

ERA-NET CRUE Funding Initiative  
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Extended Abstract

*PRO\_Floodplain*  
*Flood risk reduction by PReserving and restoring river*  
**FLOODPLAINS**

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## 1 Introduction

Over time the increasing human use of floodplains for high value enterprises not only leads to an enhanced vulnerability in the affected reach but also to a strong pressure for active, technical flood protection.

Within an integrated flood risk management non-structural measures gain increasing importance. Thereby, the existence of inundated floodplains plays a central role. Even today in many river systems cut off floodplains can be reactivated by restoration e.g. by dyke re-displacement. Social acceptance of non-structural measures for flood risk reduction and the perceptions of flood risks and of flood risk management have still to be improved.

The main objectives of this project are to identify and evaluate the hydromorphological contribution of water retention in preserved and restored floodplain systems across various geomorphological settings, to demonstrate the contribution of floodplain preservation and restoration to the achievement of the good ecological status and the investigation of the social acceptance of such non-structural measures. The transformation to a general floodplain evaluation matrix is aimed for on the basis of varying boundary conditions in different study reaches in Austria, Germany and France. The benefits and disadvantages of the floodplain enlargement are compared with each other and considered in comparison with technical measures. In particular the restoration of floodplains as a contribution for the achievement of a "good ecological status" respectively a "good ecological potential" of the river in the sense of the European Union Water Framework Directive will be examined. One important aspect will be social acceptance of non-structural measures in the context of floodplain preservation and restoration.

## Methods

### WP2 – Hydromorphology

Different operation strategies for floodplains are investigated in this project.

- *technical measure* = operation structure is necessary, there is a regulation
- *non-technical measure* = operation structure is not necessary, there is no regulation

**Hydrology:** Hydrologic analyses (*retention* [ $m^3s^{-1}$ ] and *translation* [h]) of flood waves are done mainly based on gauging stations.

**Hydraulics:** One-dimensional and two-dimensional hydrodynamic-numerical models are applied to analyze the impact of variable geomorphology (bed slope, floodplain width) on flood retention. Evaluation parameters are defined as follows:  $Vol_{floodplain}/Vol_{total}$  [-],  $Vol = Volume [m^3]$ ,  $Q_{floodplain}/Q_{total}$  [-],  $Q = discharge [m^3s^{-1}]$ ,  $h_{floodplain}/h_{bf}$  [-],  $h = water\ depth$ ,  $h_{bf} = bankfull\ water\ depth [m]$ ,  $time_{bf}/time_{peak}$ ;  $time_{bf}$  [h],  $v_{floodplain}/v_{total}$  [-],  $v = velocity [ms^{-1}]$ ,  $\Delta S_f$ ,  $\Delta k_{str}$ ,  $S_f = bed\ slope$ ,  $k_{str} = roughness\ parameter [m^{1/3}s^{-1}]$ .

### WP3 – Ecology

The ecological subproject evaluates the ecological value of still intact and cut off floodplains by means of different parameters which could be gathered in morphological, hydraulic/hydrological, floristic and faunistic parameters. Spatial parameter data are interlaced and combined by GIS. Evaluation parameters are: *duration of the flood-water on every different section of the floodplain* [ $hm^{-1}$ ], *water depth* [m], *flow velocity* [ $ms^{-1}$ ], *bottom shear stress (aggradation / degradation processes)* [ $Nm^{-2}$ ].

### WP4 – Sociology

Four axes of perception are adopted in the work package Sociology:

1. Perception of the entities in a common ecosystem,
2. Perception of structural and non structural measures: risk estimation,
3. Perception of territory identity,
4. Perception of the stakes of Upper Rhine renewal and of flood protection.

In order to collect the actors' s perceptions in these three territories, we will use, according to the types of actors concerned:

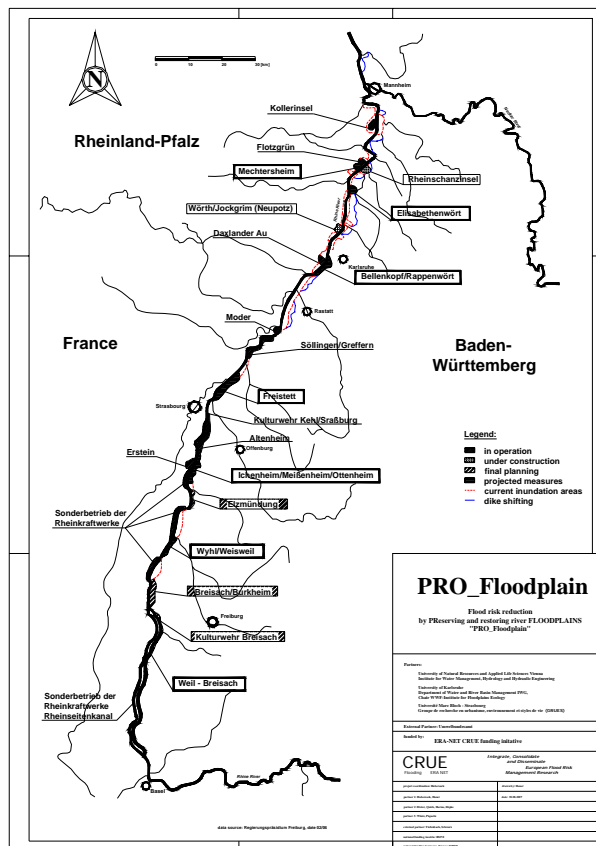
I) Semi directive interview from a list of answers regarding the four axes developed above. The interview consists of introductory themes from which the informants define their object's relation and their involvement in their own words. Interviews are recorded and transcribed.

II) A questionnaire of frequency / knowledge regarding the impacted site in French and German has been made. A statistical evaluation will be made in order to categorize the perceptions of local residents and to show the main aspects adopted in the local population's perceptions regarding the polder project.

## Results and Discussion

### WP2 – Hydromorphology

Within PRO\_Floodplain two different study reaches are evaluated for the effects of technical and non technical retention measures. The Upper Rhine River was chosen for technical and non-technical solutions based on the fact that along the Upper Rhine River 21 polders in Germany (Rheinland Pfalz / Baden-Württemberg) and France are constructed and/or planned for flood water retention (Fig. 1). These measures were listed in a flood management concept of 1982 and revised for an actual project.



France:  
concept of 1982: 56.0 Mio.m<sup>3</sup>  
polders 1982: 11.0 Mio.m<sup>3</sup>

actual concept: 58.4 Mio.m<sup>3</sup>  
actual polders: 13.4 Mio.m<sup>3</sup>

Baden-Württemberg:  
concept of 1982: 126.0 Mio.m<sup>3</sup>  
polders 1982: 63.0 Mio.m<sup>3</sup>

actual concept: 167.3 Mio.m<sup>3</sup>  
actual polders: 96.0 Mio.m<sup>3</sup>

Rheinland-Pfalz:  
concept of 1982: 44.0 Mio.m<sup>3</sup>  
polders 1982: -

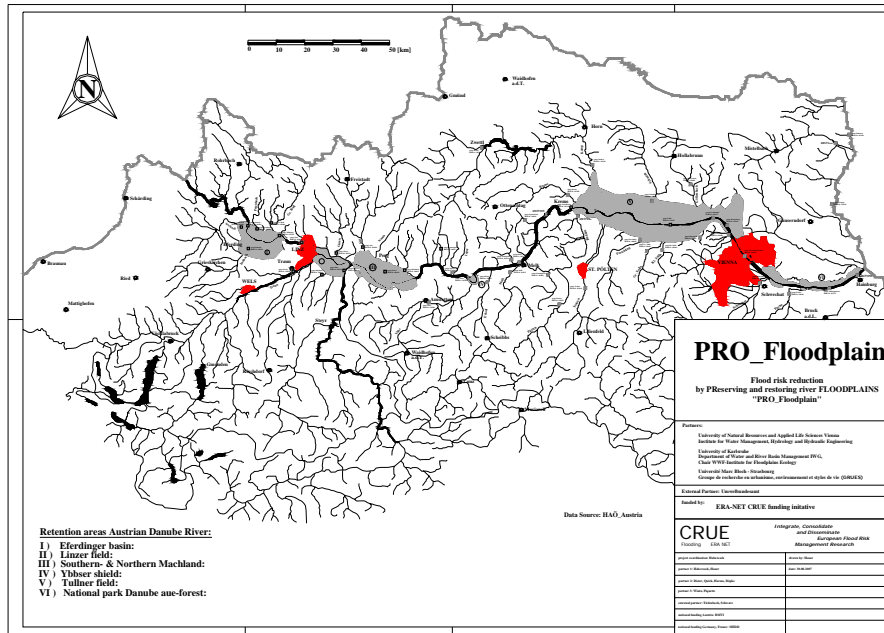
actual concept: 62.6 Mio.m<sup>3</sup>  
actual polders: 53.7 Mio.m<sup>3</sup>

**Fig. 1** Technical and non-technical retention measures along the Upper Rhine River.

Such measures are found to be necessary because during the Rhine River regulation and hydropower plant construction, which happened between 1955 and 1977 (finishing with the hydropower-plant Iffezheim), a loss of 130 km<sup>2</sup> inundation areas was documented for the study reach. These artificial interferences caused a reduction of the flood protection along the Upper Rhine River. The former 200-years protection was reduced to a protection with a recurrence interval of 60-year. To achieve the goals of a 200-year flood protection (IKSR, 2002) several artificial retention measures were planned in Germany (Baden-Württemberg, Rheinland-Pfalz) and France (Fig. 1). Some of these measures are already completed. Based on the measures in France, Rheinland-Pfalz and the three polders in Baden Württemberg the flood prevention increased to a 120-year event.

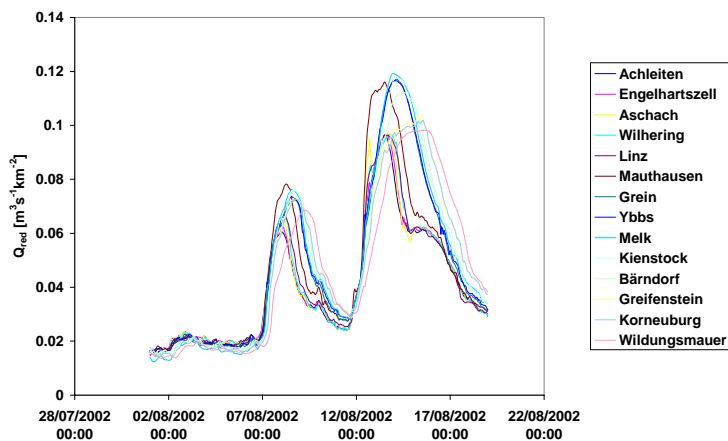
For assessing the effects of non technical measures on flood retention several rivers in Austria were selected. For preventing urban areas along the Danube River and its tributaries the floodplains are mainly affected by flood protection

dams (Austria: 100-year design flood). Polders are not as common as they are at the Rhine River. Within this area the Austrian Danube River contains six major retention basins (Fig. 2) which exhibit different effects on floods (Fig. 3).



**Fig. 2.** Catchment of the Austrian Danube River including the six major retention basins.

In the first step these basins were hydrologically evaluated for the effects of flood wave translation and retention. Based on different flood events with different recurrence intervals ( $HQ_5 - HQ_{100}$ ) measured effects on flood wave development along the Danube River were analysed (Fig. 3).



**Fig. 3.** 100-years flood wave related to the catchment size at the Austrian Danube River (gauging stations are ranked from German to Slovakian border).

The results of Figure 3 show clearly the effects of flood retention along the Danube River which was mainly documented for the "Tullner Feld" with a peak reduction of  $954 \text{ m}^3\text{s}^{-1}$  for a 100-year flood on a length of 68 km.

A major translation of the flood wave 2002 was further documented with 15 hours between the gauges Mauthausen and Grein (32 km). This seems to be a

significant effect of the Machland retention area on floods compared to a time difference between the peak discharges in other parts of Upper Austria (e.g. Gauges Achleiten – Linz = 87.8 km / 4 hours).

In the next working phase the responsible parameters for retention and translation processes will be hydraulically (1-D, 2-D unsteady simulation) determined and evaluated against variable geomorphological boundary conditions (e.g. variation in floodplain width, variable roughness, bed slope).

### **WP3 – Ecology**

In a natural floodplain certain chemical and physical parameters dominate at times of inundation, which enable well adapted organisms to survive. A critical parameter is the oxygen content of the water, which depends on the flow-velocity, the temperature and the height of inundation among other things. Therefore stagnant water bodies are normally much more negative than flowing water bodies, that is plants and animals will be much more affected. Using non-technical measures the restoration of floodplains will achieve far better and more natural inundation parameters because constructions will always restrict the water inflow and the water motion. This leads to lower flow velocities in the floodplain, depending on the water level height and difference (river vs. floodplain), to which most organisms are insufficiently adapted. The combination e.g. of the modelled flow velocity and the surveyed vegetation of a cut-off floodplain in a GIS shows very well the critical areas regarding different technical and non-technical measures. A natural floodplain, particularly a broad floodplain will provide a multitude of different ecological niches which provide for a variety of organisms different survival conditions; flow velocity is only one example. The reestablishment and regeneration of some typical floodplain biotopes could take place very quickly if the right circumstances are permitting it. This applies to all those biotopes that result from the regular perturbation by erosion and sedimentation of the river and the interruption of the succession (e.g. gravel banks and islands, bluffs and other bank structures, mud surfaces, gravel riverbeds). For the creation of the morphological structures a certain dynamic is necessary. Our own research shows that the potential of floodplain soils and their soil seed bank is very high so that even plants that seem to have disappeared long ago could reappear if inundation affects the area again. The development of floodplain forests in contrast is a long term mission that can only be speeded up a little.

### **scientific, economic and political relevance**

Using the results of work-package 3 as contribution to the floodplain evaluation matrix the effects of floodplain preservation and restoration to the EU Water Framework Directive will be specified, especially to the achievement of a "good ecological status" respectively a "good ecological potential" of the river. The floodplain enlargement (where restrictions have occurred) and the preservation of existing floodplains will serve as a fundamental and vital step towards an improved flood protection especially with the background of the ongoing climate change and increasing flood disasters.

## WP4 – Sociology

At this point we can determine three conditions of *social acceptability being* produced in a *hazard zone*:

**Remembering hazard:** the frequency and localisation of probable risk factors linked to floods. This dimension implies the permanence and the handing down of this territorial memory as common basis for the understanding or the rejection of *hazard*.

**Territory knowledge in its physical aspects:** it may be internal of the territory through various particular uses of the environment (such as agriculture, fishing, naturalism) or external by developing scientific interest. On that topic the question is the penetration and the appropriation of the scientific arguments in the uses and discourse in reaction to project planning.

**The evaluation and representation of the program stakes** through the balance sheet of the program's risk factors and advantages according to isolated actors or groups in a retrained zone.

These three conditions are the analysis scheme in the *representation*<sup>1</sup> of planning programs in flood protection.

The questionnaire has been tested in France first in a neighbourhood near from the polder's site and the second directly to the site's visitors. We have around 25 questionnaires. Local residents association has been contacted to answer this questionnaire but the return was not satisfying. Regarding the German questionnaire we had a contact with the University of Karlsruhe, (Institut für Wasser und Gewässerentwicklung Bereich Wasserwirtschaft und Kulturtechnik) to define the questions.

I) To reach our objective of 150 questionnaires for the three sites, we planned to form a group of researchers (with students from Sociology Department-Strasbourg) in order to distribute this questionnaire directly to the residents.

II) Our goal is not to make an opinion poll about the realised or planed polder, but to know how informed are the local people regarding the flood protection and the ecological aspects of retention and which arguments or aspects are mobilized in this perception. From the results of the statistical study, we want to categorize the type of perceptions of the site and also of the two problems (flooding, good ecological state).

## Synthesis PRO\_FLOODPLAIN

In a synthesis of the collaborative research project, the parameters of the different work packages (Hydromorphology, Ecology, and Sociology) will be brought together with those of the other work-packages to build an **evaluation matrix** of hydraulic, ecological and social parameters. This matrix will aim to allow decision-makers and stakeholders to find those regions at the river which are best suited for functional, ecological and sustainable flood prevention by floodplain preservation and restoration.

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<sup>1</sup> Defined as a knowledge socially produced and shared by the individuals of a global entity. A representation is a type of practical knowledge linking an individual with an object. It is always composed with two facets: personal and collective.

From, Jodelet Denise, *Les représentations sociales*, PUF, Paris,1989, 423 p.43

## Dissemination

The up-to-now dissemination of the aims and results of the project used the internet and different conferences (see the following table).

Homepage of the project	<a href="http://www.pro-floodplain.eu">www.pro-floodplain.eu</a>	since septembre 2007
further information about the project in the world wide web	<a href="http://www.auen.uni-karlsruhe.de">www.auen.uni-karlsruhe.de</a> <a href="http://www.ecologie.gouv.fr">www.ecologie.gouv.fr</a>	
29. and 30.01.2007, Wien, Austria	ERA-NET CRUE Kick-off-Meeting	➤ Projectpresentation (Poster, Fact Sheet, PowerPointPresentation)
29.03.2007, Neuburg, Germany	Bayrische Auenkonferenz in Neuburg at the Danube "Auen in Zeiten von EU-WRRL und NATURA2000" (Floodplains in times of the WFD and NATURA2000)	➤ Posterpresentation Workpackage 3
23.06.2007, Freiburg, Germany	International Workshop „Durchwanderbarkeit Rhein / Continuité écologique du Rhin" (Ecological continuity of the Rhine)	➤ Posterpresentation Pro Floodplain
10.07.2007, Rastatt, Germany	start of operation of the turbine and the path for ascending fishes at the hydroelectric power station	➤ Posterpresentation Pro Floodplain
26.09.2007, Münster, Germany	yearly conference of the „Deutschen Gesellschaft für Limnologie" (German Association for Limnology)	➤ Projectpresentation PowerPoint-Presentation and Publication
29.09.2007, Bayreuth, Germany	Deutscher Geographentag (German Day of Geography)	➤ Posterpresentation Pro Floodplain (Postersession with short oral presentation)
17. and 18.10. 2007, Lyon, France	ERA-NET CRUE - Meeting	➤ Projectpresentation
2008		➤ An article will be published in the scientific review "Economies Rurales"
2008	<a href="http://www.riverflow2008.org">www.riverflow2008.org</a>	➤ Conference proceeding and presentation at the RiverFlow Conference 2008

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Jodelet Denise, Les représentations sociales, PUF, Paris, 1989, 423 p.