2 Summary

Recent years have seen a marked increase in damage resulting from flooding caused by heavy rainfall. The discharge dynamics of many urban brooks and streams have been affected considerably by the development of their capacity for stormwater sewerage drainage. Hydraulic stress and the import of sediments, nutrients and pollutants are causing adverse ecological effects. In many residential areas the management of water resources is undergoing a process of adjustment which is accelerated by the *Flood Directive* (2007/60/EG) and the *Water Framework Directive* (2000/60/EG).

This illustrates the need for measures that can reduce run-off while at the same time supporting the ecological goals set out by the Water Framework Directive. Local measures for retaining flood water could achieve this. While the effects of such measures are generally understood, quantitative analyses pose greater difficulties: It is often impossible to quantify the effects of these measures with regard to run-off behaviour on (sub-)catchment scale and to estimate the time frame within which the measures can be implemented. The present report proposes a strategy for an initial screening of the practicability and the effectiveness of such measures in relation to urban brooks in the north German lowlands.

The case study of the river Wandse, a small urban stream in Hamburg, investigates

- which flood-related risks should be addressed within the framework of flood risk management planning,
- which ecological deficits must be reduced in order to meet the management objectives set out by the Water Framework Directive, and
- which measures for the management of water resources are suited to reduce flood-related risks, while at the same time contributing to ecological goals (synergetic measures).

The measures derived from this analysis are investigated with respect to the extent to which they are suitable for implementation in the study area. Simple and transparent methods are used to estimate their expected effectiveness for the reduction of severe floods (≥ HQ_{200}).

Results:

In the event of severe floods (HQ_{200}), areas in proximity to water including some buildings are in danger of flooding especially along the upper and middle courses of the Wandse. Within the framework of flood risk management planning, the existing flooding zone along the Wandse main course is being adjusted in accordance with the results of the most recent rainfall run-off simulations. According to the present risk assessment there is no further urgent need for action with respect to the prevention of dangers posed by floods.

However, the risk analysis carried out to date can be expanded further. Thus, it has not yet been determined which areas along the tributaries (Stellau, Berner Au, Rahlau, …) are prone to flooding. Furthermore, there is a need for a more systematic consideration of protected resources (i.e. human health, the environment, cultural heritage, and economic activity) within the context of the Flood Directive. Also, to date no risk maps for rare floods or extreme events have been drawn up.

In the area of investigation, floods occur primarily as a result of heavy precipitation from summer storms. Consequently, flooding risks resulting from the interlinking of municipal water courses and sewer systems should be included to a greater extent in the analysis and in flood risk management.

The study identifies the following main ecological deficits of the Wandse watercourse system:

- Inflow of nutrient-, pollutant-, and sediment-loads as well as hydraulic stress from (rain water) sewerage,
- deterioration of the habitat structure on the river bed, along the riverbanks, and in wetlands and meadows, and
- a lack of passability caused by transverse structures and dammed-up sections.

The following synergetic water management measures are proposed:

- Water retention through the use of sustainable urban drainage (infiltration measures),
- the retardation of water discharge through the creation of secondary floodplains, and
- the optimisation of existing retention basins.

Studies of the implementation potential and the efficacy of synergetic measures show that they can activate a considerable potential to retain flood water in the area of investigation. In the context of the on-going renewal of urban infrastructure and with a reasonable effort, synergetic measures could largely be implemented within a timeframe of 50 to 100 years. In that case it is estimated that the peak run-off from a severe flood (HQ_{200}) can be reduced by at least 10-20 %. Depending on the river section under consideration, an even higher effectiveness of up to 40 % in the reduction of peak flow can be expected. Some further details:

Infiltration is possible on most soils in the area of investigation, and is limited primarily by existing developments on the plots. Nevertheless, the introduction of infiltration facilities is considered feasible on more than 50 % of impervious surfaces in existing settlements. This would require the construction of infiltration units with a volume of 417.000 m^3, i.e. of a size comparable to existing retention basins in the catchment area. The study of the estimated efficacy of such measures shows a mean reduction of peak flow of -17 % (min. -8 % to max. -24 %) for a HQ_{200}. Both the current inflow of nutrient-, pollutant-, and sediment-loads and hydraulic stress could be reduced by about half.

In order to estimate the retardation of water discharge by the creation of secondary floodplains, details of ownership, use and development, topography, administrative responsibility, and existing woodlands were investigated in the areas adjoining watercourses. The creation of secondary flood plains is regarded to be ‘straightforward’ on 10 % of the study area. With respect to a further 20 % the effort required is considered ‘acceptable’. The study identifies a potential for re-development primarily along the main course of the river Wandse in the settlement area, as well as in the sub-catchment area of the Berner Au tributary. On the basis of comparative studies of increased water retention in river beds and floodplains a reduction of peak flow of between -5 % and -10 % for a HQ_{200} event appears to be realistic. The newly created secondary floodplains should be designed as core habitats which could contribute significantly to the reduction of the existing structural deficits of water habitats.

In five of 16 dammed-up sections that were studied, the retention of severe floods

(≥ HQ_{200}) can be improved considerably, with an expected reduction of peak flow of more than -20 % immediately downstream from the basins. In a further three dammed-up sections a moderate increase of the potential for flood water retention is identified (peak flow reductions of between -10 % and -20 %). Especially the basins of the upper Wandse and its tributaries are suited for an optimisation of their floodwater-retaining capabilities. In order to minimise the negative impact of dams on the aquatic ecology, this study recommends an optimisation of the basins in the lower and middle courses of the Wandse.