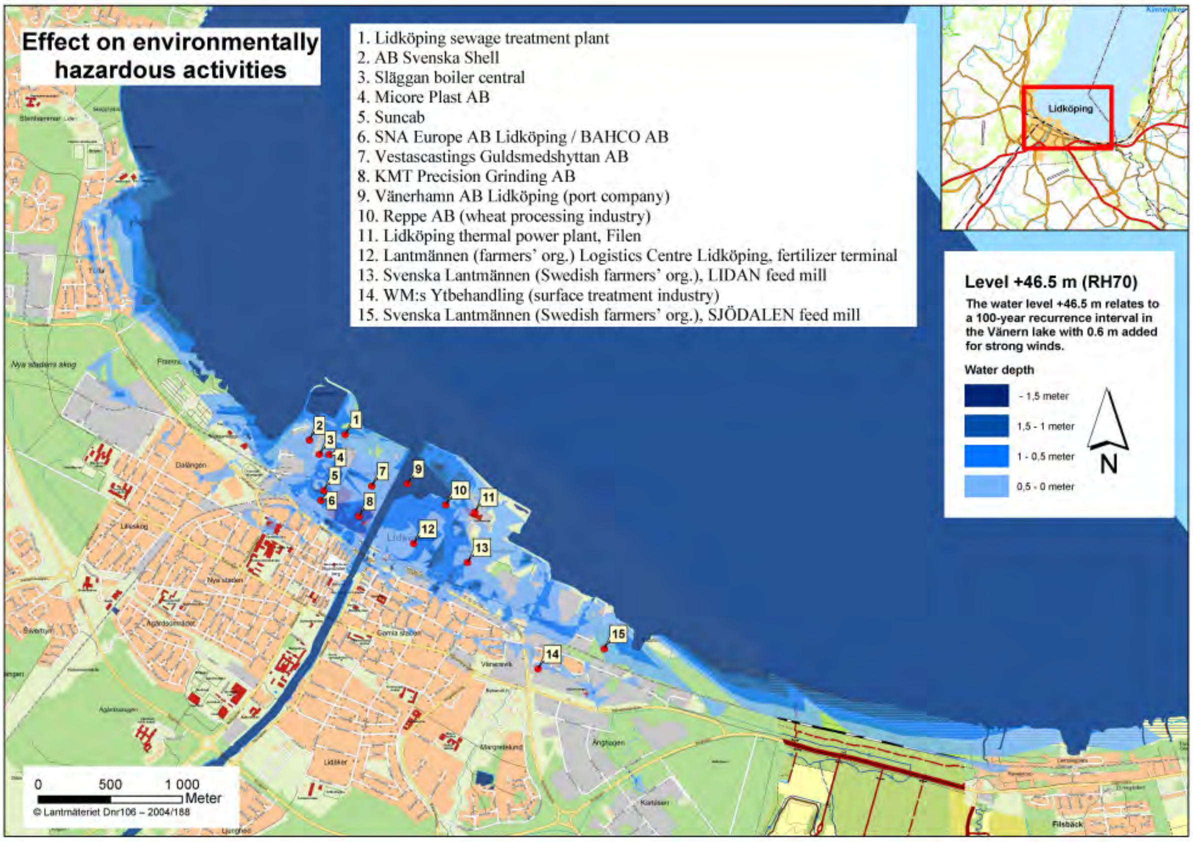


Figure 2-11 Location of larger environmentally hazardous objects in flood prone areas in Lidkoping, Sweden.

With Lake Vänern at a level of 46.5 m, 15 major environmentally hazardous activities in Lidköping are affected. Two of the installations included are the wastewater treatment plant and the district heating plant that serves a large part of Lidköping's urban population. The district heating plant is also a waste incineration facility, which is of central importance for waste management throughout the whole region. At a level of 47.4 m, further large, environmentally hazardous activities will be affected. The consequences of the flooding of these industries should be carefully identified.

2.4.5 Protected Nature

Protected nature according to the 2007/60/EC has the same definition as in the Water Framework Directive (WFD- 2000/60/EC). According to the Flood Directive information about protected natural resources should also be presented in the risk maps or in a register. Protected nature means in this case areas that have been identified as valuable or that where certain regulations are applicable according to specific community legislation. Information should contain both bodies of water affected by the type of protection, and the protected areas.

Figure 2-12 identified areas according to Waste Water Directive (91/271/EEC) and therefore special legislation, in flood prone areas in Lidköping, Sweden.

2.5 Availability of flood hazard and flood risk maps in the SAWA pilot regions

Flood risk assessment is a necessary step of flood risk management planning. However, as SAWA started before they different availability of flood hazard and risk maps can be assessed in the partner regions before and during the course of SAWA. Forced by national law the City of Hamburg and the state of Lower Saxony have begun with the development of flood risk maps before the start of SAWA. The maps used as a basis for the development of FRMP-Wandse together with the methodology for their development are given in Golder, 2009.

However, during the course of SAWA, the national guidelines LAWA have been released which had an influence on the layout and contents of flood risk maps. Instead of showing the economic impact on flood risk maps and defining the risk zones depending on it, it is now required to indicate the exposed elements, without giving any hint on the economic impact as shown in Figure 2-8 and Figure 2-9. An example of a hazards map, which has been used for the definition of the planning objectives is given in Figure 2-13.

In Sweden, the flood hazard and risk maps have been developed during the course of SAWA.

In Norway, the preliminary flood risk assessment has been performed during the course of SAWA. The main results are given in the separate report. Flood hazard maps have been produced in 2002.

The Dutch case study area had the flood maps available prior to SAWA. An overview of the available maps is given in appendix C.

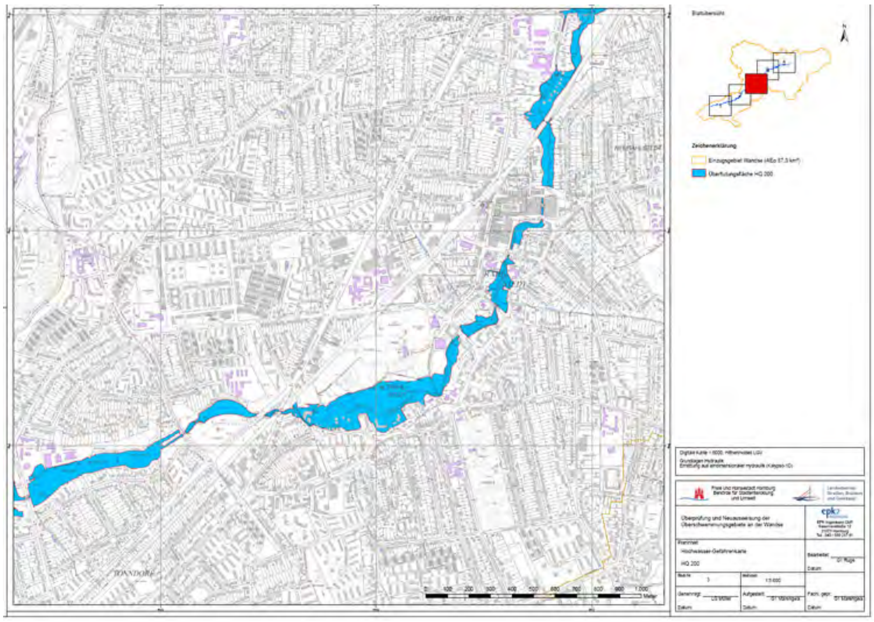


Figure 2-13 An example of a flood hazard map of the river Wandse, Hamburg

2.6 Conclusions and recommendations

- It is important to remember the limitations in the flood and risk maps. There are big uncertainties regarding how water is transported in pipe systems, which might create flooding in "safe" low land areas relatively far from the river/lake. The duration of a lake flooding is long and will most likely rise the ground water level considerably, especially in areas built on sand/gravel material. A high ground water level will create problems with technical systems underground long before the water reaches the surface. Therefore the presentation of maps is important. The material should be sufficiently detailed so that different parts of the city and its features are easily identifiable, but, at the same time, not so detailed as to misrepresent the state of knowledge to the viewer.
- It's important to thoroughly describe the nature of the flood in a particular area and the nature of the area flooded in order to decide upon relevant risk reduction measures.
- It is important to compare measures at different scales. There are times when one measure at the regional scale could replace several local measures.
- Choice of hydrological scenarios when producing flood and risk maps seems to be more or less comparable between the North European countries that participate in SAWA (Germany, Netherlands, Norway and Sweden)
- There are however differences in strategies when considering climate change and when not to. In the SAWA-pilots only Norway and Sweden have taken climate change into consideration when producing flood- and risk maps. The method used is called ensemble analysis, which means using the output of several different global climate models. The variation between the results gives a hint of the uncertainty in the results. The method and results are thoroughly discussed in the SAWA-report Climate change impacts and uncertainties: Examples from Norway, Sweden and the Netherlands, published by NVE and SMHI.

3 Methodology for Development of a Flood Risk Management Plan

3.1 Summary

FRMP as one of the key instruments defined by 2006/0/EC should be established for the areas where a significant flood risk has been assessed. Although 2006/0/EC clearly states the objectives and requirements of the flood risk management plan, little guidance is given on appropriate strategies and ways to conduct this process at the local level. Within SAWA different approaches have been explored in order to develop FRMPs in the pilot regions. The main planning aspects to consider when developing FRMP are outlined focusing on harmonisation with the Water Framework Directive 2000/60/EC, spatial planning and consideration of climate change. Different legal and organisational backgrounds in SAWA countries and their relevance for development of FRMPs have been analysed.

3.2 Introduction

Based on the preliminary flood risk assessment and the flood risk maps, ***flood risk management plans (FRMP)*** have to be developed on the level of the river basin district for river basins, sub-basins and stretches of coastline. The Flood Directive EC 2007/60 specifies very clearly the requirements and objectives of the flood risk management plan and the favourable mitigation measures to be taken for reducing the risk. FRMPs should address the whole cycle of flood risk management focusing on prevention, protection and preparedness and taking into account all relevant aspects, such as the cost effectiveness of the corresponding measures, environmental aspects or other planning activities in the area. The main requirements relevant for the development of FRMPs are given in the Article 7(1),(2),(3) of 2007/60/EC:

> *(Article 7 (1)): [On the basis of the maps referred to in Article 6, Member States shall establish flood risk management plans coordinated at the level of the river basin district, or unit of management referred to in Article 3(2)(b), for the areas identified under Article 5(1) and the areas covered by Article 13(1)(b) in accordance with paragraphs 2 and 3 of this Article].*

> *(Article 7 (2)): [Flood risk management plans shall address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin.]*

> *(Article 7 (3)): Flood risk management plans shall take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas which have the potential to retain flood water, such as natural floodplains, the environmental objectives of Article 4 of Directive 2000/60/EC, soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure.]*

2007/60/EC also sets requirements on the content of a FRMP. A FRMP should encompass results from preliminary risk assessment and the produced flood risk maps as well as the conclusion derived from them. The adopted measures for the defined protection level should be described and prioritised. Here the activities and measures adopted within other directives and frameworks (e.g. Water Framework Directive-2000/60/EC) should be considered. If available, the methodology for a cost benefit analysis should be described. The main elements of FRMP as given in 2007/60/EC (Annex A) are summarised in Table 3-1.

Table 3-1 Contents of FRMP according to 2007/60/EC

the conclusions of the preliminary flood risk assessment
flood risk maps and the conclusions that can be drawn from those maps
a description of the appropriate objectives (level of protection)
a description of the measures required to achieve the appropriate levels of protection
a prioritisation of the measures that promote the objectives laid down in the EU Water Framework Directive (2000/60/EC)
If available, methodology for cost benefit analysis should be described
a description of the coordination process within any international river basin district and of the coordination process with the EC Water Framework Directive.
a description of the public information and consultation measures/actions taken

Even if the objectives and general requirements are clearly stated in 2007/60/EC, little information is given about the strategy to develop and implement FRMP on a local level.
The need is obvious for finding a good governance[4] concept which supports the implementation process best and which will lead to acceptance and proper application of the new paradigm in flood risk management. A fundamental issue that is to be resolved is how the necessary stakeholder participation in the decision-making process can be carried out cost-effectively and in a timely manner so that the results are not technically but also socially acceptable. The Flood Directive EC 2007/60 does not give any guidance in developing such a governance concept for the implementation of the flood risk management plan. It only requires the participation of the public (Article 10 (2)) in the development and implementation process.
(Article 10 (2)): [Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans referred to in Chapter IV.]

Within SAWA, the efficient planning strategies have been explored which would suit the needs of the local planning procedures in the pilot regions in different countries. The overall

[4] In this report, "governance" is defined in general as the process of decision-making and the process by which decisions are implemented (UN – Economic and social commission of Asia and the Pacific). It is more a general road map to progress rather than being a well-defined destination to reach. Good governance stands for a multifaceted decision making process where the societal goals are pursued with the interactions of all the interested actors in all specific fields of development and in which ethical and democratic issues are respected, such as responsibility, accountability, transparency, equity, and fairness. This process requires promotion of dialogues in terms of decision-making, and participation of multiple actors.

methodology to develop SAWA governance approaches for development of FRMP is given in Figure 3-1.

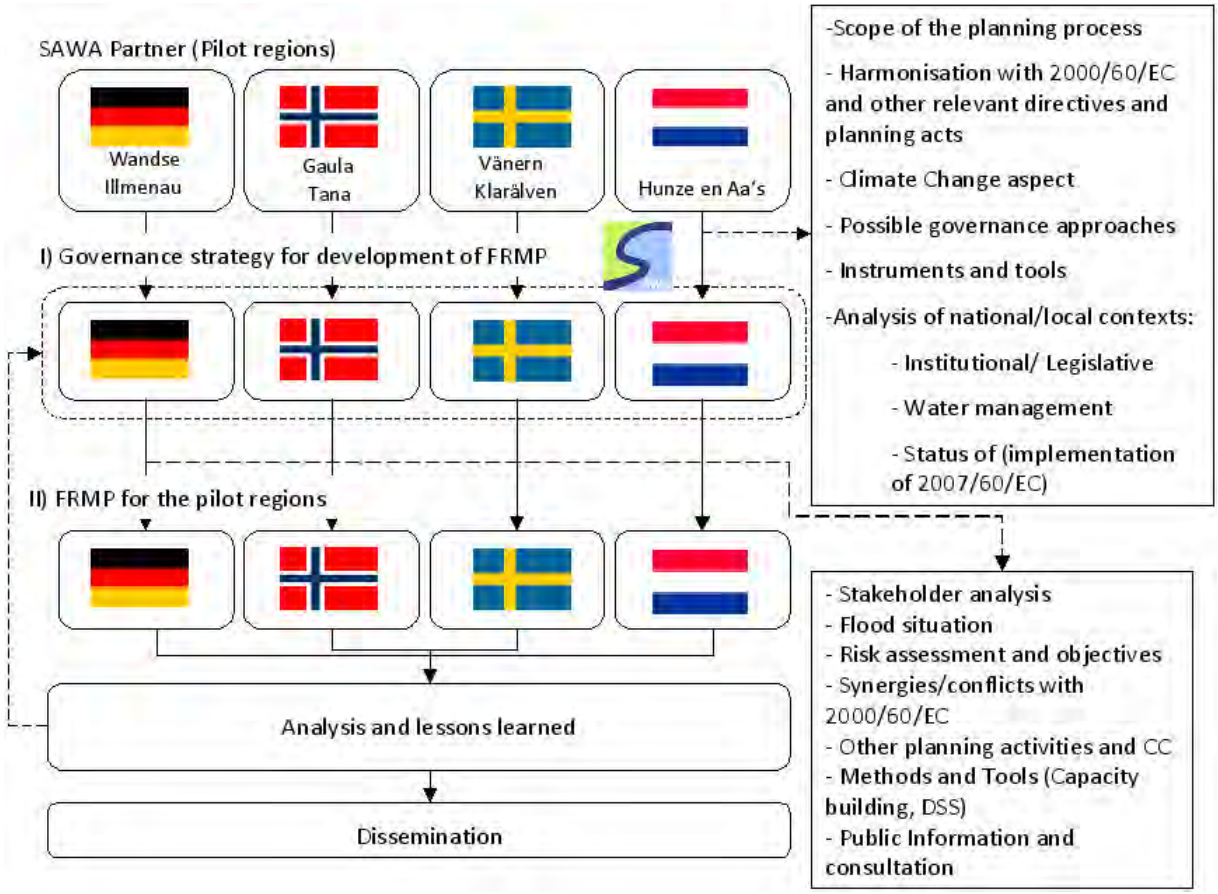


Figure 3-1 SAWA methodology for development of FRMP in the pilot regions

In order to deploy a governance strategy for the development of FRMPs, national contexts, i.e. the existing institutional infrastructure as well as the current legislation mostly related to the implementation of 2007/60/EC, have been analysed. This analysis also encompassed an assessment of the planning level of the pilot regions and their integration across scales in the relevant river basins. Requirements and possibilities of consideration of other planning activities and directives have been assessed, focusing on the potential for harmonization between 2007/60/EC and 2000/60/EC.

Based on this analysis a governance approach for the pilot region has been selected (I) and the corresponding FRMPs developed (II).

The results and experiences ("lessons learned") from the pilot regions served for improvement of the developed approaches. The reimplementation of the strategies considering those improvements has been beyond the scope of the project. The lessons learned are summarised and disseminated via partners' networks and communication channels.

It must also be mentioned that within SAWA, it has been discussed to develop one common governance approach for all pilot regions (indicated as a dashed line, rounding the block *Governance strategy for development of FRMPs* in Figure 3-1).

However, due to high heterogeneity of the national and local contexts, this approach has been reconsidered and finally abandoned.
Additionally, as the development of FRMPs was in its initial phase at the beginning of SAWA, the situation of having different approaches that were selected for different conditions contributed to the generality of the derived lessons learned.

Those national contexts in terms of organisational and legislative aspects have been assessed and are discussed in section 3.6. A detailed analysis of the flood situation and planning activities in the pilot regions is given in chapter 4 and summarised in Tables given in Appendix C.

3.3 Scope of Flood Risk Management Plans

The overall objective of the flood risk management plan is to define a set of measures to reduce the risk to an acceptable level. As risk is the product of the probability of flooding and its negative consequences flood risk management does not only seek to reduce the flood probability but also includes an alternative perspective that considers the vulnerability of the flooded area (receptor) and the exposure of the receptor to the risk. This may be envisaged using a Source- Pathway- Receptor (SPR) model, where the source is the origin of the flood (e.g. rainfall, rivers); the pathway is the way in which the flood is transmitted (i.e. runoff from urban surfaces) and the receptor represents the urban fabric and people with their activities on the flood plain which will be affected by the flooding. In the past, flood management was in general restricted to a pathway control through dikes and walls. However, those technical structures do not have the flexibility to adapt efficiently to changes in the future projections of floods and the responses thereto and frequently lead to a reduction of the detention capacity of the hydrological system with the consequence of higher flood risks downstream. For flood events above the design flood the structures lose their containment function and may cause even more disastrous damage through, for example, the breaching of dikes.
Risk management in the sense of the EU policy addresses all components of the Source-Pathway-Receptor system and prioritises the measures of prevention, protection and preparedness (Article 7(2)). Depending on the components of the S-P-R model, those measures are acting on, they can be summarised as Flood Probability Reduction Measures (FPRM) and Flood Resilience Measures (FReM). Those measures are referred to as ***Non-Structural Measures*** (also called adaptive measures). The envisaged S-P-R model with the corresponding measures is given for different flood typologies in Figure 3-2 and Figure 3-3.

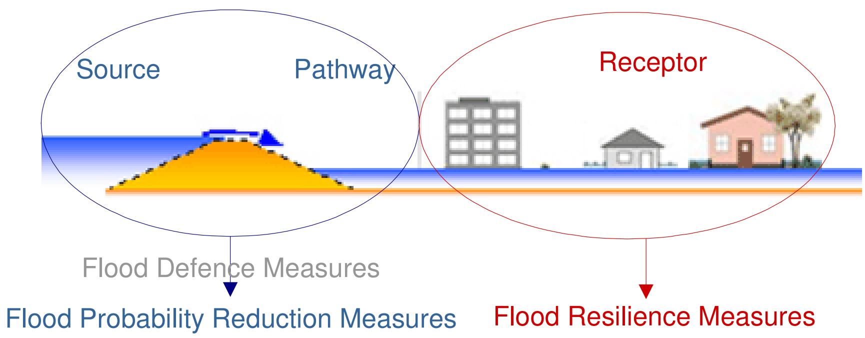


Figure 3-2 System definition for fluvial, coastal and lake floods

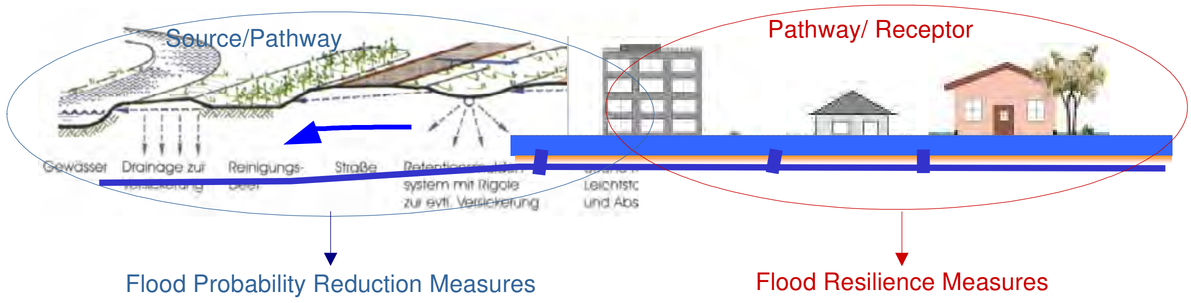


Figure 3-3 System definitions for urban flooding system composed of pluvial and fluvial floods

Flood Probability Reduction Measures (FPRM) encompass those measures which have an impact on source and pathway by restoring the retention potential of the natural hydrological system or even enhance the detention of rain water through small retention basins. On a local scale (property, allotment), this may also include 'sustainable drainage systems' (SUDS), which are already regulated by law for the drainage of new urban development in Europe, for example in most German states. At the intermediate level, surface conveyance systems such as conveyance structures or multi functional spaces are applied. At the watercourse scale, FRMP aim at giving river more space or holding back water by, for example, floodplain restoration and flood polders respectively. Those measures are summarised in Appendix A

Flood resilience measures (FReM) include those measures that improve the flood resilience[5] of the receptor by reducing its vulnerability and exposure to flooding (Pasche et al. 2008). This objective however requires that the resilience concept is not based on a more or less random composition of FReM but integrates them to a safety chain. With this intention the Scottish Government has defined the ***4 A's***: **A**wareness, **A**voidance, **A**lleviation and **A**ssistance and FReM classified accordingly (Appendix A). According to Newman et al. 2008 some of these measures can be regarded as traditional or understood, as they are based on legacy, current understanding of systems and good practice. However, most of them may be defined as emergent as they are "newly developing".

Although FRMP should contain the whole span of measures the focus of SAWA has been put to the new approaches and measures, i.e. to introduce and assess the potential of non-structural measures to mitigate flood risk. Traditional flood defence measures, although addressed in FRMP, are not given here in detail. A detailed description of non-structural (adaptive) measures is given in the Water Wiki (http://www.iwawaterwiki.org/xwiki/bin/view/Organizations/SAWA), which is one of the key outcomes of SAWA.

[5] The term resilience can be defined as [the ability of a system/community/society/defence to react to and recover from the damaging effect of realised hazards (source: Flood Site, Language of Risk, www.floodsite.net).

Small-scale adaptive measures like those aimed at improving the sustainability of the drainage systems in urban areas and even small retention basins do not have the potential to do much to mitigate flooding of a major river like the big ones in Germany and Sweden. This is relevant since the 2007/60/EC aims mainly at reducing the average effects of "floods from rivers, mountain torrents, Mediterranean ephemeral water courses and floods from the sea in coastal areas".

3.4 Harmonisation with the other directives and planning activities

3.4.1 Water Framework Directive (2000/60/EC)

2007/60/EC explicitly requires harmonisation of the measures to be developed in FRMP with the measures planned or implemented according to 2000/60/EC within River Basin Management Plans (RBMP). As both plans have the same geographical unit as a reference (river basin) and their legal and institutional context strongly overlaps, they should be integrated at the river basin level, benefiting from mutual synergies. According to 2007/60/EC, ecological measures should be given preference in FRMP which re-establish the natural potential of rivers and catchments to retain water, e.g. the protection and restoration of wetlands and flood plains, the removal of obsolete flood defence infrastructures (dikes) from rivers, the restoration of natural rivers and the enhancement of sustainable land use practices on a catchment level (e.g. afforestation). 2007/60/EC delivers explicit statements that support this approach given as:

> *(17) [Development of river basin management plans under Directive 2000/60/EC and of flood risk management plans under this Directive are elements of integrated river basin management. The two processes should therefore use the mutual potential for common synergies and benefits, having regard to the environmental objectives of Directive 2000/60/EC.]*
>
> *(14) [With a view to giving rivers more space, Flood Risk Management Plans should consider where possible the maintenance and/or restoration of floodplains.]*

As very often the measures of RBMP are already agreed on or even implemented, the potential of FRMP is seen to be to identify possibilities of "hitchhiking" on measures already agreed on in Water Framework Directive.

This aspect of harmonisation of both Directives is one of the key outcomes of SAWA and is given in a separate report Evers, M and Nyberg L. (2011). Evers/Nyberg performed a thorough analysis on the synergies and conflicts between the two directives with the objective to identify potential ways to harmonise their implementation, applying the synoptic analysis of similarities and dissimilarities and collecting empirical materials (workshop sessions, questionnaires).

The synoptic method delivered some similarities and dissimilarities across different dimensions such as political, management, legal, socio-economic or sustainability dimension Table 3-2 shows an excerpt of this analysis. While 2000/60/EC specifically defined the objectives and even gave parameters describing them (e.g. good ecologic conditions), 2007/60/EC is rather flexible when describing the planning objectives i.e. the acceptable flood risk to be taken (Table 3-2). Although both directives require the active involvement of interested parties, those groups are, in the general case, different or have a different level of effect or impact. An important similarity is seen in emphasising the ecological requirements of both directives.

Table 3-2 Examples of synoptic analysis regarding similarities and dissimilarities of 2000/60/EC and 2007/60/EC (Evers/Nyberg, 2011)

Directive Dimension	WFD	FD
Political intention & objectives	Good status of water bodies	Establish a framework, reduction of adverse consequences
Legal dimension		
Length of Directive Articles Appendixes	60 pages 26 10	9 pages 19 1
Monitoring	Monitoring of ecological quality is required	No monitoring, only report required No specific parameters
Specification of goals to be met	Specific status has to be met	No specific quantitative goal is fixed
Implementation and control of measures	Control of implementation of measures Possible penalties are described in art. 23	No control of implementation of measures No specific report on implementation of measures is required. No possible penalties described
Management	- clear time line and development of planning instruments (maps & plans) AND goals to be met 2015 - given parameters - monitoring programme - …	- clear time line for development of planning instruments (maps & plans) 2015 - no monitoring programme - no control of implementation - …
Participation	Active involvement of interested parties	Active involvement of interested parties (appr. coord. with WFD)
Aerial scope	Whole basin (assessment and plans)	Whole basin (assessment) whole or parts (plan)
Data management	Technical formats/ GIS	Cartographic data/technical formats

Based on the synoptic and empirical results, the main synergies have been identified in the coordination of goals and planning, implementation of measures, communication and public participation, data management and optimisation of resources (financial/human).

Still, there are a range of potential conflicts that must be made aware of and overcome, the main ones being: different responsible bodies, different management units, communication and culture as well as time frame for implementation.
Consequently, a potential process of integration has been developed as depicted in Figure 3-4.

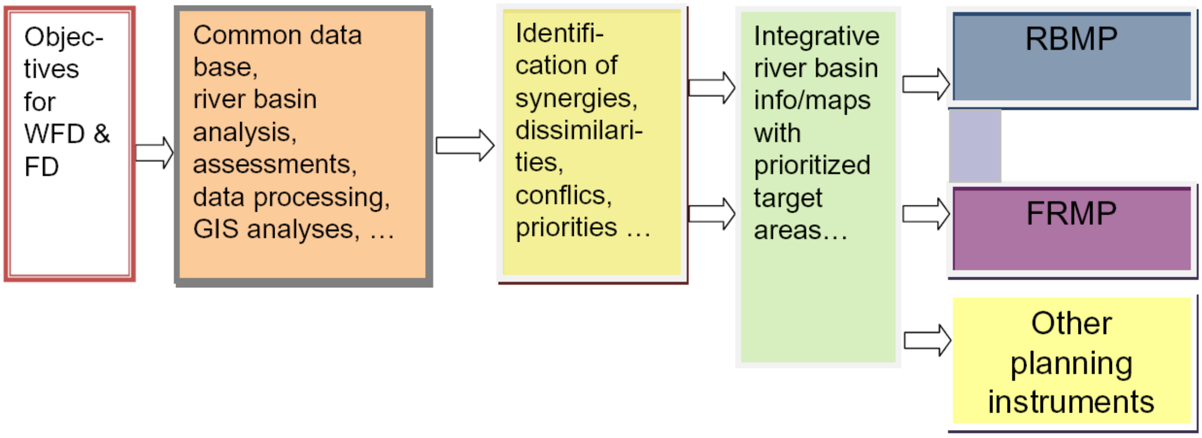


Figure 3-4 integrative analyses for identification of synergies/conflicts/prioritization (Evers/Nyberg, 2011)

Also, the flexibility of 2007/60/EC, as illustrated in Table 3-2, can be a chance for a sustainable process. Therefore, it is a challenge of the FRM- planning process to identify the potential synergies of the two directives in the given area and integrate them at the river basin scale. The aspect of harmonisation in the pilot regions is given in Chapter 4 where working approaches and plans are presented.

3.4.2 Other planning activities and directives

One of the key potential conflicts that can hamper the process of multi stakeholder involvement in the development of FRMPs is the scope and interest of other planning activities in the area, mostly related to spatial planning issues. Especially in urban areas where the economic interests and need for housing can be a strong driver for urban infill or expansion of the cities, the problem of diverging interests between spatial planning and flood management has to be addressed. 2007/60/EC requires explicit consideration of spatial planning issues and land use management (Article 7 (3)). Within the INTERREG IIIb Project FLOWS that preceded the SAWA project, the potential of joint planning between spatial planners and water (flood) managers has been explored, indicating the importance of mutual consideration. The reasons for the consideration of other planning activities in the area are manifold, the main ones being.

- Anticipating potential future flood risk in the area that can be considered for the definition of the planning objectives; by developing an area, the vulnerability of the urban fabric increases, which leads to increase in flood risk. Those future risks should be assessed (e.g. scenario analysis) and addressed during the FRM planning process. A focus is to be put on the developments close to water bodies (grabbing at the edges")

- Potential conflicts of interests between flood management and spatial planning; this can influence the stakeholder participation for the development of FRMPs. Therefore, if possible, it should be assessed beforehand. During the planning process, those conflicts are to be managed, which is one of the key challenges of the FRMP planning process

For the pilot regions it is necessary to consider the existing development plans, both the plans that have already been put in practice and the ones in the preparation and analyse the changes in flood risk. The potential of the FRMP process to influence spatial planning legal instruments should be explored throughout the planning process.

Apart from development plans, the cultural heritage, natural preservation areas, and contaminated sites are to be analysed and identified prior to the development of FRMPs. The corresponding interest groups should be considered and analysed within the stakeholder analysis.

3.4.3 Adaptability to climate change

Apart from changes in urban environment that can influence the future flood risk, the climate change aspect should be considered as the likelihood of its impact on the future flood risk. 2007/60/EC addresses the aspect of climate change by stating that the climate change contributes to an increase in the likelihood and adverse impacts of flood events (2). Also, for the updating process of FRMPs it is required to take into account the likely impacts of climate change on the occurrence of floods (Article 14 (4)).

The assessment of the impacts of climate change in the SAWA partner countries has been one of the key outcomes of the SAWA project. Lawrence et al. (2012) performed a thorough analysis on the climate change projections in the partner countries as well as the possibilities for its dissemination. The results and recommendations are given in a separate report Lawrence D., Graham Ph., Van den Besten J (2012). "*Climate change impacts and uncertainties in flood risk management: Examples from the North Sea Region*".

It has been assessed that climate change will lead to changes in several factors, which can impact flood hazards (e.g. sea level rise or changes in precipitation patterns) and the local impact of these changes varies significantly between areas within the North Sea region. The way to integrate the climate change aspect in flood risk mapping is discussed in chapter 2.

For the scope of flood risk management planning, the climate change aspect is to be considered when defining the appropriate planning objectives. As there are no specific requirements given in 2007/60/EC on how to perform this, each pilot region managed this issue differently, depending on the previous experiences (e.g. the Netherlands) and perception of the responsible authority on the acceptable uncertainty level when addressing the climate change issue (e.g. Hamburg).

The climate change aspect for the developing flood risk management plans in the long-term perspective has been the focus on the INTERREG IVb Project MARE (http://www.mare-project.eu/) aiming at the development of a toolbox and guidance for the development and implementation of climate-proof FRMPs. The parallel project lifetimes enabled continuous exchange between the SAWA and MARE partners.

3.5 Strategy and Governance Approaches

In the context of the SAWA project, a governance concept (concept for stakeholder involvement) has been sought which best fits the national context and given problems in the area. Although participatory planning is not a novel issue in water management, few examples of good practice are yet available on efficient methods for developing FRMP and theoretical guidance is developing rather slowly. An important experience has been gained in the implementation process of the EU Water Framework Directive (EC-WFD) leading to innovative strategies and new knowledge about the more efficient involvement of stakeholder groups in the planning process (Pahl-Wostl et al, 2008). Further EU based research within the ERANET CRUE and FP6 initiatives has focused on stakeholder involvement in flood risk management (Pasche et al, 2008, Samuel et al, 2008).

Within the ERANET CRUE Project DIANE- CM, the method of collaborative modelling has been developed, applied and tested to involve relevant stakeholders for development of flood risk management strategies and alternatives in the Alster catchment area of Hamburg (Evers, 2011). This approach is exploring the possibilities of interactive modelling and online participation and addressing professional and non-professional stakeholders. The project's lifetime overlapped with the SAWA project enabling possibilities for an exchange of experiences.

Lach et al, 2005 regards one of the key problems in participatory water management the occurrence of so called "*wicked*" problems. According to Rittel/Webber, 1973 these problems have multiple and conflicting criteria for defining solutions, the solutions can create problems for others, and no rules can be applied for determining when problems can be considered to be solved. These wicked problems are inherent in developing flood risk management plans. They will show up during the planning process as the key stakeholders can be considered as separated rather than united and in a situation in which knowledge and information is scattered. This fragmentation will be further amplified by the different views from the different stakeholders and the fact that each individual view is regarded as the most correct and their problem as most urgent and needs to be addressed as a priority – and according to Verhagen et al, 2008 their view on the problem and solution is preferable. According to Pacanowsky, 1995 we do not really solve wicked problems; we rather "design" more or less effective solutions based on how we define the problem.

Referring to the Governance for sustainable development and Newig et al., 2008 emphasised the main problems that are to be aware of when envisioning and planning the governance process being (1) ambivalence of goals, (2) unclear means and guidelines to achieve them and (3) lack or distributed power to carry out the governance process. Those problems are generally inherited in the flood risk management planning process and should be kept in mind when designing the planning process and defining the planning objectives.

Another key challenge in participatory flood risk management is that the new Flood Directive replaces traditional flood defence strategies through a risk based management concept which requires that the technological entrapment (Walker, 2000) of "stationary" design and operational assumptions and the continuing "traditional" investments of large technical systems have to be broken (Ashley/Blanksby, 2009). Professional and public stakeholders need to build up their capacity in the application and understanding of flood risk management by non-structural measures (Pasche et al, 2008). As they are not a fixed set of tangible measures but an evolving process of transfer to a more adaptive flood risk management, their immediate benefit can usually not be identified, and it is more difficult to grasp them and the capacity building process has to be carefully planned and integrated into the decision making process.

There are different levels and ways of stakeholder participation. The simplest way of classifying the level of participation differs between a *top-down* and a *bottom-up* approach. In the first case the plan is developed by professionals. The public's opinion and input is only requested through public hearings and written objections at the end of the approval process. According to Article 10 (1) this scope of public participation is in line with the 2007/69/EC. But Article 10 (2) encourages seeking the active involvement of stakeholders in the whole planning process. More active public involvement can be achieved by employing the bottom-up approach. Here all stakeholders, professionals and public, are involved right from the start and together they develop the plan in a continuous collaborative process.

A more differentiated approach defines different levels of participations of the stakeholder groups including "non professionals". In that sense, the concept of the "participation ladder" has been introduced by several authors (e.g. Arnstein, 1971, Row &Fewe, 2005, WMO, 2005). The method used by WMO, 2005 is depicted in Figure 3-5.

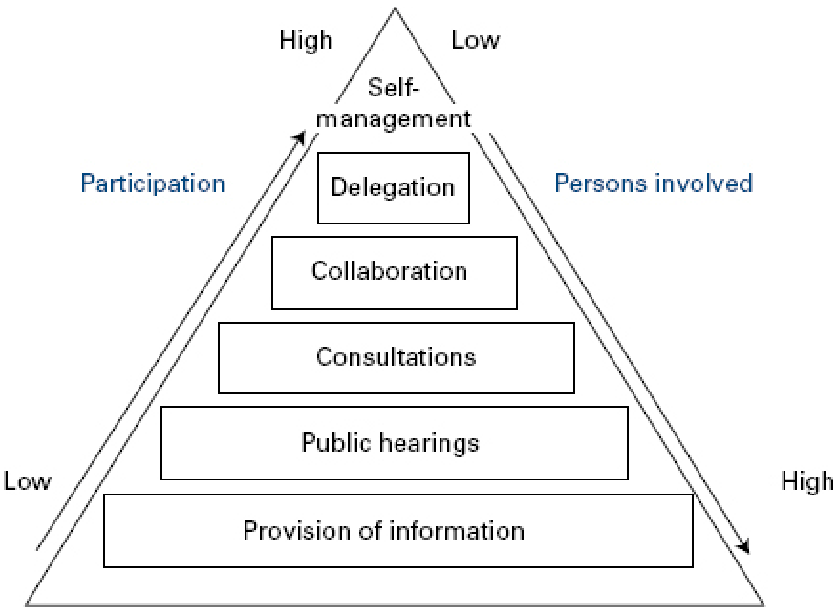


Figure 3-5 Levels of stakeholder participation (WMO, 2005)

The greater the extent of participation and control over decisions, the fewer the numbers of stakeholder representatives that are engaged in the process. Surpassing simply the provision of the information, the next participatory level, public hearings, requires more interaction with the public and dwellers, as their feedback is sought in the decision making process. Consultations mean engaging stakeholders in a dialogue. A step further is made through collaboration with the stakeholders, meaning that different groups come together with the authorities to share, negotiate and control the decision-making process. Delegation involves joint decision-making. Here stakeholder involvement is intensive, but is carried out through

the representatives. Under self-management, the community or individual makes its own decisions (WMO, 2005).
Which level of participation will be adopted depends on the given social, political and legal conditions relevant for the planning area and the goal for the participatory approach.
Another possibility of selecting an appropriate method is to look at the theoretical guidelines of flood risk management planning at the international or national level. Although their availability is rather low, a few national documents and initiatives can be identified aimed at providing guidelines for development of FRMP plans. Out of the partner countries, such a document has been already put in practice in Germany in March 2010.
Document "Recommendations for development of FRMP", by the German Working Group on water issues of the Federal States and the Federal Government- LAWA, 2010 has been published and is considered by the federal states as a reference document. Within the document, LAWA recommends the structure of the process and relates the steps to the corresponding requirements of the 2007/60/EC. A streamlined process describing the development of FRMP defined by LAWA, 2010 is given in Figure 3-6.

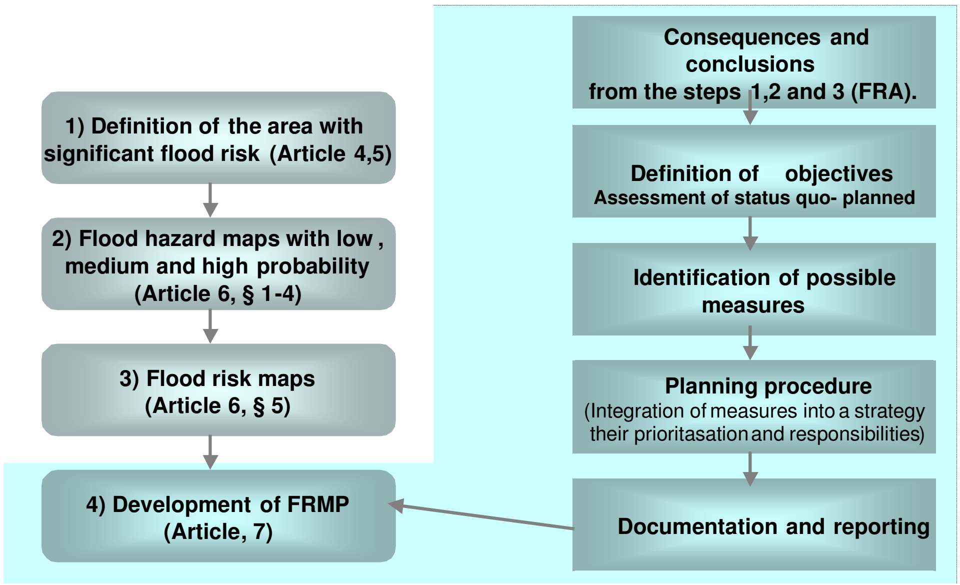


Figure 3-6 Development of FRMP (LAWA, 2010) (translated from German)

This flowchart is to be considered as a recommendation. Apart from giving the generic concept on how to develop FRMPs, the document outlines the measures to be considered as well as the structure of the final document- FRMP. The LAWA Recommendation Document is currently being used by a range of responsible authorities in Germany for developing FRMPs. Having the same document as a baseline enables comparison and exchange of experience among the federal states and municipalities.
At the beginning of SAWA this document was still in preparation and could not be used as a reference document. Still, during the course of planning in German pilot regions, some aspects have been considered and will be presented in Chapter 4. Currently, there are not any published documents at the national level in the other partner countries, but they are expected in the next years (e.g. Sweden).

3.5.1 Instruments supporting the development of FRMP

For the development of FRMPs with active multi stakeholder involvement, methods and tools are needed to support the decision making process. The tools should be available which give guidance on the selection of the members, provide material for capacity building of stakeholders and software instruments for the support of the decision making process. Within SAWA a set of tools and methods have been identified and is summarised in Table 3-3.

Table 3-3 Methods and tools required to support the FRM-planning process

	Methods and tools supporting the planning process
Social	a) Guidance for role assignment (stakeholder analysis)
	b) Conflict analysis
	c) Social learning methods
Technical	d) Raising risk awareness
	e) Capacity building
	f) Decision support tools

3.5.1.1 Guidance documents for stakeholder analysis, role assignment and conflict analysis

Independently of which governance approach is selected the process of development of FRMP starts with the selection of relevant stakeholders and the analysis of their interests, impacts or the level of effect. The selection of the relevant stakeholders and definition of their role in the process of development of FRMP is not a trivial issue and needs careful preparation. As each region has its own institutional and legislative framework a detailed stakeholder analysis has to precede the selection process. Especially in urban areas many stakeholder groups will be affected by the actions to be taken in a flood risk management plan. The stakeholder analysis should provide the existing political, social and institutional structure with special reference to the organizational structure of the flood and drainage management within the area of interest.

A list of potential stakeholder groups to be involved in flood risk management planning is given in Table 3-4a.

All stakeholder groups have to understand their responsibilities, the temporal and spatial scale of activity and their relationship between each other.

High priority should be given to setting a clear definition of the roles which each stakeholder should take within the planning process. Only little experience exists in this role assignment so far. It is dependent on the objectives and expected outcomes of each planning process as well as the special stakeholder situation in the area under consideration. Some general guidance for stakeholder grouping has been given by Ashley/Blanksby, 2009. They suggest to group stakeholders according to their key interest as given in Table 3-5.

Table 3-4 a) Categorising stakeholder groups of FRMP

Categories of Stakeholders
Strategic flood and drainage management
Implementation and maintenance
Urban development
Agriculture
Public transportation infrastructure
Urban and landscape design
Environmental protection and nature conservation
Emergency services
Politicians
NGOs
Public interest groups or special ethnic groups
Economy and Industry
Research

Table 3-5 Stakeholder grouping according to their main interest (Ashley/Blanksby, 2009)

Stakeholder Grouping
Catchment based groups
Interest based groups
Functional groups
Research led groups

In the catchment based groups all stakeholders are integrated which act on a regional level (ministries, national agencies) and thus have an interest that regional aspects are considered and that ideas and consequences resulting form the LAA are transferred into regional planning. The largest group is the interest-based group, which integrates all stakeholders, which have specific interests in the area under consideration (e.g. spatial planner, ecologist, dweller, NGOs, water utilities). Their role will be to contribute with their specific knowledge and expertise in the development of the FRMP, raise awareness of conflicts and to contribute in finding ways to avoid or compensate them. The functional group integrates the actors, which are responsible for the development of a FRMP, e.g. water boards, water authorities, or the community. They have the most active part in the planning process, as they have to develop the measures of flood risk management and to integrate them into a consistent plan.
The research-lead groups integrate universities and other research organisations active in this area. They have to support the transfer process of innovative systems and intervene to make them work in practice. They need to assist stakeholders in their capacity building, either by face-to-face presentations and sessions or by providing learning materials or instruments that should support the planning process.

In multi stakeholder groups with conflicting interests the multi-criteria analysis methods are to be developed to manage potential conflicts and enable democratic decision-making. The conflict matrix method of development visualises the main conflict potentials and enables its reduction to an acceptable level.

3.5.1.2 Social science instruments

Stakeholders need assistance in improving their communicative and cooperative skills to perform effectively in the planning process. As the background and educational level of the stakeholders vary considerably this task needs didactic competence and experience. In the end an atmosphere of mutual trust, respect and openness has to be established. Social scientists can be supported in this task through instruments such as “social games”, bilateral discussion panels or workshops. They must give the stakeholders an active role, activate oral and written communication and invite them to actively listen. Access to autodidactic learning tools and all material produced or delivered during the learning sessions is critically important. This implies for example, the application of modern web-based communication platforms equipped with e-learning tools and discussion forums.

3.5.1.3 Decision support tools

Successful participatory planning requires understanding the interactive structure of the components contributing to flood risk. This includes in urban river basins the understanding of the dominating hydrological processes, the impact of anthropogenic changes on the flood risk and its feedback with the socio-economic situation. Due to the complexity of these processes and system functions, instruments are needed in the decision process which give stakeholders the possibility to define and test scenarios and study the impact on the hydrological and socio-economic system.

EC/2007/60 addresses several aspects where the decision making process is required:

1. combination of measures tailored to the specific characteristics of the river basin and flood typology
2. evaluation of the measures or combination of measures in terms of their cost benefit performance, or in the wider sense multi criteria analysis considering issues such as ecological or social impacts.

Due to the complexity of these processes and system functions, instruments are needed in the decision process which give stakeholders the possibility to easily define and test different planning options and study the impact on the hydrological and socio-economic system.

Decision support systems are given as computer models in which a non-expert has the possibility to analyse complex problems and to find appropriate solutions (Hahn/Engelen, 2000). They range from simple assessment tools to complex systems in which scenarios of different solutions can be easily generated, their efficiency quantified by mathematical models and their preferences generated via a multi-criteria analysis. In all cases, the user is the centre of the system and determines the capabilities of the system. Within SAWA different tools have been applied in terms of their scales, targeted users, the aspects of the flood risk management cycle they are addressing or technologies applied.

A detailed description of DSS applied or developed within SAWA is given in a separate report *Daal D et al. "SAWA- DSS*" and their application in pilot regions is outlined in chapter 4 together with the corresponding planning process they were supporting.

3.5.1.4 Learning Instruments for Capacity Building of Stakeholders

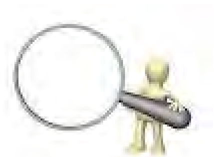
The development of innovative solutions and concepts for integrative flood risk management requires that especially engineers and spatial planners give up some of their traditions and common practices of river management and urban development. Social science research has shown that stakeholders behave conservatively and do not change their habits despite better solutions (Walker, 2000). This Entrapment Effect (Ashley et al., 2007) marks a key barrier in the transfer process in urban river basin management. Due to the importance of capacity building in the FRMP process, SAWA has defined it as one of its key outcomes.
The main methods for capacity building developed or applied in SAWA are given in a separate report Capacity Building Methods for Flood Risk Management and summarised in Appendix C.

Within SAWA different DSS have been applied, mostly depending on the nature of the flood problem, data and tools availability or planning objectives. The SAWA DSS tools will be discussed together with the planning process in chapter 4.

3.5.2 Design and planning of the participatory process

The process of flood risk management planning involves expertise from different fields involving a range of tools as given in section 3.5.1. In order to perform efficient planning and process design, a coordination of activities is required. Apart from the responsible authority, a contribution from the research institutions and consultancy is important in order to design and conduct the planning process. A general overview of the activities to be carried out in a coordinated manner is summarised in Table 3-6. The first stream covers the activities to be performed by the responsible authority. They are mostly related to the implementation and operation of the planning process as well as to the decision-making process. The second one deals with the development of the tools and instruments to support the participatory planning procedure and the third one focuses on consultancy support which is needed in the planning process, e.g. development of simulation models, hydraulic design and planning of site specific measures out of the group of FReM and FPRM and their integration in thematic plans of river restoration, urban drainage and urban development.
Within SAWA, all three groups of partners have participated in the planning process. Depending on the selected method for stakeholder involvement, specific problems in the area and available data and resources different activities as listed in Table 3-6 have been carried out in different pilot regions. A detailed description of the activities is given in chapter 4, together with the descriptions of SAWA flood risk management plans.

Table 3-6 Main contributions from key parties involved in design and conduction of the process assessed within SAWA

Responsible authority (Decision Makers) 	Research 	Consultancy 
	- Development of concepts and methods for FRMP or integrated RBMP	
- Coordination of approval of flood hazard and risk maps		- Setting up mathematical models of the water system under consideration (Rainfall-runoff, hydraulic and damage model), - Development of Flood Risk Maps
- Selection of relevant stakeholders	- Guidance Document for Stakeholder selection, - Learning Material for social competence building	
- Raising Flood Awareness	- Development of methods for raising risk awareness - Supporting the capacity building process by lectures, presentations	
- Capacity Building in Risk Management and NSM including WFD measures - Definition of the planning objective considering the aspect of climate change	- Learning material for capacity building in Flood Risk Management and integrated River Basin Management - Supporting the capacity building process by lectures, presentations - Inventory of best practice of adaptive measures (NSM) and WFD measures - methodology and tools for modelling of the climate change impacts	
- Active planning at the catchment level - Discussion on different planning options based on NSM - Exploring the hitch-hiking options with RBMP	- Development of corresponding Decision Support Tools for the efficiency assessment of the measures	- Designing NSM on a local level, - Integrating single measures to alternatives plans on urban drainage, river restoration and urban development
- Agreement CBA and MCA approach and assessment parameters - Assessment of alternatives by Decision Support System - Minimization of conflicts and adoption of the final plan	- Development of cost benefit assessment methods and tools - Development of Assessment Matrix for MCA - Development of methods for conflict minimisation and adoption of the final plan	- Moderation of the process of finding the final option

3.6 Institutional/Legislative context in the SAWA countries

3.6.1 Germany

Germany is a state with a federal structure consisting of 16 separate Federal Constituent States (Länder). Federal Government, Federal States, administrative regions as well as districts and municipalities have different administrative responsibilities in the implementation of the EC FD. The Federal Government is responsible for the transposition of EU law into national law (Federal Environment Ministry (BMU). The Länder are responsible for the implementation of flood risk management at Länder level (Länder ministries for environment). The administrative regions, districts, municipalities, communities or boroughs are responsible for the implementation of flood risk management at local level.

After a reform of the federal structure in 2006 the German water law transferred into a "concurrent federal legislation". With this reform of the federal structure the federal government obtained the possibility for comprehensive management of water resource. However, the Länder can set out proper regulations that differ from the federal provisions if the variant rules do not pertain to materials or facilities associated to water management.

The major benefit of this new legislative power is that the Federation can now implement EU law by a single federal legislative act. Other benefits are the substitution of the previous framework legislation by a comprehensive legislation, systematization and standardization in order to improve the comprehensibility and practicability of the complicated water law and last but not least the transfer of former Länder law pertaining to certain areas of water management to federal law.

The new law relating to the management of water resources (Water Management Act, (WHG)), came into effect on March 1, 2010(Federal Water Act (WHG) of 1 July 2009).

With this act the Directive 2007/60/EC of the European Parliament and of the Council on the assessment and management of flood risks (Floods Directive / FRMD) was transposed into German law.

The implementation process on national level is coordinated through the joint working group on water issues of the Federal States and the Federal Government (LAWA). The LAWA has a permanent committee on "flood protection and hydrology" (LAWA-AH), which has the lead responsibility in the join working group. Its duties are to discuss methods and courses of action. It also serves as forum for an exchange of experience. Based on these experiences it develops joint approaches for the implementation of the EC Floods Directive.

2007/60/EC, and also the 2000/60/EC, compels Member States to institutionally embed consultations between Member States on how to meet the objectives of the directives for an entire river basin. Member States are required to create a river basin district for each river basin, which includes the incorporation of the necessary administrative regulations and the appointment of an appropriate competent body. If a river basin is covering more than one territory of a member State, than the Member States involved should cooperate within an international river basin district.

The international cooperation in Germany is transacted in seven transboundary river basin commissions, which are Danube, Rhine, Elbe, Oder, Mosel/Saar, Maas and Ems. These

commissions are subdivided into thematic working groups e.g. hydrology, water quality or flood protection.
For the preliminary assessment of flood risks and the drawing of maps for international river basins, it is necessary to ensure an exchange of information between the responsible authorities in the respective member states. Also the flood risk management plans have to be coordinated between the states being involved.
It is important to reach a common understanding on the flood risk management between the authorities, the private sector and also the non-profit organizations involved in the planning process.
To achieve this goal the planning process is based on an interdisciplinary approach to ensure active involvement of all parties. To reach all relevant stakeholders on different levels the whole process is subdivided on different planning levels. These are often called A, B or C level. (e.g. river basin, sub-basin, coverage area). A-level is representing the highest level and covers the entire river basin. The flood risk management plans are drawn up for flood risk areas at A-level (river basin level).
A general structure of the German administrative structure focusing on water management is given in Figure 3-1.

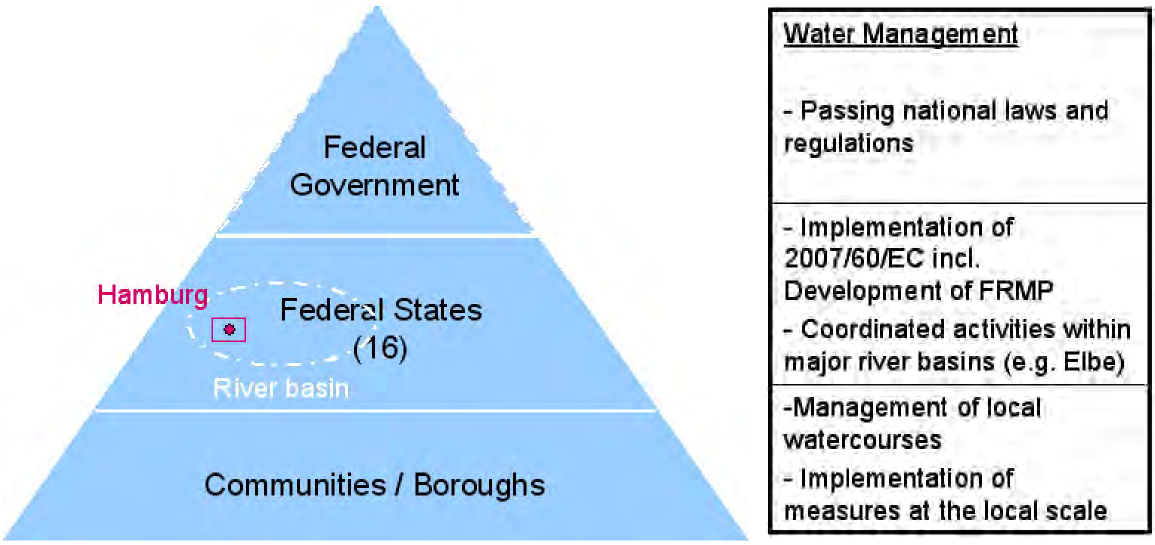


Figure 3-3-7 Governance pyramid- Germany (red dot indicates the SAWA partner) (Source: TUHH)

For the scope of the FRM- planning within the SAWA project two federal states are involved, being The City of Hamburg and Lower Saxony.

For the scope of the FRM- planning within the SAWA project, two federal states are involved being The Free and Hanseatic City of Hamburg (FHH) and Lower Saxony.
In the FHH, the supervisory authority for management and monitoring of watercourses is the Ministry of Urban Development and Environment (BSU). The BSU assigns the Agency of Roads, Bridges and Waters, (LSBG) with the implementation of the flood risk management plan which implies development of flood (risk) maps and FRMPs. Those activities are coordinated within the Elbe River Basin Working Group (FGG- Elbe http://www.fgg-

elbe.de/). At the end one plan for the river basin Elbe will be established. The activities at small urban catchments in Hamburg are at the C (local) planning level.
The main responsibilities in the city of Hamburg relevant for the development of FRMPs are summarised in Table 3-3-7.

Table 3-3-7 Main responsible institutions for Water Management focusing on Implementation of 2007/60/EC in the City of Hamburg (the SAWA project partner is underlined)

Administr. level	Institution	Responsibility
City Level	**Ministry of Urban Development and Environment (BSU)**	supervisory authority for management and monitoring of watercourses in the Hamburg area
	<u>Agency for Roads, Bridges and Waters (LSBG),</u>	Responsible for development and implementation of FRMP
	Storm Water Utility	in charge of management of the sewerage network in the area, which involves construction, maintenance and monitoring of the system.
District level	**Local Authorities- Wandsbek**	implementation and maintenance of FRM measures

In Lower Saxony the main responsible institution is the NLWKN (Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency).

The most involved institutions in the SAWA Ilmenau project are the counties of Uelzen, Lueneburg and Harburg, which cover the biggest part of the catchment area. Also the contribution from and the exchange with the Chamber of Agriculture of Lower Saxony, the city of Lueneburg, the Waterboard of the middle and upper Ilmenau and the Government agency, division Regional Development and Regional Planning has been required for the development of integrated river basin management plans.

Status of the implementation of 2007/60/EC at the beginning of SAWA:

In Germany, development of FRMP is an ongoing process and is expected to be on time set by 2007/60/EC. On the national level, German Working Group on water issues of the Federal States and the Federal Government- LAWA (2010) published the document "*Recommendation on development of flood risk management plans*" which serves as general guideline and is currently being considered for development of FRMP in Germany. The PRA has been accomplished and the areas with the significant risk identified.

3.6.2 Norway

In Norway, flood management has been taken care of by the local municipalities in cooperation with the state. The department taking care of the states responsibilities is the Norwegian Water Resources and Energy Directorate (NVE). This practice has its origin in a White Paper, no. 42 (1996-1997).

For the Norwegian pilot regions the Norwegian Water Resources and Energy Directorate has been the main actor. One of the plans (Gaula) has been developed in close corporation with the municipality (Melhus municipality).
The local municipalities have the responsibility for safe building ground including flood risk management. Land use and planning are regulated by the plan and building act, which places the responsibility for planning according to the law to the municipalities and the regional planning authorities. The municipalities are obliged to regulate land use in a sustainable way that will be the best for individuals, the society and future generations. Affected authorities have the opportunity to object to the municipal plan in matters that are of national or regional significance, or of other important reasons. The municipalities have, in cooperation with local police authorities, the responsibility for the local preparedness. If there is need of structural measures to protect existing buildings, the municipality applies to NVE for funds.
The governmental pyramid is given in Figure 3-8.

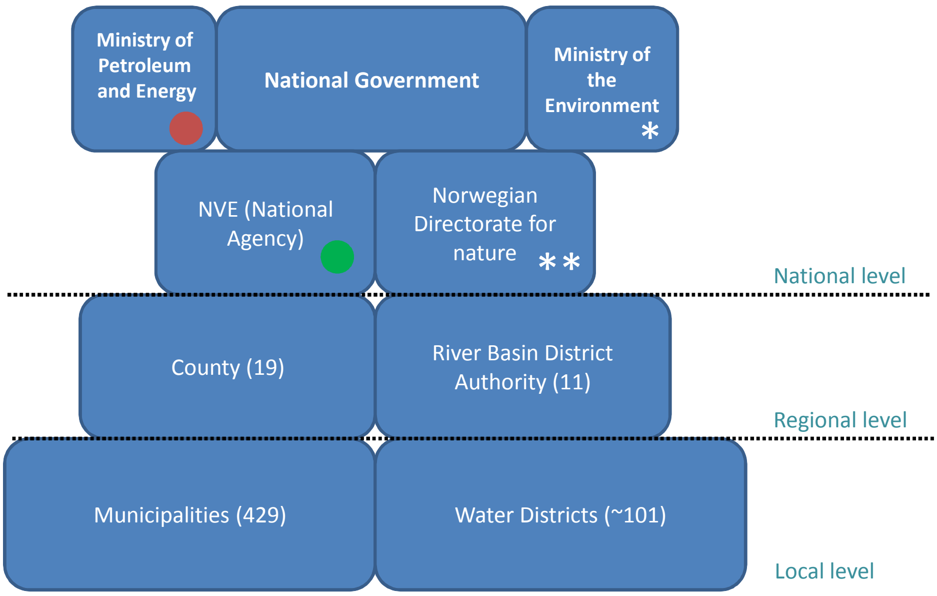


Figure 3-8: Governmental pyramid for some water related tasks in Norway. The red dot indicates the responsible agency for implementing the flood directive; the green dot indicates the SAWA-partner (source: NVE).

Existing flood risk management in Norway includes both structural and non-structural measures. The focus however has mainly been directed towards structural measures, which we have tried to balance by introducing some new non-structural measures.

In terms of the implementation of FRMP the issue of <u>significance</u> has to be raised.
In general, the Nordic countries have made use of the fact that they are sparsely populated areas when defining the term of significant flood risk. In sparsely populated countries, it will not be beneficial to include all rivers and streams in plans, because by some rivers there are hardly any settlements or structures.
The total length of all rivers in Norway is 410.000 km, but far from all possible flood prone areas are developed. In many flood prone areas the structures at risk are solely roads and

railroads, which are important, but the consequences of flooded roads cannot compare with the consequences of flooded cities. By European standards, there would be few areas in Norway, if any, with adverse consequences at a noteworthy level. It is expected that Norway will identify approx. four areas with significant flood risk.
Also, an important aspect for the pilot region Tana is the role and position of the ethnic group Sami. Today Sami in Norway, Sweden and Finland each have their own representative (political) body – the Sami Parliament. Finnish Sami were the pioneers, founding the Sami Parlameanta in 1973 and established thus a model, which became the basis for the Norwegian (1989) and Swedish (1993) Parliaments. The Sami Parliament of the different countries do not have decision-making powers in matters concerning Sami, but serve in an advisory capacity. Despite of this the Norwegian Sami Parliament has from the very beginning been able to have a great influence on the different Sami issues. The political mandate of the Sami Parliament includes all issues that the Parliament considers affect Sami interests. The Sami Parliament's activities are twofold: (1) to serve as the Samis' elected political body to promote political initiatives and (2) to carry out the administrative tasks delegated from national authorities or by law to the Sami Parliament. The parliament works with the issues that are considered to relate to or are of special interest for the Sami people. One of the recent developments related to the Sami issue is that the Norwegian authorities now have an obligation to consult the Sami Parliament in all the cases where Sami interests are affected.

Status of the implementation of 2007/60/EC at the beginning of SAWA:

Norway has not implemented the 2007/60/EC yet because it is not a part of the EEC agreement.

3.6.3 Sweden

Sweden is traditionally a decentralised country with a lot of power delegated to the local level, i.e. the municipalities. There is no single national agency in Sweden responsible for flooding and flood protection issues. The municipalities are thus the sole responsible groups for protecting its citizens against flooding by preventive measures and emergency services.
Two national agencies exist, being the Swedish Civil Contingencies Agency (MSB) which is responsible for implementing the 2007/60/EC and the Swedish Agency for Marine and Water Management which is responsible for implementing the 2000/60/EC. At the regional level 21 County Administrative Boards are responsible for carrying out part of the work to implement both directives at the regional level. Five of these County Administrative Boards are at the same time Water Authorities, which coordinate the work with implementing the 2000/60/EC. The SAWA-partners, the County Administrative Boards of Värmland and Västra Götaland belong to this administrative level, the latter one being one of the five Water Authorities. The municipalities (290) are responsible to provide water of good quality to its citizens and treat sewage waters and carry out measures for flood protection. An overview with the main responsibilities is given in Figure 3-9.

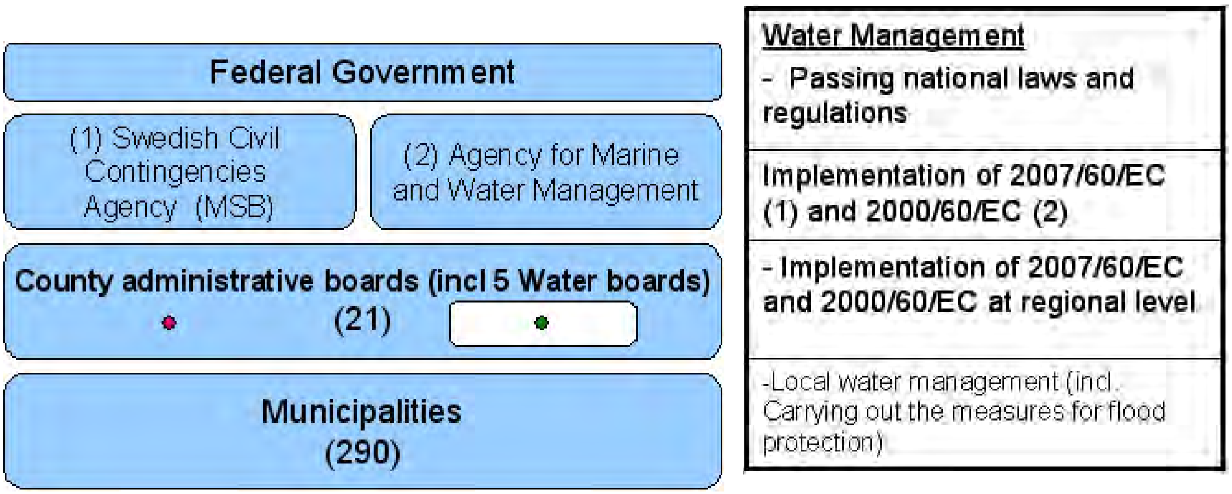


Figure 3-9 Swedish administrative structure (red dot indicates County Administrative Boards of Värmland and green dot Västra Götaland which is at the same time one of the five Water authorities

An important aspect shaping flood management in Sweden is that it is the responsibility of each municipality to work out flood risk plans and guarantee good emergency preparedness.

There are however a few issues of special importance where the County Board has the power to overrule a local plan, and one of these issues is risk of flooding. When it comes to preventive measures for flood protection the County Boards and the national agencies (The Swedish Civil Contingencies Agency, the Hosing and Planning Board and the Environment Protection Agency) give advice and some financial contribution to initiatives from the local level, but leave it essentially to them to launch flood relief programmes, either local ones or in co-operation with neighbouring municipalities.

The Swedish Civil Contingencies Agency, MSB, that for example supports the local work of the municipalities by compiling and maintaining general flood inundation maps, created basic data for prevention work with the help of available models for those areas at risk close to watercourses. The maps are intended for use during the planning of emergency services work and as a basis for land use planning by municipalities. They can also be used as basic data for various risk and vulnerability analyses. The watercourse model can also be used during the emergency stage of a flood to calculate probable water levels and the development of water discharges during the flood.

The MSB has also established so called local river groups. Theses groups are a forum for collaboration between and coordination of concerned stakeholders in the drainage basin area of a river. The collaboration increases knowledge about responsibilities, function and capacity of the stakeholders. The relevant County Administrative Board or boards convene. During major floods the state can, through the MSB, support municipalities with specific extra resources, which consist of e.g. sandbags, temporary flood barriers and water pumps. The incident commander can requisition materiel via the MSB's duty officer. Finally the MSB have available a certain amount of financial support to flood protection measures for municipalities to apply for.

At the regional level, the County Administrative Boards support the work of the municipalities and see to it that flood preparedness gets the appropriate attention in municipal physical planning and emergency preparedness.

In terms of significance, the issues raised for Norway also apply to Sweden. Sweden has identified 18 areas with significant flood risk.

Status of the implementation of 2007/60/EC at the beginning of SAWA:

At the beginning of SAWA the government had not even decided about the institution, which is responsible for implementing 2007/60/EC.

3.6.4 The Netherlands

In the Netherlands the operational water management is divided in national waters (the sea and the big rivers and lakes) and the regional waters. The National Ministry of Water Infrastructure and Environment is responsible for the national waters and the 25 Regional Water Authorities (Waterschappen) are responsible for the regional waters. The overall structure is given in Figure 3-10.

The ministry also provides legislation and policies on water management. The province is responsible for regional strategic water management and for example decides about the safety standards along regional waterways. The Regional Water Authority is responsible for the realization of standards for the regional water system including water quality and quantity and the safety standards. The regional water authorities have a status and structure that is comparable with a municipality with a regional water tax system and regional elections for the steering board. Some Regional Water Authorities have existed since 1300. The last decades they developed into bigger and integrated water management organisations. Due to this process the number reduced from 2500 in 1950 to 25 today.

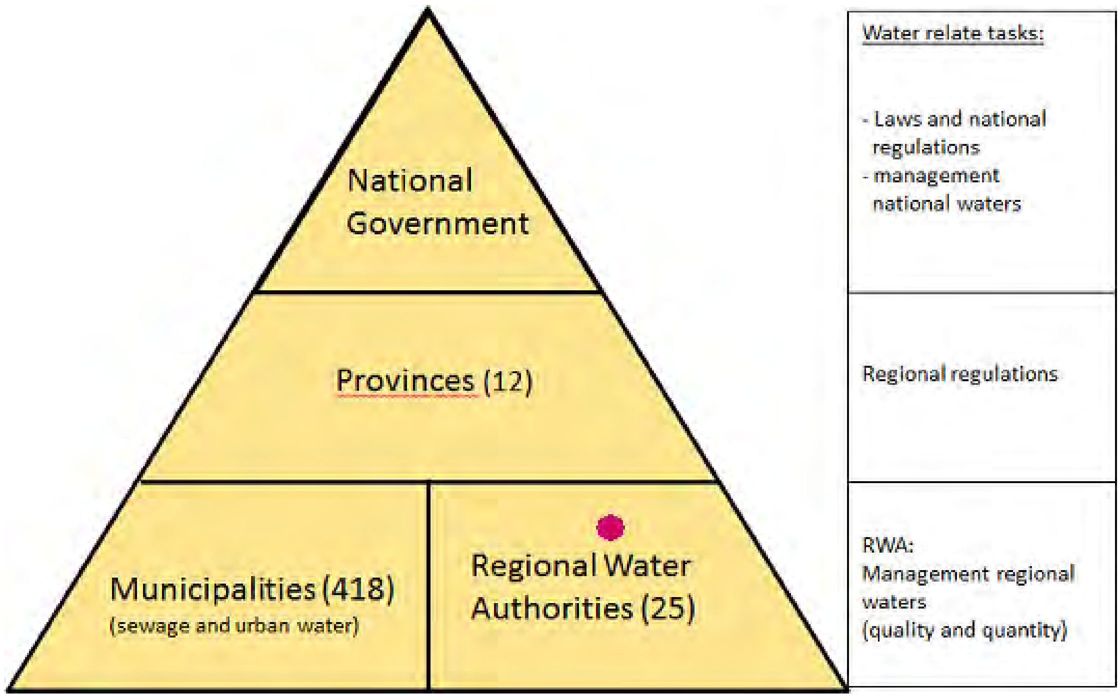


Figure 3-10 The governmental pyramid in the Netherlands with the responsibilities related to Water Management (red dot indicates the SAWA partner) (source: Hunze en Aa's)

Status of the implementation of 2007/60/EC at the beginning of SAWA:

In the Netherlands in the last decade many plans to reduce flood risk have been made by all Regional Water Authorities and by the National government. Therefore it has been decided that for 2007/60/EC first all existing plans will be collected and put together in concept-FRMP's. In a next phase these concept FRMP's will be evaluated and the missing parts will be added. This is a top down organised action. This means that participation was mainly done in the processes related with the previous plans.

Summary:
This analysis indicates a rather heterogeneous situation and context in the partner countries in terms of administrative structures, responsible institutions for implementation of 2007/60/EC and status of the implementation. The role of the national contexts and different planning activities and relevant directives are given together with the description of the strategies for development of FRMP in the pilot regions.

4 SAWA Flood Risk Management Plans

4.1 Summary

This chapter presents the Flood Risk Management Plans (FRMP) developed within the SAWA Project. Different working approaches are presented and the experiences gained during the process are outlined. The developed FRMP are given as the following (Figure 4-1):

- Germany: the Wandse and the Illmenau[6] river,
- Norway: the Gaula and the Tana rivers
- Sweden: Lake Vänern and the river Klärelven.

Originally, the river Trysil, Norway was selected for the development of a transnational FRMP, as it continues into Sweden where it changes names to Klarelven. According to Norwegian and Swedish criteria for making a FRMP, floods in River Trysil will not have enough impact on human health, culture, etc to be considered significant. Nevertheless, NVE wanted to make a pilot plan as an exercise to learn what it takes to meet the EU regulations. When capacity problems made the river Trysil project difficult to conduct, it was decided to relocate the project area to another cross border river, River Tana in the north of Norway. Tana is also a cross border river with comparable flood challenges.

- The Netherlands: the Hunze en Aa's region

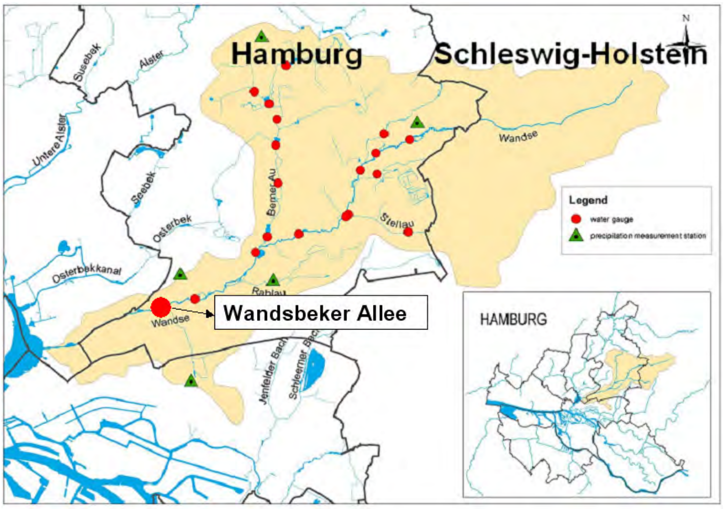
Figure 4-1 Overview of the pilot regions

[6] For the Illmenau river, an integrated river basin management plan has been developed, which includes measures that mitigate the flood risk.

4.2 Flood Risk Management Plan-Wandse, Germany

4.2.1 Description of geographical area represented by the FRMP

The catchment area of the river Wandse is about 87 km^2, whereby 60 km^2 is located in the Hamburg area and 27 km^2 belongs to Schleswig- Holstein as depicted in Figure 4-2. With a length of approx. 21 km (~ 17,3km in Hamburg), it is the longest tributary to the river Alster. In terms of its topographic characteristics it is considered to be a low-lying area (0-80 m as), spreading from the NW to SE. The upper catchment is close to the natural state and is dominated by farmland and nature protection areas. The main urban area, located in the mid and lower catchment, is a high-density residential area dominated by detached buildings (23,85% out of all landuse types in the Wandse catchment). The industrial area is mostly located in the mid and lower catchment, in part directly at the river (e.g. Yeast factory at the km 4.500 or a commercial centre encroaching the river Wandse at the km 12.162). 66,6 % of the catchment drains in the separate system, the lower catchment part to the combined sewerage system. The main characteristics of the Wandse catchment are summarised in Figure 4-2b.
The largest borough dominating the catchment area of the river Wandse is the Wandsbek borough, with 409.771 inhabitants (http://www.immobilo.de/stadt/hamburg/hamburg-wandsbek-bezirk).



Catchment Size 87 km^2
Watercourse length 20 Km

Topography:
- predominantly lowland
- 6-48 m a s l

Soil type:
- dominated by medium to light clayey sand

Urbanization type:
- differentiated; upstream and middle part areas are closer to the natural state

Sewerage system:
- partly combined, two third of sewer system is of separate nature

Figure 4-2 a) The Wandse catchment area and the summary of the main characteristics of the Wandse catchment. The main gauging stations of the river Wandse and its tributaries are highlighted in red (Golder, 2009) b) Summary of the main parameters of the Wandse catchment

4.2.2 Flood problems /relevant flood types

In terms of its flood typology, this catchment is characterised by a combination of pluvial and riverine floods[7]. The catchment has a good network of gauging stations as depicted in Figure

[7] Although Flood Risk Management Plans are not applicable to floods due to sewerage overflows, they are given here.

4-2. The recorded history of recent floods of the river Wandse dates back to 1998. The historic flood events are given for the downstream rain gauge Wandsbeker Allee 99341 in Table 4-1.

Table 4-1 Historic flood events at the gauging station Wandsbeker Alle (see Figure 4-2) (source: Golder, 2009)

Date	Peak discharge [m3/s]	a.r.i
October 1998	Q= 5,2 m3/s	1-2
February 2002	Q= 8,5 m3/s	3-5
July 2002	Q= 10,9 m3/s	10
July 2005	Q= 6,4 m3/s	2-3

The combination of pluvial and fluvial floods in small, highly urbanised catchments (such as the Wandse catchment) represents one of the dominant flood typologies in the city of Hamburg. Due to the high level of urbanisation, which is to continue in the future (according to the ongoing concept of the City of Hamburg "Growing city" http://wachsender-widerstand.de/wachsende-stadt-fortschreibung.pdf), this area is considered to be highly vulnerable to floods in the future and therefore it is relevant for the development of a FRMP.
It must also be mentioned that flood problems in the Wandse catchment have been sporadically addressed within programs of diverse action groups acting in the Wandse area. It has been either integrated into the initiatives dealing with the watercourse as a whole or within urban planning strategies or the protection of natural areas. Some examples of such groups are Rahlstedt e.V (natural protection and river as a whole) or Kleingartenverein Am Berner Wald e. V (urban planning).

4.2.3 Other directives and planning activities in the area

Water framework Directive (2000/60/EC)

A detailed plan of possible WFD measures in the Wandse catchment has been developed and is available at the local authorities. The existence of such a catalogue enables integration of and harmonisation with WFD measures from the initial planning phase in FRM.
The catalogue of WFD measures encompasses the types of measures together with the river sections where they are to be implemented. Those measures are mostly related to the following activities:

- restoration of natural conditions and flow capacity along the river (e.g. removal or modification of the existing weirs)
- improvement of morphological river structure (e.g. activation of flood plains, improvement of the river conditions during droughts)

The implementation of those measures is still pending; approx. 80% of the planned measures are now considered for the implementation. This enables good coordination with the measures to be developed as a part of FRMP.

Additionally, a thorough analysis of the potential for has been performed (HCU, 2011). The synergetic potential of the WFD measures (200/60/EC) as well as of the SUDS has been assessed at the catchment level indicating the potential for "hitchhiking" (HCU, 2011). Figure 4-3a illustrates the assessed retention capacity of the Wandse river and its tributaries, whereby Figure 4-3b shows the potential of SUDS (here the combination of swales and trenches) to retain water based on the hydro-geological conditions, landuse and availability of the area (HCU, 2011).

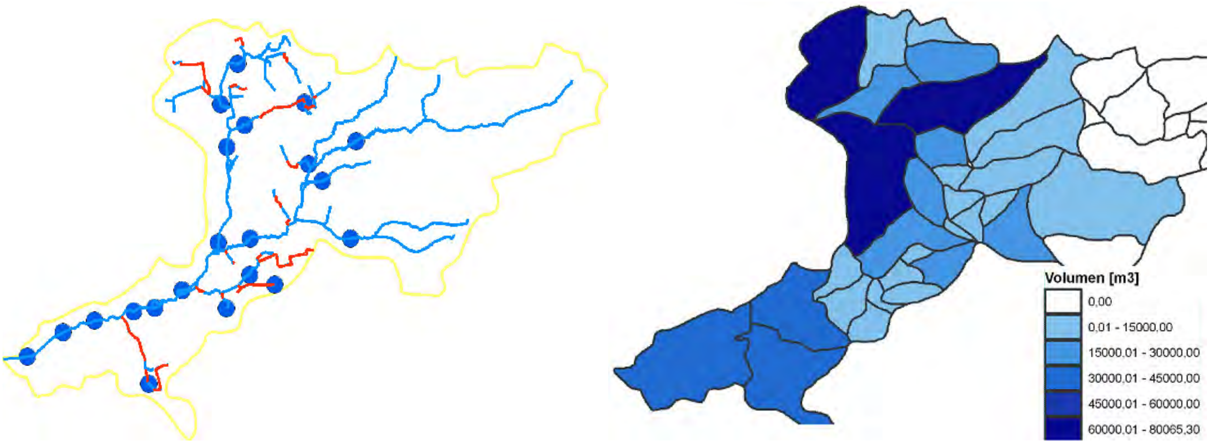


Figure 4-3 a) Assessment of the retention capacity of the river Wandse and its tributaries (HCU, 2011) b) assessment of the retention potential of swales with trenches at the catchment level (HCU, 2011)

Spatial Planning

The concept of the "growing city" is an umbrella term for all urban development activities in the City of Hamburg influencing the city planning in the Wandse catchment. Through urban infill the fallow areas should be urbanised and the population density of already urbanised area should increase.

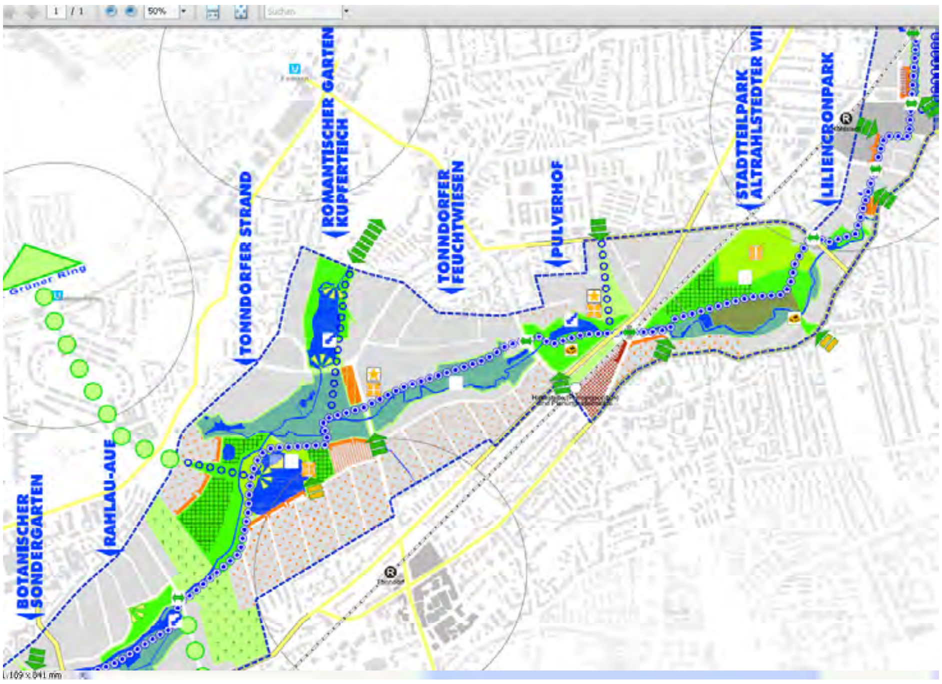


Figure 4-4 Current strategy of the urban development along the river Wandse (BA Wandsbek, 2010)

The current strategy of development in the Wandse area implies infill of urban fabric in the catchment, but also directly along the river Wandse with “grabbing at the edges” as depicted in Figure 4-4. Here the river Wandse (blue dotted line) with the main planned urban development activities is seen, located directly in the flood plains of the river. This driver of future development is to be considered when assessing the future risk in the area.

Other directives and planning activities

The upper catchment part is designated as a naturally preserved area. Höltigbaum). Also, there are potential contaminated sites in the area directly on the riverbank in the mid catchment part (“Alte Fabrik”) which should be considered for the definition of planning options.

Adaptability to Climate Change

The existing studies (Golder, 2009, KLIMZUG-Nord, 2011) on the influence of climate change to flood risk indicate increases in flood hazard as depicted in Figure 4-5. Still, the aspect of climate change has been considered just as an additional aspect to be analysed and was not decisive for the assessment of the efficiency and effectiveness of NSM.

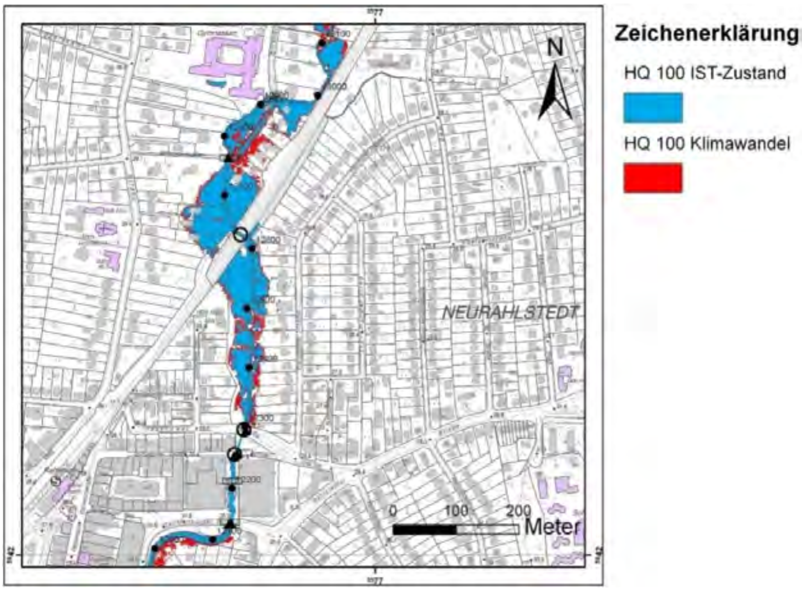


Figure 4-5 Influence of climate Change to flood hazard in the Wandse catchment (Golder, 2009)

4.2.4 Framework for the Participatory Planning (Governance Process)

Development of the flood risk management plan- Wandse (FRMP) has been performed by means of the Learning and Action Alliances (LAA). It implements a bottom up governance approach and has been used as a communication and decision making platform throughout the process. The LAA extends the concept of the “Learning Alliance”, which Batchelor/Butterworth, 2008 define as a [group of individuals or organisations with a shared interest in innovation and the scaling-up of innovation in a topic of mutual interest], by emphasising the importance of the “active behaviour” in the learning and planning process. This concept of LAA has been designed as a spiral process subdivided into 4 main phases: “Scoping”, “Understanding& Envisioning”, “Experimenting” and “Testing & Evaluation”. Here, public and professional stakeholders of the Wandse catchment developed the FRMP together in a 4-step-cycle composed of *scoping, understanding and envisioning, experimenting and evaluation*.

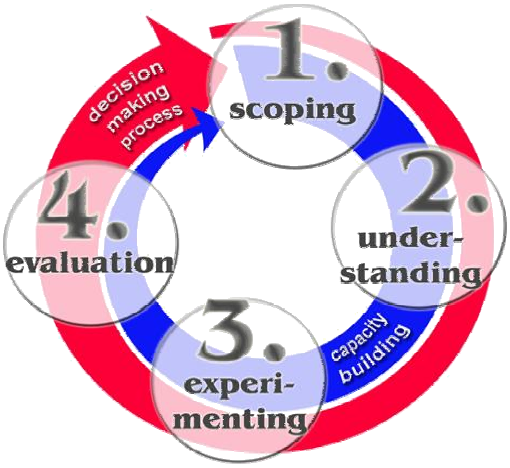


Figure 4-6: General Framework of Participatory Planning in a LAA (Adapted from Ashley/Blanksby, 2009)

The main objectives of the single phases are summarised in Table 4-2.

Table 4-2 The main phases of the LAA Approach and their objectives

Phase	Objectives
Phase 1 scoping	(Stakeholder analysis) Development of shared vision of the problem
Phase 2 understanding	Development of shered vision of where to get to
Phase 3 experimenting	Formulate options of adaptive flood risk management by NSM
Phase 4 evaluation	Adoption of the final FRMP

In this cycle capacity building and planning/decision making run in a diametrical order. While at the beginning the focus lies on capacity building/learning, the intensity of planning and decision-making increases in the order of workshops.

Stakeholders analysis

Due to a high diversity of institutional and legislative framework a detailed stakeholder analysis supported by the guidance for the selection process preceded the planning process. The stakeholder groups have been either directly addressed or “snowballed” through the existing contacts, building upon the existing networks and initiatives in the area. As the selected approach is of the bottom up nature, both professional and private stakeholders have

been considered for the participation. Table 4-3 outlines the main stakeholder groups considered for the LAA Wandse and the corresponding number of participants.
While it had been rather straightforward to recruit the professional stakeholders, some challenges have been encountered selecting and motivating the persons out of the public and the NGOs. Finally, a public interest group has been recruited which is active in supporting a larger nature reserve area at the upstream part of river Wandse as well as some NGO members concerned with the good ecologic conditions along the river Wandse. The private stakeholders involved belong to the groups of "champions" and joined the process on their own initiative. In the end 25 stakeholders could be recruited with a good representation of the relevant stakeholder groups as given in Table 4-3a, which coincide with the stakeholder groups suggested by the LAWA, 2010 guidelines. The public representatives turned out to be especially beneficial as they seem to be leaders in public opinion and serious in wanting to learn and cooperate within the team.

Table 4-3 a) The LAA- Wandse configuration/ per number of stakeholder group (Manojlovic et al., 2011)

Categories of Stakeholders	Nr of partic
Strategic flood and drainage management	4
Implementation and maintenance	3
Urban development	2
Agriculture	0
Urban and landscape design	1
Environmental protection & nature conservation	3
Emergency services	1
Politicians	2
NGOs	2
Public interest groups	2
Economy and Industry	1
Research	4

All stakeholder groups have to be understood in their responsibilities, temporal and spatial scale of activity and their relationship between each other. Appendix B gives the main parameters determined during the stakeholder analysis. On this basis it has been possible to detect overlapping responsibilities, institutional obstacles and barriers as well as competition and redundancy in competence between stakeholder groups, which are indicators of emerging conflicts in the cooperation of stakeholder groups (Appendix B). These results helped to assign the stakeholder groups the adequate role within the LAA.
The information collected has been given either in a tabular or graphical form. Figure 4-7 depicts an example of the current relations among the stakeholder groups being a) asking for

approval and b) participatory planning. Whereby the stakeholder groups already interact in a form of asking for approval, the participatory planning is underdeveloped among the observed stakeholder groups and needs further improvement through empowering of stakeholders to work together more efficiently.

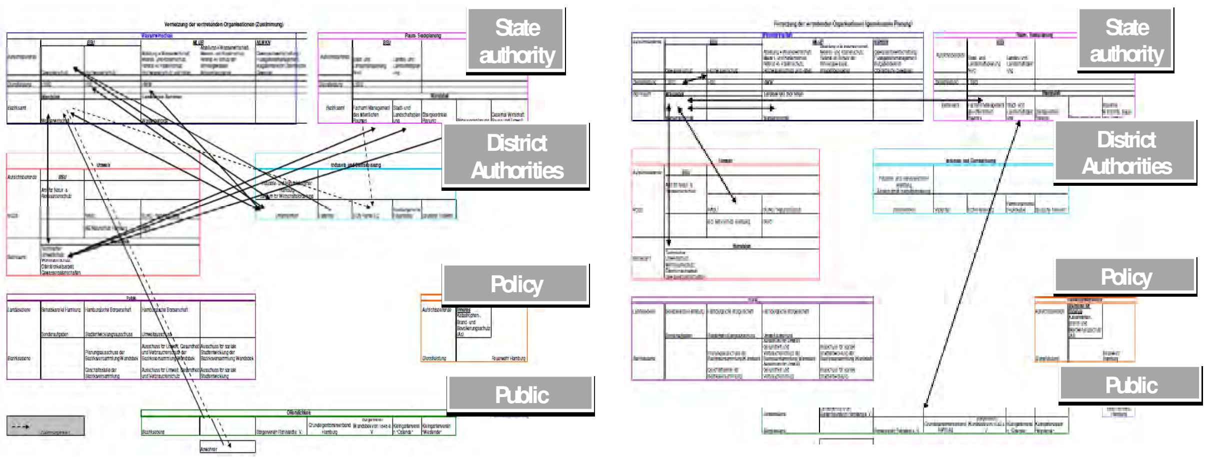


Figure 4-7 The relationships among the stakeholders before the FRMP a) Relation "approval" b)participatory planning (source: TUHH)

Stakeholder Involvement and the conduction of the process

Learning& Action Alliance Wandse (LAA) has been implemented as a set of workshops that took place in the period of 05.10.2009- 03.11.2011 under the leadership of the LSBG (formal leader), which is the responsible authority for development of FRMP and the SAWA partner at the same time. Two Universities participated in the design and contents of the single sessions (Hamburg University of Technology and Hafencity University). In addition to face-to-face sessions, an online participation has been integrated into the process (http://laa-wandse.wb.tu-harburg.de/) with the objective of supporting the data exchange and communication beyond the workshop sessions. It supports the basic principle of the LAA that all information that is available will be given to stakeholders and discussed and evaluated in most objective and fair way. The participants were also encouraged to leave their opinions in the forum provided within the platform. On site visits support the understanding of the system and specific problems in the area. The summary of the main activities implemented within the LAA is given in Table 4-4.

Table 4-4 Implementation of the LAA for the project area Wandse, Hamburg (source: Manojlovic et al., 2012)

Type of activities	Description
Constitution (Kick-off meeting)	- An official session with the objective to Increase profile of the LAAs and raise awareness among decision makers/ politicians
Phase 1-4 **14 Working sessions,** **once a month/ 2months, 2 h each**	- Working sessions following the phases of the governance approach given in Figure 4-6 - Core part of the LAAs

One site visits	- Assessing the criticality of the system - Embedded into the phases of the governance approach
Online participation **via the LAA- Wandse portal** **(**http://laa-wandse.wb.tu-harburg.de/**)**	- Making available materials relevant for the sessions - Scoping the expertise of the participants via forums

Constitution (Kickoff LAA)

The LAA has been constituted at an official session involving high-ranking politicians and relevant decision makers. This helped in raising awareness of the LAA process among the decision makers and institutions involved.

Phase 1- "Scoping"

Phase 1 sets the framework for planning by scoping the flood problem to be addressed in the planning process as well as the interrelations and activities of the key players in the local flood management. At the end of phase 1 the LAA members should develop a shared vision of the problem as given in Table 4-2. In order to scope the problem, the main issues addressed during this phase can be summarised as:

- scoping and understanding the roles of the relevant stakeholder groups, their interests and limitations
- scoping the current flood risk (probability x consequence) in the existing system (the Wandse catchment)
- scoping and understanding the criticality of the system by assessing its weak points and quantifying the effect of their mismanagement
- scoping the future flood risk considering the main drivers of future development, being climate change and urbanisation

This phase is very learning intensive as the baseline for planning and decision making has to be created, helping the members to get a common understanding of the problems. 4 sessions have been organised and conducted within this phase including an onsite visit.

Understanding the system started with understanding and accepting the activities and interests of the other LAA members, developing mutual trust among the LAA members. For that purpose the social games have been applied, supported by discussions on the roles of different stakeholder groups, their interests and motivation for participation as shown in Figure 4-8a. At the beginning the stakeholder group has been rather fragmented with diverging interests and ideas of what the role of different stakeholders should be. The attitude towards the social games among the participants changed throughout the process. It has been especially difficult for professional stakeholder to get out of their comfort zones and be open for interdisciplinary planning, which positively changed during the course of the LAAs. Also, the discussion about each professional background and interest in the river Wandse was most supportive in creating understanding and team spirit.

Figure 4-8 a) Social games during the phase 1 of the LAAs b) Understanding risk by understanding the flood maps (source: TUHH)

In the next step the participants had a hands-on experience with the flood maps, which were supported by the "e lectures[8]" where the language of risk was presented in a clear and distinct way. These e lectures were available via the LAA platform. For envisaging flood risk and raising flood risk awareness among the participants the consequences of floods to people and properties the Flood Animation Studio (Manojlovic/Pasche, 2011, Nyberg et al., 2012) has been applied (Figure 4-9a). During the live simulation the flood room (2x2x2 m³) is flooded within minutes. A person is "living" in this room and has to respond to this flood by securing all values (computer, laptop, passport etc.) in the room. The other stakeholders were standing around the box and observed the event.

In order to understand the sensitivity and criticality of the system an onsite visit has been organised. The weak points along the river have been assessed and the impact of their mismanagement (failure analysis) quantified utilising the Kalypso modelling Suite (http://kalypso.bjoernsen.de/) as depicted in Figure 4-9b. The flood risk has been projected to the future considering the climate change aspects (Golder, 2010) and urban planning projections in the area as introduced in chapter 3.

[8] A combination of presentations and videos

Figure 4-9 a) Flood Animation Studio b) Sensitivity of the system assessed during an onsite visit and application of mathematical models (Kalypso). The blue areas indicate additional flooding due to the blockage of the bridge at Km 12.162 (source: TUHH)

The final issue to discuss openly is what an "acceptable risk" means, considering both current and future risks. The available flood hazard (Figure 2-13) and risk maps have been taken as a basis for discussion. This turned out to be more of a social issue than a question of expertise. Also the factors shaping the future development have been discussed in that context. Due to high uncertainty of the future projections, certain reluctance towards consideration of climate change has been reported by the responsible authority and water management sector.
At the end of this learning phase the stakeholders improved their awareness of the current and future flood risk in the area and the group shared the idea of the flood problem in the Wandse catchment, marking the first milestone of the learning cycle.

Phase 2- "Understanding&Envisioning"

Phase 2 of the LAA is the key to opening towards flood risk management planning, as stakeholders have to give up their traditional ways in dealing with flood issues and to develop new skills and understanding. This phase can be understood as a delivery of the toolbox for the planning procedure taking place in phase 3.
In that sense, 3 sessions have been organised with the main objective of introducing the possible measures to mitigate flood risk (as introduced in chapter 3) as well as to highlight the synergies and conflicts (potential of "hitch-hiking") with the measures already agreed on in the River Basin Management Plan (RBMP). The effect of those measures as introduced in section 4.1.3 has been quantified, indicating a potential for risk mitigation (e.g. SUDS), but at the same time requiring more room for river when restoring river sections in order to be able to convey 100-year floods. This should be considered when developing planning options in phase 3. Capacity building methods supported stakeholders to acquire the required knowledge for planning utilising face-to-face sessions or making use of the e-lectures.
At the end of phase 2, the main objective of the FRMP is envisioned, i.e. the LAA members developed a shared vision of how to deal with the flood risk by reducing it to the "acceptable level" defined in phase 1, considering both the current situation and drivers of future development such as climate change and urbanisation. It has been agreed upon to consider a 200- year flood as a goal of FRMP, assuming that it would implicitly include the uncertainties of the future developments.

Phase 3- "Experimenting"

After the agreement on the objectives of the flood risk management plan, the stakeholders entered the "concrete planning phase"- phase 3. Within this phase, the participants could make use of the new knowledge by selecting the appropriate structural and non-structural measures and discussing them with the other participants. 5 sessions have been organised where the participants were enabled to have a hands on planning experience either by editing the measures on a map (Figure 4-11a) or in the final phase by the means of the DSS Tool (KALYPSO- Planner Client Figure 4-10b). For the purposes of the interactive planning, the KALYPSO- Planner Client has been enhanced to support multi touch technology (as shown in Figure 4-11b), enabling a group of participants to simultaneously perform planning.

All measures suggested by the LAA members have been divided into the quantifiable and non-quantifiable measures.

Based on the suggestions and given retention potential, the planning options have been defined and their efficiency and effectiveness assessed utilising the DSS KALYPSO- Planner Client. For the purpose of the modelling, the whole catchment has been divided into 6 sub-catchments for which different combinations of the measures have been defined and grouped in so-called simulation cases. Over 250 simulations have been run to assess the efficiency of the suggested quantifiable measures to mitigate the flood risk in the Wandse catchment. An example of the efficiency assessment performed by the Kalypso- Planner Client tool has been shown in Figure 4-10b. A cost estimation of the combination of the measures has been exemplified, but not systematically performed. An Internet based tool FLORETO (http://floreto.wb.tu-harburg.de/) has been used to support the risk mitigation of the built environment at the property scale. Based on the assessed risk of the properties, the adaptation strategy is suggested by the tool for which the cost benefit analysis is performed (Manojlovic/Pasche, 2010). For the scope of the planning process within the LAA, an exemplified assessment of selected buildings in the Wandse catchment has been performed, illustrating the potential of flood resilient measures to mitigate flood risk. A more detailed description of the tool has been given in the SAWA Report on DSS and a summary in chapter 3. At the end of phase 3, a portfolio of the planning options is developed by the LAA members.

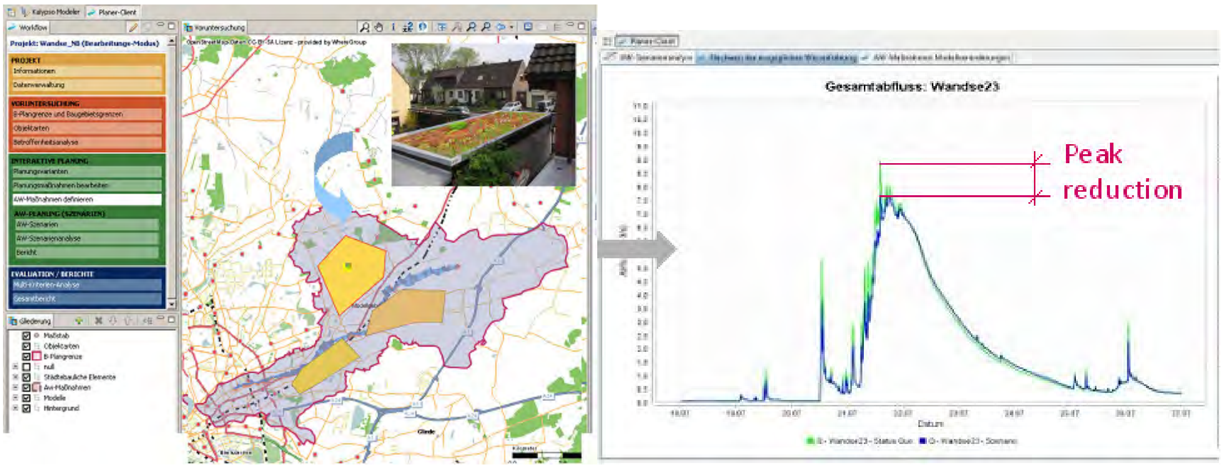


Figure 4-10 An example of the assessment of the efficiency of the measures utilising the Kalypso- Planner Client (here green roof) (source: TUHH)

Figure 4-11 a) Developing planning options a) hands on maps b) utilising the multi touch board (source: TUHH)

Phase 4- ”Evaluation and Decision Making”

The final phase (4) of participatory planning is the process of finding the planning option with the lowest conflict potential. The process has been organised in two steps. In the first step, the participants were asked to deliver their final opinion on the measures and their appropriateness and acceptability to be a part of the FRMP. For that assessment, all the measures suggested by the participants in the experimenting phase have been summarised resulting in a total of 26 statements. For each of them a decision-making matrix has been given with the objective of helping the LAA members to give their final opinion on the measures. The DM matrix for each measure is given with the main criteria given in Table 4-5.

Table 4-5 Criteria for decision making on the measures to be included in FRMP- Wandse given for an example of a measures suggested by the participants

”Creation of the continuity of the river Wandse and ist tributaries focusing on the Nordmarkteich and the river Ralau”

Criteria:	hydrologic efficiency	cost effectiveness	potential for implementation	synergies/ conflicts with the other planning activities
Assessment:	High (referred to the technical documentation)	Should be further researched	High, building upon the existing activities in the sense of WFD	High synergies related to the current activities of creation of the good ecological condition of the river

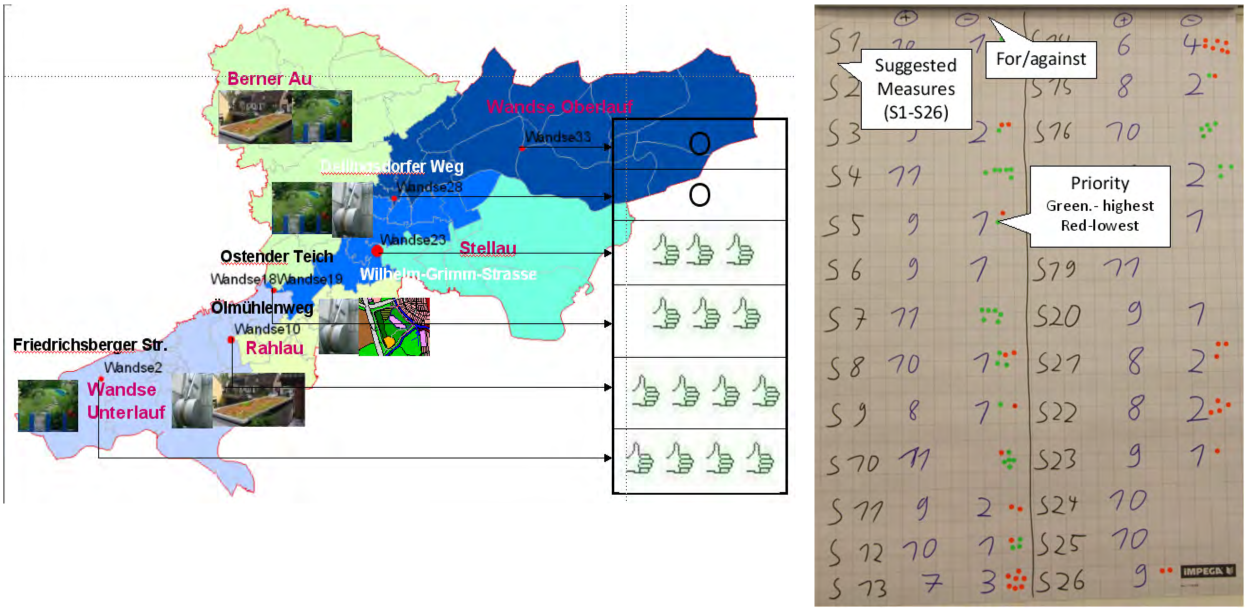


Figure 4-12 a) Assessment of efficiency of different measures used for the decision-making matrix b) Voting on measures. The figures indicate the number of participants consented and opposed to a measure. The dots indicate the priorities given to the measures (green- highest priority, red- lowest priority) (source:TUHH)

The DM matrix has been supported by the results from the experimenting phase and visualised as depicted in Figure 4-12a. The feed back from the participants has been used to create a conflict matrix. The analysis indicated high uniformity in the statements as illustrated in Figure 4-12b. A conflict potential has been identified in only 2 cases. Those measures were further discussed with the participants. In the second phase, the participants were asked to prioritize the measures for implementation by placing red and green dots (3 of each per participant) next to the selected statements (red- lowest priority, green- highest priority). Based on the results the list of measures defining the FRMP has been defined and the final conflict matrix has been developed. The remaining conflicts have been managed by defining the "acceptable level of conflict" and the statements have been partly reformulated.

4.2.5 Planning results- Flood Risk Management Plan

The final result of the planning process is the SAWA- Flood Risk Management Plan are composed of a written document following the LAWA, 2010 guidelines and the corresponding maps as given in Figure 4-13. In total 26 statements (measures descriptions including specific actions) are formulated and included in the plan. The measures are elaborated according to the structure given in the LAWA Guidelines. It defines the main scope of actions (Handlungsbereiche) as:

- Land use control
- On site retention in the water course and catchment
- Structural (engineering) measures
- Flood preparedness
- Contingency measures
- Capacity building
- Capacity building for contingency

- Recovery
- Regeneration

The measures adopted are given at different scales that are:

-the catchment scale (e.g. "the retention capacity of green areas in the upper catchment should be used for retaining rainfall. The potential should be assessed in a more detailed study building upon the preliminary results obtained during the SAWA planning process")

-the water course scale (e.g. "regular maintenance of the river to prevent blocking of the bridge river profiles due to debris flow")

-addressing the specific weak points in the Wandse catchment (e.g. " installation of a coarse rack at the outlet Liliencronpark")

Further, those measures are assigned responsibilities according to the LAWA guidelines and the tasks and responsibilities of different authorities participating in the LAA process.

The priority analysis showed that the highest priority is given to the probability reduction measures (SUDS) or restoration of flood plains and improvement of the morphologic conditions in the river (measures S4, S7, S16 resp. see Figure 4-12b).

The lowest priority is assigned to the construction or extension of new polders (S13, S14 resp, see Figure 4-12b). The member's arguments relate the low acceptance of those measures to the anticipated ecologic drawbacks but also to the unclear ownership of the land at the considered locations.

Here is to be mentioned that flood resilient technology on private properties is not a part of the official plan to be implemented by the responsible authority, according to LAWA, 2010. However, those measures represent a substantial part of the flood risk management cycle and have been indicated in the plan.

The SAWA- FRMP has a pilot status and should serve as a best practise document for the authorities and municipalities that are challenged to develop FRMP until 2015. The fact that the development and the implementation of FRMP is a novel task for most of the responsible authorities, including the LSBG, leaves the question open of to which extent the results of the SAWA process will be included in the final decision on activities in the Wandse catchment. In any case, due to its novel nature, the experiences from the FRMP- Wandse are expected to have an impact on the forthcoming FRM planning activities predominantly in Germany.

Also, the established stakeholder networks and measures will be used by other projects and initiatives giving the legacy of the LAA- Wandse another aspect (e.g. KLIMZUG- Nord http://klimzug-nord.de/ analysing the aspect of the adaptation of cities to climate change). As FRMP have to be revised every 6 years, the LAA Wandse is planned to be reborn in the moment of the revision phase. It is planned to keep the participants informed about the further activities in the Wandse catchment, especially regarding the implementation of measures and their control.

The quality control of the planning process and results has been performed though monitoring and the final evaluation after the process has been completed. The monitoring process took place after each session by asking the participants to fill in the questionnaire indicating their oppositions to the contents and the organisational aspects of the LAAs. The feedback has been used to improve the further sessions during the course of the LAA process. The results of the final evaluation are still in preparation and will be available by April 2012.

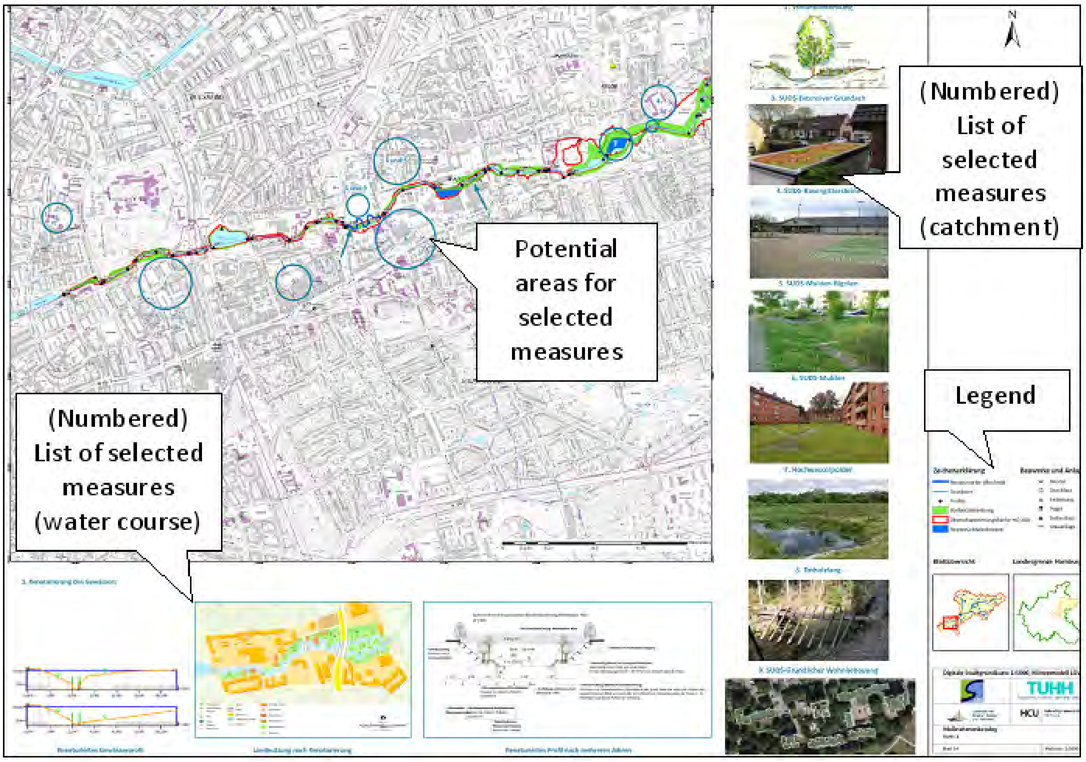


Figure 4-13 An example of the map depicting the measures and potential locations for their implementation (source: TUHH)

Public information and consultation

Within the whole process of FRMP the LAA has not been acting as a closed shop, but has informed the public and especially decision makers and politicians about their activities. Also, external experts have been invited to participate in the selected sessions or to comment and discuss through a public forum. A range of public presentation to both experts and non-experts contributed to the awareness of the process at the Wandse catchment (the list of the events and media reports can be found in the corresponding reports of the SAWA Project).
The SAWA- Wandse FRMP is currently being prepared for publishing as a document that will be accessible to the public.

4.2.6 Lessons learned- the Wandse catchment

The main finding during the process at the Wandse catchment can be summarised as the following:

Stakeholder involvement:

- Mutual trust is a key for initiating the participatory planning and required participation of the LAA members. It is a process for which enough time should be planned at the beginning of the LAA. The social science methods such as social games can be used to support overcoming the sector or personal barriers, strengthening the team spirit
- The sessions have to be inviting and attractive to participants especially in the initial phase

Process- Methods and tools applied:

- Good understanding of the system by delivering facts is crucial (such as quantification of the effect of pressures and drivers, NSM)
- Combination of capacity building with the decision making process important for empowering the stakeholders for active planning
- It is a time and resources intensive process that involves different tools (social, hydrodynamic, learning) and interdisciplinary teams (social science, hydraulic engineers, IT specialists, political sciences etc). The presented process took over 2 years for which preparation, conduction and post processing required over 750 person hours[9].

End Product- FRMP (e.g. content, legitimacy, legacy):

- The legacy of the LAA should be addressed during the process. Also, the potential of the LAAs to hibernate and be re-born should be explored.
- It must be made clear from the beginning what is expected at the end of the process (level of impact of the planning results)

4.3 Integrated River Basin Management Plan- Ilmenau, Germany

4.3.1 Description of geographical area represented by the RBMP/FRMP

The catchment of the river Ilmenau has a size of 2984 km², and is located at the west side of the river Elbe close to Hamburg. The Elbe River has a tidal effect on the lower part of the Ilmenau and one of its tributaries, the river Luhe. In 1973 the Ilmenau barrage was completed at the mouth to the Elbe in Hoopte to shorten the dike length in the case of storm surges.

The Ilmenau catchment is part of ecoregion 14, the central lowlands. The north is dominated by the flat marsh lands. The middle area is structured by several hills and the valleys of the rivers, especially the Ilmenau valley. Going south to the basin of Uelzen, a big flat area is surrounded by hills at the border of the catchment.

The precipitation in the catchment is 724 mm/a (1974-1999), which is less than the average precipitation in Germany. The western part has a higher precipitation than the eastern part. This lack of water is a problem for the agriculture in the county of Uelzen. A lot of water and energy is used for watering the crops. The catchment area is mostly used for agriculture (55%) and forestry (33%). The catchment is also crossed from north to south by the Elbe Lateral Canal.

The total number of inhabitants is around 320,000. There are three midsized cities in the catchment – Uelzen, Lueneburg (biggest city with 82.000 inhabitants) and Winsen – which are all located at the river Ilmenau and are the areas of the highest vulnerability. Beside these cities there are two smaller cities, Bad Bevensen and Bardowick, and 15 communities. The population density is 107 inhabitants per km².

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[9] Here it is to mention that the LAA has been implemented for the first time in this way and due to the ”learning effect” more efficient procedure in the next round can be exprected

The Ilmenau River is identified as a river with significant flood risk. It is also a priority water body for implementing WFD measures and is protected as a Flora-Fauna-Habitat area.

4.3.2 Flood problems/relevant flood types

In the catchment of the river Ilmenau the main causes for flooding are intensive rainfall in the wintertime – with or without melting snow – (fluvial flooding) or heavy rainfall in the summer time in a very short time (flash flood).

One special effect of the Ilmenau barrage in Hoopte can be the backwater effect if the gates are closed for a longer time due to a storm surge from the North Sea. This could affect the city of Winsen.

One of the results of the SAWA Ilmenau project is a historical analysis of flood events of the last 65 years. It shows that most events happen between November and March, with peaks in January and March. But floods also occur during the summer time, with a small peak in August which might be mainly flash floods.

During historical flood events there were some reports about the destruction of bridges, mills, roads and houses. Today the common problems from floods with a high probability are flooded roads, meadows and basements.

4.3.3 Other directives and planning activities in the area

Water Framework Directive (2000/60/EC)

In the Ilmenau pilot region, an Integrated River Basin Management Plan has been developed. In that sense, the aspects of measures in accordance to WFD have been considered from the beginning of the planning process. The procedure followed the methodology given in Evers/Nyberg, 2011 and is summarised in Figure 4-15.
Today, levees protect residents from flooding along this stretch of the river. From source to mouth the ecological continuity is interrupted many times by cross-river structures (primarily weirs). Whereas the upper and middle Ilmenau still clearly present semi-natural structures, below Lüneburg the river has been classified in the categories of the WFD as a heavily modified water body (HMWB) (Evers et al, 2011).

Spatial Planning

The Ilmenau River is predominantly a rural area, with the residential areas mainly concentrated in the urban areas of Uelzen, Lüneburg and Winsen. Agriculture, with its connected industry, has an outstanding importance for the economy of the region. To reduce the impact of flood events or flood events themselves, the agricultural and forestland would especially be considered to implement flood probability reduction measures (FPRM). Even though these areas have great potential to increase the retention in the catchment area, the implementation of measures has to be integrative to reduce the concern of agricultural sectors.

Within the project, the responsible authorities have been involved in the planning process and in that sense, the interests of the agricultural sector have been considered.

Other directives and planning activities

The Ilmenau also provides suitable habitat for the European otter (Lutra lutra). The designation of the Habitats Directive FFH protected area No. 71 “Ilmenau and tributaries” illustrates the high status and significance of this water body. The Ilmenau is classified as a first priority water body under the Flowing Waters Protection Scheme (Fließgewässerschutzsystem) of Lower Saxony (Das Niedersächsische Fließgewässerschutzsystem - Elbe Einzugsgebiet 1991). (Evers et al, 2011)

Adaptability to climate change

Due to the complexity, climate change has not been considered in separate analyzes. With reference to the North German Climate Atlas temperature will increase about 2K to 5K by 2100. The number of rainy days will increase in winter and decrease in summer. (http://www.norddeutscherklimaatlas.de/klimaatlas/2011-2040/jahr/durchschnittliche-temperatur/lueneburger-heidewendland.html, 22.03.2011). Further investigations are made in KLIMZUG-NORD.

4.3.3 Framework for the Participatory Planning (Governance Process)

Stakeholder analysis

The stakeholders in the SAWA Ilmenau project are mainly the counties Uelzen, Lueneburg and Harburg with their water management, nature conservation and planning administrations. They were chosen in a very early stage of the project process and contacted via phone and email. The counties supported the project with their expert knowledge, geo and spatial data and other information in the beginning of the project. During the later project phases the counties were actively involved in the development of the SAWA Ilmenau products.

Stakeholder Involvement and the conduction of the process

An integrative approach has been applied to involve the key stakeholders. There was close contact with the regional cooperation partners throughout the course of the project. The involvement of stakeholders took place in workshops, meetings and interviews. The ideas and results were discussed and refined together with the stakeholders during two workshops held at Leuphana University Lüneburg; practical relevance and practicability were also topics of discussion. The contents of the target area analysis and the possible measures from the matrix of the catalogue of measures can be included in the development of the flood risk management plans but equally in the management plans and planned measures for the Water Framework Directive in landscape and regional planning, etc. Thus, the agreed measures become incorporated by means of different tools into planning and management, making implementation more effective and efficient.

Figure 4-14 a) Hands on work during the workshops b) presentation of results (Source: Evers et al., 2011)

For identification of action priorities/-options, the steps given in Figure 4-15 were undertaken.

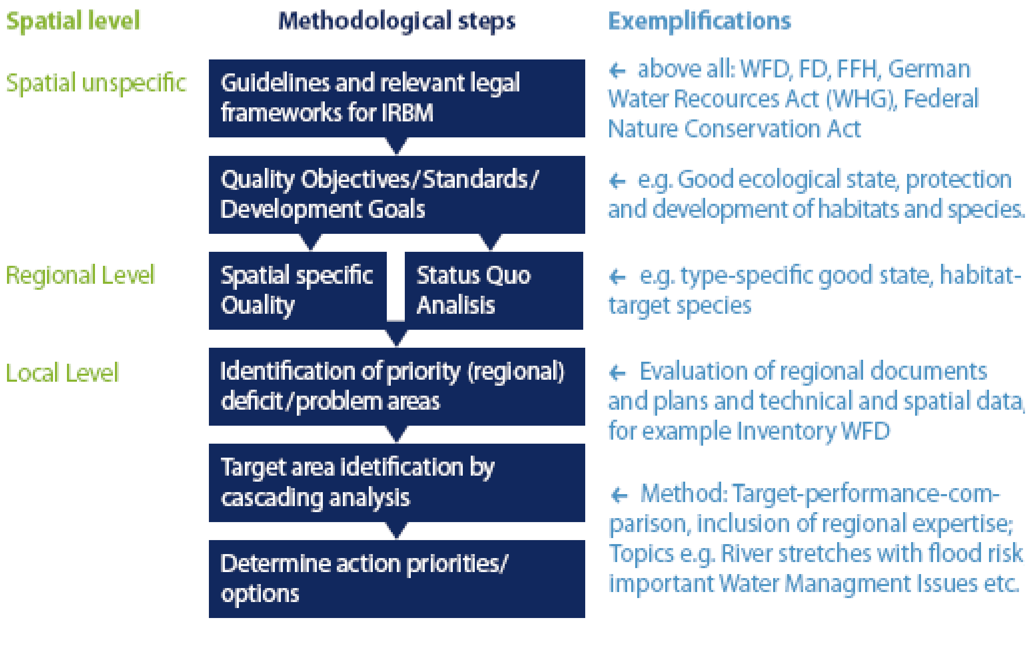


Figure 4-15 Methodological approach for development of the Integrative River Basin Management- Ilmenau (Source: Evers et al., 2011)

4.3.4 Planning results

The objectives for the river basin management plan for the river Ilmeneau have been to identify synergies between goals and measures for flood risk reduction and improving ecological status. A broad range of measures is planned. A matrix of measures related to all relevant planning fields like water management, agriculture or nature conservation has been developed. The RBMPlan indicates the most suitable areas for certain measures or a set of measures.

This takes into account the four subsidiary objectives of preventive flood risk management:

A Securing retention capacity
B Reclaiming/expanding retention areas
C Water retention on land
D Minimising the damage potential

This matrix of measures aims to provide the stakeholders with a quick overview of the various starting points and approaches to reducing flood risks and to list management measures and tools as well as plans and funding programs which may be relevant to a given local situation. The intention is to show that flood risk management is not purely a water management issue but one which can be influenced and approached by all stakeholders, both on an institutional and on an individual, private level. The fields of action for preventive flood risk management are summarised in Figure 4-16.

Figure 4-16 Fields of action for preventive flood risk management (Source: Evers et al., 2011)

The expected advantages from implementing the measures are identifying synergies, coordinating measures and pooling different instruments for the implementation of measures for a more efficient and effective accomplishment of the WFD and FD goals.

For this project, a digital catchment atlas (Ilmenau-Atlas) has been created with a series of maps and the corresponding information.

The Atlas contains identified target areas for
specific goals and measures. A target area analysis aims to focus on areas which are particularly relevant for a given analysis and which are thus potential areas for the implementation of management measures, such as restoration of a water body. The cascading GIS/analysis approach narrows down the areas step by step until the target areas are eventually identified. This approach provides a fast and relatively easily achievable overview of the major problem areas and suitable actions for the catchment area. Potential synergies can also be deduced from the results of multiple target area analyses. Diverse relevant The maps (such as hydrology, flood risk, landuse etc.) and maps illustrating the target areas for goals and measures are geo-referenced pdf maps and compiled in the Ilmenau Atlas).

It must be mentioned that in SAWA both structural and non-structural measures were identified, but there was no budget for implementing exemplary measures. In the Ilmenau region the joint research project KLIMZUG-NORD is analysing the aspect of adaptation to climate change (http://klimzug-nord.de/). The Chamber of Agriculture, Lower Saxony is testing the KLIMZUG-NORD measures such as infiltration of grey-water, storage of process water, re-allocation of agricultural land and its influence on water management and spatial planning. The established stakeholder network and measures will be used by this project, ensuring the legacy of the SAWA work and results.

4.3.5 Lessons learned- the Ilmenau catchtment

Stakeholder involvement:

- Include stakeholders in the early stage
- Stakeholders were very interested in the process and in looking for synergies between FD (2007/60/EC) and WFD (2000/60/EC).

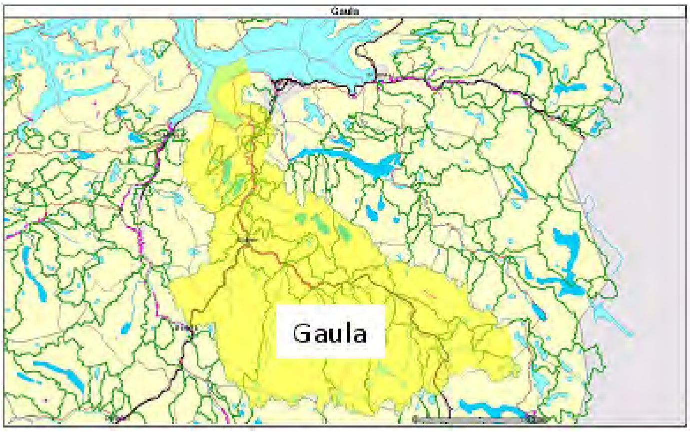
Process- Methods and tools applied:

- Use existing data as much as possible
- Look for synergies
- Catalogue of measures specified for all relevant planning fields
- Limitations and challenges: The main data problem for the project is based on the administrative situation, in which there are three main counties involved and several counties with very low parts of the catchment area. The spatial data in the project area is hosted by lots of different institutions and agencies with different policies in data contribution to scientific projects. Additionally the data is of a very different standard and not always covering the whole catchment area. Another problem was that elevation data, which are existent in a good quality/resolution are too expensive to buy for the SAWA project.

4.4 Flood Risk Management Plan –Gaula, Norway

4.4.1 Description of geographical area represented by the FRMP

The catchment of Gaula is 3566 km^2 and drains from southeast to north in the middle part of Norway. There are no lakes in the main channel and only a few small lakes in the tributaries. The area mainly consists of forest (37 %), bare rock (36 %) and swamp. Less than 1 % is developed area. 70 % of the area is between 300-900 meters above sea level while the highest point is 1332 meters above sea level. The river is steep in its upper area, and all tributaries show a considerable slope. The abruptness leads to fast runoff, which means that floods might happen within some hours. Because there are considerable amounts of quick clay in the area, there are locations that are extremely vulnerable to erosion.



The River Gaula

Catchment area (km^2): 3566

Total population: 23105 (sparsely populated)
Landuse: forest (37 %), bare rock (36 %) and swamp, <1% developed area

Figure 4-17 The catchment area of the river Gaula, Norway (highlighted in dark yellow) (source: NVE)

The area is sparsely populated. The river runs through three municipalities with a total population of 23,105. In the area at highest risk, Gimsøya, live approximately 350 people.

Gaula is protected against development for hydropower, however there are a few small-scale hydro power plants in the tributaries. The area has been a priority area for the implementation of the water frame directive.

4.4.2 Flood problems /relevant flood types

Flood problems in the region are related to floods in Gaula during spring, summer and autumn. The river is especially vulnerable for floods caused by intensive rains, but also spring floods caused by snowmelt can cause damage. Many of the villages are situated near the river, partly in flood prone areas. Floods in the past caused by heavy rainfalls have showed devastating damages. These floods are estimated to have large return periods. However, the climate change may cause more heavy rain and such events could be less seldom in the future.

Floods in Gaula have a tendency of happening very fast, and the summer and autumn flood can be especially difficult to predict. Historical floods have destroyed farms, houses, bridges, railroad and roads.

Flood problems of a smaller scale can cause damages in the tributaries and in the villages in periods with heavy rainfall and is a concern because partly because of floods alone but mostly because of the risk of a quick clay avalanche connected to it.

4.4.3 Other directives and planning activities in the area

Water framework Directive (2000/60/EC)

When making the pilot plan in Gaula, the water framework directive was considered as we tried to identify measures that were in line with it. The water directive has been implemented in the Gaula river basin with focus on sewerage systems in dispersed settlements, agriculture and potable water and environmental objectives. As the river Gaula is a protected river, primarily against hydropower development, there is already an existing tradition of managing the river in an environmental friendly way. Most of the suggested measures were in step with the water framework directive.

Adaptability to climate change

According to the calculated impacts from climate change, there is expected to be a decrease in fluvial floods in the area, at least when it comes to spring floods caused by a combination of snowmelt and rain. For smaller catchments with area less than one square km, there is expected to be an increase in floods due to more intense rainfall. The flood risk management plan did therefore also take into account flood problems in smaller tributaries as well as the risk of flood events in the main course as explained in chapter 2 and in a separate report Lawrence et al 2011.

4.4.4 Framework for the Participatory Planning (Governance Process)

The planning process at the river Gaula, together with the one at the Tana River (see section 4.4), is the first flood risk management plan developed in Norway and is considered as a pilot project. Within the SAWA project the focus has been put to explore the possibilities and constrains to develop such plans within the existing legislation and organisational structures utilising existing systems and tools. In the next step, the involvement of the broader stakeholder group is planned. Public meetings were postponed to later processes.

For the analysis of the flood risk management planning, it is necessary to understand the planning procedure in municipalities as it is given in Figure 4-18. Here, private persons have a right to and officials have a duty to interact with the municipality. While official authorities take an active part in the consulting procedure, municipalities often solve the inhabitants' right to participate to public meetings to hear the people's opinions. Within the scope of the SAWA project, the plan has not gone through the planning process as depicted in Figure 4-18, but created a basis and better understanding of the future challenges and obstacles while developing FRMPs.

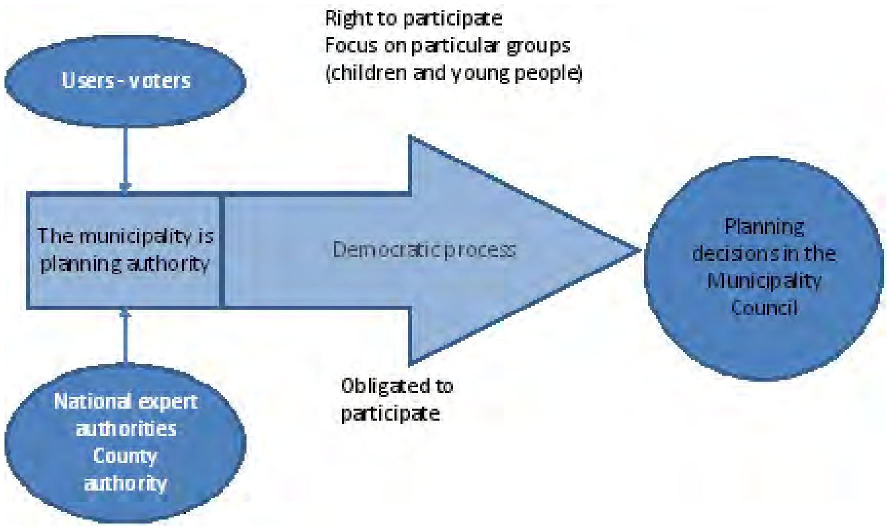


Figure 4-18: Planning process in municipalities (source: NVE)

Stakeholder analysis

In the first planning phase conducted within the SAWA project the employees in the municipality have been involved. Seven persons within NVEs own organisation and six persons from Melhus municipality contributed to the Gaula FRMP. In the next phase, a broader stakeholder involvement will be considered which will depend on the local conditions along the catchment. Several meetings were held in order to find out what the different departments in the municipality saw as the main challenges in flood management, and to find possible solutions to these matters. Since there already had been made several measures concerning flood risk management during the last years, it was also important to identify existing management and existing area planning towards flood risk management. The approach could be identified as a top-down approach, as neither the local nor the national authority involved invited stakeholders like fishing associations, inhabitants in the risk areas, farmers, etc.

Although the Gaula River is protected against hydropower development, there are still a few small hydro power stations. Stakeholders to be involved in the FRM-Planning process would then include both the owners of the hydro power stations, farmer associations, fishing associations and others. In more densely populated and built-up areas of the catchment there could be other interests, depending on whether there is business, industry, residential areas, cultural sites or others.

Stakeholder involvement and the conduction of the process

The flood risk management plan was developed together with the municipality of River Gaula, which was believed to have the highest risk. It was considered to include the other two municipalities belonging to the watershed, but because of the scattered settlements and relatively small consequences compared to significant risk areas, it was decided to focus on

the downstream area (Gimsøya) where the risk was considered to be higher. The catchment in its entirety was, however, assessed in order to look for measures for flood risk reduction.
The work of preparing the plan was mainly done by NVE. In order to include the municipality, four meetings with staff from different departments of the municipality and the rescue service have been conducted (May 2011- October 2011). The draft of the plan was circulated to the municipality for feedback several times. This was a very small-scale process conducted in a small-scale risk area.
For the development of the FRMP the MCA tool developed by the Swedish Geotechnical Institute (SGI) has been used. The test was conducted during a one-day workshop in Melhus municipality where three representatives from two different sections in the municipality, one representative from the rescue service and one representative from the municipal property company were present. SGI and NVE had prepared the exercise beforehand by adjusting the tool for flood risk management planning, filling in one example and finding a few measures that could be used for the testing. In total, NVE has made a list of approx. 150 non-structural and structural measures for use in urban and rural areas to prevent or reduce the negative effect of inundation.
The DSS-process started by a presentation of the DSS system where the objective of the process was explained. Today's situation was described and potential future scenarios were given in order to identify consequences and identify and select measures. The measures had to be presented to give more knowledge about the general benefits and impacts of each measure. Each measure was then evaluated by the following criteria:

- Health and environment,
- Resources,
- Social and economical aspects,
- Flexibility, risk management
- Goal achievement. The goals were agreed on in the beginning of the session.

During the last meetings, a matrix-based decision support tool was tested in order to get a more systematic evaluation of the possible measures.
Conflicts between different stakeholders could be an issue if the interests of different stakeholders are not in accordance with each other, but this was not identified at this time.

The tool is further described at http://www.swedgeo.se/upload/publikationer/Varia/pdf/SGI-V613.pdf.
As the application of the DSS has been rather time consuming, a minor group from NVE and the municipality picked out presumably the most interesting measures for a deeper evaluation. Another problem is the insufficient knowledge of measures that were new to the audience and of too complex a matrix, which had to be adjusted to both the water framework directive and the flood directive. Considering the efficiency of the matrix, the testing showed that a decision making tool can give decision makers a better understanding of recommendations worked out by the professionals in the municipality administration. The final list will be tested by a group of different professions employed in the municipality and NVE. A cost-benefit analysis in a narrow sense was not conducted during the FRMP.

It must also be mentioned that during the conduction of the planning process a flash flood in Gaula occurred causing damage to a village upstream Melhus, triggering interest in flood management. The flood was caused by heavy rain and was very local. The peak was believed to be a 1000-year event and made severe damages to the community it hit, but downstream the river did not exceed the main channel so the damages were minimal. This event called for the attention of the local authorities and press, raising the awareness of the flood problems in the area.

4.4.5 Planning results

The objectives for the flood risk management plan were to enhance the flood risk management in the catchment including the different steps in the flood cycle: prevention, protection, preparedness, emergency response and recovery, and lessons learned and to identify measures to ensure a more flood sustainable environment.

The final product- FRMP- Gaula is a written document that includes references to hazard maps and tables summing up suggested measures. In total, 50 measures have been considered. They are divided into seven categories, and the responsibility for each possible measure is identified as far as possible within today's legal framework. The seven categories are:

- Mapping
- Planning
- Protection
- Preparedness and early warning
- Emergency response
- Recovery and review
- Measures intended for the water framework directive, but also beneficial to the flood directive

The water framework directive (WFD) was considered when choosing the measures, and the area of interest had been assessed in the pilot period of the water directive implementation. The measures are described in text, but also listed in tables to give an easily available outline. Some measures are described very briefly and some more comprehensively, from one line to several pages, with on average about 10 lines describing each measure. Table 1 gives an overview of the parts of the suggested measures.

Table 1: One of the tables giving an overview of some of the suggested measures, within the category of protection (source: NVE)

Protection				
Nr	Suggested measure	Measure focus on	Status	Responsible
12	Maintenance of flood protection and erosion protection along the river banks	Fluvial flood	In progress	- NVE - Municipalities - Norwegian National Rail Administration - Norwegian Public Roads Administration
13	New flood protection or erosion protection at risk sites	Fluvial flood		- NVE - Municipalities - Norwegian National Rail Administration

				- Norwegian Public Roads Administration
14	Enlargement of the river profile	Fluvial flood	Suggestion	- NVE - Municipalities
15	Restoration of rivers and creeks	Fluvial flood, flash flood, storm water floods	Suggestion	NVE County Governour Municipality Land owner
16	Flood retention basin	Fluvial flood	Not recommended at the site assessed in this FRMP	-
17	Raingardens	Storm water flood	Suggestion	Land owner
18	Green roofs	Storm water flood	Suggestion	House owner

The plan is a pilot plan and will serve as an example document for municipality workers in the process of upgrading flood risk management skills. The municipalities can use the plan as an example of how to deal with floods. If the 2007/60/EC is implemented in Norway, the River Basin District Authorities can get inspiration from the plan when they are coordinating the river basin.

As creating flood risk management plans has not been a tradition in the flood risk management in Norway there is not an existing legacy or framework concerning this. The municipality's involvement in the process was limited due to resource shortage as other tasks decreed by law had higher priority than the pilot plan. The DST process was therefore not finalized as it was a very time consuming process. Thus, the process has been interesting for the local municipality as during this project they got the chance to strengthen the flood management and cooperate with different departments.

Public information

The work was a cooperation between NVE and the municipality and conducted without public participation. However, the expected advantages from the FRMP are increased flood awareness amongst the municipality workers and the political administration. Another expectation is more knowledge of the risk areas and knowledge of how to live with floods. The municipality would also like to train the inhabitants in flood prone areas to be more self sufficient in mitigating local damages from floods. General knowledge amongst inhabitants about how to act safely in a severe flood situation would also be of advantage, i.e. give people the knowledge about which roads are safe evacuation routes and which routes should be avoided in a flood. In that sense, the SAWA FRM- Planning process can be considered as an initiation of a more intensive collaboration between different stakeholder groups including the public in flood risk management.

4.4.6 Lessons learned- the Gaula River

Stakeholder involvement:

- The flood event occurred during the planning process was a wake up call for the local municipality that raised the question of conducting a revision of the emergency plan for floods

Process- Methods and tools:

- Climate change can cause more intensive rainfalls in the future and there is need for more knowledge on what can be expected of rainfall and corresponding flash flood events in the future.
- A decision support system was tested on employees from different divisions in the municipality, which was time consuming but gave benefits on clarifying the pros and cons of different measures and made the process more transparent.
- The most important experience was the need of a good presentation of the measures of discussion, as the knowledge of different measures was not known to the municipality workers.
- Good access to real knowledge, pros and cons of the individual measure, is key for choosing the right solution. Many of the measures are new for the Norwegian climate and conditions. It is easy to value a measure too highly or too lowly if the knowledge is insufficient.
- In terms of resources it was assessed that one person was employed full time for one year to work out the Gaula pilot. In addition, one person worked approximately 600 hours each divided over three years. Also, four persons spent 40 hours altogether and three people have contributed on smaller parts during the planning process.

4.5 Flood Risk Management Plan – Tana, Norway

4.5.1 Description of geographical area represented by the FRMP

The Tana River with a catchment area of 16 380 km², drains from south to north in the midst of the Sámi area of Northern Norway and Finland as depicted in Figure 4-19. The river, with a total length of 338 km is one of the largest rivers in Scandinavia and the fifth largest river in Norway, and it acts as a part of the official border between Norway and Finland for over 288 km. One third (31 %) of the river's catchment is found in Finland, while two thirds (69 %), including the mouth and outlet of the river, is situated in Norway. The lake percentage of the catchment area is 3.1 and the total height of fall in the main channel is 380 m.

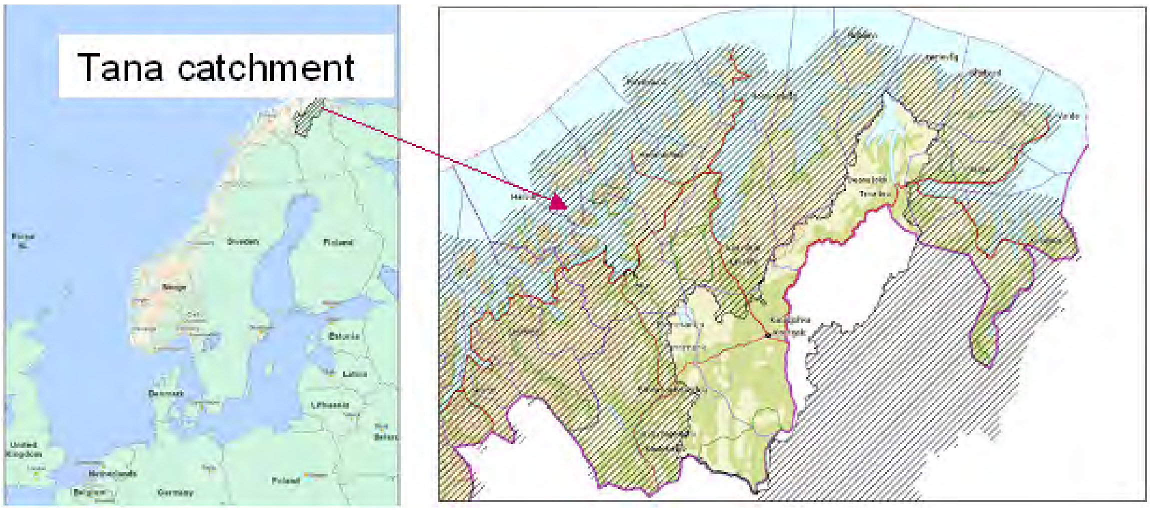


Figure 4-19 The catchment area of the Tana River, Norway (source: NVE)

The Tana River is home to one of the most genetically diverse salmon populations in the world and is one of the largest and most productive salmon rivers in Finland and Norway that is still in its natural state. Each tributary has a unique genetic salmon group specific to that river, and thanks to good management as well as excellent water quality in these water bodies these populations have been kept healthy and thriving. Due to this the river offers one of the best locations for fly fishing anywhere in the world and tourism increases remarkably during the fly fishing season. There are also important natural values connected to the river banks of Tana with several eastbound endemic plants and insects. One of the most beautiful species to be found is Tanatimian – Thymus Tanaensis – a small but very decorative species which can cover large areas of the flood banks during the summer season. Last but not less important, the Tana River delta is one of the largest Virgin River deltas in Europe. It is rich in birdlife, with many different species of duck, waders, geese and other divers who feed, nest and migrate in this area. Various fish species as well as seals are commonly found in this area.
The vegetation of the Tana River Basin consists of extensive forests of mountain birch, broken up by large areas of peat bogs. There are also some isolated pine forests found in some river valleys, particularly in the Karsjok and Kautokeino municipalities. Tundra heaths dominate the landscape above forest level, whilst the highest peaks are mainly barren and rocky. Over 90 % of the river basin area in Finland is forest and marsh. The catchment area on the Norwegian side differs however a lot from the Finnish in containing much more mountain areas, with altitudes from 500 up to 1000 masl. Approximately 40 % of the Norwegian area contains a mixture of mountain and forest areas while10 % consists of bog and wetland areas. Developed and constructed areas constitute less than 0,5 %.

Tana River flows in many locations about 2-300 meters below surrounding highlands (Figure 4-20). The river has piled up within years huge sand layers, to which it has dug river terraces of different levels. These terraces act as good agricultural and living places. The median elevation within the river basin is 333 m above sea level and approximately 80 % of the area is located between 200 and 450 m above sea level. The highest mountain area in the basin is Gaissaene with its highest top Rasti Gaissa (1067 m above sea level).

The Tana River basin is sparsely populated with only about 10 462 inhabitants (2005) within the totality of the river basin. Constructed areas are mainly situated in the three villages of Utsjoki, Nuorgam and Karigasniemi on the Finnish side and the two villages of Karasjok (at the beginning of the river) and Tana Bru (at the outlet) on the Norwegian side. In Karasjok Township there live approximately 2768 (2011) people while Tana Bru has only 545 inhabitants. On the Finnish side the biggest population centre is the village of Utsjoki with about 300 inhabitants.
The Tana River basin is of extreme importance to the people that live here. The river not only offers opportunities for leisure activities, like fishing, hiking and hunting, it plays a crucial role in terms of a livelihood. Primary industries like reindeer herding, agriculture, forestry and fisheries has traditionally been the dominated occupations while the service industries has become more and more important during the last years. Despite this development a relatively large part of the population is still employed in agriculture and reindeer husbandry (15-17 %). The municipalities of Tana and Karasjok are among the largest agricultural areas in Finmark County, and the unique form of arctic river farming along the river are of specific importance to the Sami identity formation. A unique type of riverboat has been developed for the purpose of salmon and trout fishing in the river, which only the local people are allowed to use. These boats are often hand-made and tailored for a specific part of the river and are for the fishers in Tana just as important as the fishing rod and the fishing line.
The indigenous Sámi people in these areas have utilized the watercourse for many thousands of years and it plays an important role in their cultural identity. The cultural identity of the Sámi people (Figure 4-20b) also applies to the many cultural heritages situated along the river. Since the Sámi is recognised as an indigenous people, the Norwegian nation state has to grant them specific rights. This may point to the necessity of giving special attention to the different monuments of antiquity along the river, and find a way, if necessary, to incorporate the protection of them into the flood risk management plan. From an indigenous perspective the cultural heritages along the Tana River are not only of local value, they have global significance as well.

The Tana River is a dynamic watercourse that is almost untouched by human impacts; none of the rivers or lakes is regulated in the Tana River basin. The river course can change remarkably from season to season, catalyzed by the naturally occurring erosion processes that change and sculpt the riverbanks after periods of fluctuating rainfall and variations in flow. The riverbanks and sandy riverbeds represent huge sediment sources laid down during the end of the last ice age. These sediments can easily be eroded and transported downstream, thus changing the appearance of the river drastically.

The Tana River basin is in general sparsely populated (Figure 4-20a). In Norway the watercourse is divided into the areas of three municipalities: Kautokeino, Karasjok and Tana; in Finland it is divided into the two municipalities of Inari and Utsjoki. At the end of 2008 there 5900 people lived on the Norwegian side and 1305 on the Finish side of the watercourse (RHR 2008-date, NVE). In the area of significant flood risk, Karasjok, there live approximately 2768 (2011) people, of which approximately 500 live in the flood prone area of the village.

Figure 4-20 a) The catchment areas of the river Tana; The municipality of Karasjok can be seen on the right side b) The Sámi ethnic group (source: NVE)

4.5.2 Flood problems/ relevant flood issues

The river course can change remarkably from season to season, catalyzed by the naturally occurring erosion processes that change and sculpt the riverbanks after periods of fluctuating rainfall and variations in flow. The riverbanks and sandy riverbeds represent huge sediment sources laid down during the end of the last ice age. These sediments can easily be eroded and transported downstream, thus changing the appearance of the river drastically. Erosion of the Quarternary sediments deposits is the most important source of sediment transport in the river.

Flows in the Tana River vary greatly during a twelve months period. The watercourse has its naturally highest discharge during and after the annual spring floods, brought on by snow melts and increased precipitation (usually around May turning to June). Most of the runoff takes place during this period. The lowest flow regime occurs naturally during winter when precipitation falls only as snow. Some years floods may occur in the summer and fall due to heavy rain fall. Such annual changes in flow regimes can cause high erosion rates, particularly in areas with sand and gravel, and particularly with rapid increases in the volume of water in the river runs.

The river basin has little possibility for tackling large flood event; because of the small lake percentage, the low amount of marshland and the topography of the river basin there are almost none retention areas for flood water. Storage of floodwater in the water basin is therefore not an option and due to the few overflow recipients for increased runoff, flood events can occur rapidly in the main watercourse.

Tana the river in Norway with the heaviest ice jam processes and is known for large ice drift. The basin is located in a subarctic region where the winter provides long, stable periods of cold and relatively small amounts of snow. This means that when spring comes, the ice layer is often thick and minor layered. Since the river flows from the south to the north, with a much warmer climate in the south, the ice meltdown and thus the ice drift will often start at the beginning of the watercourse. So instead of a harmoniously meltdown from the sea level and backward, the breaking-up and transfer of the ice will regularly result in the formation of ice plugs and ice dams when the large amount of ice moves downstream and meets more stable ice at slow current areas, or stops at narrow/shallow areas of the river where the ice masses are blocked. Since the breakup process starts at the beginning of the river the whole river is affected by ice jam flooding when it happens.

Floods in the Tana River are usually caused by snow melt in combination with ice break-up during spring time (May-June). Ice break up in Karasjokha usually occurs in the period May, 15-20, but has happened as early as late April (1990 and 2002) and as late as mid June (1867 and 1881). Ice jam processes occur in some way every year, but the effects differs quite much. There seems to be a connection between large discharge and heavy ice jam processes and the combination of these two factors seems to cause the biggest flooding in Tana. There also seems to be a connection between the point in time of the ice break up and the extent of flooding. Late ice jam processes at the end of May and beginning of June seems to cause the biggest problems.

Because of the ice masses and the big ice rafts that floods into settled areas, ice jam floods often cause huge economic damages. An ice jam flooding also usually happens much faster than a regular water flooding. In addition to this prognosis and localization of hazard areas are a challenge – even if the ice break up usually occurs some days before the maximum spring flood, and ice dams often are located at the same places, a flood caused by an ice dam at one point will for example cause a much bigger flood scenario than a flood caused by an ice dam at another point. This means that risk and danger related to ice jam flooding can be difficult to foresee. There is also a need for climate projections concerning ice jam flooding as this matter has not been included in the previous climate projections.

4.5.3 Other directives and planning activities in the area

Adaptability to climate change

In terms of making the plan flexible to future uncertainties like climate change, NVE has written an extensive report on climate change related to the Norwegian context: *Hydrological projection for floods in Norway under a future climate. Report no. 5 – 2011.* The results from this report is incorporated as an explicit perceptive in the FRMP for Tana.

The Tana River basin is characterised by peak flow regimes dominated by spring to early summer snowmelt and ice jam. This is expected to continue in the future, although the increase in temperature and precipitation, together with a decrease in snow cover, are expected to lead to earlier peak flows of reduced magnitude (Lawrence & Hisdal 2011). Autumn and winter floods are expected to become more frequent. There is however some uncertainties to this picture one needs to take into consideration:

Warmer climate may result in a scenario of *alternating freezing and melt down periods* during the time of ice built up. If this is happening minor ice jam processes may occur during late fall and early winter resulting in ice dam formations at specific locations. The ice will then build on top of the ice dams resulting in a several meters thick and layered ice cover. Large amount of frazil ice under the ice cover in these locations do also contribute. Another factor that may increase the flood risk is that a warmer climate may results in a *rapid temperature shift* and weather change in the transition from winter to spring/summer, which historically have seemed to be an important factor for ice jam flooding in Tana.

4.5.3 Framework for the participatory planning

Together with the Gaula planning process, FRM- planning in the Tana River represents a novel experience to Norwegian authorities. As in the case of the Gaula River, the objective of the SAWA FRM-Planning process has been to explore the ways to develop such plans under the existing legislative and institutional structures and utilizing the existing tools and following the established planning procedure at the municipalities as illustrated in Figure 4-18. Additional aspect that considerably shaped the planning process has been the consideration of the cultural distinctiveness of the area, being the Sámi ethnical group. Although NVE was the main responsible for the making of the Tana FRMP, the process has also involved cooperation with the municipality of Karasjok and consultation with the Sámi Parliament.

The governance approach of NVE has primarily been of a top down character. There has however also during the last years been of more and more importance to stress a local ownership approach related to NVE's work in the different local contexts. The local ownership approach has also been important related to the FRMP of Tana, but we have also tried to expand and develop further this concept. As a part of this development, we have in our stakeholder cooperation used a very conscious cultural approach related to the Sami-Norwegian multicultural context of Tana. The national authority (also the SAWA partner) has seen the importance of knowing the history and the cultural landscape of the Sami.

Stakeholder analysis

As the SAWA planning process has been just a first step in development of the final FRMP, a broad stakeholder analysis and involvement has been beyond the scope of the project. The involved stakeholders have been five employers of the NVE's, one person from the Finnish Centre for Economic Development, Transport and the Environment, two persons from the Norwegian Sámi Parliament and five persons from Karasjok Municipality has contributed in total 13 persons, which were directly addressed.

Stakeholder involvement and the conduction of the process

The work of preparing the plan was mainly done by NVE, but it included meetings with Karasjok Municipality and the Norwegian Sami Parliament. One meeting with the municipality was conducted in May 2011 and one meeting with the Sami Parliament in October 2011. In working with the FRMP for Tana the focused has particularly been on understanding and applying the new perspective that underlies the new Flood Directive (2007/60/EC). Underlying this policy shift is the understanding of flooding as a natural phenomenon and the realisation that we must learn to live with and adapt to flood events. Structural or engineered solutions to manage existing risks should still be an important part of the new directive, but the direction forward is to be found in an integrated, holistic and catchment-based approach to flood risk management. The key messages in the new approach reflect a radical new approach, not only towards water management, but towards the relationship between human and nature.

4.5.4 Planning results- Flood Risk Management Plan

The objectives of the flood risk management plan are to enhance the different steps in the flood cycle: Prevention, protection, preparedness, emergency responses and the lesson learned, which should lead to a better flood risk management in the area. The final product – FRMP Tana – is a written document that includes an explanation of the new flood risk paradigm, references to hazard maps and lists containing the description of the suggested measures. In total 27 measures are suggested divided into six categories:

- Flood mapping
- Land use planning
- Flood forecasting and emergency preparedness
- Physical measures
- Recovery and evaluation
- Cultural and philosophical measures

The development of what is called cultural and philosophical measures has been an essential part of this pilot plan and can be described in the following way:

1. Implementation of the paradigm and the way of thinking underlying the Flood Directive. The most important points to take into consideration related to the new paradigm are mentioned in 1.2. According to these principles management is not only about objectives and measures – it also reflects a specific way of thinking in terms of nature, culture and society. Related to this one central goal should therefore be an educational approach towards the implementation of the new paradigm or underlying thinking of the Flood Directive. We therefore see the necessity of what can be called a paradigmatic education wherein different levels of stakeholders, from the government to the local people, learn the new principles in flood risk management. This can be done from simple presentations to more extended seminars and workshops. It could also involve interviews or writing of articles in the local newspapers.
2. Flood marketing stone: A concrete measure related to risk awareness could be to set up one or more flood marketing stones, where the historical as well as the future floods are marked.
3. Integrate the Sami indigenous context into the plan. As a national authority one is obliged to consult with the Sami Parliament Norwegian authority is obliged to consult the Sami Parliament in all cases where Sami interests are affected. In addition to the more formal requirement, incorporating an indigenous perspective in flood risk management means on the one hand that the National authority needs to develop Sami cultural competence, and on the other hand that both parties needs to engage in creative dialogues and active involvement with each other. In writing this report we have both studied written literatures about the topic and engaged in dialogues with representatives from the Sami Parliament.

The plan is a pilot plan and will serve as an example document for municipality workers in the process of upgrading flood risk management skills. They can use it as an example on how to deal with floods. When the flood directive is implemented in Norway, the River Basin District Authorities can get inspiration from the plan when they are coordinating the river basin. Also, the NVE developed closer relationship to the Sami Parliament.

Public information and consultation

There was no public participation in the development of this flood risk management plan.

4.5.5 Lessons learned- the Tana River

Stakeholder involvement:

- It is important to understand that management is not a fixed structure but an evolving process. The new Directive thus takes into account elements that previously haven't been part of flood risk management, neither in EU nor in Norway. These are: Living with flood instead of defending ourselves against it. This leads to a new concept of nature. Living with climate change and risk. This implies a future oriented relationship to life. Stakeholders' involvement and creative learning. This reflects a new way of cooperation and an expanded concept of governance. Non-structural solutions. This implies a move from survival and defence to new possibilities. Integrative and inter-disciplinary thinking. This is necessary if one wants to create a more developed governance concept and new possibilities in culture, consciousness and society.
- The Sami culture has to be integrated through dialogue and with a shared focus on the Sami local knowledge of the river course and flood events and also with a shared knowledge about the historical colonisation process. The Sami issue is not a temporary or a decreasing one. Rather the opposite; it seems to concern more and more areas of culture and society. Related to climate change there is for instance a discussion if the Sami people will be more affected than the Norwegian, since a future climate may degrade or destroy the natural recourses vital for the Sami lifeway.
- Cultural heritage: Sami cultural heritages are of more importance than the Norwegian cultural heritages. Sami cultural heritages are directly related to the formation of the Sami identity. What does it mean to protect a culture and not only nature?
- It is recommended in the initial phase of the project to develop a cultural competence related to the relevant area. This means to incorporate a cultural understanding of the place and the people but also to develop this understanding into a fruitful way of communication and cooperation with the relevant stakeholders.

Process- methods and tools:

- The problem of scattered settlement: The Tana River Basin District is as already mentioned characterized by dispersed settlement, flood problems caused by ice jam and cultural challenges related to the indigenous people of the area. The population question is an interesting one. For an area in Norway to qualify as a significant flood risk area it has to constitute a geographically continuously area of more than ten squares (250 m x 250 m) with more than ten people in each. Related to Norway this is problematic. Since most of the country has a dispersed settlement, many areas that qualify as significant related to flood risk will not be taken into consideration because of the population picture. This goes specifically for the Northern part of Norway having an ever-lower population density than the south. Concerning the Tana River there is only two townships of approximately 500 and 3000 inhabitants respectively, the rest of the population is scattered in small settlements throughout the watercourse. One could therefore ask if one need another way of measuring vulnerability related to people in Norway.

- It is recommended to start the development of the flood risk management plans with an educational approach towards the cultural and philosophical issues. This means that the stakeholders involved in the project have to understand the paradigm and philosophical perspective underlying the Flood Directive. Since the paradigm involves new understanding about resilience, communication, cooperation, capacity building and governance education and training in this way of understanding management may reduce the conflict potential between stakeholders at the different stages of the process. The new paradigm also has the potential to push our way of thinking into a more complex and stratified (multi-leveled) way.
- In terms of the efforts for preparing and conducting the FRMP process, one person was occupied 50 % for one year. In addition, one person worked approximately 600 hours divided on three years contributing to the plan development. Additionally, one person spent 150 hours on the Tana pilot and three people have contributed on smaller parts during the plan development.

The pilot plans in Gaula and Tana has been the first flood risk management pilot studies in Norway, and will not be implemented in the municipalities as implementing of the flood directive has been put on hold awaiting the EEC-discussions.

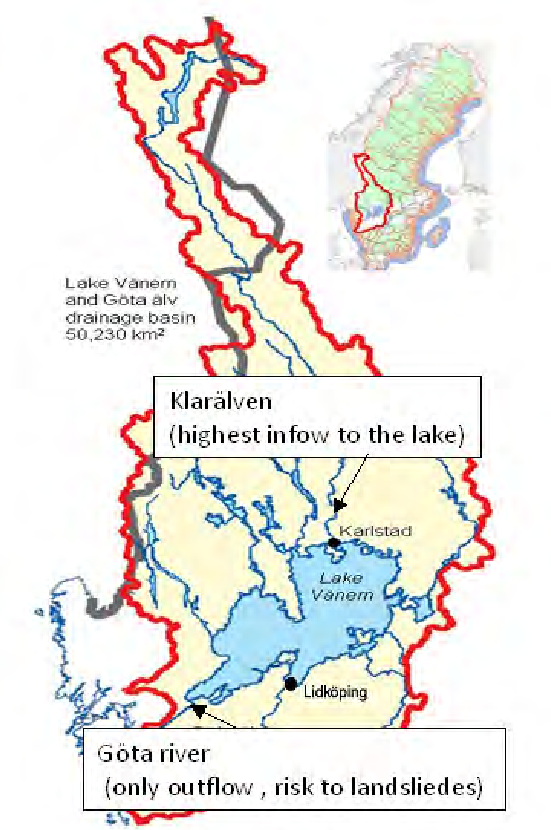
4.6 Flood Risk Management Plan- Lake Vänern and Göta river[10]

4.6.1 Description of geographical area represented by the FRMP

Lake Vänern:

The Lake Vänern (depicted in Figure 4-21) is Sweden's largest lake and the third largest lake in Europe after Lake Ladoga and Lake Onega. The lake is counted as an inland sea and offers a unique setting. Characteristic for the lake are its bare cliffs and rich birdlife. The lake is also an important resource for commercial fishing in western Sweden. The lake has been regulated since the year of 1934 for hydroelectrical purposes. Since April 2008 the regulation strategy has changed in order to minimize the effects of floods.

[10] Although two FRMP have been developed, they are ehre given together, as the river Göta and the lake Värnen represent one interacting system.



River Klarälven:

Catchment area (km^2)	11800
Lakes in catchment area (%)	8
$Q_{average}$ (m^3/s)	171
HHQ_{25} (m^3/s)	1211
HHQ_{100} (m^3/s)	1490

Lake Vänern:

Catchment area (km^2)	46800
Area of the lake (km^2)	5650
Volume of the lake (km^3)	153
Average depth (m)	27
Maximum depth (m)	106
Highest possible flow (m^3/s)	2300

Figure 4-21 a) Lake Vänern with the main characteristics b) Summary of the main hydrologic and physiogeographic characteristics of the pilot regions (source: County Administrative Board of Västra Götaland)

River Klarälven:

Is the biggest river discharging into the Lake Vänern. It originates in Norway. It is heavily regulated with 12 power stations in the main river channel. The main characteristics are summarised in Figure 4-21b)

The two pilots were both chosen due to their vulnerable location and previous experience in the area. Since both counties (Värmland and Västra Götaland) have worked closely together it has also been an advantage to look at the same drainage area.

The floods of Lake Vänern and the river system discharging into the lake affect the settlements nearby, the most important being Lindköping and Karlstadt, as depicted in Figure 4-22.

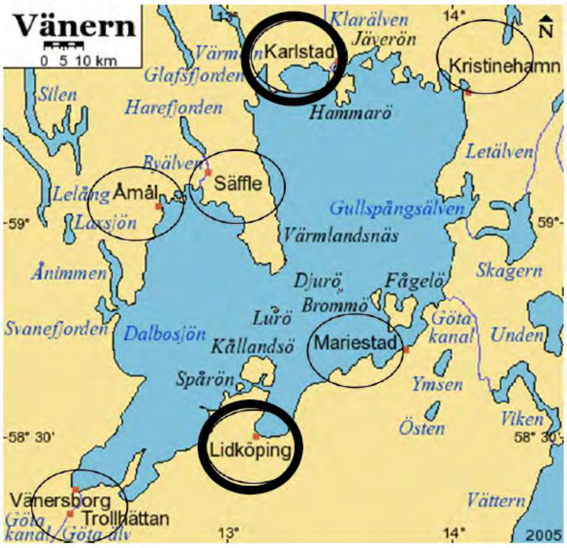


Figure 4-22 affected communities around the lake- the municipalities of Lindköping and Karlstadt are indicated (source: County Administrative Board of Västra Götaland)

<u>**Lidköping**</u>

Lidköping is located at the southern side of Lake Vänern. The city is divided in two parts of the small river Lidan. The city on the east side of Lidan called the old town and the district west of Lidan called the new town. The city is old and received its town charter in 1446 making it the first city around Vänern. The city's population amounts to just under 25000.

<u>**Karlstad**</u>

Karlstad Municipality, with its nearly 59000 inhabitants, is the largest urban area around Lake Vänern, located at the north shore of Lake Vänern. The city is the county seat of Värmland County, and since 1999 also hosts a university. Karlstad has been an important trading town in Sweden since Viking times and the town received city rights in the year 1584.

The city is located by the shore of the outlet of Lake Vänern. The area is a delta area of on-going erosion and sedimentation. In the large investigation " Sweden facing climate change – threats and opportunities (SOU 2006:94)" that was published in the year 2007, Karlstad was identified as particularly vulnerable. Generally, the high flows in the River Klarälven are a more major threat to Karlstad than a high water level in Lake Vänern.

An important aspect for selection and conduction of the FRMP- process was the issue of the data availability, especially with the quality of the elevation data (vertical error is on average 2,5 m). In Karlstad however the municipality already made a scanning of the town, and in Lidköping it was possible to use scattered information from other sources, e.g. spatial planning, and make a fairly good model for the necessary analysis.

4.6.2 Flood problems/ relevant flood types

Vänern is a large lake with a large catchment area, flat surroundings and a small limited outlet through the River Göta. This means that at unfavourable conditions the inflow to the lake is far greater than the outflow. A higher water level in the lake also becomes quickly clear

because the surrounding area is flat and every inch of the higher water level over a certain level will claim considerable land. Göta River, which drains Lake Vänern, is sensitive for landslides and therefore the flow in the river cannot increase to the same extent as the inflow to the lake increases without significantly increasing the risk of landslides. To date, decision-making authorities have always chosen to rather accept the extensive damage caused along the shores of Lake Vänern at high water levels than take the risk to human life that may be a consequence of increasing flow in the Göta River. Some investigations have been made about the possibilities of storing water in reservoirs located upstream Lake Vänern. The results clearly show that this is not an option. Vänern can be seen as a large tray and when the largest magazine starts to become full all the smaller lakes upstream are already full. Especially vulnerable are the settlements located close to the lake, the main ones being Lindköping and Karlstadt as shown in Figure 4-22.
The principal causes for flood inundation in the area of our two pilots can be summarized as:

- Flooding in a very big lake, Lake Vänern, and a combination of flooding of the same big lake and fluvial flooding (River Klarälven)

- The flooding of both the lake and the river Klarälven is traditionally associated with spring snowmelt flooding in April/May. One of the most serious floods during the last thirty years, however, took place in autumn/winter 2000/2001 and was caused by intensive and prolonged raining. The area of the lake is 5.648 km² and the volume 153 km³, thus it is not sensitive to torrential rains.

The principal problems anticipated with the pilot in Lidköping is a slow rising level of Lake Vänern that will successively affect parts of the urban area and a long time flood situation, that could last several months.
In the case of Karlstad the biggest threat is thought to be flooding of the river Klarälven, still most sensitive to spring flooding but in the long run with the consequences of climate change taken into account a switch over to flooding during the winter months can be anticipated.

4.6.3 Other directives and planning activities in the area

Water Framework Directive (2000/60/EC)

The WFD was not included in either of the pilot FRMP's. Conflicts have, however, already been caused by a recent agreement on a new tapping strategy for Lake Vänern between the two County Administrative Boards and the company that owns the right to produce hydroelectric power at the outlet of the lake. The agreement states that the level of the lake should be kept under strict control in order to avoid it reaching dangerously high levels in a flood risk situation. Practically this means that the level is somewhat lower than before the agreement was signed. This in turn is a disadvantage for the ecosystems on the islands and islets of the lake. A special monitoring program has been developed in order to follow changes in the environment that can be explained from the new normal water levels in the lake. Therefore, the efforts to permanently lower the water level put natural values along the coast and on the islands at risk of deteriorating.

Spatial Planning

In Sweden, urban planning is characterised by a traditional top-down process controlled by professionals and political elites. Users and citizens in general are mostly absent in the planning and decision-making process. The Plan and Building Act could serve as an example to concern citizens and other stakeholders' participation in the municipalities' work. According to the Act citizen participation should be an important feature. According to researchers at Örebro University, although steps have been taken in order to democratize urban planning it has not been too successful.

A development of urban development plans is an ongoing process in both pilot areas. The development includes controversial seashore areas that are beautifully situated by the lake but where there also is a risk of more or less regular flooding events. Rules in the planning and building act allow authorities to stop developing very risky spots. There is also a possibility to put up hard conditions on functionality and so on for new establishments. However there are more difficulties with older parts of the city that are situated at spots that would not have been approved today. Sometimes an argument for new plans is that by building wisely in front of risky old areas, the new development will help protect these older parts. Many municipality planners strive at condensing urban areas in order to decrease the need of transportation in order to decrease CO_2 emissions. Sometimes this could of course solve a negative situation. On the other hand experience shows that housing development is among the most permanent change in the landscape that our society has created. New developments in inappropriate places could in the long run force the municipality to take protective measures that could both be costly and negative from an environmental point of view.

In the case of Lidköping the new urban plan for the area called Hamnstaden, situated on the low lying border of the lake Vänern, was discussed during one of the four meetings. It was clear that the problems of flooding, especially from the perspective of a changing climate, have recently been taken into serious consideration.

The two County Administration Boards of Värmland and Västra Götalans are currently writing new common guidelines for housing and building around Lake Vänern in order to take account of the increased water level anticipated as a result of climate change.

In the case of Karlstad on the other hand, most of the natural areas affected in the delta are expected to benefit from flooding from time to time. There it is instead mankind's insisting drive to exploit the lowlands that have put economical and human values at risk.

Many vulnerable locations are also often potentially attractive residential areas, therefore the flooding subject was initially considered as sensitive by the politicians who don't want to close definite doors for potential prestigious exploiting projects. An example of such an area is given in Figure 4-24a. There is also a worry about public reactions when seeing maps over flood prone areas. For the same reason it was therefore sometimes difficult to use the knowledge from the vulnerability studies regarding floods in the spatial planning processes.

Adaptability to Climate change

A couple of years ago the municipalities around Lake Vänern initiated a co-operation in order to deal with the challenge of a changing climate with risks of a substantial increase in the water level of the lake towards the end of this century. The co-operation is called Kommuner i samverkan om Vänerns vattenreglering (municipalities in co-operation regarding the water regulation of lake Vänern).

4.6.2 Framework for the participatory planning

The process has been conducted by the local authorities of the municipalities Lidköping and Karlstad, addressing the local issues and flood problems. Although the FRMPs have been developed considering floods of the lake and rivers, it is given in this report from the perspective of the main municipalities involved, being Lindköping and Karlstadt.

4.6.3.1 Lidköping

Stakeholder Analysis

It has been assessed that for the scope of the SAWA project (a first attempt to produce a local FRMP of an urban area) the representatives from the municipal departments were the most important stakeholders. The following departments participated:

- Water and sewage
- Electricity provision
- Broadband provision
- Municipal heating plant
- Planning and construction
- Environment and health
- Civil contingencies
- GIS

The response of the addressed stakeholders has been very high as they got a task to participate. Ten persons participated in the sessions, eight of whom represented different departments of the municipality.

Stakeholders outside of the municipal administration were not invited to participate but the most threatened units were identified: industrial sites at risk and infrastructure like the port, some roads and the railroad. One of the “soft” measures that were suggested was to make a communication plan between the municipality and other stakeholders in case of flooding. The stakeholders discussed in this situation were private landowners, industries and the Transport Administration.

Stakeholder involvement and the conduction of the planning process

The stakeholder involvement in Lidköping, led by the representatives from the two County Administrative Boards, has been organized in the following steps:

- **Scoping:** Describing the scope of the task (there are requirements posed by 2007/60/EC, flood risks for the urban area, risk maps produced etc)
- **Understanding:** assessing the flood risk in the area and the possible measures to mitigate it
- **Decision Making:** As a last step, a set of proposals was laid forward to the executive board of the municipality for them to discuss further within the municipality and with external representatives as well. The process is ongoing.

The main focus was put on the **Understanding** phase, composed of four special workshops with representatives from the municipality and the two County Administrative Boards. The key aim was to make the participants understand the flood risks in detail and discuss threatened areas at different water levels of Lake Vänern and possible solutions.
The first step was to make an analysis of what happens to key community infrastructure and services at different water levels in the lake. Due to the crisis in the years 2000/2001 the knowledge about this, at least until a certain water level is reached, is rather well known. The group was focusing on drinking water, sewage systems, electricity, heating and broadband.
The first meeting was held 30 August, 2010 and then once a month for the following three. The last one was held 30 November, 2010. The final results were presented to the municipal executive board 30 March, 2011 (Figure 4-23). It should be mentioned that the result was not a final FRMP (this work is still ongoing) and the above process did not include initial contacts with the municipality and the production of risk maps.
The meetings were held in a meeting room and with a detailed digital map as the main tool. On the map a gradual increase of the water level of the lake was shown and threatened plants, institutions, residence areas, etc were shown and discussed. The most important aspect was perhaps to discuss the interlinkage between the different sectors over the "weakest link of the chain". One of the meetings was combined with a specialist's lecture about the Cost Benefit Analysis tool.

Figure 4-23 Presentation of the project to the Municipal Executive Board in Lidköping by the SAWA Team (Susanna Hodgin) (source: County Administrative Board of Västra Götaland)

Karlstad

The City of Karlstad, situated in a river delta, is threatened by flooding from both the river (Klarälven) and the lake (Vänern). The municipality decided on an individual flood protection program in June 2010. The objectives of the flood protection program were to find out which of the two water bodies that constitutes the biggest threat, to get a comprehensive overview of the complete flooding challenge, to evaluate the probabilities and consequences of flooding and to make clear what measures need to be taken on a short and long term. The program takes climate change into consideration. The program also implies preparation of flood maps. An example is depicted in Figure 4-25. To elaborate this program was not an activity of SAWA, but it has been evaluated as a FRMP according to the 2007/60/EC as part of the SAWA project.

The general public was not given the possibility to participate in the process other than through the elected politicians. There was no feedback from the national agencies concerning guidelines for planning, which was a disappointment for the municipality. Some of the guidelines proposed in the program were taken from the Norwegian NVE. Today, a few years later, there are guidelines at the regional level on how to consider flood risks in spatial planning, but a lot of work still remains to be done, especially at the national level.

Figure 4-24 a)Example from Karlstad of new constructions in the attractive Inner Harbour area b) Communication with the general public has improved. In August 2011 the municipality of Karlstad invited its citizens to participate in one of two so-called vulnerability walks along flood prone areas in the city (source: County Administrative Board of Värmland)

Figure 4-25 Map showing the extension of water and the water level for a 200 year flow in the river Klarälven in some of the central areas of the city (source: County Administrative Board of Värmland)

Stakeholder Analysis

A workgroup was created within the municipal organization with representatives from the different departments. One consultation was held with external representatives being:

- the County Administrative Board
- some private construction and civil engineering companies
- one insurance company
- researchers from Karlstad University

The Road Authority was invited as well but they declined to participate. A second consultation was held with the County Council, the responsible authority for the central hospital, because of the hospital's vulnerable position (Figure 4-26). Possible stakeholders are also representatives of the inhabitants like local interest groups and political party representatives.

Figure 4-26The central hospital in Karlstad needs protection from future flooding – a combined dike and cycleway between the hospital and the river is under projecting (source: County Administrative Board of Värmland)

Stakeholder involvement and the conduction of the planning process

The workshops have been conducted in a form of workshops with different stakeholders.
In March 2010, after approximately one year's work, a draft program was ready which was then referred back to all participants including political committees and those who participated in the external consultations. Some other organizations which seemed important were also asked for their opinion, such as the neighbouring County Administrative Board of Västra Götaland, the Swedish Civil Contingencies Agency (MSB), the Swedish National Board of Housing, Building and Planning, the SMHI and the different traffic modes' authorities.
In general, the work progressed slowly. The municipality of Karlstad together with Karlstad University and the County Administrative Board took the initiative in late August 2011 to organise two so called vulnerability walks for the public along the flood prone water areas in the city. The aim was to inform them about the municipality's work with flooding and invite the public to comment on it. Around 20 persons participated in each walk.

4.6.3 Planning results- Flood Risk Management Plan

Lidköping

The final results of the SAWA FRMP process were flood risk maps and a series of proposed measures. An example of a map is given in Figure 2-11.
Suggested protective measures in the pilot area of Lidköping can be divided into three categories:

I) Technical measures

- Protective measures at the heating power plants, probably some kind of semi-permanent wall
- Securing pump capacity and electricity supply at the sewage heating plant by installing redundant systems
- Change of location of the electricity power plant in the harbour area
- Change of location of the municipality equipment storage situated in the harbour area, which is difficult to reach when water levels are high.

The municipality is at the moment looking into how to fulfil the first two measures. To be able to decide upon the best technique there is a need to perform a much more detailed investigation than we had the opportunity to do within SAWA. The third and fourth measures are more of a long-term objective. The electricity plant will need extensive renovations within 10 years and most likely investment will be put into changing location instead.

II) Planning measures

- New guidelines for spatial planning in the whole municipality area (within four years, following the political election periods, responsibility of the planning section)
- Guidelines need to be developed for environmental licensing and to support environmental inspections at industries in vulnerable areas in order to avoid leakage of chemicals and fuel when water levels are high
- A Communication plan has been developed, targeting other important official stakeholders like national transport organisation etc. and private landowners in vulnerable areas. Discussions should focus on responsibilities and spread information about the result of the vulnerability studies performed within SAWA in order to raise awareness and preparedness.

III) Identification of needs of further investigations and documentation

- Change of coordinate system (need several years and will include several people). By the change the municipality will have access to better accuracy in elevation data
- Further need of documentation on vulnerable pipes, building etc., will be done during the year of 2011 by the technical department

The measures are described but not in detail. No cost-benefit studies were made, but there was a lecture given to the working group and interested politicians during the autumn. The lecture was arranged by SAWA. Most likely a cost-benefit study will be made looking at measures at the sewage treatment plant and heating plant. The municipality has however proceeded with the work to produce more detailed plans for some of the measures.

There has been no evaluation procedure on the process or results throughput the process. The proposed plan is not legally bound. It is up to the municipality to carry on with the work. The work initiated within SAWA has continued and is considered as a catalyst towards the development of the final FRMP.

Apart from direct outcomes and measures agreed on within the group, the objectives of the work with a FRMP in Lidköping was also to increase the consciousness among decision makers in the municipality of the risk of flooding and its consequences, especially taking climate change into consideration. As most municipalities bordering the lake, the municipality of Lidköping has advanced plans of building new residential areas along the lake's shores.

Furthermore some central issues were raised and discussed

- To what extent do the guidelines for spatial planning support municipal officials to consider flood risk when giving building permits plans?
- What knowledge is required to develop a good contingency plan for a flood situation?
- How could flooding be considered in the ordinary work of supervising large industries in vulnerable areas?
- How is dialogue with interested businesses, governments and government agencies and individuals? Is there a need for some form of communication plan?
- The results from the work were presented to the politicians in Lidköping in March 2011 and some of the measures are now being implemented.

Karlstad:

As final products of the planning process in Karlstad, four types of measures are described, discussed and proposed being:

- Contingency measures (like contingency plans, buying and storing pumps and temporary barriers, elaborating evacuation plans etc.)
- Physical planning measures (new guidelines for planning and building, risk and vulnerability analyses etc.)
- Technical measures (such as dredging in the river, warning systems etc.)
- Communication measures (information to inhabitants and other stakeholders)

As regards housing, the basic aim is that people should be able to stay in their homes during a flood and that water, electricity, sewage and heat shall function with people being able to travel to and from their homes. Concerning required measures, these have to be decided upon according to each individual case. It could be resilient measures or protective measures.

A cost-benefit study is carried out in a suburb area of Karlstad, as part of the city's SAWA project. This study is in its termination phase.

The cost-benefit study is one DSS used. Hydrological and hydraulic analyses have been carried out for the River Klarälven to establish today's and tomorrow's flood risks.
The expected advantages of Karlstad's perspective are that different solutions are fitted to deal with different individual cases and that a risk assessment (generally built on cost/benefit considerations) is made in each case. In each case the "function" of an entity is considered: it

is not satisfactory if flat, institution or industry is safe from flooding if it can't be reached for example by ambulance and fire brigades or if there is no electricity or water supply.

4.6.4 Public information and consultation

Consultations took place with external organisations like the County Administrative Board, the County Council, Karlstad University, the insurance company Länsförsäkringar and a number of construction companies. The mission to develop the flood protection program was given to the department of Technical Management and Housing but several other municipal departments and bodies participated in the work such as the departments for City Building, for Environment Protection, for Rescue Services, the municipal Energy Company and the municipal Powerline Company.

In 2009/2010 the flood protection program was referred to several institutions and authorities (both regional and national) for consideration before it was finally decided upon by the municipality.

4.6.4 Lessons learned- The lake Värnen and River Kläralven

Process- methods and tools:

- A good approach is to concentrate on the water level and analyse what happens to the most important public or private operations when it successively rises. It is better than the more traditional way of looking at a scenario, say a 100 year flood, and analyse the consequences of such a scenario. The method works particularly well when working in areas with previous experience with floods. The approach is the one that was used in Lidköping.
- It is important to include surface water run-off in case of heavy rains in the flood management program. It was not done within the program, but is studied now.

Particular "lessons learned":

- Municipalities need elevation data of high accuracy to be able to draw up maps capable of functioning as a basis for flood protection programs. Such maps are not yet available in Sweden today in all municipalities.
- Representatives from several municipal departments need to participate in the work to develop a FRMP. An important success factor is the engagement of spatial planners.
- It is important to think in terms of functionality, i.e. to make an establishment safe from flooding means to not only protect the establishment itself but also assure that it has electricity and internet connections, that it can be reached by roads that are not flooded, that the water supply and sewage system is working, etc.

Methods or techniques that can be applied in future flood risk management plans

- A cost-benefit analysis, CBA, is one important tool for developing efficient strategies to prevent flooding and prioritize resources. The analysis should have a societal perspective and should be performed in co-operation between representatives from the municipality and personnel trained in CBA.

Cost-benefit analysis

A cost-benefit analysis was not used as a DSS in our work with developing the risk management plans. But we had a lecture about it during one of the workshops in Lidköping, and in Karlstad a cost-benefit analysis will be carried out for a flood sensitive suburb area north of the city.

The lecturer who was in Lidköping was commissioned to present the method in a written document. Here's a summary of his comments and recommendations:

"The cost-benefit analysis, CBA, should be seen as a tool for providing support for decisions regarding flooding protection measures. The results should be an important, but not the entire, decision basis. The CBA includes several steps and requires a substantial amount of information. Some information is typically available, whereas other information needs to be collected. In order to perform a relevant CBA for flooding protection measures, the following recommendations are given:

- The modelling of the flooding scenarios requires proper data, hydraulic and hydrological models in order to provide relevant results on the levels and extent of flooding events. The use of laser scanning of the land surface is important to provide a terrain model with good accuracy for the modelling of flooding events.
- The estimation of damage costs, leading to the estimation of benefits, and the costs for performing the flooding prevention alternatives can be rather challenging. There are apparent possibilities for the double accounting of benefits and discounting and selection of time horizon should be carefully performed.
- The CBA should preferably be performed in cooperation between the local community and personnel trained in CBA, flooding scenario modelling, and flooding protection design. Integrating the relevant knowledge on hydrology, hydraulics, climate, flooding protection design and CBA will produce the most relevant outcomes.
- It is estimated that a CBA of a "typical" flooding protection project will require 2-6 weeks of work. Considering the high costs associated with flooding protection - in the range of tens to more than 100 million Swedish kronor - the decision basis for such investments should be developed with relevant data and knowledge. It is therefore recommended that the CBA is primarily based on relevant site specific data and not only on generic data.
- Given the inherent uncertainties of the input information, it is recommended that a CBA always includes an uncertainty analysis. This will provide a more transparent analysis and will also provide information on what information to collect to efficiently reduce the uncertainties of the CBA.
- Depending on the ambitions and strategies of the local community, the CBA can in parts or in its entirety be performed by the community. It should be emphasized that a CBA of flooding protection measures includes a large number of inputs and

assessments and it should never be performed by a single person, rather by a group of persons comprising the necessary knowledge in the various parts of the CBA."

Examples of good cooperation during the development of the pilot plan

For a local FRMP the co-operation should be built-up in different steps, starting with creating a representative group within the municipal administration. The co-operation could then be stepwise enlarged to include also regional local enterprises, building companies, and regional bodies (like the County Administrative Boards and the County Council).

End Product- FRMP (e.g. content, legitimacy, legacy):

The most important outcomes from the work are:

- Further need of documentation on vulnerable pipes, building etc, which will be done during the year of 2012 by the technical department
- New guidelines will be developed for handling spatial planning and environmental licensing
- Investigate possibilities to get more respite time in case of an emergency at the sewage treatment plant at high water levels
- Investigate another location of the electricity power plant in the harbour
- Protective measures at the heating plant, municipality heating company

4.7 Flood Risk Management Plan- Hunze en Aa's

4.7.1 Description of geographical area represented by the FRMP

The area of the Regional Authority is 2000 km² and is located in the northeast Netherlands as shown in Figure 4-27a. It is a predominantly low-lying area with elevations varying from <-1 m bsl to ~20 m asl as depicted in Figure 4-27b. The grey lines represent the main waterways. The higher southern parts discharge into a collector canal that normally has a water level of 0,5 m above mean sea level. During low tide these canals discharge by gravity to the sea by means of spill sluices. The low northern parts are below sea level. They have their own collector canals that discharge to the sea by pumping stations. The water level in these canals is normally less than 1 m below average sea level.

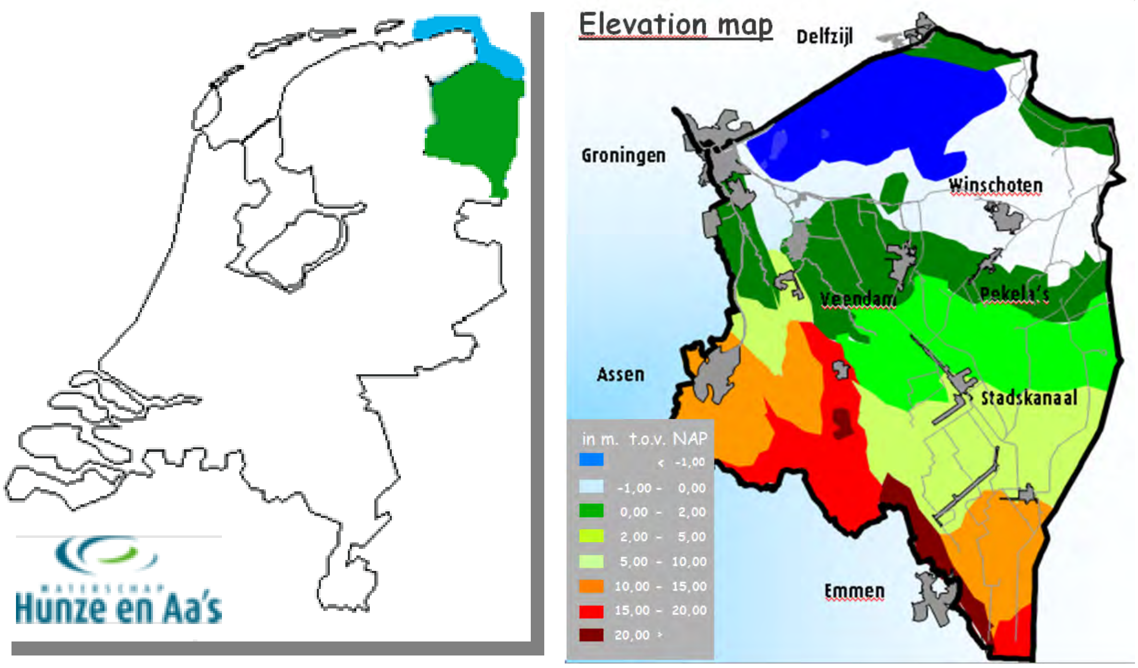


Figure 4-27 a) Location of Regional Water Authority Hunze en Aa's in the North-East corner of The Netherlands b) Elevation Map of Hunze en Aa's (source: Waterboard Hunze en Aa's)

4.7.2 Flood problems /relevant flood types

The type of flooding occurring in the area is of riverine nature. The most extreme floods originate from a high rainfall combined with high sea level that blocks discharge through sea spill sluices. A structural problem is the development during the last 6 decades to solve water problems in upstream areas by increasing the discharge capacity. Peak floods are short (less then 3-5 days) and the volume is limited (only water from the own areas).

4.7.3 Other directives and planning activities in the area

Water Framework Directive (2000/60/EC)

The water quality targets used in the project Waterdrager were derived from the WFD. Synergy between 2007/60/EC and 2000/60/EC occurred mainly in nature development along small rivers. With reconstruction of the natural flow conditions by removing weirs, reducing the wet cross sections of the rivers, re-meandering and flood plain restoration we reached here both WFD and FD targets. These types of measures are implemented in steps along the rivers Drentse Aa, Hunze and Ruiten Aa. The old canal will be blocked by low dams.

Figure 4-28 Left: Re-meandering of the river Hunze in combination with land use change; near Spijkerboor; right: Inundation of the area in 2008 (source: Waterboard Hunze en Aa's)

Spatial planning& other planning activities

The aspects of spatial planning, agriculture and ecology have been considered for planning by engaging with the relevant stakeholders.

In the Netherlands a policy existed to develop an ecological main structure (EHS). The idea is to connect nature areas so animals can migrate. The EHS includes much nature development along rivers because the long shape makes them ideal as natural connection corridors. This calls for nature zones along the rivers, which can easily be combined with restored flood plains that can function for water retention.

Adaptability to climate change

In the project Waterdrager water quantity and water quality issues have been discussed together. As a preparation for this project hydrological studies have been carried out to determine the water quantity target for the year 2050 taking climate change into account. Risk of flooding occurs mainly along the downstream main water system. Due to climate change a 10% increase of rainfall is expected (middle-climate change scenario). The strategy was to avoid increase of flood risks in the downstream area by retention of the increase in rainfall in upstream areas. This was translated to an amount of water retention in m³ per sub-catchment.

During the project measures were selected to realize this water retention.

In the lower northern sub-catchments increased discharge to the sea does not cause problems in downstream areas. So here increase of the pumping capacity to the sea was selected as a better option than retention.

In the lower parts near the sea non-structural measures like evacuation plans will be looked at on the larger scale of the main water system in the coming years.

4.7.4 Framework for the Participatory Planning

In the area of the Regional Water Authority Hunze en Aa's stakeholder participation was mainly done in an interactive integral project called "Waterdrager" (water carrier) in the period of 2005-2007. In this project the water issues of the WFD in combination with the issue of flood risk reduction have been discussed. A part time project leader with experience in interactive planning and a full time assistant were contracted for two years to organise this

interactive process of studies and meetings. During these two years, several internal and external specialists were involved in these studies and stakeholder meetings. The total budget for organising the interactive process and the technical studies was about 400.000 euro.
For planning purposes, the Hunze en Aa's area was divided into 6 hydrological sub-catchments of approx. 300-400 km². One of the reasons for this division was to be able to communicate with people that have local knowledge of an area. The first sub-catchment functioned as a learning pilot for the other sub-catchments. The process took at least 1 year per sub-catchment.
In cooperation with 2 of the involved provinces and our neighbouring Regional Water Authority Noorderzijlvest in 2011 we started a project called "Dry Feet 2050". This project aims to up-scale the measures that were carried out in the sub-catchments to the level of the main canal system and to find out if additional measures are necessary on that level. In September 2011 a start-up meeting with representatives of stakeholder groups was held and the end results are expected in 2013.

Stakeholder Analysis

Based on the analyses of social, economic and spatial developments in our area the relevant stakeholder groups for water related problems have been identified in 2005 (see table below). Much of this was done based on expert judgment as we have a large network of relations within the area. The stakeholder groups differed for each sub-catchment depending on the land use and developments in each specific area. In each sub-catchment 15 to 20 representatives of stakeholder organisations participated in the meetings, in total approx. 100 persons.

Table 4-6 Most relevant stakeholder groups for water related problems for the area of Regional Water Authority Hunze en Aa's

Public organisations

- Municipalities in the area
- Ministry LNV / ELI (=Agriculture and Nature)
    - Local formal platforms around:
        - river restoration
        - urban development
        - landscape restoration plan
    - Rural land use change committees

Agriculture

- Regional agricultural organisation (LTO Noord)
- Local agricultural associations.
- Agricultural nature associations.

Nature:

- Management organizations for nature reserves.
- Foundation of provincial landscape management
- Organisations for nature education

Companies / economy

- Chamber of Commerce;
- Trade federations.
- Professional fishermen

Recreation:

- Association of (recreational) fishers;
- Association for water recreation
- Local department of national recreational association (ANWB);
- Several owners of recreational infrastructure;

Citizens

- Association of local villages
- Individual citizens

In 2011 an update of the stakeholder analysis has been carried out. This was necessary because the authority works on the larger scale of the whole catchment. On this scale, other, often more strategic members of stakeholder organisations and sometimes even other organisations are relevant. For this update the method of 'mapping' (Hage & Leroy, 2007) has been used. The scheme as shown in Figure 4-29 has been used to analyse the stakeholders and the way they should be involved. The filling of the scheme was done by expert judgement.
Most of the stakeholders in the central ring were invited to the start-up meeting in September 2011.

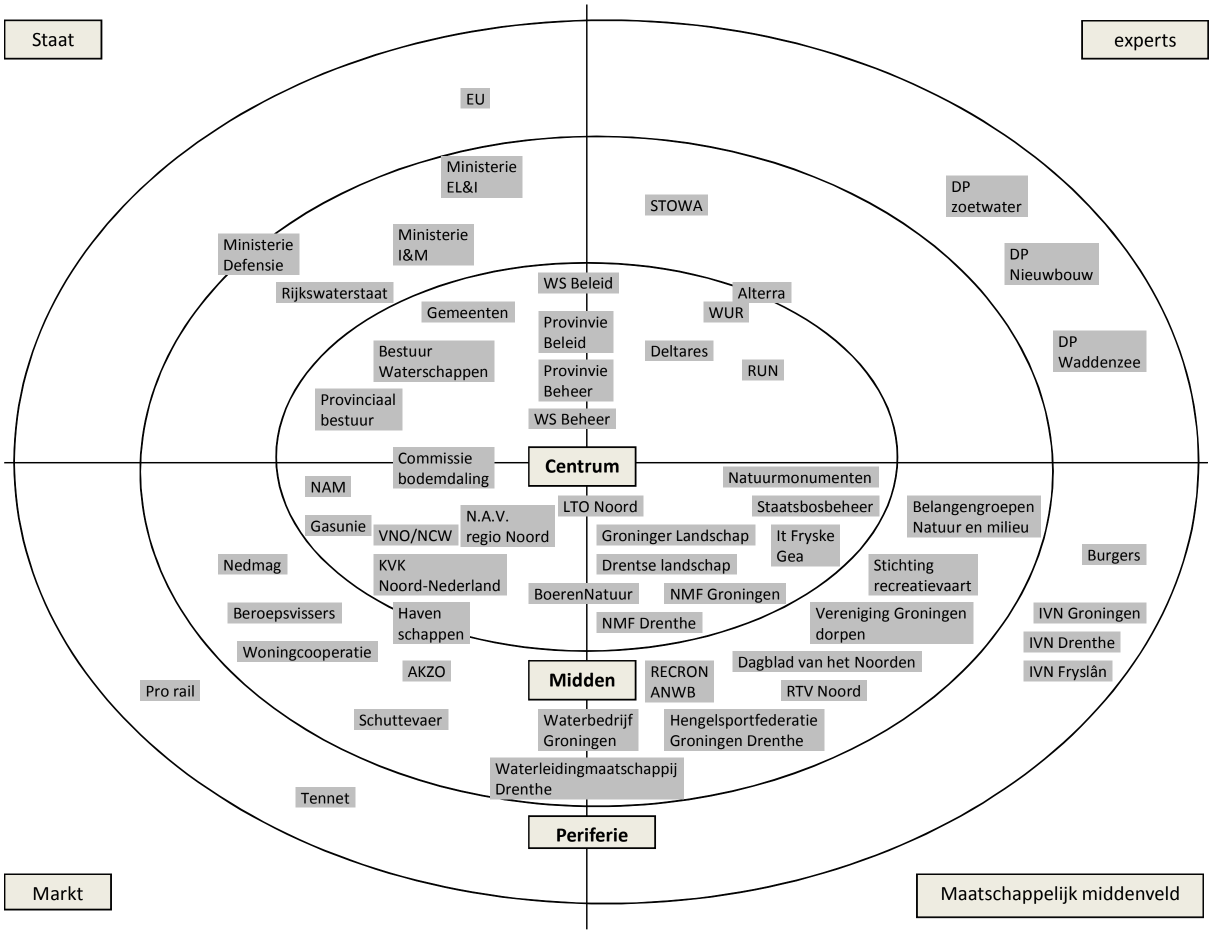


Figure 4-29 Stakeholder map for the main water system (D. Boezeman; 2011). Four categories of stakeholders are used (from the left top clock wise): government, experts, general society and market. Per category, 3 levels of involvement: central = intensive involvement, middle = less involvement (ad hoc), periphery= only informing

Stakeholder involvement and the execution of the process

The role of stakeholders in the Waterdrager process was to provide local knowledge and to give advice. So we organised the stakeholder participation as shown in Figure 4-30

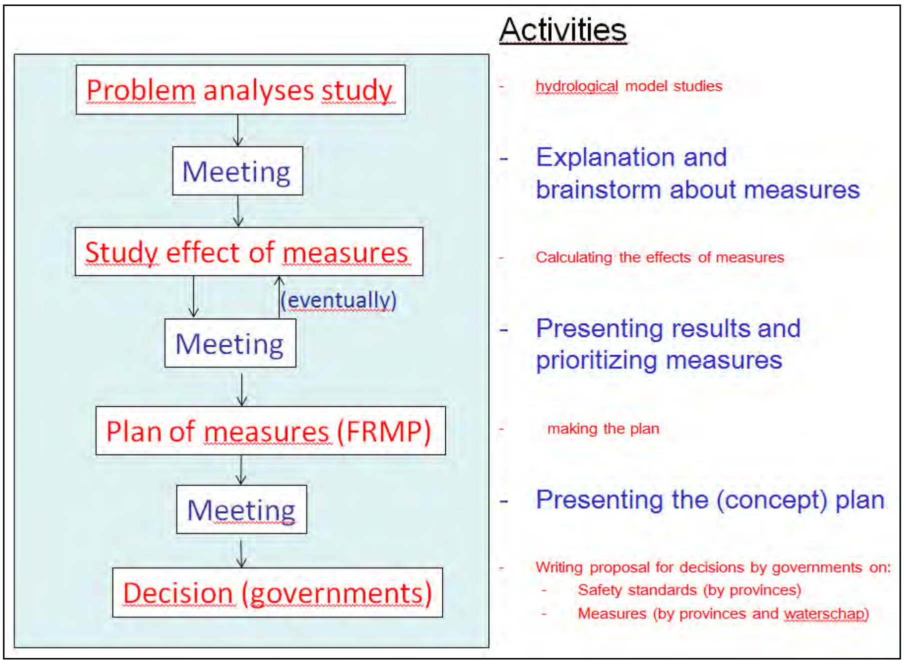


Figure 4-30 Flow chart of the working approach for stakeholder participation in the project Waterdrager (source: Waterboard Hunze en Aa's)

In some sub catchments several measures were possible to achieve the targets. In that case simple selection methods, such as voting with help of red and green stickers, have been used. For one sub–catchment with nearly only large scale agricultural land use a GIS-tool has been developed. This tool was used to choose the right location for water retention in canals by raising weirs. In one sub-catchment a discussion arose between green parties that wanted the restoration of a small river in agricultural areas and the Provincial politician that did not want to have new conflicts with farmers. At the final session the stakeholders had 3 stickers to stick to the measures to select and all votes were treated equally. It was difficult if you had one dominant group form a certain sector. In the end, the organisation with the most political power (the Province) won and so restoration of that small river was not included in the list of measures.

4.7.5 Planning results- Flood Risk Management Plan

The project "Waterdrager" resulted in 6 plans, with measures to reduce flooding and water shortage and to reach WFD targets in the 6 sub-catchments. The plans contain, besides a written report, a list of measures, including costs and the responsible organisations. Next to that, a map indicates the location of the measures. The Regional Water Authority, as the responsible government for most of the measures, had to take the final decision. The summaries of the plans (measures and respective costs) have been sent as a proposal to the steering board of the Regional Water Authority. The summaries have been approved and included as attachments in the official policy plan called "Waterbeheerplan 2010-2015 (http://www.hunzeenaas.nl/Organisatie,ontwerp-beheerplan-2010-2015). This plan has been approved by the provinces. With this latest decision, the "Waterbeheerplan" and the included integral water system plans became legal water policy. So since 2010 the implementation of the measures has started. The "Waterbeheerplan" is updated every 6 years. In this way the plan is kept flexible, to cope with the uncertainties in predictions of economic developments, land use developments and climate change.

Table 4-7 Measures for WFD and FD as included in the integral water system plan per sub-catchment (source: Waterboard Hunze en Aa's)

Maatregel(pakket) vóór 2015	*Maatregel(pakket) ná 2015*	*Totale kosten vóór 2015*	*Indicatieve kosten ná 2015*
oplossen wateroverlast landelijk gebied (290 ha)	oplossen wateroverlast landelijk gebied (70 ha)	€ 725,000	-
onderzoek maatregelen wateroverlast door maaivelddaling door veenoxidatie	mogelijkheden instellen hogere grondwaterstanden door aangepast peilbeheer	€ 25,000	-
verhogen en inspectie kaden	onderhoud en inspectie kaden	€ 1,000,000	-
optimalisatie peilbeheer extreme situaties (slimme stuwen) 1 mln m3	optimalisatie peilbeheer extreme situaties (slimme stuwen) 2,8 mln m3	€ 2,000,000	afhankelijk van invulling restant wateropgave
pilots vermindering waterkort landbouw + beschikbaarheid water IJsselmeer	met kennis om watertekort te verminderen maatregelen inzetten	€ 150,000	-
bestrijding verdroogd gebied, meeliften met gebiedsontwikkelingen	bestrijding verdroogd gebied, meeliften met gebiedsontwikkelingen	(terreinbeh.?)	onze kosten afhankelijk van rol in verdrogingsbestrijding
knelpunten baggeren stedelijk gebied	onderhoud aanwas baggerspecie	€ 5,500,000	€ 11,500,000
realiseren beperkt oppervlak berging voor stedelijk gebied	realiseren beperkt oppervlak berging voor stedelijk gebied	€ 100,000	-
aanpassing rioleringsstelsel aan basisinspanning		(gemeente?)	-
afkoppelen hemelwater t.b.v. optimalisatie rwzi's	afkoppelen hemelwater t.b.v. optimalisatie rwzi's	(gemeente?)	-
nautische baggeren	-	(Provincie?)	-
aanleg natuurvriendelijke oevers: 2 km Vaarverbinding Erica-Ter Apel, 5 km Veendam-	aanleg 17 km natuurvriendelijke oevers	€ 375,000	€ 1,275,000
oplossen 5 tal migratieknelpunten	-	€ 300,000	-
onderzoek voedselrijkdom slib	? (onderzoek)	€ 50,000	afhankelijk van onderzoek
		€ 10,345,000	

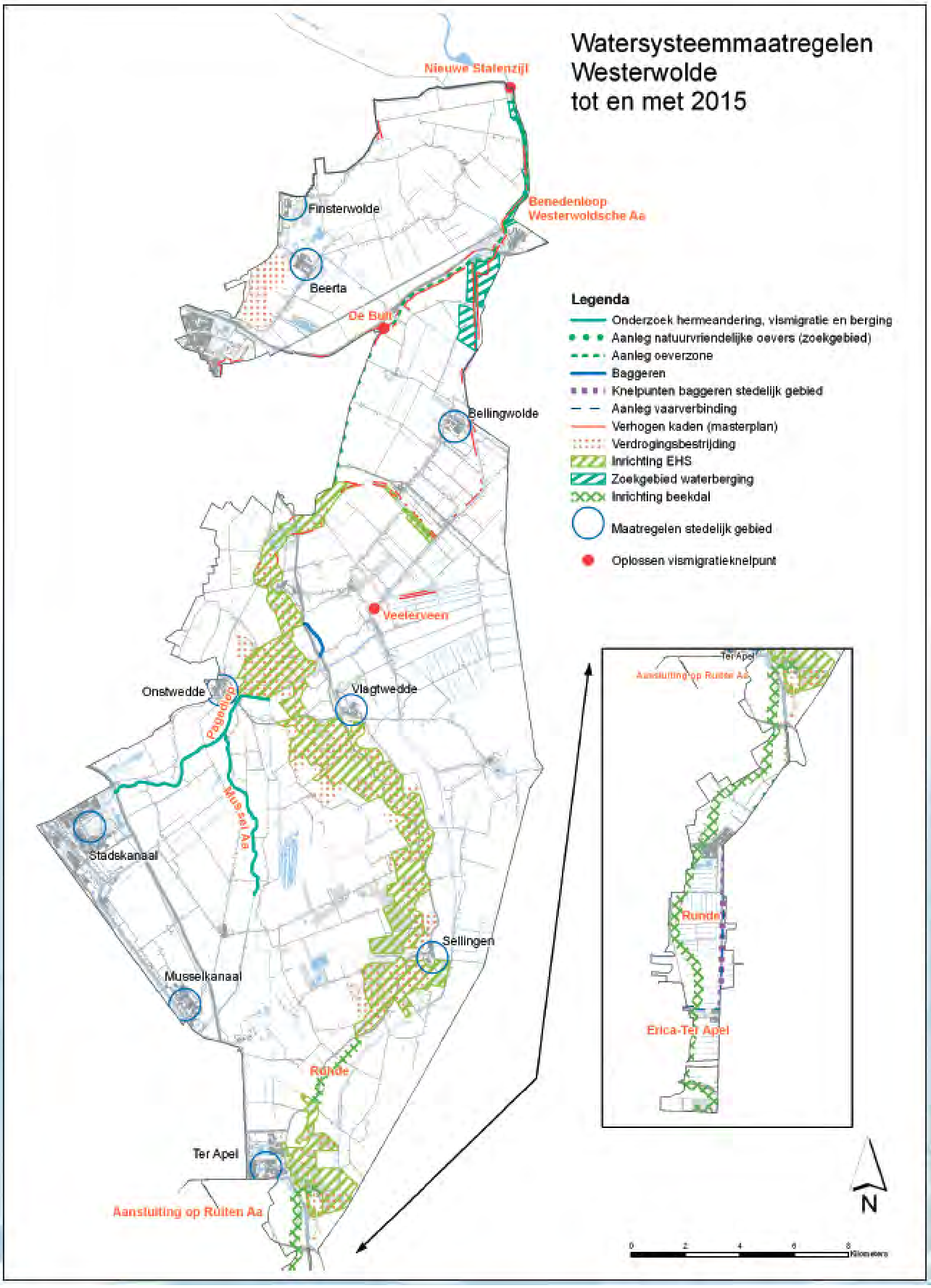


Figure 4-31 Map with location of the measures for WFD and FD as included in the integral water system plan per subcatchment (source: Waterboard Hunze en Aa's)

In most areas it was possible to find retention measures supported by stakeholders that could be combined with local development or local aims. The following combination was found:

- Synergies with the EHS (ecological main structure, see section 4.6.3) by restoring flood plains that can function for water retention
- In agricultural areas we wanted water retention of the right moment in wet periods by putting weirs on remote control. The farmers supported this idea because the weirs will also help to reduce the water shortage they have by water conservation in spring and summer.

- Around new urban areas, new lakes are constructed for recreation and to improve the quality of the landscape and living area. These lakes can also be used for water storage during extreme wet periods (multifunctional spaces).
- In one case a development has been created that could be combined with flood risk reducing methods. A landscape plan for an attractive landscape along a small river has been developed. In this plan, room is provided for investors in new economic activities at some distance of the river valley. In this way a change in land use has been made financially possible. This landscape plan also includes river restoration combined with water retention. Investors are now invited to come with plans. The municipalities, province and Water Authority in fact only provide opportunities (and smooth spatial planning procedures) and try to encourage private investors to participate. Two investors started already (a horse holiday house park for horseriding, and a care organisation for senior people).

Public information and consultation

The "Waterbeheerplan" has an official procedure for public consultation. After approval this plan has a legal status for the water policy in the region.

4.7.6 Lessons learned- Hunze en As's

Process- methods and tools:

- It took the Regional Water Authority approx. 2 man-years and 400.000 euro to organize the communication project and the related studies. The result was that the stakeholders involved were generally satisfied by the way they were involved during the development of proposals for the regional water policy.
- The Regional Water Authority had well prepared plans that were supported by stakeholder groups. This reduced the time to prepare our policy plan and also reduced the number of objections during the procedure of formal public consultation. So the Authority benefited from the investments in the participation.

End Product- FRMP (e.g. content, legitimacy, legacy):

- The most important result was the achievement of finding sufficient measures to retain the rainfall increase due to climate change in areas upstream of the main canals. In most areas the project team succeeded in locating water retention measures supported by stakeholders that could be combined with local development or local aims. In this way it was possible to avoid large-scale measures in downstream areas that would have cost a lot of money and space and therefore would experience a lot of resistance from stakeholders.

Comment: the final documents- FRMP in the pilot regions are at the moment in the revision process for publishing and are expected to be available in national languages on the SAWA website by June 2012.

5 Discussion of results

This chapter summarises the main outcomes of the planning process in the pilot regions.
Here, *Results* are not related only to the end product of the planning process- FRMP, but also the experiences gained in the process design, execution of the planning activities and the factors shaping them.

5.1 Discussion of results

5.1.1 Preliminary Flood Risk Assessment and Flood Risk Mapping

The strategies for preliminary risk assessment in different north European countries differ considerably due to the variety of conditions. Whereby in the Netherlands this step has been omitted and the focus has been put to flood risk management plans, the Scandinavian countries, as very sparsely populated will most likely only identify very few areas as being in severe risk of flooding.
The experiences in the partner countries indicate that it is important to keep in mind the limitations of the flood and risk maps. They depict only statistical flood events, but without considering malfunctioning of the system (e.g. blockage of river sections). Also, there are big uncertainties regarding, for example, how water is transported in pipe systems, which might lead to flooding in “safe” low land areas relatively far from the river/lake. It’s also important to thoroughly describe the nature of the flood in a particular area in order get the full picture of the flood risk. Due to these factors the presentation of flood and risk maps is important. The material should be sufficiently detailed so that different parts of the city and its features are easily identifiable, but, at the same time, not so detailed as to misrepresent the state of knowledge to the viewer.
Whereby the choice of hydrological scenarios when producing flood and risk maps seems to be more or less comparable between SAWA countries, there are however differences in attitudes and strategies regarding the consideration of climate change in flood risk mapping. In the SAWA-pilots only Norway and Sweden have taken climate change into consideration when producing flood and risk maps. The variation between the results gives a hint of the uncertainty in the results and needs further research.
At the beginning of SAWA the availability of PRA results and flood hazard and risk maps considerably varied in the partner countries. In Germany PRA had been accomplished and the areas with the siginificant risk identifed. The Norwegian Partner carried out the prelimiary flood risk assessment within the course of SAWA.

5.1.2 Organisational and Institutional structures relevant for FRM- Planning

In the partner countries there is a high diversity in terms of the administrative structure (centralised vs. decentralised) but also regarding the implementation of 2007/60/EC. Also the SAWA partners take different roles in flood risk management.
Great differences between the case study areas exist in the national legislation and in institutional organization and responsibilities. The city of Hamburg and the water boards have

more sovereignty in water management. Countries like Norway are much more centralized, hampering the flexibility in the development of a FRMP.

In Sweden and Norway it has been unclear in which way and which institution is responsible for the implementation of 2007/60/EC. In Norway, 2007/60/EC is not implemented yet because it is not a part of the EEC agreement. A contribution of SAWA is seen in gaining experience on the implementation process. In the Netherlands in the last decade regional water authorities have developed a set of plans to reduce flood risk but in the context of national water laws. Their interest has been more in finding efficient ways to adapt these plans to the needs of the 2007/60/EC.

In all the pilot regions, the SAWA partners were either a responsible authority for development of FRMPs (e.g. in Hamburg, Karlastad, Lindköpig) or had an advisory role (e.g. Lower Saxony, or partly in Norway).

An overview of the organisational and institutional responsibilities in implementation of 2007/60/EC in general and referring to the SAWA partners is given in Appendix C. The variety of national contexts has been one of the decisive factors for selection of the appropriate governance/stakeholder involvement strategy.

5.1.3 Baseline for planning (Given conditions- scale, flood typology)

Diversity in flood problems could have been identified across the partner countries in the pilot regions. They range from pluvial/fluvial floods in a small urban catchment (City of Hamburg, Germany), to lake floods affecting the urban environment (City of Karlstadt and Lidköping in Sweden), fluvial floods with land slide (municipality of Melhus/Norway), fluvial floods in predominantly rural areas (province Hunze en Aa’s or Illmenau, Lower Saxony) or large transnational rivers in rural areas with ice jam problems (Tana, Norway). The experience of extreme floods and their consequences varies considerably. While in the cities of Karlstadt and Lidköping the impact of the recent floods of Lake Vänern is still present in the public awareness, the population in the Hamburg pilot area has not faced severe floods in the last decades but is concerned about the consequences of climate change. The recent flood event in Norway that occurred during the planning process within SAWA drew attention of the local authorities and public to the increased importance of the SAWA planning activities in the area.

An overview of different flood conditions is given in tabular form in appendix C.

5.1.4 Synergies with the other directives and planning activities in the area (2000/60/EC, spatial planning, climate change)

In general all areas apart from the Swedish pilot regions are giving priority to the measures agreed within 2000/60/EC. Integrated River Basin Management Plan- Illmenau is the best example of the consideration of both Directives applying an integrated strategy. However, it has been assessed that the impact of those measures has to be quantified, for which the corresponding hydrodynamic models are required. An example of such an assessment is given for the Wandse catchments, Hamburg.

In terms of urban planning, the pilot regions show different situations. The six pilot regions encompass both urban and rural areas. Whereby in Hamburg the urban planning is “grabbing at the edges” the pilot areas in Norway are sparsely populated, raising the issue of significance in terms of the area and people affected. A special issue addressed in the Tana catchment is the adaptation of the flood risk management planning in the area with the activities and the culture and of the ethnic group Sami and the Sami Parliament.

The consideration of the climate change aspect in FRMPs varies considerably. Norway and Sweden have considered this aspect already in flood risk maps, defining a safety margin. In Hamburg, the climate change issue triggered an intensive discussion. The responsible authority has been reluctant to take the uncertainties due to climate scenarios as an aspect of the planning process, questioning the reliability of the methods applied to derive them. Still, the climate scenarios have implicitly been considered for assessment of future risks by adopting the 200-year-flood event for the planning objective. Taking an extreme event for the planning objective, it has been considered that a certain buffer is already included in this assessment. However, this approach has been assessed as unsatisfactory and further research is required to find appropriate ways of including the climate change aspect onto FRM-Planning. In the Netherlands, 3 scenarios varying the rainfall increase have been run, giving at least the idea of the sensitivity of the system.

5.1.5 Strategies for stakeholder involvement

5.1.5.1 Selection of the appropriate method

Different approaches have been applied in the partner countries to involve stakeholders. The idea of having one common approach within SAWA has been abandoned due to the high heterogeneity of the national and local contexts. The main differences and at the same time the main criteria for the selection of the appropriate method of stakeholder involvement have been identified as:

- Administrative and organisational structures (centralised vs. decentralised) and the role of the SAWA partner (advisory – responsible for development of FRMPs)
- Planning levels (small urban catchments to large catchments)
- Different status of the implementation of 2007/60/EC (not implemented, to the situation where flood risk maps according to 2007/60/EC have already been produced and available for planning)
- Flood situations (lake, fluvial, pluvial, landslides, ice jams)
- Differences in availability of resources, tools or data (poor data to already existing flood maps)
- Different significance criteria for definition of risk threshold values
- Different priorities set to different planning aspects (the process itself, testing of tools, the specific outcomes that are to be implemented)

An overview of differences in the pilot regions regarding those parameters is given in a tabular form in appendix C together with the approaches selected.

In general, the SAWA partners made good experiences with the methods selected.
The applied bottom up approach in Germany as given in Figure 4-6 managed to gather relevant stakeholders, both professionals and non-professionals (in total 25-30). For the responsible authority (which is at the same time the SAWA partner – LSBG) this approach has been used to get a hands-on experience for the future plans. Close cooperation with academia (2 University partners involved are SAWA partners) enabled the availability of tools, methods and resources to conduct such a process. Due to the size of the catchments the plan has been developed for the local planning level (< 100 km^2) and it was possible to get a converging snowballing process and get the relevant stakeholders on board. At the same time, such a bottom up approach is resource and capacity building intensive. Due to the high intensity in terms of resources and variety of methods and tools required, the question of the up-scaling of this approach to larger catchments has to be raised. Possible integration in the planning procedures on the higher levels is still a matter of discussion.

In Sweden and Norway, the involved stakeholders are the employers of the local municipality.
In Sweden, mere involvement of the local municipality is considered as a first step. In the second step, a broader group of stakeholders beyond the local authorities should be involved. A good experience with this two-step approach can be reported. By addressing the local municipality in the first step, it was possible to capture the main interests and ideas of the local authorities, raising the awareness of the planning process at the municipality level. Despite its size (e.g. Lindköpig- 10 people), the group involved captured the main interested parties well at the local level. Still, the second step in the process has been assessed as necessary as not all relevant stakeholders have been involved. The transportation authority has been identified as an important missing group. The main benefit of the process has been seen in the initiation of the cross-sectoral discussions and cooperation, which was rather an exception before the process.
In Norway where the SAWA project partner has an advisory role in a rather centralised system, the addressed stakeholders are employers of the municipality. Through engaging with the municipality representatives, it has been aimed at raising awareness of the planning process within the administration.

In the Netherlands, the stakeholders involved belong to both professional and non-professional groups, implying different participation levels ("participation ladder"). The involved stakeholder groups are created depending on the issues and problems in each of the sub-catchments the whole area has been divided into. A stakeholder analysis has been made per type of area being addressed, urban or rural, and per catchment area. In total 6 sub areas have been created for the planning purposes, depending on the type of landuse (urban/ rural) and their hydrological and physiological conditions. Although little new ideas have been derived out of the process it was important to involve all key groups including civilians from the very beginning as in that way they were aware of the planning

5.1.5.2 Conduction of the planning process

The stakeholder involvement strategies have been implemented in a form of face-to-face sessions and workshops. Additionally an online participation has been partly used to support the process.
The process took between 5 months (workshop phase in Norway) to 2 years (Hamburg, Hunze en Aa's). In general the application of DSS for the assessment of efficiency and effectiveness had a decisive influence on the duration of the overall process.
In the Wandse catchment, Germany a good experience has been made from the series of workshops with the overall duration of 2 years (in total 14) to develop a FRMP. The process has been time intensive and required a considerably intensive preparation and amount of resources. Additionally an online platform has been used to support the process in terms of discussions and capacity building activities (e.g. e-lectures). Apart from the intensive preparation, the process of changing mindsets of the people towards participatory planning has been time intensive. The sessions took place in the evening, enabling the participants to disconnect from their daily business and "put the LAA hat on". The sessions were aimed to be different and attractive, also adding a learning effect to it. An example is the application of the flood animation studio or on-site inspections with specific tasks or changing locations.
A good experience with the combined approach (meetings, interviews, workshop sessions) involving both public and private stakeholders has been made in the Illmenau catchment area. Very intensive preparatory work has been assessed in order to organise and conduct the final two workshops with the relevant stakeholders. However, as an integrated river basin management plan has been developed, the overall efforts are spread over two participatory processes (for development of FRMP and RBMP). Close cooperation between the local authorities and university partner has been perceived as very fruitful and important.

During the development of the FRMP for the River Klarälven and lake Värnen in Sweden it has been observed that it is important to make the sessions attractive, especially for the people that do not have a "mandate" to participate. Learning something new has been an important motivation to join the sessions. External expert presentations on the selected relevant topics (e.g. CBA) have been highly appreciated. It turned out to be important to fit the work within the FRMP process into the daily tasks of participants that have to be done anyway.

In Norway, the preparatory work has been performed by NVE and the meetings with the local authorities have been conducted in a period of 5 months, which turned out to be sufficient for the selected planning scale (the downstream municipality where flood risk has been assessed to be the most significant in the Gaula catchment). However, in spite of the approval of this process by the politicians, a rather moderate commitment has been observed, expecting that the leading authority (NVE) solves the problems. The main problem was the lack of time and low readiness to invest extra time for this process. However, the recent flood events in Norway (June 2011) has been seen as a strong trigger to increase the priority given to the flood problems and planning processes related to it, which has been positively reflected in the motivation. It must also be mentioned that the legitimacy of the developed plan is limited as the developed plan has a pilot status. For the official plan the counties would be involved, as they are the ones to implement FRMP but also the railway authority.

In the Netherlands the sessions have been organised over four half days, which turned out to be too intensive. A special difficulty has been seen in the point that the volunteers cannot attend the sessions during working hours. Harmonisation of schedules is one of the main organisational problems assessed. The sessions took place in the area, starting with a relaxing part and continuing with the presentations. The whole days have been planned for the sessions, which turned out to be a good approach. The whole process took approx 2 years. It was a thorough process where the understanding of the problem, suggestion of measures and calculation of the effects took a long time. The preparation for the sessions was time intensive. The impact of the planning process has been seen in both, outside of the responsible organisation, which challenged people to understand and accept the FRMP process, but also within the responsible organisation, which is facing new ideas that have to be considered and internally discussed.

5.1.5.3 Methods and tools supporting the planning process

Different methods and tools have been applied in the partner countries to support the participatory process. An overview of the tools applied is given in appendix C.
In the Wandse catchment, the role of the university partners enabled application of a range of tools throughout the planning process. The most intensive part was related to the experimenting phase (see Figure 4-6) where different planning options have been created (in total 250 simulations). Although very intensive, the application of the DSS for the purposes of the efficiency assessment of the planning options has been assessed as one of the crucial elements for decision-making and as such has to be integrated into the planning process. A good experience has been made with the tools for raising risk awareness (flood animation studio) and capacity building (e lectures), which should be considered for the future planning activities despite of the effort and preparation time.
In Norway a good experience has been made with the multi criteria matrix. It enabled getting an integral picture of the problems and issues for FRMP, which brought more transparency of the problems related to the planning process to the politicians. However it has been also assessed as time consuming and required an expert performing the multi criteria analysis, which can limit its applicability for future cases.
The aspects of the application of the CBA tool used in the Swedish pilot regions have been well elaborated and analysed within the team. Additionally, an external expert's opinion has been requested. Although seen as an important decision criterion, the costs are not to be considered as the only decision basis. Also, in order to perform a reliable CBA, a range of data has to be made available such as a reliable terrain model with good accuracy for the modelling of flooding events. Additionally, as the results of the CBA depend on the data quality an uncertainty analysis should be enclosed to the statements derived by the CBA method. Again, for reliable statements, enough time and resources (including an expert) should be allocated.

In the Netherlands a good experience has been made with the GIS based CBA. However, although the tool delivered results, which could be discussed in the group, politicians made the last decision, especially when the measures are not cost effective. The local decisions could have an impact on the final decisions. Also, another problem was that some of the people are reactive and some active.
In all the cases it has been pointed out that some of the measures cannot be quantified (e.g. guidelines or informing the dwellers), for which alternative methods are to be developed in order to assess their efficiency. Those were beyond the SAWA project.
The selection of tools and methods has been influenced by the data quality and availability in the area.

5.1.6 The “end product”- FRMP

The FRMP is discussed in terms of its content, scale, definition of the acceptable risk, legitimacy of the plan, public information and consultation and the legacy of the planning process.

5.1.6.1 Content and Scale of FRMP

The end products in all pilot regions are composed of a list of measures and maps. The lists of measures are given in tabular form with short descriptions of the content and responsibilities for their implementation. In the Dutch pilot region, the measures are assigned specific costs. The maps enclosed to the lists depict the locations of the measures. All maps from the pilot regions have high a diversity of layouts and presentation methods.
For the adopted measures, different levels of detail have been assessed in different pilot regions. In the Ilmenau, Germany and Tana, Norway regions the measures are kept rather general and should rather serve as guidelines emphasising the aspect of the integrated approach and the risk awareness in a specific cultural context (the Sami population) respectively. On the contrary, in the Dutch, Swedish pilots or in the Gaula catchment, Norway specific measures related to selected locations or hotspots have been discussed and finally adopted. In the Hamburg pilot region the measures on different scales have been adopted-catchment, watercourse and at the specific locations. FRMP final document follows the LAWA, 2010 guidelines. In addition to the document, a technical memorandum with more technical information is attached to the plan. Every measure is given with an objective, a short description, responsible party, control mechanism for its implementation and its priority.

In terms of scale of planning it ranges from small catchment in an urban area (the Wandse river in Hamburg) up to the transboundary large rivers (e.g. Tana).

5.1.6.2 Definition of objectives/acceptable risk for development of FRMP

The methods for definition of the planning objectives (acceptable risk) vary across the pilot regions. Whereby in Hamburg the planning goal has been discussed within the groups and finally set to a 200-year flood (extreme event) implicitly taking into consideration the aspect of climate change, the Swedish case studies defined their planning objective by varying the

water level in the lake and analysing the sensitivity of the system. In the Dutch pilot, the cost benefit analysis has been used to assess the planning objective.
However, a common finding of the partners is that finding the planning objective is a trade off of different factors (e.g. safety vs costs) and should be discussed in the group (it is more a social issue rather than a result of a mathematical model).

5.1.6.3 Legitimacy of the plan

All plans but the plan developed in the Hunze en Aa's region have a pilot character. As the flood risk management planning is a novel issue to the authorities, it is unclear in which way the SAWA pilots will influence the legal process and the implementation of the measures. However, in all pilot regions awareness among the responsible authority could be observed. It has also been reflected by a participation of the representatives of the responsible authorities in the workshops and sessions that has been assessed in the SAWA pilots.
The fact that the responsible authorities were at the same time SAWA partners enables that the developed plans will have an impact on the measures to be implemented in the pilot regions.

5.1.6.4 Quality control/Evaluation of the results and process conducted

The quality control of the process and results has not been systematically performed. Flood risk management planning is a novel issue and as such, the methods by which a reliable evaluation can be carried out are still a matter of research (Renn, 2011). In the Hamburg pilot region, such an assessment has been performed taking advantage of the experiences of further projects in the Hamburg area whose lifetime coincided with the SAWA project (e.g. the ERA Net Crue Project DIANE CM http://hikm.ihe.nl/diane_cm/). The results will be available in April 2012. An exchange of experiences can further help the Hamburg responsible authority (LSBG) to define a "Hamburg strategy" for flood risk management planning.

5.1.6.5 Public Information and consultation

As all plans but the Dutch have a pilot status, there were no official procedures for public consultations. In German case studies, representatives of the public have been involved in the planning process in contrast to the Norwegian and Swedish pilot areas. Only in the Dutch pilot region is there an official procedure for consulting the public.

5.1.6.6 Legacy of the planning process

As all developed plans apart from the Dutch area have a pilot character and had an objective to initiate the planning process, the process will continue in all pilots.
The aspect of the legacy of the SAWA flood risk management activities can be analysed from different perspectives:

- Continuation of the initiated work within SAWA (e.g. in Sweden where the two step approach is planned and within SAWA the first step has been accomplished)
- Using the established networks of stakeholders for further initiatives in the area (e.g. in Hamburg within the KLIMZUG- Nord Project (http://klimzug-nord.de/)
- The recommendations and lessons learned from SAWA will be used for future planning activities of the responsible authorities

The possibility to hibernate and reborn the created networks beyond the course of a project or current planning activity should be explored (Ashley/Blanksby/Dudley, 2012)

6 Lessons Learned and Recommendations for Future Work

In this chapter the main lessons learned applicable to all partners are given. Some additional lessons learned that are related to particular partners' experiences and were intensively discussed among the partners throughout the planning process:
Finally some recommendations for future activities and work are given. They separately address the responsible authorities, research and consultancy as the main players in the design and conduction of the flood risk management planning process as described in section 3.5.2.

6.1 Lessons learned

Strategies for Stakeholder Involvement:

- At this stage of the implementation of 2007/60/EC it has been assessed as inappropriate to use a common approach for FRMP due to variety of flood situations, organisational structures and national contexts
- Open atmosphere and mutual trust is the key to constructive planning and discussions; the environment is important -make the sessions attractive
- Capacity building is an important aspect and should underline the planning process
- Development of a FRMP is process and enough time should be allocated for it. The experience from the partner countries indicate durations from 5 months to 2 years, depending on the level of detail and application of decision support systems

Process- Methods, Tools, Resources:

- Flood Risk Management Planning involves a range of tools and methods (social, hydrodynamic, learning) and needs interdisciplinary teams
- It is assessed as not applicable to apply standardised tools and methods for development of FRMP due to different experiences and expertises, specific flood problems and conditions and data availability.
- The types of tools to be used vary from hydrologic and hydraulic models for assessment of efficiency of NSM (e.g. Kalypso- Planner Client, FLORETO in Hamburg), CBA (Swedish tool) to MCA (Norway) for the cost effectiveness and multi criteria assessment. The tools that can be applied range from simple tables and matrices up to complex hydrodynamic models and chained processes and tools (e.g. Kalypso Planner Client or High Water) depending i.a. on the specific problems and planning objectives.
- Data management and availability varies considerably in the partner countries. For high quality FRMPs, high quality data is required. A harmonisation of data standards and formats would facilitate more efficient FRM- Planning especially at the transboundary level
- *Application of DSS time and resources is intensive but necessary! It is important to deliver facts and figures (Germany, The Netherlands)*

- It is possible to harmonise WFD and FD, but important to quantify the effect of WFD measures to a flood situation
- The climate change aspect in FRMP needs more research. As a good practice the definition of safety margins in flood hazard maps is assessed
- For the success of the process it is important to make transparent to the participants what kind of impact the planning results will have (legitimacy of the plan).
- *One of the main benefits from the process is seen in initiation of cross-sectoral communication and mutual trust (Sweden, Germany)*
- *Include key stakeholders in an early stage (Germany, Norway)*

Final Product- Flood Risk Management Plan:

- The tables containing a list and a short description of measures have been assessed as the most useful. Cost estimaiton of measures to be applied is useful

Particuular problems occured during the planning process and suggested ways to overcome them

Motivation of the participants to commit especially in the initial planning phase (Hamburg, Sweden, Norway)
→ Make sessions attractive including social games (Hamburg), invite experts to give lectures on the topics of particular interest (CBA in Sweden), embed a ”surprise effect” in the way the sessions are conducted without losing the focus and the objectives of the session (Hamburg)
→ Make the planning objectives clear as well as what is expected from the participants (all)

Breaking the organisational/sectoral perspective and moving towards collaborative planning (all)
→ It is a process not a single event and enough time has to be allocated for building mutual trust within the group supported by the capacity building process

Definition of the planning objective (all)
→ Assessing the sensitivity of the system and based on it discuss the acceptable risk within the group (Hamburg, Sweden)
→ A cost benefit analysis (for the areas protected by dikes) (The Netherlands)
→ Important to keep in mind that the adaptive measures are to be planned i.e. consider the drivers of future development (Germany, Sweden)
→ Consider other relevant planning activities and Directives in the area (all)
→ Consider cultural aspects of the area (Norway)

Getting the process of selecting the planning options started (all)
→ Start with a smaller number of rather general measures (~10) and refine them within the group (Norway)

→ Start from a specific acute problem, which the group is dealing with in their daily business to get the momentum and interest of the participants (Sweden)
→ Identify hot spots in the area and address them within the group, give some suggestions as discussion points (Hamburg)
In all cases, the project team is giving the first suggestions in order to initiate the process

6.2 Recommendations for Future Work

6.2.1 Responsible authorities/ Decision Makers

The following issues have been assessed as important for future activities of the responsible authority:

- Integration of the planning activities on a local scale into flood risk management planning on larger scales. The developed plans within SAWA addressed a specific location or area and it has been beyond the SAWA project to address the integration aspect. An exchange with the responsible authorities in adjacent areas or larger catchment units is required.
- It must be acknowledged that the quality of the decision making options as well as efficiency and effectiveness assessment is very much dependant on the data quality. Therefore, for reliable results and an adequate decision support basis good quality data as well as flood hazard and risk maps are to be provided by the responsible authorities. Some of the data are crossing administrative borders and their management has to be optimised within the responsible authorities. The deficiency assessed during the SAWA Project in pilot regions in terms of data quality and availability (e.g. in Sweden, Lower Saxony) calls for further improvements and should be addressed before the future planning process within the responsible authorities

6.2.2 Research

Research should mainly focus on the further development of the methods and tools given as:

- The governance methods that consider local scale planning into the planning at the larger scales, which are still matter of research
- Within SAWA the aspect of climate change has been addressed, however the partners dealt with the issue differently. In general, the methods used to integrate the climate change aspect in the plan need further research. The methods used in Sweden and Norway to include safety margins in flood hazard maps can be a first step to this.
- Decision support tools applied contributed to having a better insight into the problems and giving the overview of the main options to be undertaken with the impact to flood

risk. Still, there is room for improvement of the applied tools mostly related to the following issues:

  - o Improvements of the physical models of the processes described
  - o More user friendly interfaces and tools in general (easier to use, less time intensive)

- Although assessed as useful and important, there are till a few tools for raising risk awareness and capacity building actively included in the planning process. Within SAWA e lectures and
- As flood risk management planning is still a new process the appropriate evaluation methods are a matter of research
- Together with the consultancy and responsible authorities, the contents of FRMP and layout of the corresponding maps is to be discussed and further improved. In case national initiatives or guidelines exist (e.g. in Germany- LAWA, 2010), the feedback can be given and coordinated with the other planning activities in the German catchments.

6.2.3 Consultancy

The main role of consultancy where further work is needed is related to the acceptance and utilisation of new tools and methods, mainly DSS or mathematical models being:

- Acceptance and utilisation of new methods and tools for the efficiency assessment of different measures (e.g. SUDS). The tools developed and used within SAWA, although important for decision making, require experts to run them (e.g. Kalypso-Planner Client applied in Hamburg) or facilitate their application (CBA tool applied in Sweden)

The process of the development of FRMPs is time and resources intensive and for the efficient planning a close cooperation and coordination among these three groups, with the general distribution of tasks as given in Table 3-6 is needed. The contribution of single parties for a given case can vary depending on the scale, planning phase or specific problems addressed during the course of planning. Apart form the current planning activities, the aspect of legacy should be considered in a timely fashion so that the expertise, ties and created networks can be (re-) activated in the future.

Acknowledgments

The Authors of the Hamburg case study wish to acknowledge the commitment and cooperation they received from local authority in Wandsbek and all LAA participants that dedicated their time to participate in the development of FRMPs. The preparation and conduction of the LAA program has been performed in a close cooperation between LSBG, Hamburg University of Technology (TUHH) and Hafencity University (HCU).

References

[1] ARNSTEIN S. (1971): *A ladder of citizen participation*, Journal of the Royal Town Planning Institute.

[2] ASHLEY R.M., BLANSKBY J., NEWMAN R., GERSONIUS B, POOLE A, LINDLEY G., SMITH S., OGDEN S, NOWELL R. (2009): *Learning and Action Alliances to build capacity for flood resilience,* Journal of Flood Risk Management, 5 (2012) 14–22

[3] GOLDER ASSOCIATES (2009): *Ermittlung und Neufestlegung vonÜberschwemmungsgebieten und überschwemmungsgefährdeten Gebieten für das Einzugsgebiet der Wandse* im Auftrag von LSBG, Hamburg

[4] EUROPEAN PARLIAMENT Water Framework Directive for Community Action in the field of water policy, Official Journal of the European Communities, L327/1, Brussels, 22.12.2000

[5] EUROPEAN PARLIAMENT, (2007, November 6): *Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks*. Official Journal of the European Union .

[6] EVERS, M., NYBERG L. (2011): *Coordination of the Water Framework and the Floods Directives – why a coherent approach is not that simple*, Journal for Water Resources Management

[7] EVERS, M., M. TISCHBIEREK, J. MUSSBACH, P. ARNDT (2011). *Integrative River Basin Management. Sznergies and target areas in the Ilmenau catchement area.* ISBN 978-3-935786-54-6

[8] EVERS M, JONOSKI A, MAKSIMOVIC C, OCHOA-RODRIGUEZ (2011): *Enhancing Stakeholders Role through Collaborative Modelling for Reduction of Urban Flood Vulnerability"*, Proceed. Of the International Conf. On Urban Flood Risk Management (UFRIM), 21-23 September 2011 in Graz, Austria ISBN 978-3-85125-173-9

[9] LAWA (2010): *Empfehlungen zur Aufstellung von Hochwasserrisikomanag. – Plänen*

[10] LAWA (2010): *Empfehlungen zur Aufstellung von Hochwassergefahrenkarten und Hochwasserrisikokarten*

[11] MANOJLOVIC N. BEHZADINA N., BARBARINS D., PASCHE E† (2011): "*On the Way to a Flood Risk Management Plan",* Proceed. of the Acqau Alta Confeence, October, Hamburg 2011

[12] MANOJLOVIC N. BEHZADINA N., BARBARINS D., PASCHE E† (2012): "*Learning adn Action for Flood Risk Management Planning",* Proceed. of the Acqau Alta Confeence, October, Hamburg 2011

[13] NEWIG J., VOSS J-P., MONSTADT J. (2008): *Governance for Sustainable Development in the Face of Ambivalence, Uncertainty and Distributed Power: an Introduction*. In: Newig, Jens / Voss, Jan-Peter / Monstadt, Jochen (Hrsg.) Governance for Sustainable Development. London, S. 7-14

[14] PARRY M.L, O. C. (2007): *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds).

[15] STERN, N. (2006): The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University.

[16] PASCHE, E., LAWSON N., ASHLEY, R., SCHERTZER, D. (2008): *Risk Assessment and Risk Management in Small Urban Catchments*, Final report, ed: on CRUE Funding Initiative on Flood Risk Management Research

[17] RITTEL, H. AND WEBBER, M. (1973): Dilemmas in a general theory of planning, Policy Sciences, Vol. 4, No. 2, pp. 155-169.

[18] ROWE G. AND FREWER L. (2005) *A typology of public engagement mechanisms.* Science, Technology and Human Values. 30. p. 251 – 290.

[19] Walker, W. (2000) *Entrapment in large technology systems: Institutional commitments and power relations*. Research Policy, 29, 833-846.

[20] WORLD METEOROLOGICAL ORGANISATION,- APFM (2005): *Integrated Flood Management- Concept Paper,* APFM http://www.apfm.info/pdf/concept_paper_e.pdf

Appendices

Appendix A: Non- Structural Measures

Flood Probability Reduction Measures (FPRM)

FPRM	Type of measure	Description	Scale
Sustainable Drainage Systems (SUDS)	**Source Control**		Allotment scale
	green roofs	vegetated roofs that reduce the volume and rate of runoff and remove pollution	
	rainwater re-use	involves the collection and storage of rainwater on site and its use as a substitute for mains water, for example in watering gardens or for flushing toilets	
	permeable pavements	through porous pavement rain water directly infiltrates into the subsoil. Here it can be stored in an underground reservoir before slowly percolating into deeper parts of the underground.	
	infiltration techniques		Allotment scale
	filter trenches	is a shallow, excavated trench that has been filled with permeable material to create an underground reservoir	
	filter drains	similar to filter trenches through which a perforated pipe runs. This facilitates the storage, filtering and some infiltration of water passing from the source to the discharge point.	
	filter strips	vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt & other particulates	
	soakaways	sub-surface structures that infiltrate runoff	
	detention structures		Inter-mediate
	swales	grassed depressions which lead surface water overland from the drained surface to a storage or discharge system and may in combination with filter drains permit infiltration.	
	bioretention area	a depressed landscaping area that is allowed to collect runoff so it percolates through the soil below the area into an underdrain, thereby promoting pollutant removal	
	detention basin	designed to hold back storm runoff for a few hours and to allow the settlement of solids. They are dry outside of storm periods. In combination with filter drains permit infiltration.	
	ponds & wetlands	areas of permanent water, designed to accommodate considerable variations in water levels during storms, thereby enhancing flood-storage capacity. They can be fed by swales, filter drains or piped systems, and the use of inlet and outlet sumps will enhance performance by trapping silt and preventing clogging of the outlet.	
Controlled surface conveyance	diversion structure	small structures (dam, walls, curbs) to capture and lead surface runoff along streets, green corridors, foot paths or between building lots	Inter-mediate
	multi-functional space	area in the landscape whose primary function (park, place, biotope) will not be affected by flooding	
	conveyance structures	human-created rills, very shallow ditches (swales) to convey and direct overland flow to multi-functional space, storm sewer inlets, watercourses and detention structures	
Fluvial Flood Detention Measures	**Give rivers more space**		Water-course
	Daylighting watercourses	reopening of culverted watercourses and restoration of natural geomorphological structure (meander, wooded vegetation)	
	flood plain restoration	by dike reallocation, wetland development and lowering the flood plain elevation	
	Holding back water		
	Flood polder	low lying area on the flood pain, separated from the watercourse through dikes. Used for temporary storage of flood water. Inflow and Outflow from watercourses via hydraulic structures (controlled and uncontrolled)	
	small detention reservoir	flood-control reservoir with low dikes and small volume, which retains flood water in a semi-distributed way, by receiving flood water from a central stormwater pipe or a small watercourse in SUCA’s	

Flood Resilience Measures (FReM) covering the 4 A's

FReM	Type of measure	Scale
Capacity building of human resources A1: Awareness of flood risk	Information Flood maps (Inundation and Risk) Info material (brochures, public presentations, internet portals etc	Intermediate
	Education - Communication Face-to-face learning Web-based learning Training Collaborative platforms	Intermediate
Land use control A2: Avoidance of the risk where possible	Spatial Planning Flood risk adapted landuse Building regulations Building codes Zoning ordinances	Catchment
Flood preparedness A3: Alleviation of the effects of the flood	Flood Resistant buildings Wet-proofing Dry-proofing	Local
	Flood action plan (local scale) Infrastructure maintenance	Local
	Flood conveyance systems and multi functional spaces	Internmediate
Contingency measures A4: Assistance in the event of difficulties	Financial Preparedness Insurance of residual risk Reserve funds	Catchment
	Emergency Response: Evacuation and rescue plans Forecasting and warning services	Catchment
	Control Emergency Operations	Intermediate
	Providence of emergency response staff	Intermediate
	Emergency infrastructure Allocation of temporary containment structures Telecommunications network Transportation and evacuation facilities	Intermediate
	Recovery: Disaster recovery plans, pecuniary provisions of government	Intermediate

Appendix B: Specific information related to the pilot regions

Parameter characterizing stakeholder groups analysis in the Wandse pilot region

Parameters	Description
Responsibility	Linked to scope of activities. Administrative or legislative responsibility, e.g. approval and permit are legislative, implementation and maintenance are administrative
Expertise	The knowledge of institutions/individuals especially related to the FRMP process
Current activities	Brief description of on-going developments in the area (any planning activities, implementation projects, or other actions), which can serve as "hitch-hiking" in implementing the measures of a FRMP
Policy making	Influence of a stakeholder group to control processes and other stakeholders, e.g. advisory group for the ministry, parliament etc. This parameter is one of the key criteria for stakeholder selection in LAA. It should be given with the type of the influence (direct, indirect) with whom/what and brief comment in which way and at which level (high/low) this influence is exerted.
Spatial scale	Area of responsibility or activities. Can be: political, administrative, operational or planning boundaries of stakeholder group. To be classified in: local or regional. In large cities local refers to boroughs (institutions) or property (dwellers) and regional to municipality/metropolis/ state/country.
Temporal scale	Time scale in which stakeholder group is practicing their main business (planning, design, implementation, maintenance)
Data ownership	Defines the data owned by the stakeholder group, including information of data availability and accessibility
Current relations	Type of relations among the existing stakeholder groups mostly related to: - Being informed /informing - Asking for approval/ delivering approval - Complaining - Cooperation - Participatory planning

Parameter characterising the conflict potential and shared interests

Parameters	Description
Level of impact	Shows in which way and to which extent the stakeholders are affected by implementation of FRMP. It can be differentiated as direct or indirect. This parameter implicitly contains the motivation of the stakeholders to participate in the FRMP process and as such it is one of the key parameters for their selection.
Level of Understanding/ Knowledge	Assessment of the present knowledge and background of the stakeholder groups. It addresses the flood risk awareness and understanding of the flood situation in the area as well as the understanding of the paradigm "living with water" reflected in the Flood Risk Management
Need for Capacity Building	Based on the knowledge available, their interest and possible role in implementation of FRMP, the requirements for capacity building are assessed stating the thematic units related to it and if possible which measures of capacity building should be applied to address the stakeholders.
Overlapping (unclear) responsibilities	Ambiguities among institutions/individuals
Diverging Interests – conflicts	Description and assessment of the conflicts due to the implementation of the FRMP
Congruent Interests	Description and assessment of shared interest between stakeholders to develop FRMP

Appendix C: Overview of the main parameters describing flood risk management planning in the pilot regions

Table 0-1 Organisational and legal background in the partner countries relevant for the implementation of 2007/60/EC (underlined are direct SAWA partners)

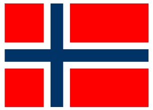
Area	Organisational/ Institutional structure at the state level	PRA	FRM	FRMP	Status of implementation at the beginning of SAWA
Wandse  Illmenau	Decentralised	Hamburg: Federal State BSU/LSBG	Hamburg: Federal State BSU/LSBG	Hamburg: Federal State BSU/LSBG to be coordinated within river basins	- Flood hazard maps and preliminary flood risk maps available in Hamburg -LAWA Guidelines for the development of FRMPs released in March 2010
		Lower Saxony: Federal state NLWKN	Lower Saxony: Federal state NLWKN	Lower Saxony: Federal state NLWKN	
 Gaula Tana	Centralised	State (NVE)	State (NVE)	Local municipality (Mahlus) with the State (NVE)	- 2007/60/EC not implemented because it is not a part of the EEC agreement
		State (NVE)	State (NVE)	Local municipality (Krasnajok) with the State (NVE)	
 Vänern Klarälven	Decentralised	Swedish Civil Contingencies Agency (MSB)	County Administrative Board Värmland	County Adm. Board Prod. by County Administrative Board Värmland	- The government had not even decided about the institution, which is responsible for implementing 2007/60/EC
 Hunze en Aa's	Decentralised	Water Boards	Water Boards	Water Boards but not produced on the basis of 2007/60/EC	- A range of plans to reduce flood risk developed by Water boards already existed

Table 0-2 Summary of the main characteristics of the SAWA planning areas

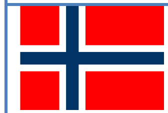
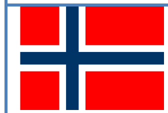
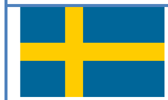
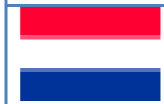
Area	Planning area	Flood Type	Area at risk	Physiography & Landuse	x- year floods[m³/s] floods in the past
 Wandse	81,6 km² Two main rivers	Pluvial/Riverine	Small parts of the city	Low lands, Upstream- rural, downstream- urban	HQ100 = 15,70 m³/s HQ200 = 17,10 m³/s No recent mayor floods
 Illmenau	2984 km²	Riverine, Flashfloods, backwater effect tidal infl	Identified as area with significant F.R	Upper- flat marsh land Mid- hills and valleys Lower- urban area	Highest discharges- Nov-March - severe floods in the past
 Gaula	3 566 km² One main river	Riverine, snowmelt, landslide	City of Melhus, farms, infrastructure	Mountainous, Farming, river training Forestry	HQ100 =2533 m³/s HQ200 =2829 m³/s - severe floods in the past
 Tana	16380 km²	Riverine Ice jams	Small communities along the river 8rather sparsely populated area)	Mountainous Mostly agricultural, Sami ethnic herritage	- severe floods in the past
 Vänern Klarälven	50230 km² Several large rivers (Klarälven and Göta)	Lake, landslides, riverine	2 mayor cities flooded Lidköpping Karlstad and several smaller communities	Mountainous, steep and long catchment	HQ100 = 1490 m³/s Floods in the past
 Hunze en Aa's	**Various small catchments 2000 km² (6)**	Riverine	Mainly rural area	flat, low lands	Floods in the past

Table 0-3 Consideration of other planning activities and directives in pilot regions

Area	WFD (2000/60/EC)	Other Planing Activities/ Directives	Climate Change aspect	Data availability
Wandse	- Local authorities have a list of WFD measures with priorities - Considered for development of FRMP	- Spatial planning: - “grabbing at the edges” -- Natural preservation area in the upper catchment	- Discussed with participants - Safety margin defined through adoption of 200 year flood as objective - Should be improved!	- Good; responsible institution is involved in the process - GIS data and mathematical models (including flood maps)
Illmenau	Integrated into the planning and given priority for the implementation	- Spatial planning, - nature protection		- Distributed responsibilities (3 counties) that hinder optimal data collection - Different data quality and high costs for good quality data
Gaula	- Priority area for implementation of WFD - WFD measures considered for FRMP to be analysed by the DSS		- Safety margin in hazard maps	- Data mostly available
Tana		- Developments in the areas with the ethnic group Sami	- Safety margin in hazard maps	- Data mostly available
Vänern Klarälven	- Not considered	- Spatial planning	- Projected changes in extreme design flood - Projected changes in 100 year flood	- Low quality of elevation data (2,5 m vertical error)
Hunze en Aa’s	- Water quality - Synergies mostly along small rivers (e.g. natural restoration)	- Spatial planning	- 3 scenarios varying the rainfall, assessing the sensitivity of the system	Data mostly available

Table 0-4 Flood Risk Management Planning in the pilot regions

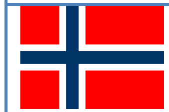
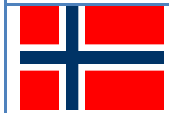
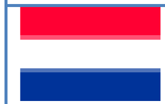
Area	Type of Stakeholder Involvement	Stakeholders addressed	Definition of objectives	Final Product and Legitimacy of the plan
 Wandse	Bottom up LAA: workshops, online, on site	Snowballed process: professional and private in the Wandsbek district	a matter of discussion (social acceptance) rather than modelling result 200 year flood as a basis	A list of 26 measures given as a document (LAWA, 2010) and map - Recommendation
 Illmenau	Bottom up - Workshops, meetings, interviews	Affected counties Lüneburg, Uelzen, Harburg	Harmonisation with WFD	- Ilmenau Atlas - Recommendation
 Gaula	Top down	Employees from the municipality	Best practice recommendations for implementation of the FD at a regional level	- Documents with a reference to hazard maps, and summary tables In total, 50 measures, divided into seven categories - Pilot study
 Tana	Top down	- Professional stakeholders - Karasjok municipality and the Sami Parliament	Best practice recommendations for implementation of the FD at a regional level	- Enhancement of the 4P management cycle, focus on raising risk awareness - Pilot study
 Vänern Klarälven	“Top down” 2 step approach 4 workshops	1. step: local municipality 2 step: further affected professional stakeholders (e.g. transportation utilities)	- Varying the water level in the lake - It is a trade off and should be discussed with the group	- A list of technical and planning NSM - Pilot study but served as a catalyst for further activities
 Hunze en Aa’s	Different level of participation Participation ladder	Professional and private	- CBA as a basis	- 6 plans (list of measures with costs and maps) - Included in the official policy plan “Waterbeheersplan 2010-15

Table 0-5 Methods and tools used for development of FRMP

Area	Social Learning & Capacity Building methods used	DSS	Duration of the planning process	SAWA Partners resp. for design and cond of the process
Wandse	- Presentations - E-Lectures - Flood Animation Studio - Social Games, - "Conflict Matrix"	Efficiency of NSM: - Kalypso Planer Client for efficiency of SUDS, restoration of rivers, - FLORETO for resilient built environment CBA: - Kalypso Planner Client FLORETO (just exemplified)	~ 2 years	LSBG- responsible authority TUHH, HCU- University partners
Illmenau	Lectures	GIS based tool for integrated planning		Leuphana- university partner supported by Chamber of Agriculture, Lower Saxony
Gaula	Lectures	MCA: - Tool developed by the SGI on multicriteria analysis, selection among 200 measures	5 months	NVE- national agency
Tana	Presentations &Talks	-		NVE- national agency
Vänern Klarälven	Lectures given by external experts	CBA tool		County Administrative Board of Västra Götaland, Göteborg- local authority County Administrative Board of Värmland, Karlstad- local authority
Hunze en Aa's	Lectures during the course of workshops	GIS based tool for selecting the right location for water retention by putting weirs on remote control	~ 2 years	Water board- Responsible authority

Table 6 Availability of PFRA and flood hazard and risk maps in the partner countries

Area	Preliminary FRA	Flood hazard maps	Flood risk maps
Wandse	-	Available before SAWA	Available but the layout and contents changed during the course of SAWA according to LAWA 2010a, guidelines
Illmenau	-	Available before SAWA	
Gaula	Developed during SAWA	Available	-
Tana	Developed during SAWA	Accomplished 2002	-
Vänern Klarälven	Developed during SAWA	Developed during SAWA	Developed during SAWA
Hunze en Aa's	-	Available before SAWA	Available before SAWA