

# The status report on German floodplains

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## 1 Introduction

Near-natural inland waters, littoral zones and floodplains as well as connected aquifers are among the most valuable, but also most endangered ecosystems in Europe. They are hotspots of biodiversity and central elements of an ecological network. For instance, about 80% of the Swiss fauna species occur in floodplains and many of the riparian species (47%) are listed as endangered (Tockner & Stanford 2002). Considering the limited taxonomic knowledge on many species groups of fresh waters it can be assumed that the biodiversity of fresh waters as well as its decline is significantly underestimated (Balian et al. 2008). There is almost no other ecosystem type that offers such a remarkable variety of goods and services to humans like rivers, their floodplains, aquifers and wetlands (e.g. Constanza et al. 1997, Antrobus & Law 2005, Turner et al. 2008, Maltby 2009). Freshwaters can provide these ecosystem services only, if their ecological integrity is sustained. However, the ambitious objective of the European governments to stop biodiversity loss until 2010 most probably was not achieved for freshwater ecosystems and floodplains.

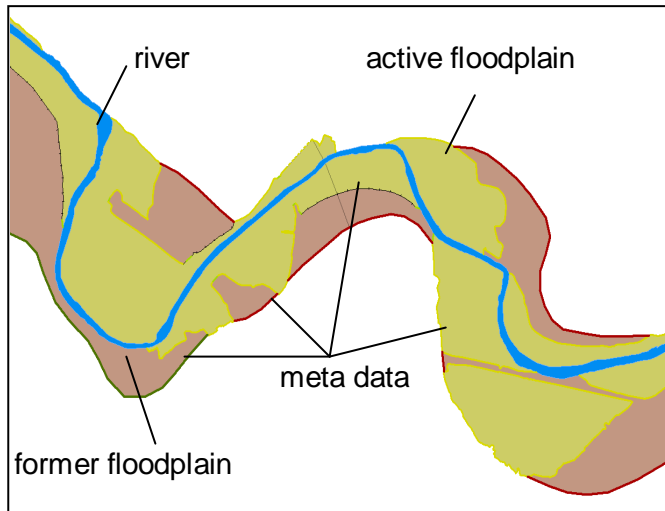
In particular, the main reason for the loss of biodiversity in floodplains is the continued decline in floodplain area due to competing land uses. The floodplains of the larger rivers in Germany have lost on average two-thirds of their former area and in many sections even 80 to 90% of its original extent (Brunotte et al. 2009). Even the remaining active floodplains, which maintained more or less their typical flooding dynamics, are partly under agricultural use or are developed areas and have lost their habitat function. Thus, conservation of biodiversity in floodplains mainly depends on conservation and restoration of active floodplains. However, for Germany a nationwide inventory of the loss and status of floodplains was lacking until now. The Federal Agency for Nature Conservation (BfN) funded several projects, which compiled an inventory of the former floodplain area for the larger rivers in Germany, the remaining active floodplains and their status (BMU & BfN 2009, Brunotte et al. 2009). The methods and results of this nationwide survey of active and former floodplains are presented in this paper.

## 2 Methods of assessing floodplains

The survey of the floodplain area was conducted for sections of the rivers with a catchment area of at least 1,000 km<sup>2</sup>. Tidal waters were not included. Remaining active floodplains and former floodplains were assessed. Together they form the geomorphologic floodplain which is defined in this case as the area which could be inundated, if there were no man-made dikes. For each 1-km section of the rivers, separately for the left and the right side, the active and former floodplain areas were assessed and land use, nature conservation value, and protection status were documented. The data base of the floodplain assessment consists of several digitally available georeferenced information (GIS) provided by German federal/state administrations. This way, for 10,000 km of river course of 79 German rivers a consistent data base exists about the floodplains (Figure 1), which can serve as a spatial background for a sustainable development of rivers and their floodplains (compare also Fig 3a and 3b).

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**Figure 1.** Exemplary detail of the basic GIS-map of floodplain delineation indicating river, active floodplain, former floodplain and metadata like data origin.

Koenzen (2005) developed an approach to define reference conditions for riverine landscapes (potentially natural status) which were further used to assess the status of active as well as former floodplains based on the floodplain data suggested above (Brunotte et al. 2009). Main input data for the status assessment of floodplains comprises the main factors of habitat quality for all species, including the geomorphologic and hydrologic habitat conditions, vegetation and land use. Thus, just like the WFD (EC 2000) this methodology refers to a reference status, which is mostly unaffected by human intervention. The more the status of a floodplain section differs from this potentially natural status the more modified it is assessed. The assessment is presented in five classes of the degree of modification compared to the potentially natural status (Table 1). The classification of the status of each assessed floodplain section is based on a number of clearly defined factors and is, hence, completely transparent. This assessment provides a nationwide overview of the degree of the modification of floodplain habitats.

**Table 1.** The five classes of floodplain status with a condensed specification

class		specification
1	nearly natural	Floodplains not or to a very small degree disconnected from floods by river regulation and/or flood protection measures Rivers only slightly regulated, with high flooding possibility Mainly no or very low intensity land use, mostly forest, wetlands, and rarely grassland
2	slightly modified	Floodplains to a small degree disconnected from floods by river development and/or flood protection measures Rivers variably regulated, but usually with high flooding possibility Mainly low intensity land use, mostly forest, wetlands and grassland
3	moderately modified	Floodplains partly disconnected from floods by river development and/or flood protection measures Rivers generally regulated, but usually with flooding possibility Variable intensity of land use
4	severely modified	Floodplains widely disconnected from floods by river development and/or flood protection measures Rivers generally regulated, partly dammed High intensity land use, mainly intensive agriculture and urban areas
5	totally modified	Floodplains completely disconnected from floods by river development and/or flood protection measures Rivers generally regulated heavily, frequently dammed High intensity land use, mostly with high percentage of urban areas

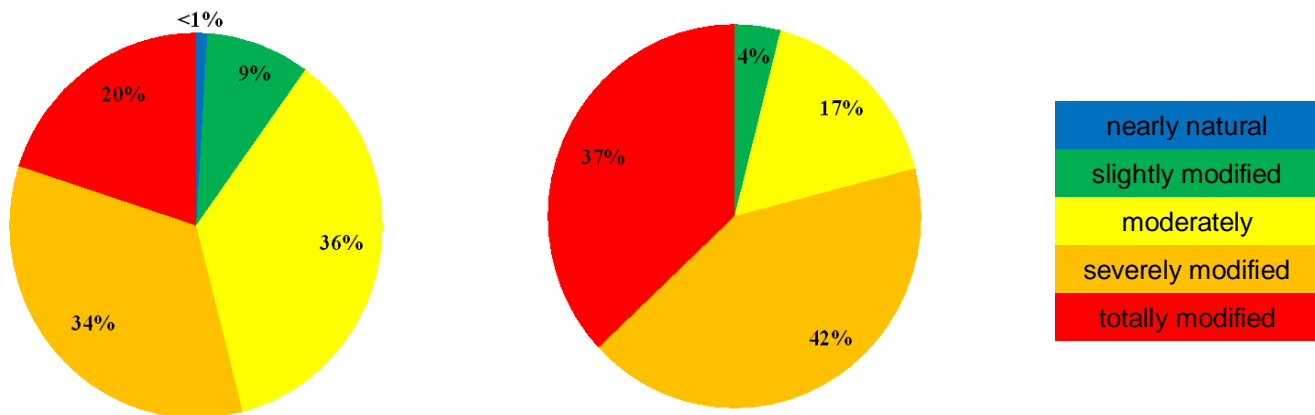
In order to validate the presented assessment of floodplain status an additional detailed methodology was developed and applied to 21 selected sections of different floodplain types and degrees of river modification. It is based on additional locally available information and can be used to meet on-site needs of planners.

### 3 The status report on German floodplains

This first nationwide consistent and updatable inventory of the loss and status of German floodplains provides an efficient overview of the position, dimension and status of floodplains at larger rivers in Germany. Moreover, because of the unique data basis, the results are comparable between federal states and river catchments.

Floodplains of larger rivers (except small rivers and tidal waters) in the past covered about 15,000 km<sup>2</sup>, which corresponds to 4.4% of the German territory, of which two-thirds were lost by embanking. At large parts of rivers like Rhine, Elbe, Danube and Odra only 10-20% of the former floodplains can be inundated nowadays.

More than one-third of the remaining active floodplains are intensively used as agricultural (28%) or urban (6%) areas. Less than 10% of the active floodplains fully provide their ecological functions. The remaining near-natural hardwood forests of floodplains cover only about 1% of the active floodplain area. Compared to the potentially natural status, less than 1% of the assessed active floodplain sections are rated as “nearly natural” (compare Table 1), 9% as “slightly modified”, and 36% as “moderately modified”, while 54% of the floodplain sections are rated the worse status classes as “severely modified” or “totally modified”. On the one hand, this situation resulted from the intense agricultural use on fertile soils of floodplains and on the other hand from the former importance of rivers as routes for transport and trade as well as the arising settlements and infrastructure.

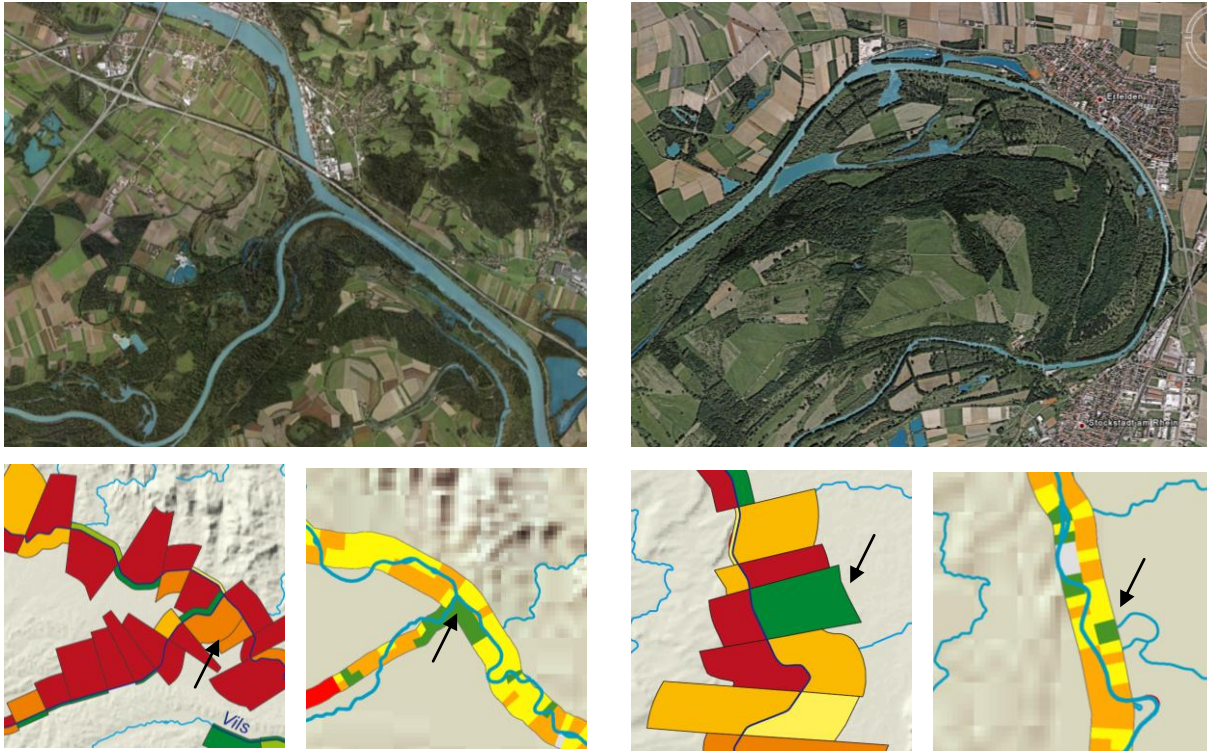


**Figure 2.** Comparison of the distribution of the floodplain status classes for all assessed sections of active floodplains (left) with former floodplain areas (right)

A comparison of the status of the active floodplains with the former floodplain areas showed that the classes 4 and 5 are clearly more abundant (79%) in the former floodplains (Figure 2). However, there is a small percentage (4%) of “slightly modified” floodplain sections, which apparently still maintained a “floodplain-like” environment without being inundated for a longer period. Hence, these areas should be targeted for a potential restoration (activation) of former floodplains.

The assessment of the active floodplains shows clear regional differences. Larger “slightly modified” sections of nationwide importance are to be found for example at the Peene and the Tollense, at the Spree between Cottbus and Berlin, at the lower Havel, at the middle and lower Mulde, at the middle Elbe near the Saale confluence, at the Danube near the Isar confluence (Figure 3a) and at the upper Rhine near the “Kühkopf” (Figure 3b). Several of these floodplains have been admitted to the federal program that supports nationally representative nature conservation areas.

In contrast, rivers, which are German federal waterways, especially when they are additionally used to produce hydro power, are massively regulated and their discharges as well as their groundwater conditions are heavily modified. Together with the intense agricultural and urban use of the floodplains at these rivers, these are the reasons for the rating of such floodplain sections as “severely modified” or even “totally modified”.



**Figure 3a:** Danube with Isar confluence

**Figure 3b:** Rhine floodplain with Kühkopf

Map sections: left = loss of floodplain area; right = floodplain status

The Federal Agency for Nature Conservation will provide the nationwide inventory of the loss and the status of floodplains in the form of a GIS-based internet service called “Flussauen in Deutschland”. The maps will present the area and status of the floodplains at variable scales (starting from 1:25,000). Users will be able to access and download summaries for any floodplain section.

## 4 Discussion

The status report on German floodplains is the first nationwide consistent inventory of the loss and current status of the floodplains of larger rivers in Germany. This inventory shows, for example, that only 0.1% to 0.2% of the former geomorphologic floodplain is currently covered with near-nature floodplain forest (Brunotte et al. 2009). This is insufficient to sustainably preserve the extraordinarily high biodiversity which has remained in these forests in active floodplains. Nevertheless, near-natural freshwaters and floodplains are hotspots of biodiversity (Robinson et al. 2002, Hughes et al. 2005). Therefore, more than 50 % of the area of rivers and active floodplains belong to the Natura 2000 network of protected sites (Brunotte et al. 2009). This emphasizes their importance as linking elements of a transnational network of protected areas. One of the main reasons for the high biodiversity in floodplains is the small-scale variability of habitat conditions, which enables different species communities to coexist (Naiman & Decamps 1990, Ward et al. 2002). Without measures to protect and restore rivers and their floodplains this biodiversity will continue to decline.

Floodplains are not only hotspots of biodiversity but also natural flood protection areas. They delay the discharge of flood waves and, thus, contribute to mitigate flood peaks (Acremann et al. 2003), especially when the floodplains are covered with near-natural forests. Even if the significance and acceptance of floodplain restoration programs increased over recent years, it remains difficult to put them into practice. Thus, the available inventory and assessment of floodplains can serve as a useful tool to identify nationally important

floodplain areas and potential areas for restoration of near-natural floodplains as well as flood protection areas. This way the status report on German floodplains can contribute to the implementation of synergies between nature conservation and flood protection measures.

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