Abschlussbericht/Final report

Forschungsvorhaben 0330768
´Raum für den Fluss´und ´Wasserrückhalt in der Landschaft´.
Modellierung der Landnutzungseinflüsse und Szenarioanalysen – Fallstudie Obere Iller

Efficiency of non-structural flood mitigation measures: "room for the river" and "retaining water in the landscape"
Case Study Upper Iller

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1 Introduction

Floods are the costliest natural hazard in the world and account for 31% of economic losses resulting form natural catastrophes (Yalcin and Akyurek, 2004). The economic losses of the combined European countries from 1998 to 2003 amounted to more than US$ 60 billion (Plate, 2003). A review of the losses caused by floods events in the period of the last ten to fifteen years indicate that in Europe economic losses are dramatically increasing, mainly because there has been a marked increase in the number of people and economic assets located in flood hazard zones.

On one hand, it is clear that the flood hazard must be estimated with the maximum precision, as was pointed out by Francés (1998) and Jarrett and Tomlinson (2000), especially when the hazard is affecting urban areas. Flood hazard underestimation contributes to larger damages than expected, but unnecessary overestimation leads to costly overdesign of flood protection measures. On the other hand, an inappropriate flood risk management (or the absence of it) may lead to considerable losses of property and life.

Traditionally, flood hazard is estimated based on a design storm (without taking into account the actual spatial and temporal variability of extreme storms), transforming it in discharges using an aggregated rainfall-runoff model (not considering the spatial variability of the hydrological characteristics and loosing the possibility of analysing the effect of land cover changes within the basin) and computing the maximum water depth not using the most appropriate hydraulic model. I.e., the flood hazard uncertainty can be high if the new trends in flood hazard estimation are not used.

The difference between hazard and risk must be clear (Figure 1). The flood hazard in a given point of the flood prone area is the probability distribution function of the flood magnitude at this point. The magnitude is defined by different variables related with the flood damages, as maximum water depth, maximum velocity, flood duration, amount of sediments, etc., but in most cases the first one is the most representative. The flood risk (or impact to be clearer) is the mean annual damage per unit area. Damage in a wide sense: it can include economical, social and environmental losses. Potential damages are considered through the vulnerability of each element of the flood prone area. The vulnerability is a function of the flood magnitude, and it usually takes the form of a depth-damage curve (Grigg and Helweg, 1975). Therefore, flood impact is the probabilistic integral of the combination of flood hazard and land use vulnerability (Francés et al., 2001 and Plate, 2002):

$$D = \int_0^\infty V(h)\, f_H(h)\, dh$$

where V is the land use vulnerability, h is the flood magnitude and f_H is its probability density function.

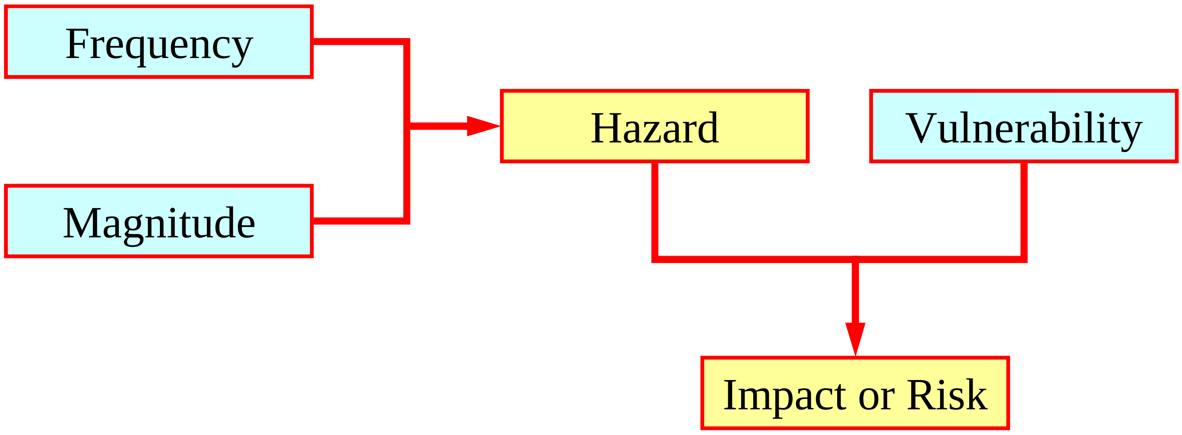

Figure 1-1. Basic definitions (computed concepts in yellow).

A detailed classification and description of flood protection measures was done by Yevjevich (1994), but the most common classification is to distinguish between structural and non-structural measures. Very often it is forgotten that the objective of the flood protection measures is to reduce the total flood impact, and not specifically the flood hazard. In fact, most of the non-structural measures don't change the hazard: they just reduce the flood impact by land use vulnerability changes. We will like to underline the worldwide experience has shown that in the long term and in most cases non-structural actions are the most effective ones (Natural Hazards Research and Applications Information Center, 1992; Smith and Ward, 1998).

We believe the flood impact (risk) analysis is needed in order to objectively compare different future scenarios that can affect either the flood hazard and/or the vulnerability in the flood prone area. These different scenarios arise mainly because land-uses changes in the basin and in the flood prone area and because the flood protection measures that can be adopted.

The project described in detail in this report is part of the ERA-NET-CRUE project:
Efficiency of non-structural flood mitigation measures: "room for the river" and "retaining water in the landscape". ERA-NET CRUE is funded by the ERA-NET Scheme under the 6th Framework Programme,General Directorate for Research in the European Commission.

This project has focused on a comparison of the efficiency of non-structural flood mitigation measures which include the non-structural flood risk mitigation concepts “retain water in the landscape” and “room for the river”. The study of three catchments located in Spain, Austria and Germany has permitted to cover a wide spectrum of flood processes that can be expected in Europe.

Main focus of the study described here is the Upper Iller Catchment in the Bavarian Alps, Germany.

2 Objectives

The aim of the overall project, including all three case studies (Iller, Kamp and Poyo) is to examine the relative effectiveness of two particular non-structural flood mitigation measures:

> “Retaining water in the landscape”: Land use changes and Local retention measures in the landscape
>
> “Room for the river”: flood retention along the main stream by providing additional inundation area

To do this, new scientific frameworks and technical tools integrating multidisciplinary approaches (meteorological, hydrological, hydraulics and socio-economical) on flood risk assessment have been used and tested in three different and, at the same time, complementary case study areas.

For the Upper Iller specifically, the main goal was to determine scenarios of forestation and small uncontrolled retention structures and to quantify their effectiveness with the help of the process based hydrological model Wasim-ETH. Results were compared to the the effectiness of large polders as well as to similar scenarios generated for the Kamp and the Poyo case studies.

3 Study area

The Iller river is situated in Southwestern Germany at the border to Austria (see Figure 3-1). It is one of the most important tributaries to the German part of the Danube. The upper reaches of the Iller upstream Kempten drain an area of 954 km2 (103 km² in Austria), the highest point of the catchment lies at 3000 m asl, the lowest (gauge Kempten / Iller) at 650 m asl. The Iller river starts at the junction of the Breitach (catchment area 117 km²), Stillach (82 km²) and Trettach (76 km²) rivers near Oberstdorf. The main other tributaries are the Ostrach (127 km²), Gunzesrieder Ach (47 km2), Konstanzer Ach (66 km²) and Rottach (31 km²).
The flow regime of the Iller can be characterized as alpine and sub-alpine with low flow in winter, high discharge during spring snowmelt and medium flow in summer. The mean annual flow at gauge Kempten is 47 m³/s. Due to the alpine setting, the soil cover is, except for highly permeable gravel deposits in the floodplains, mainly shallow. The area is predominantly covered by coniferous forest and meadows, the urban areas cover less than 3 percent of the catchment. The main flood season is summer, where heavy rainfall events of about 24 to 48 hours duration, usually orographically enhanced, can cause disastrous floods: The two highest recorded floods in over 100 years of observation took place in May 1999 (peak discharge at gauge Kempten: 850 m³/s) and August 2005 (peak discharge 900 m³/s) which means a return period of approximately 300-400 years.
After the disastrous flood in 1999, a 100 Mio € flood protection project was launched, ranging from the reinforcement of existing dikes, widening of the riverbed for increased transport capacity, structural measures like new flood protection walls in the cities of Sonthofen and Kempten and the construction of a 6 Mio m³ Polder near the city of Immenstadt. Thanks to the measures completed until August 2005 (just before the 2005 summer flood), the damage during 2005 was substantially smaller than in 1999, despite the higher discharge in 2005. Both extreme floods and some other smaller ones will be analyzed in this study.

The catchment is well equipped with rainfall gauging stations and several discharge gauges. These data are available at the Kempten water authorities (WWA Kempten) and have been provided to the project.

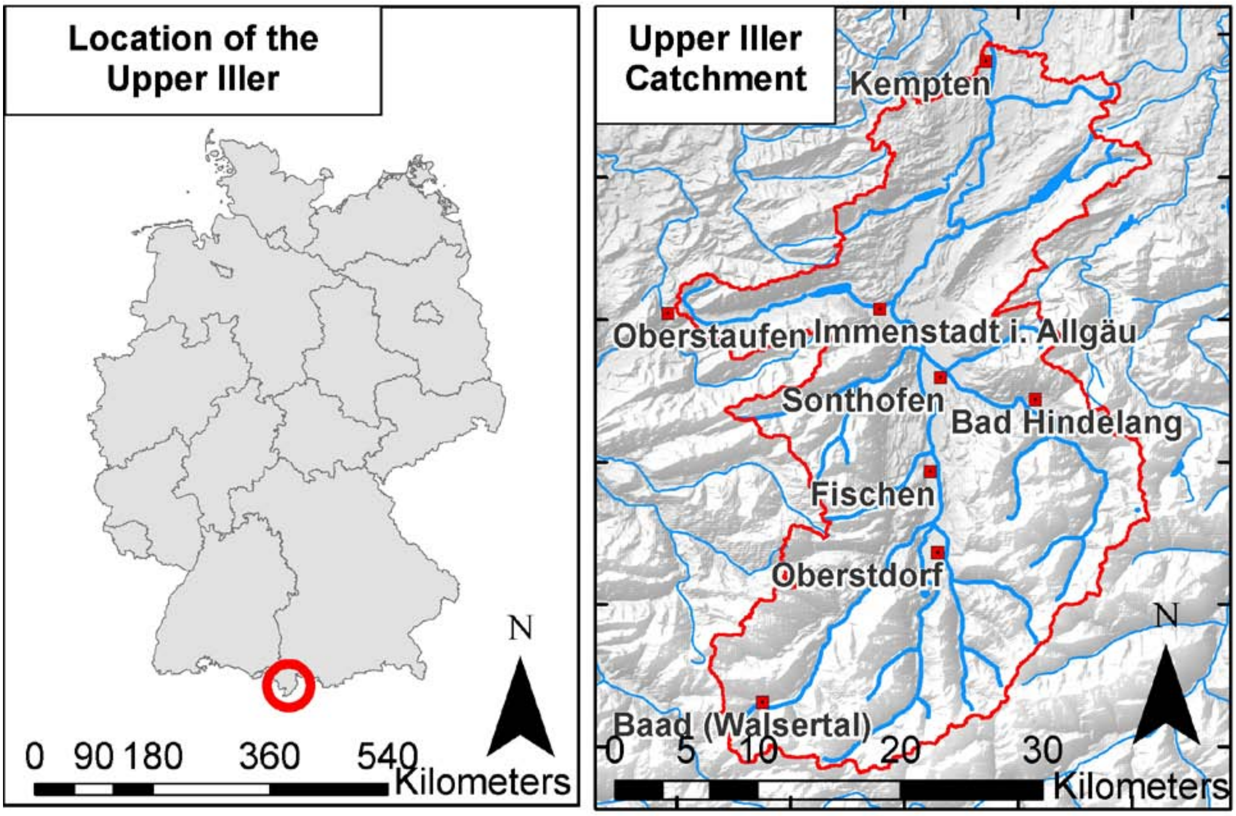

Figure 3-1 . Location of the Upper Iller Catchment

4 Work packages of the ERA-NET CRUE Project Efficiency of non-structural flood mitigation measures: "room for the river" and "retaining water in the landscape"

The work packages including the work done for the three different case studies are listed below. Not all methods described in this section have been used for each of the study areas, as the methodology was adapted towards local necessities, data availability and expertise of the project partners.

Taking into account the project objectives and the problems to be solved at each case study, this section describes the work packages of the project. The project is divided in 4 work packages, closely related as it is shown in Figure 4.1. For the sack of clarity, the proposed mathematical models to be used will be described below.