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Floodplains in Germany

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1 Key facts at a glance

- The 2021 Status Report on German Floodplains, which comprises both text and national overview maps, presents the current results of the loss of inundation areas, the status of river floodplains and the progress made in implementing floodplain restoration measures on rivers in Germany. The results on the loss of inundation areas and floodplain status cover the floodplains of 79 rivers with a length of 10,297 river kilometres and a total area of 16,185 km² (4.5% of Germany's total area). The area covered includes rivers with catchments larger than 1,000 km² (excluding tidal areas). The results are based on several years of research and the Federal Agency for Nature Conservation's own research.

- Since publication of the first Status Report on German Floodplains in 2009, 4,183 hectares of floodable areas have been reclaimed by removing, relocating and cutting gaps in dikes. This means that over the entire period from 1983 to 2020, on the 79 rivers a total of 7,100 hectares were regained, of which some 3,000 hectares were made possible by funding from the Federal Environment Ministry. This represents an increase in the floodable river floodplains of around 1.5 %. Despite these successes, only a small part of Germany's potential for reconnecting tens of thousands of hectares of floodplain areas has been tapped so far. Due to the large losses in the past, only about one-third of the rivers' former inundation areas (morphological floodplain) can still be inundated during major flood events. The areas designated as active floodplains stand in contrast to the two-thirds of former floodplains, which are currently no longer available as retention areas when floods occur.

- The overall results of the 2021 national floodplain status assessment show that just under 1% of the active (floodable) river floodplains are very slightly modified (floodplain status category 1) and 8% are only slightly modified (floodplain status category 2) and are thus still largely ecologically functional. A total of 33% of river floodplains are classified as floodplain status category 3 (significantly modified), but still have "floodplain character", i.e. the potential for inundation still exists, but is limited due to river engineering. The prevalence of floodplain status categories 4 (severely modified) and 5 (very severely modified) with 32% and 26% respectively reflects the continued intensive use of the river landscapes. This means that there will continue to be considerable changes in floodplain status, which, however, will only be partially reversible due to the historical evolution of floodplains as hubs of settlement and economic development along rivers. Farmland and settlements still comprise about one third of the active floodplain areas. Compared to the 2009 Status Report on German Floodplains, the distribution of the floodplain status categories is more or less the same overall. Status categories 3 and 4 registered slight decreases, whereas the worst status category 5 saw an increase of 6%, which, however, is largely due to a change in how the boundaries of floodplains are determined.

- From the beginning of the 1980s until 2020, around 220 major floodplain restoration projects were undertaken on rivers throughout Germany, 167 of which are located within the area covered by the Status Report on German Floodplains and 56 of which are located on other rivers. While the number of projects was still small in the 1980s and 1990s, more and more floodplain restoration and dike relocation projects have been carried out on rivers since 2000, with 80 projects alone since the 2009 Status Report on German Floodplains was published.

Prolonged flooding, oxbow lakes, wetlands and alluvial forests are characteristic of near-natural floodplains in lowlands.

- Restoration measures, which involve restoring typical (ground)water levels and the capacity for flooding, developing near-natural habitats, such as wetlands and alluvial forests, and relocating dikes, result in a measurable improvement in floodplain status. Some rivers, such as the Peene, the Lower Havel, the Middle Elbe, the Wümme and the Lippe, have seen considerable regional success stories in the restoration of river landscapes and the reactivation of natural inundation areas. However, as the findings of the 2021 Status Report on German Floodplains clearly show, this is not yet enough to achieve significant improvements throughout Germany and reverse the trend.

- Long-term and comprehensive programmes to implement effective local and supra-regional measures are needed to counteract the impacts of the extensive water and land management measures, which in some cases extend far back into the past and have permanently changed the rivers and floodplain sites.

- The goals outlined in the National Biodiversity Strategy to safeguard the natural diversity of water bodies and floodplain habitats and to increase the natural floodplains along rivers by 10 % have clearly not been achieved to date. There is thus still an urgent need for action to give more room to rivers in Germany again and to develop near-natural floodplains.

- Under near-natural conditions, river floodplains fulfil a range of ecological functions that benefit not only flora and fauna, but above all society, including flood protection, nutrient retention and climate change mitigation. Considerable synergies can be leveraged if measures for the near-natural development of water bodies and floodplains are planned jointly with stakeholders involved in nature conservation, water management and shipping from the outset and the agreed goals are implemented in the different areas of responsibility.

2 Introduction

In 2009, the Federal Environment Ministry and the Federal Agency for Nature Conservation published the first national Status Report on German Floodplains (BMU & BfN 2009, Brunotte et al. 2009). This Status Report on German Floodplains was based on a national survey of floodplain areas and a specially developed assessment method, which for the first time provided an overview of the status of the floodplains along Germany's major rivers and waterways.

In recent years, floodplains and their importance for the natural balance and landscape ecosystem have increasingly attracted public attention. Near-natural floodplains are treasure troves of biodiversity in Germany and home to many habitats that are endangered nationally and throughout Europe, with a unique diversity of flora and fauna typical of floodplains. They are also vital for flood prevention as an important part of Germany's green infrastructure. Many activities at Land and federal level, such as floodplain programmes and extensive watercourse restoration measures, underscore the major socio-political importance of the issue of floodplains and its high level of acceptance among the population. The launch of Germany's Blue Belt programme in 2017 marked an important step in nature conservation and water protection, flood prevention and eco-friendly leisure and recreational use of rivers, with the aim of developing a biotope network of national importance.

To show what has been achieved so far and expose existing weaknesses in floodplain protection and flood control measures compatible with the natural environment, the floodplain status assessment must be updated and continued at appropriate intervals. This is because the results of the Status Report on German Floodplains are incorporated into various environmental and nature conservation policy strategies and programmes of the German federal government and Länder and serve as a gauge of the progress that has been made.

For instance, floodplain status is one of the indicators for monitoring the success of the National Biodiversity Strategy, and the "reclamation of natural floodplains" is part of the set of indicators used in the German Strategy for Adaptation to Climate Change. In Germany's Blue Belt programme, floodplain status is one of the metrics used to evaluate the success of projects and the overall programme in terms of improving the biotope network. All of the indicators mentioned above are the subject of regular reporting in the German Bundestag. The current findings of the second Status Report on German Floodplains can now be used to update the indicators and for further evaluations.

In line with expectations, the overall result of the updated 2021 floodplain status assessment shows that, compared to 2009, no far-reaching changes, whether major pressures or a downgrade in status, were documented at federal level during a ten-year period. Furthermore, considerable losses of natural inundation areas and significant changes to the current floodplain status can be seen. On the other hand, however, many restoration measures were implemented, which locally or regionally improved the floodplain status and reactivated natural inundation areas with measurable effects in the project areas. In addition to the updated national overviews documenting the loss of inundation areas and floodplain status, this report also includes many examples of measures to demonstrate the enormous potential on site and the accomplishments of sustainable floodplain development. The updated and higher-resolution data allows a more nuanced and in-depth view of the status of Germany's floodplains.

The marsh harrier uses floodplain landscapes with their extensive reed beds as a hunting and breeding ground.

However, the effects of intensified use have also become evident, such as increased farming of energy crops and more buildings constructed on floodplains. Dike reinforcements on existing dike lines close to rivers also limit the existing potential for improving the floodplain status in the long term.

Overall, the 2021 Status Report on German Floodplains shows that stepped-up efforts and investments for the restoration of river floodplains in Germany are worthwhile and can generally make a significant contribution to achieving the goals of the Biodiversity Strategy. However, it is also clear that more projects with a broader overall impact are necessary. There still is a need to implement the policy objective of “giving more room to rivers”, which is clearly confirmed by the report findings.

3 Data used to establish the status of the floodplains

As in 2009, the results of the Status Report on German Floodplains relate to the floodplains of 79 rivers with a total length of 10,297 river kilometres. The study area of the individual rivers begins in each case at the point of the river where the catchments exceed 1,000 km². Areas closer to the source and tidal areas were not surveyed. The floodplains analysed cover a total area of 16,185 km² or 4.5% of Germany's area. The study area is divided into the main catchments of the Rhine (including the Maas tributaries), Elbe, Danube, Weser, Ems, Oder and the direct tributaries to the North Sea and Baltic Sea.

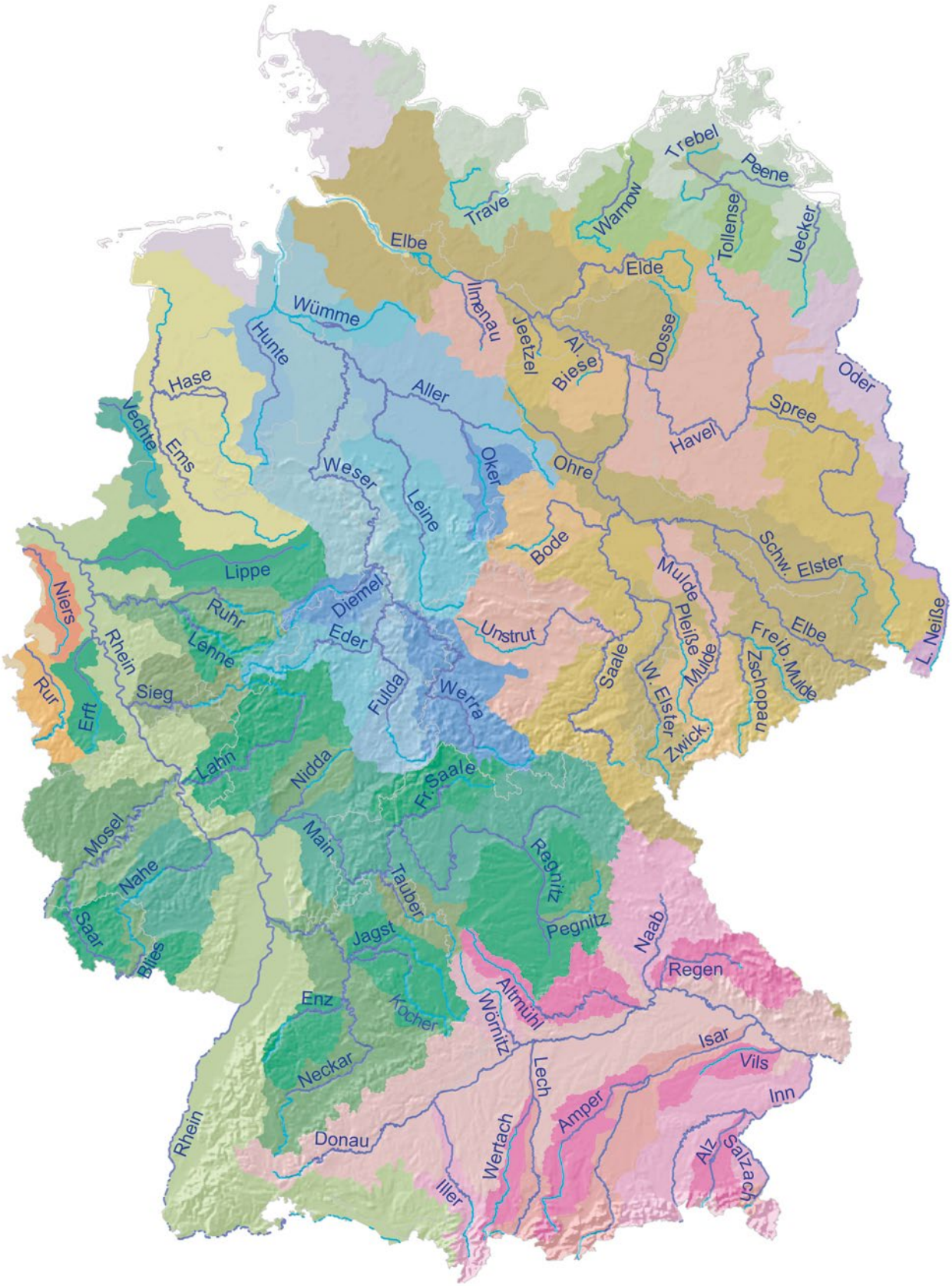
For the survey and assessment of the river floodplains, a wide range of geobasic and geospecialist data is used, including terrain models, aerial photographs and data on flood areas and protected habitats. This set of data makes it possible to compare the results of floodplain status across the boundaries of Länder and catchment areas. There is currently no dedicated monitoring or survey programme to collect the data needed to determine the national floodplain status.

The availability and quality of the underlying data have improved significantly in recent years, so that new and more detailed data was available for the 2021 floodplain survey and floodplain status assessment than in 2009. For example, the floodplain boundaries were determined using a recent digital terrain model with a high degree of accuracy and flood area data for all 79 rivers. Data on biotope types and habitat types defined under the Habitats Directive made it possible to perform a much more detailed, qualitative assessment of land use – especially of grassland sites and forests. This allowed the habitat quality of the floodplains to be directly incorporated into the floodplain status assessment for the first time.

The technical quality of the assessment was improved by integrating current data on water structure quality as well as more precise data on the flooding situation and backwater conditions.

The prevalence of species-rich grassland, alluvial forest and oxbow lakes has a positive effect on the assessment of the floodplain status.

Changes and, in individual cases, additions to the methodology for determining the floodplain boundaries and assessing floodplain status were necessary to be able to use this data for the 2021 floodplain status assessment.



Surveyed rivers and their floodplains in Germany

However, the basic approach to the area-related evaluations and the calculation of floodplain status remained the same, so that the core statements of the 2009 and 2021 reports on the size of the river floodplains, their use and protection status, loss of inundation areas and floodplain status can still be compared. However, there are data-related discrepancies from the initial assessment in 2009, i.e. changes in the floodplain status assessment are due to changes in the input data and not to actual changes in the watercourse and floodplain. As a result, the new assessment provides a more nuanced view of the status of river floodplains in Germany due to the updated and, in some cases, higher-resolution data. The underlying data and the methodology used to survey floodplains and assess floodplain status are described in detail in GÜNTHER-DIRINGER et al. (2021). The following sections 3.1 to 3.3 provide a general introduction to the assessment of floodplain status and the preliminary work required.

3.1 Delineation of the floodplains

Floodplains are the natural floodable areas of our rivers. Those areas along rivers that, under natural conditions, would be covered by more or less regularly recurring floods are referred to as morphological floodplains. The morphological floodplain is thus defined on the basis of natural conditions. If no flood control measures, such as dikes, existed, the morphological floodplain could still be extensively inundated during extreme flood events. In fact, nowadays only very few floodplains are inundated over large areas during floods. The construction of dikes and deepened riverbeds have partly cut off floodplains from the rivers' flood regimes.

The morphological floodplain is therefore divided into two areas: the disconnected areas are called the former floodplain, the areas that can still be inundated are called the active floodplain.

The national delineation of floodplains is therefore based on a subdivision of the morphological floodplain into the following three units:

- Area of the main watercourse: river channel without harbours, oxbow lakes, etc., which are designated as water areas of the two floodplain areas below.
- Area of the active floodplain: areas inundated during floods, including river polders with ecological flooding. Synonymous terms are current floodplain or dike foreland.
- Area of the former floodplain: areas cut off from the river's flooding regime, including polders without ecological flooding. Also referred to as historic floodplain, dike hinterland or inactive floodplain.

The morphological floodplain with its active and former floodplain has different characteristics both along the course of the river and on both bank sides.

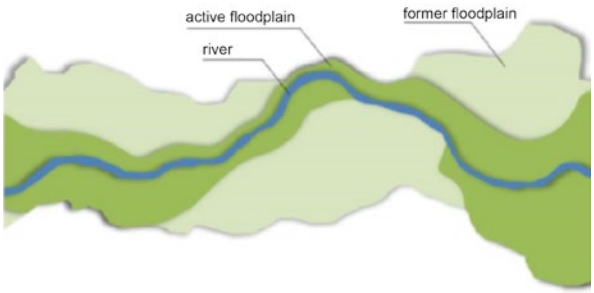


Diagram of the morphological floodplain with its subunits river, active floodplain and former floodplain

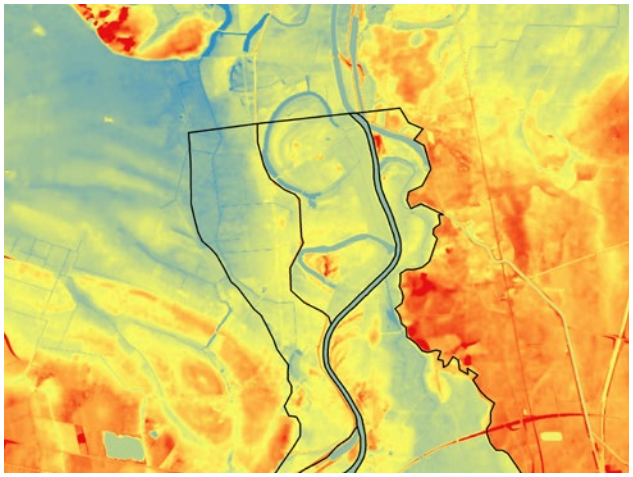
Floodplain inundated during floods (left), cropland in the floodplain protected from frequent flooding by a dike (right)

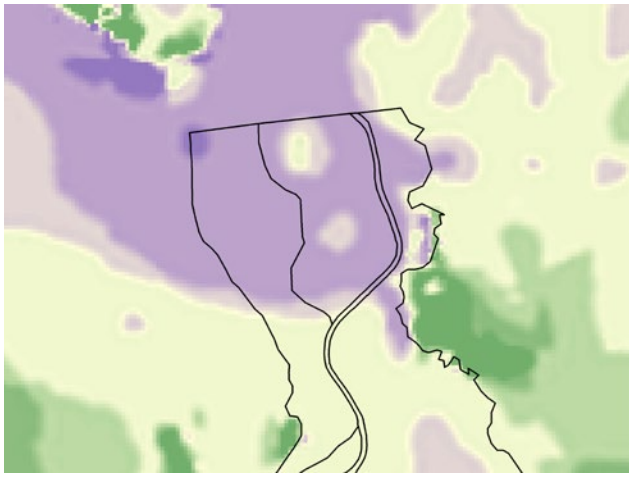
The following steps were used to determine the boundaries of the sub-units:

1. The river area is taken from the Digital Land Cover Model.
2. The active floodplain is determined on the basis of flood probability data (medium probability, “100-year flood”).
3. The boundaries of the morphological floodplain are determined by a semi-automated calculation based on a detailed digital terrain model and flood areas of rare floods (low probability).

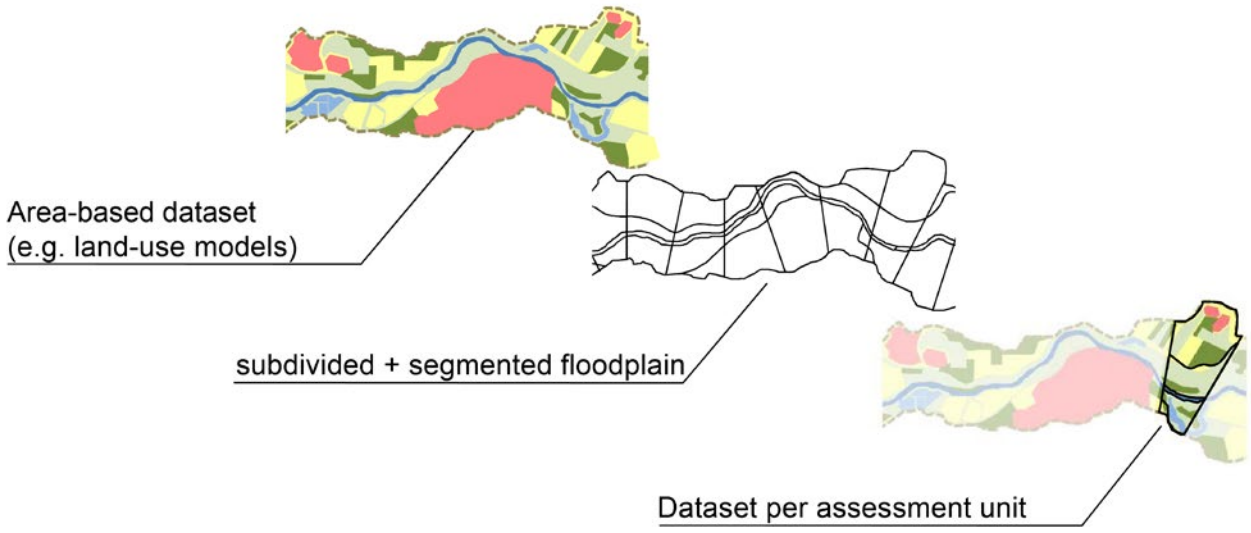
This boundary of the morphological floodplain and the boundary of the active floodplain yield the area of the former floodplain. The active floodplain includes areas close to the river with frequent flooding as well as areas that are protected by summer dikes and are therefore inundated less frequently.

New and more detailed data was available than in 2009 to delineate the floodplains in 2021. A clear increase in quality can be seen in the digital terrain model. Due to improved accuracy, terrain structures such as former river bends and terrain edges are easier to recognise and the boundaries of the floodplain can be determined more precisely. Detailed aerial photographs with a ground resolution of 20 centimetres, current land use data and boundaries of flood areas available for all 79 rivers also helped to provide an updated and more accurate floodplain delineation as a result.





To delineate the river floodplains, a more accurate digital terrain model was available in 2021 (left) than in 2009 (right).



General process for merging and assigning area-based data to the assessment categories (right and left side of 1-km floodplain sections of the active floodplain)

The updated and nationally standardised delineation of river floodplains in Germany is the basis for area-based evaluations of land use and protected areas in floodplains as well as for the assessment of floodplain status.

3.2 Floodplain status assessment

The floodplain status measures the extent of changes to the specific characteristics of the site, including the intensity of use and biotope structure of the active river floodplains with their frequently and rarely inundated areas. The status assessment thus simultaneously reflects essential features of habitat quality for plants and animals as well as the biotope network function.

The assessment is based on the potential natural floodplain status that would occur in the absence of land use and that is defined for the floodplains covered in the report (river floodplains > 1,000 km² catchment) (KOENZEN 2005). Like the European Water Framework Directive, the process thus relates to a reference status unaffected by human intervention. The more the status of a floodplain section deviates from the reference status, the lower its natural capacity to function.

The floodplain status is assessed separately for the right and left side of the active floodplain for 1-km-long sections. The area-based input data is assigned to these sections through spatial overlay.

The assessment process comprises three assessment categories, called functional units that include the following criteria:

1. Morphodynamics, floodplain profile and floodplain waters
2. Hydrodynamics, drainage and inundation
3. Vegetation and land use

The three functional units are the basis to calculate the overall assessment.

In addition, other attributes are incorporated into the overall assessment as bonuses and penalties to reflect the value of large, contiguous near-natural floodplain sites as well as large-scale deficiencies: Bonuses are awarded for typical floodplain biotope structures consisting of wetland, grassland and/or alluvial forest complexes that have a special function as a biotope network and have special value for nature conservation (bonus for connectivity). In active floodplains, most of which retain their original dimensions, points are also added for a near-natural mosaic of biotope structures (bonus for active floodplain). By contrast, regulating impoundments alter or prevent fluctuations in water level typical of floodplains and thus interfere considerably in the hydrological

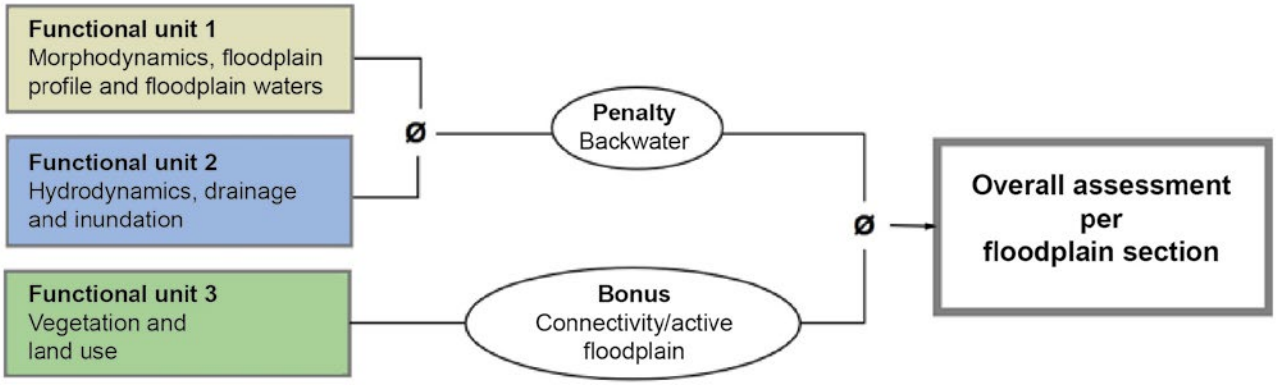


Diagram of the floodplain status calculation

regime of water bodies and floodplains and bring dynamic processes to a standstill. If the impoundment impacts at least three 1-km-long floodplain sections, a “backwater penalty” is imposed.

In areas of recent restoration activities, discrepancies may occur between the national GIS data available, which may be several years old, and the actual conditions on the ground. In these cases, the actual floodplain status after the measures were implemented was determined using current aerial photographs.

The floodplain status is assessed in five categories that indicate the degree of divergence from the reference status. The table on page 14 describes possible characteristics of the various floodplain status categories. For each characteristic, information is provided on inundation conditions, preservation of the active floodplain, the degree of watercourse engineering and the intensity of land use. Assigning colours to each category makes it easy to interpret the floodplain status on the maps.

Status of the engineered Ems near Saerbeck before (left) and after implementation of the restoration measures (right). The river channel has become more diverse, and the floodplains in the river bend can develop naturally to a large extent.

Category		Characteristics
1	Very slightly modified	► Floodplains not disconnected or only very slightly disconnected from flooding due to river engineering and/or flood protection measures ► Rivers usually with a very low degree of engineering, rarely with standard profile, with very high potential for inundation ► Mainly no land use or very low-intensity land use, mostly forest, wetlands and occasionally grassland
2	Slightly modified	► Floodplains disconnected to a small degree from floods by river engineering and/or flood protection measures ► Rivers with varying degrees of engineering, partly with standard profile, but generally with high potential for inundation ► Mainly low-intensity land use, mostly forest, wetlands and grassland
3	Signif-icantly modified	► Floodplains partially disconnected from flooding by river engineering and/or flood protection measures ► Rivers usually engineered, but with potential for inundation ► Variable land use intensities
4	Severely modified	► Floodplains largely disconnected from flooding by river engineering and/or flood protection measures ► Rivers generally engineered, partially impounded ► Intensive land use, mainly intensive agriculture and settlements
5	Very severely modified	► Floodplains disconnected from flooding by river engineering and/or flood protection measures ► Rivers generally heavily engineered, often impounded ► High intensity land use, mostly with higher proportions of settled land

Floodplain status categories

3.3 Results of the assessment

Both the quantitative loss of floodplain areas and the qualitative condition of the active floodplains that can still be inundated are important in assessing floodplain status. To be able to present both aspects appropriately in a way that is generally understandable, the two central maps of the 2009 Status Report on German Floodplains were updated and their cartographic structure was further developed:

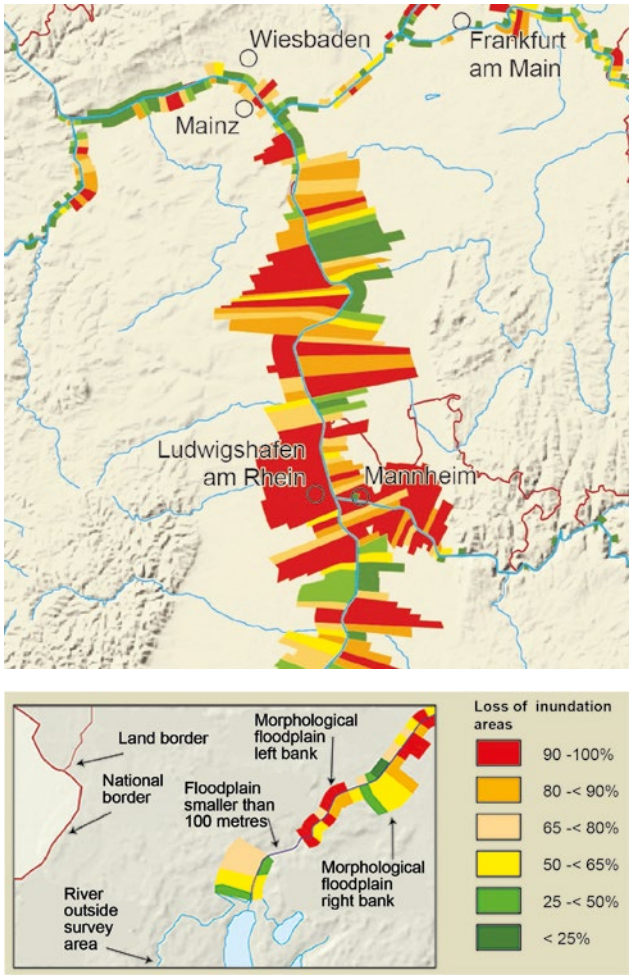
► Map 1: “Loss of inundation areas” (page 17)

► Map 2: “Floodplain status” (page 23)

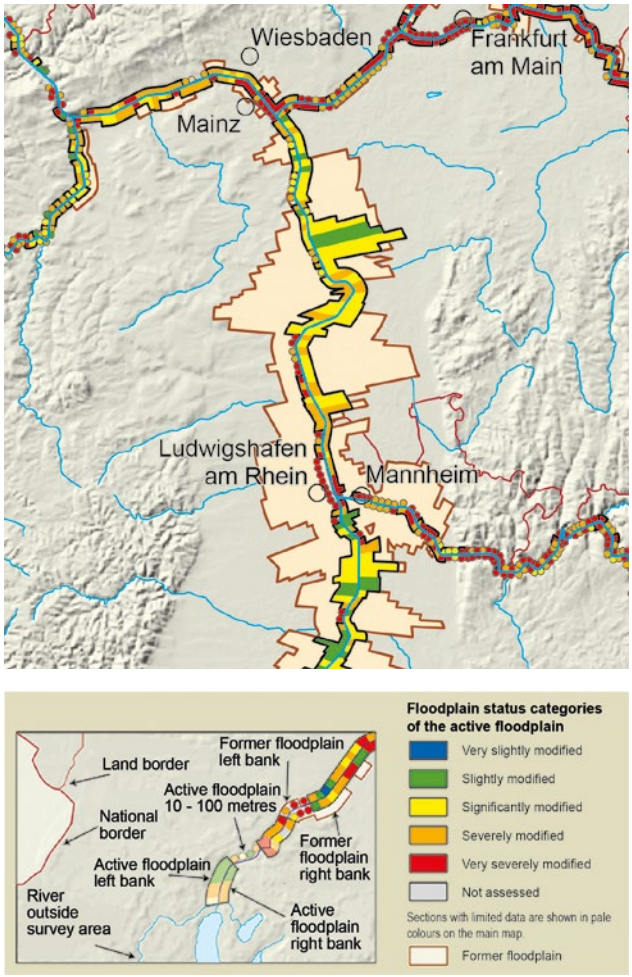
Viewing both maps together allows for a nuanced assessment of floodplain status both at the federal level and for specific watercourse and floodplain sections.

The “Loss of inundation areas” map provides a national overview of the percentage of natural floodplains that have been cut off by dikes and backfills and can no longer be inundated during major flood events. The loss is determined by the area share of the former floodplain in the natural floodplain for both the left and the right side of the watercourse. Compared to the map in the 2009 Status Report on German Floodplains, the resolution of these maps is higher and now depicts the loss of inundation areas for each kilometre section.

The “Floodplain status” map provides a national overview of the scale of changes in specific characteristics of active floodplains. Compared to the 2009 Status Report on German Floodplains, the map shows the assessed 1-km floodplain sections proportionally to their area



Section of map “Loss of inundation areas”



Section of map “Floodplain status”

– separately by left and right bank. In addition, the dimensions of the former floodplains not assessed are shown proportionally to their area, so that a reference to the respective loss of inundation areas can be established. This allows the quality of the active floodplains, the floodplain width and the floodplain loss to be intuitively mapped.

In addition to the floodplains of the 79 rivers included in the assessment, the watercourse network shown in both maps contains other waterways, place names, the borders of the Länder and the national borders for better orientation. The maps “Loss of inundation areas” and “Floodplain status” are available for download from the Federal Agency for Nature Conservation (BfN) website.

4 Status of river floodplains in Germany

Following the first report published in 2009, an overview of the status of river floodplains in Germany is being presented once again with the 2021 Status Report on German Floodplains. Its findings provide a basis for the formulation of programmatic and strategic statements and objectives at the federal and Land levels. Supplementary information will have to be drawn on or gathered for detailed appraisals and planning statements. The methods to be used can be found in KOENZEN et al. (2020 a, b).

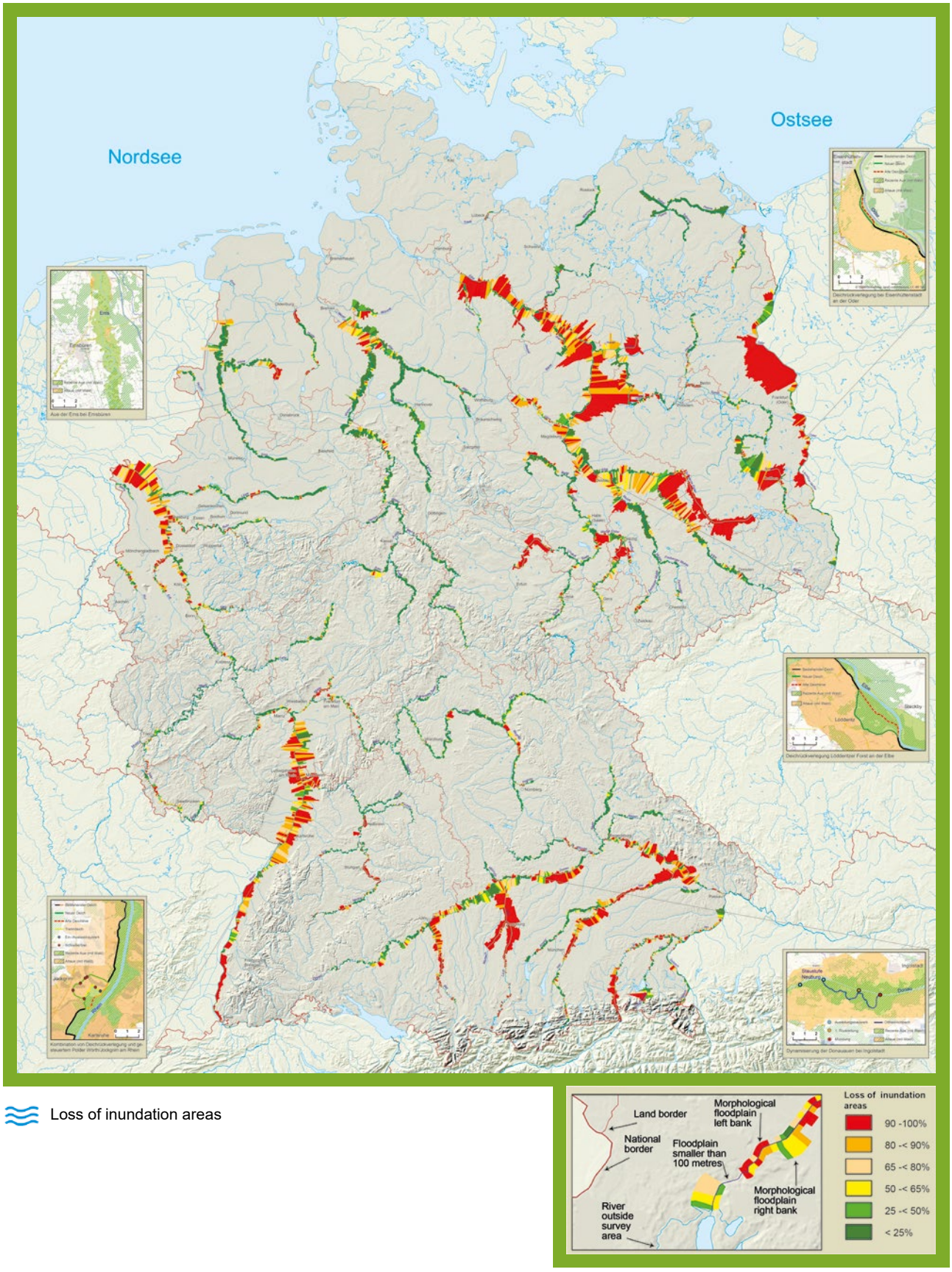
This section summarises the latest findings about the loss of inundation areas, the status of river floodplains and the progress made in floodplain restoration along rivers throughout Germany. Furthermore, the findings relating to individual river basins are described in greater depth. In addition, selected floodplain restoration projects that have contributed locally to improvements in floodplain status are discussed.

4.1 National overview

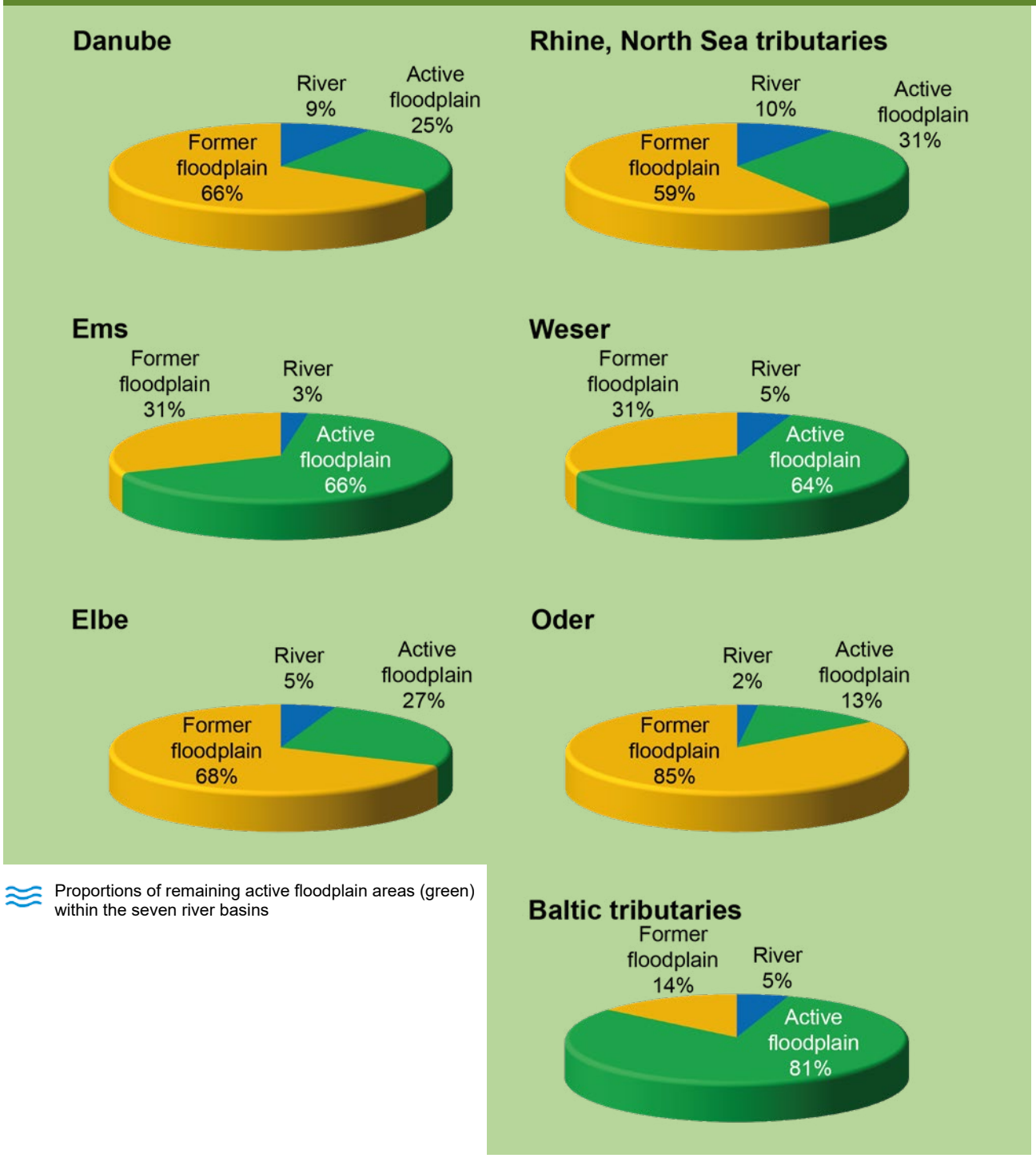
Many of Germany's floodable areas have been lost in the past. It is only possible for about one-third of the natural inundation areas to be inundated when major flood events occur. Due to the construction of flood protection dikes, two-thirds of the country's original floodplains therefore continue to be unavailable as retention areas. In particular, over 80% of inundation areas have been lost across broad expanses of land on the rivers Rhine, Elbe, Oder and Danube, as well as the Dosse, Ohre, Unstrut, Black Elster and the Alpine tributaries of the Danube (see the map "Loss of inundation areas" on page 17). By contrast, large parts of the natural inundation areas along the Ems, the Upper Weser, the Middle Weser and most smaller rivers are still inundated when major flood events occur (100-year recurrence interval). There are only certain sections along these rivers that have suffered larger losses, within settlements for instance. However, engineered rivers with deepened riverbeds discharge moderately elevated volumes of water (recurrence intervals of approx. 5 to 20, in rare cases even up to 100 years) within their channels or the narrow floodplain areas between the embankments or summer dikes that run alongside them. The majority of active floodplains are therefore only rarely inundated, and are often used intensively for agriculture.

The active floodplains of the 79 rivers surveyed cover a total area of 5,119 km². The figures suggest their area has increased by 11% compared to the situation in 2009 due to a variety of factors. Relatively small changes have occurred on the major rivers with flood defences all the way along their banks. In these cases, alterations to the area of active floodplains, which are clearly identifiable from the dike lines, have usually been brought about by engineering measures (e.g. the relocation of dikes and polders that are flooded regularly for ecological reasons). On small rivers, changes in the size of active floodplains are only attributable to such measures to a lesser extent. Rather, these changes compared to the 2009 floodplain delineation are explained by the recalculation of flood areas that has now been available for all rivers (100-year recurrence interval). The changes identified are of various orders of magnitude, depending on the river, and the expansion of active floodplains has often been accompanied by a reduction in the size of former floodplains. The causes for these data-driven alterations are described in detail in the publications that set out the methodological foundations for the Status Report on German Floodplains. Overall, the gains due to the relocation of dikes make up only a small proportion of the total increase in the area of Germany's active floodplains.

The ratio of active to former floodplains certainly differs between the seven major river basins. Particularly massive losses of active floodplains have been seen in the Danube, Rhine, Elbe and Oder river basins, where the proportions of the area taken up by former floodplains that are



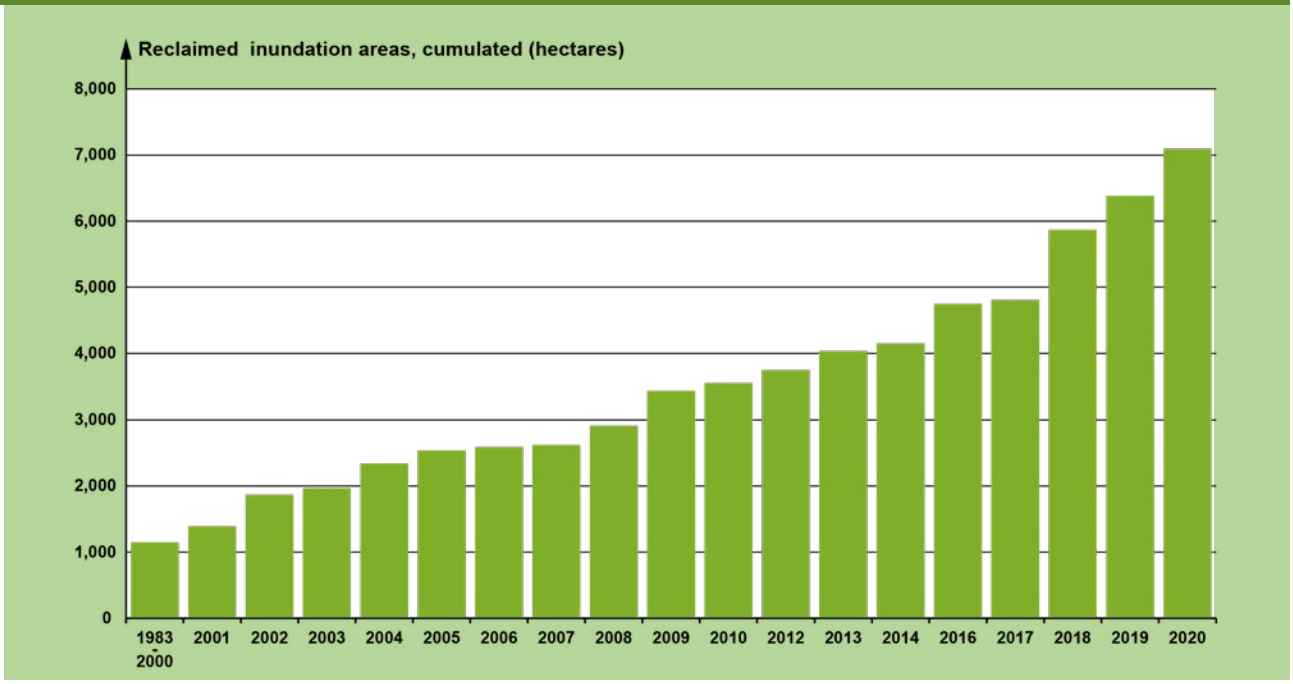
Loss of inundation areas



Proportions of remaining active floodplain areas (green) within the seven river basins

no longer inundatable range between 59% and 85%. In contrast, comparatively large proportions of active floodplain are present in the catchments of the Ems, the Weser and the Baltic Sea tributaries.

With regard to gains in area that can be attributed to restoration measures, there have been remarkable successes both locally and regionally. A total of 65 dikes were relocated along the 79 rivers during the period from 1983 to 2020, increasing the area of their active floodplains by a total of 7,100 hectares. Decisions to lower dikes and embankments close to rivers, move them further away from the banks and cut gaps in them have expanded the area of inundatable river floodplains by about 1.5%. Thirty-two projects affecting a total area of 4,183 hectares were undertaken just during the period from 2009 to 2020. The largest number



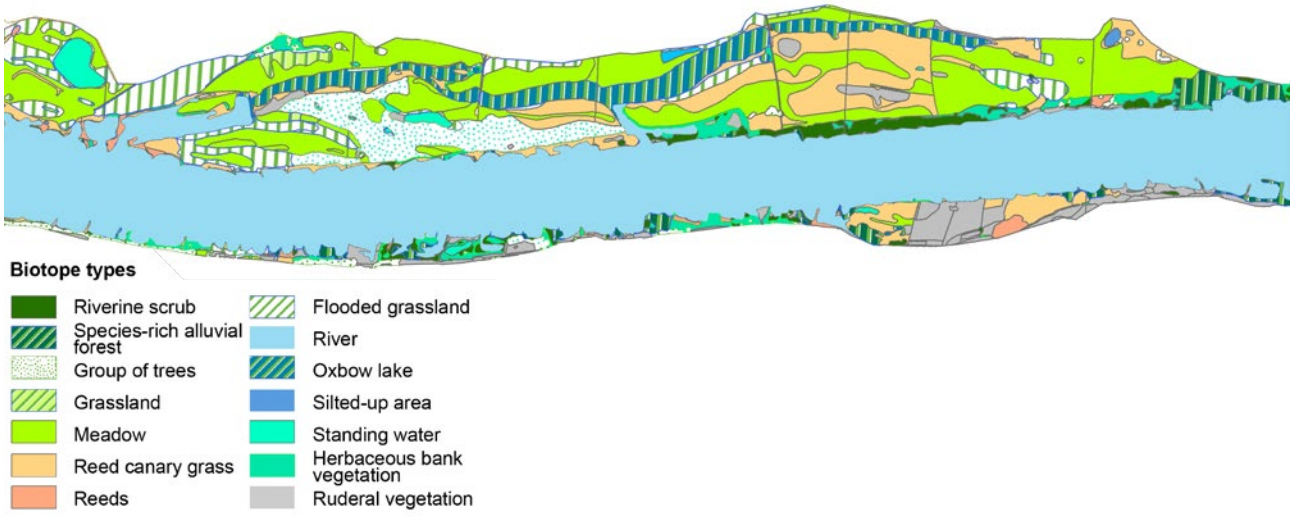
More than 7,000 hectares of floodplain areas along Germany's rivers have been reclaimed thanks to the relocation of dikes; data basis: dike relocation projects on 79 rivers

of dike relocations have been carried out in the catchment of the Elbe (see the table on page 26). Apart from projects in which former floodplains were reconnected with a river's inundation regime, projects involving cutting gaps in dikes or the removal of summer dikes and levees so that active floodplains could be inundated more frequently and for longer periods again have also been counted as dike relocations.

The figures make it clear that the target of enlarging retention areas at least 10% by 2020 set in the German National Strategy on Biological Diversity has not been achieved, and that a great deal of effort is still needed to make progress towards this goal.

Nine of the biggest floodplain restoration projects involving the relocation of dikes were carried out with nature conservation funding from the Federal Environment Ministry in collaboration with the Länder and various project-executing agencies. They covered a total area of 2,897 hectares (about 40% of the area restored by dike relocation projects in Germany), were implemented as major nature conservation projects under the federal nature conservation funding programme "chance.natur", as part of the Federal Programme for Biological Diversity or as trial and development projects, and were technically supervised by the Federal Agency for Nature Conservation. A number of these projects are described in section 4.2.

Floodplain areas on the Elbe at Lenzen have been reconnected with the river's inundation regime and developed into a near-natural state.



A mosaic of different biotope types on the active floodplains of the Elbe

The use of active floodplains continues to be dominated by grassland, which takes up 43% of their area. 26% of active floodplains are arable land, and 7% are taken up by settlements, transport infrastructure and commercial facilities, which means these uses occupy a good third of the total between them. Only 16% are forest. Relative to the area of the floodplains on all 79 rivers, the changes in the proportions occupied by the different land use categories (water bodies, wetlands, forest, grassland, arable land and settlements) compared to 2009 are negligible. Apart from the altered delineation of active floodplains, these developments are only attributable to real changes in land use in about one-quarter of cases. A more detailed evaluation of representative subareas on floodplains showed that, in the other instances, minor adjustments to the categorisation of land use data (e.g. scrub being classed as forest instead of grassland) and the greater precision of the data available were responsible for such discrepancies.

Of the grassland and forest areas on river floodplains, only small parts are usually still of high nature conservation value and fully perform their functions as habitats for floodplain-typical species of flora and fauna. For example, near-natural riparian mixed forests take up a total area of about 12,500 hectares along Germany's rivers.

The majority of the forests on floodplains do not exhibit the characteristics of alluvial forest any longer. Of the grassland areas, approximately 10% are farmed extensively, while the overwhelming majority of the roughly 220,000 hectares of grassland on active floodplains are used intensively, and wet grassland in wet and periodically wet locations is declining sharply. The wetlands and highly characteristic wet grasslands that would naturally occupy large proportions of the total area take up around 13,000 hectares, just under 3% of Germany's active floodplains.

Nevertheless, the differentiated analyses of floodplain-typical habitats conducted for the 2021 Status Report on German Floodplains show that there are diverse mosaics of habitats to be found in near-natural floodplain areas, which accounts for the significant role they continue to play as species diversity hotspots.

Apart from high-conservation-value meadows, the sites designated as protected areas also include alluvial forests, wetlands and broad expanses of more intensively used floodplain, less species-rich grassland locations in particular. For instance, the proportion of floodplains categorised as nature conservation areas is disproportionately high at 21%. In fact, 52% of active floodplains are Natura 2000 sites and are therefore subject to special conservation

requirements as far as their development is concerned.

According to Germany's latest report to the European Commission on the national implementation of the Habitats Directive, most habitats typical of floodplains continue to have an unfavourable status (BMU & BfN 2020). It is only possible for structurally diverse alluvial forests and species-rich meadows to be safeguarded permanently if suitable development measures are taken. Above all, such measures involve the creation of dynamic riverbank habitats, the restoration of floodplain-typical groundwater and inundation conditions and management approaches tailored to each individual site.

As a rule, the intensity of land use on former floodplains is markedly higher than on active floodplains, which is attributable to the favourable conditions for farming, essentially because the land is not inundated.

Over the last 12 years, there has been no significant change in the status of the river floodplains in Germany – measured in terms of the overall results for all 79 rivers. Severely and very severely modified areas (floodplain status categories 4 and 5) also predominate in the

Near-natural alluvial forests are regularly inundated when floods occur, as here in a riparian mixed forest on the Middle Elbe during a spring flood.

2021 Status Report on German Floodplains. This outcome was certainly to be expected in view of the great pressures that continue to be placed on floodplains by different uses. However, considerable regional differences are evident.

Only about 1% of Germany's floodplains are "very slightly modified" compared to their potential natural status, which puts them in floodplain status category 1 and means they are largely characterised by "nearly natural" conditions. Floodplains of this kind are found, for example, on the Middle Elbe near Dessau, around the

Wet grassland interspersed with standing waters

Different land uses in floodplains: an excavated water body (top left), a landfill site (top right), arable land (bottom left) and grassland (bottom right).

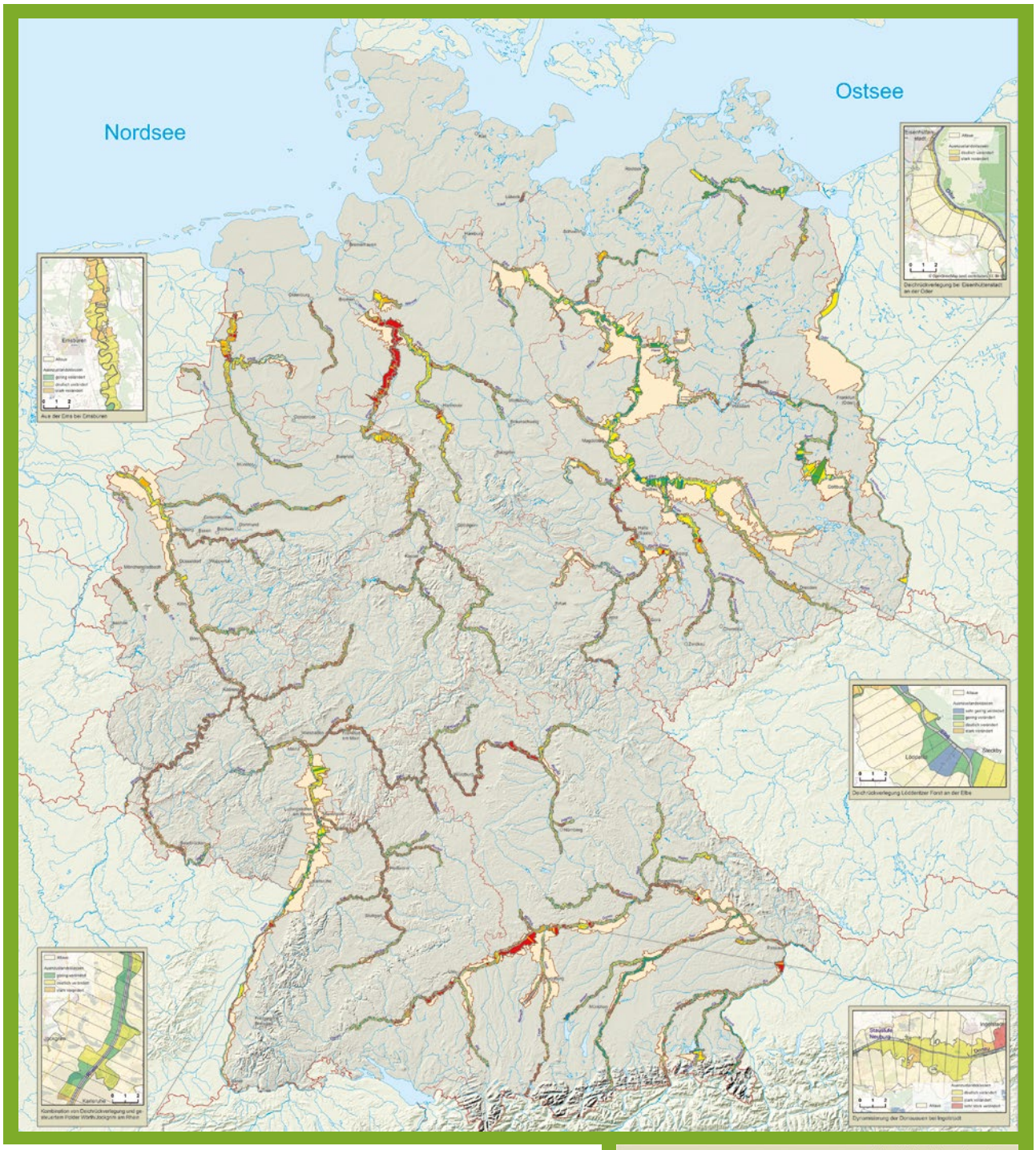
mouth of the Tyrolean Achen and on the Amper below Lake Ammer.

8% of active floodplains are “slightly modified”. These river floodplains in status category 2 are located in particular on the North-East German Plain, along the Middle Elbe, on the Upper Rhine, on a number of rivers in the Alpine Foreland and scattered along a number of smaller upland rivers. The proportions in floodplain status categories 1 and 2 are therefore largely similar to those recorded in 2009.

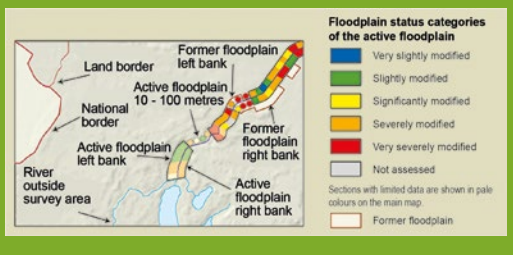
One-third (33%) of Germany’s floodplains are “significantly modified” (floodplain status category 3). These floodplain areas continue to possess a clear “floodplain character”. However, the potential for inundation they still have has been limited by watercourse engineering, and the proportion of land used intensively on these floodplains is increasing as well. Floodplain status category 3 is assigned to many river floodplains in lowland areas, floodplains on unimpounded upland sections of rivers that are overwhelmingly used as grassland and forested floodplains on river segments regulated by impoundment, in the Alpine Foreland for example. In comparison to the 2009 floodplain status assessment, the proportion of “significantly modified” floodplains (floodplain status category 3) has fallen by 3%.

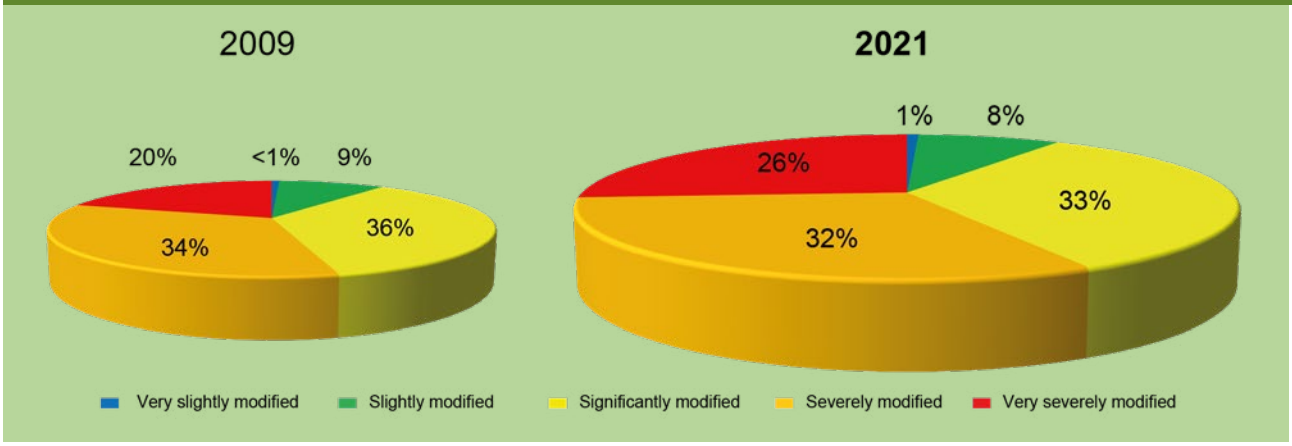
The proportion of “severely modified” floodplains (floodplain status category 4) has gone down by 2% to 32% since the 2009 floodplain status assessment, while the proportion of “very severely modified” river floodplains (floodplain status category 5) has increased from 20% to 26%.

Floodplain areas on heavily engineered, sometimes impounded sections of rivers that are



Status of river floodplains in Germany





The status of floodplains in Germany, 2021 – distribution of floodplain status categories; the distribution of floodplain status categories in 2009 is shown for comparison; data basis: assessed 1-km floodplain compartments on 79 rivers

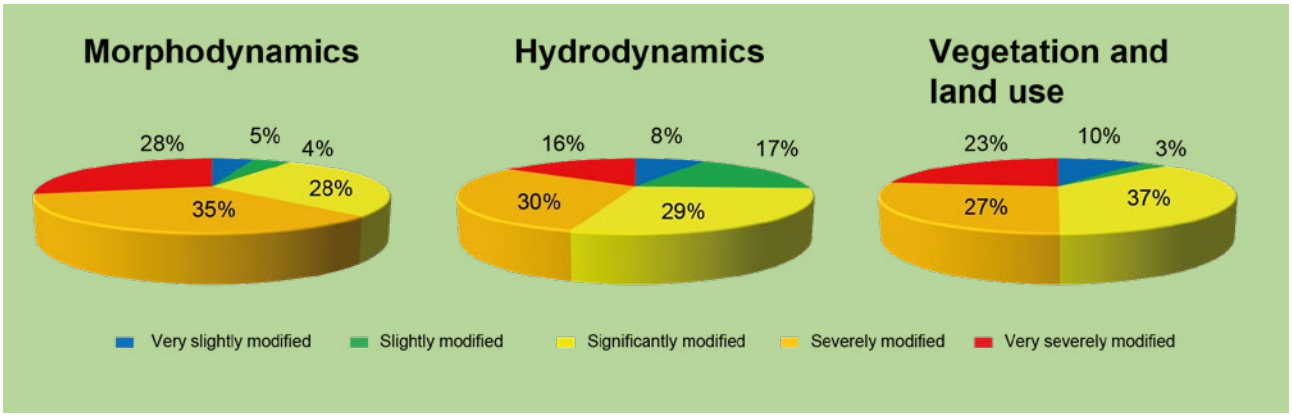
used for intensive farming or have large proportions of their land occupied by settlements belong in floodplain status categories 4 and 5. The floodplains along lengthy sections of the navigable Ems, Weser, Saale, Moselle, Lahn, Main and Neckar fall in this group.

The fact that floodplain status category 5 has grown by 6% while floodplain status categories 3 and 4 have shrunk is not entirely explained by the intensified use of active floodplains, but is essentially an effect of changes in active floodplains' delineation. Locally, the enlargement of the active floodplains as a result of methodological changes has resulted in higher proportions of arable and settled land in floodplains and a downgrade in their status.

When the three functional assessment categories are looked at separately, different aspects of the results are revealed that are partially obscured by the levelling effects of the overall assessment:

63% of the active floodplains assessed are classified as having severely or very severely modified morphodynamics (floodplain status categories 4 and 5). This shows that naturally dynamic developments can no longer take place on the banks and active floodplains along about two-thirds of river segments because of the great extent to which they have been engineered or regulated with impoundments. An essential characteristic of near-natural river landscapes has therefore been lost along these segments or is hardly able to have effects on their status any longer.

The intensity of land use is also high overall on active floodplains. 13% of the total area of floodplains is placed in floodplain status categories 1 and 2 as far as its vegetation and land use are concerned. These categories are found mainly in areas with large proportions of forest and wetlands, as well as areas with alluvial waters. Floodplain status category 3 covers 37% of Germany's floodplains, including many



Distribution of assessment categories for the morphodynamics, hydrodynamics and vegetation and land use of active floodplains in the 2021 assessment

The engineered mouth of the Lippe before it was redesigned (left) and following its restoration (right). The widened parts of the river, the islands in its mouth and the areas that have been developed on its floodplains are clearly visible.

river segments dominated by grassland. River floodplains have also been affected by the deteriorating quality of grassland sites that can be observed throughout Germany due to more intense use. For instance, species-rich alluvial meadows have been assessed as having an unfavourable conservation status all over the country. The fact that the hydrodynamics of over 50% of floodplains are assessed in floodplain status categories 1, 2 and 3 shows that, fundamentally, there are floodplains with high potential for inundation on many rivers, and that a quarter of sites even have high to very high potential for inundation.

However, the possibility of banks overflowing at an early stage when small floods occur is increasingly limited because riverbeds are being deepened ever more, while floodplains are simultaneously being affected by “accretion”. The hydrodynamics of 46% of floodplains are severely or very severely modified (floodplain status categories 4 and 5).

A sustainable, comprehensive improvement in floodplain status is usually only possible if improvements occur in all three assessment categories, for example as a result of the removal of bank reinforcements, measures to re-establish the connectivity between the river and its floodplains and reductions in the intensity of use. The Germany-wide evaluations show floodplains’ morphodynamics have been particularly impaired because 63% are assigned to floodplain status categories 4 and 5 (severely and very severely modified) for this assessment category, which suggests a particular need for development in this area.

Local and regional improvements in floodplain status can be achieved by means of restoration measures on water bodies and floodplains. This is evident, among other things, from the total of 167 major projects that were implemented during the period from 1981 to 2020 on the 79 rivers surveyed, 80 of which were conducted following the publication of the 2009 Status Report on German Floodplains. The map of floodplain restoration projects on rivers in Germany (page 27) also shows floodplain projects on rivers outside the areas covered by the Status Report on German Floodplains, but no projects on streams. While increased efforts to restore floodplains were undertaken by the nature conservation and water management authorities from the 1980s on, the objective of restoring natural retention areas in order to improve protection against flooding has also been pursued since the 1990s. In all, about 220 major floodplain restoration projects were implemented on rivers across Germany between 1981 and 2020. The spectrum extends from water restoration measures involving the reconnection of oxbow lakes and flood channels along a several-hundred-metre section of river to extensive measures that cover more than 100 hectares of land, entailing the restoration of floodplain-typical inundation conditions and appropriate adjustments to the ways these areas are used. Measures centred on the controlled flooding of retention areas (polders) are not included in this figure because they are

Catchment	Number of projects	Thereof dike relocations
Rhine	64	14
Danube	32	14
Elbe	27	20
Weser	19	3
Ems	14	8
Oder	6	5
Baltic Sea	3	1
Maas	2	0

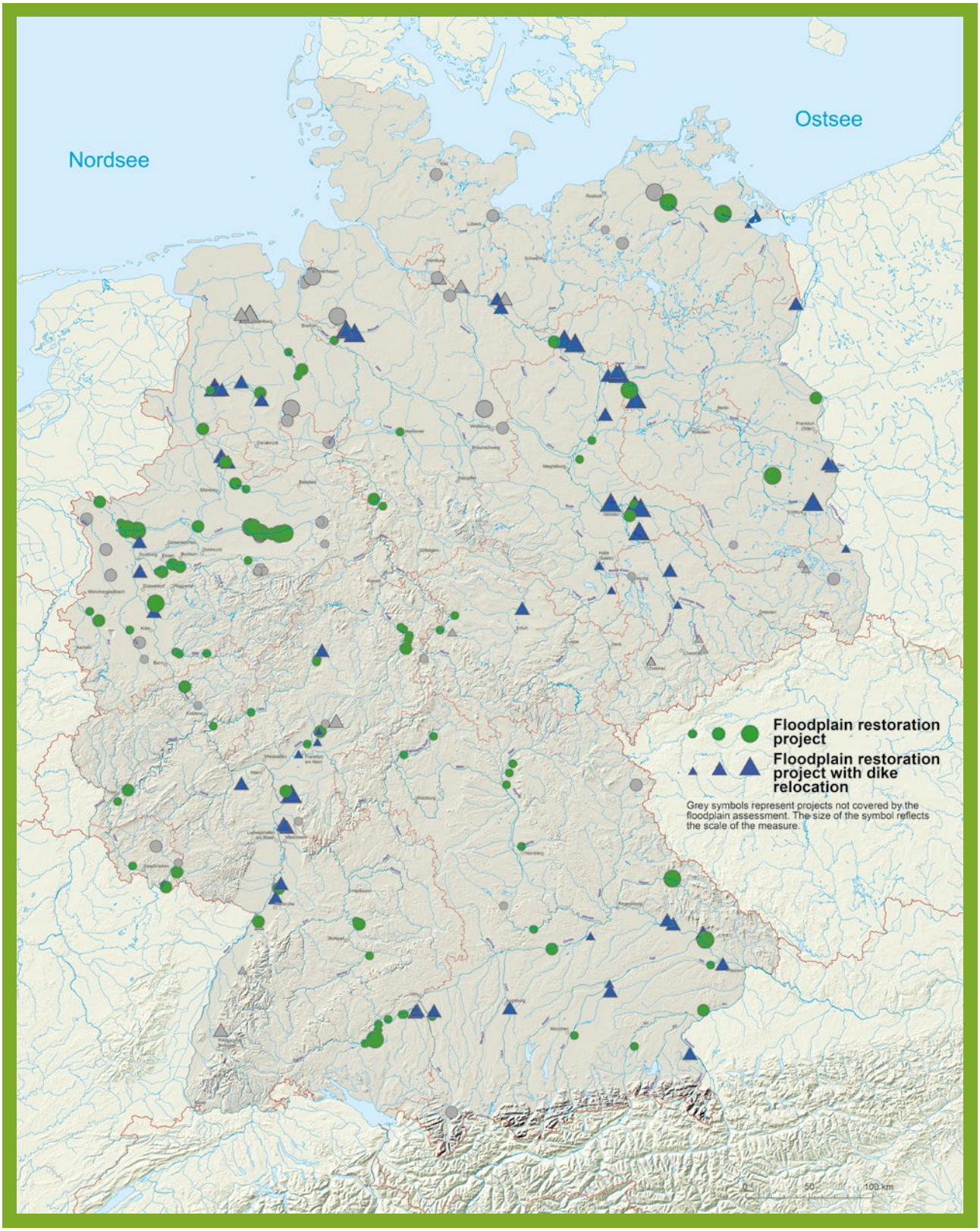
Floodplain restoration projects and dike relocations in German catchments, 1981–2020

usually only inundated when floods peak at extremely high levels, and it is therefore hardly possible to restore natural dynamics and near-natural wetland habitats at these sites.

The number of large-scale measures and collaborative projects is slowly but steadily rising. For example, remarkable successes have been achieved regionally by restoring river landscapes and reactivating natural inundation areas on the Peene, Lower Havel, Middle Elbe, Wümme and Lippe. Some of these nationally significant projects are described in detail in section 4.2. When banks are restored, side waters reconnected to the main river and wet meadows and alluvial forests developed, a clearly measurable enhancement of the floodplain status is seen in the project areas. Nationally, however, the positive effects of restoration measures remain limited, as is also reflected in the floodplain status assessment. A great deal still needs to be done to restore rivers and their floodplains.

More floodplain restoration projects have been implemented on the Rhine and its tributaries than anywhere else in Germany. Many projects have also been carried out in the catchments of the Elbe, Danube, Weser and Ems. The numbers of projects implemented are accordingly lower in the smaller catchments of the Oder, the Maas and the Baltic Sea tributaries.

Former floodplains have been reactivated by cutting gaps in dikes on the Elbe at Lenzen



Floodplain restoration projects on rivers in Germany

4.2 Catchments

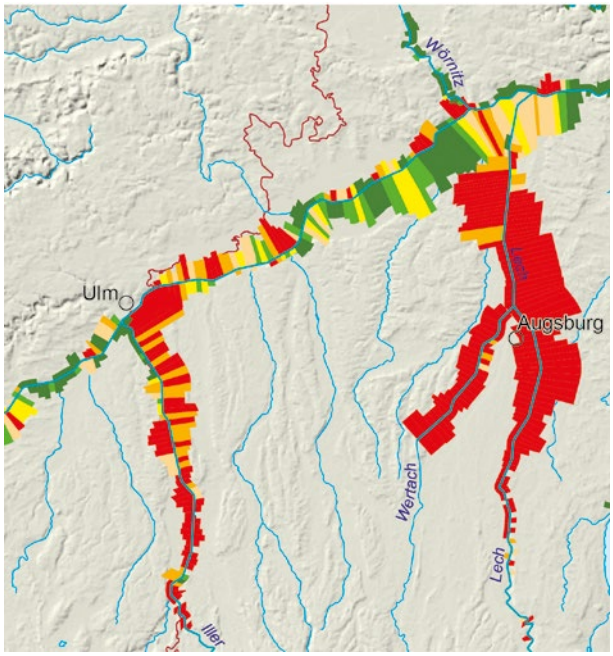
4.2.1 The Danube

The Danube runs to the north of the foothills of the Alps and is fed by both Alpine waters from the south and smaller tributaries that rise in the hilly landscapes of its northern catchment.

In the discussion that follows, the Danube catchment is subdivided into the areas upstream and downstream of its confluence with the Lech. Large amounts of floodplain are still present along the Danube upstream from the mouth of the Lech, but are used intensively for agriculture. Broad swathes of its inundation areas have been lost in localities with higher proportions of settled land, where over 65% of the floodplains are former.

On the alpine tributaries of the Iller, Lech and Wertach, the loss of inundation areas is very high, usually exceeding 90%.

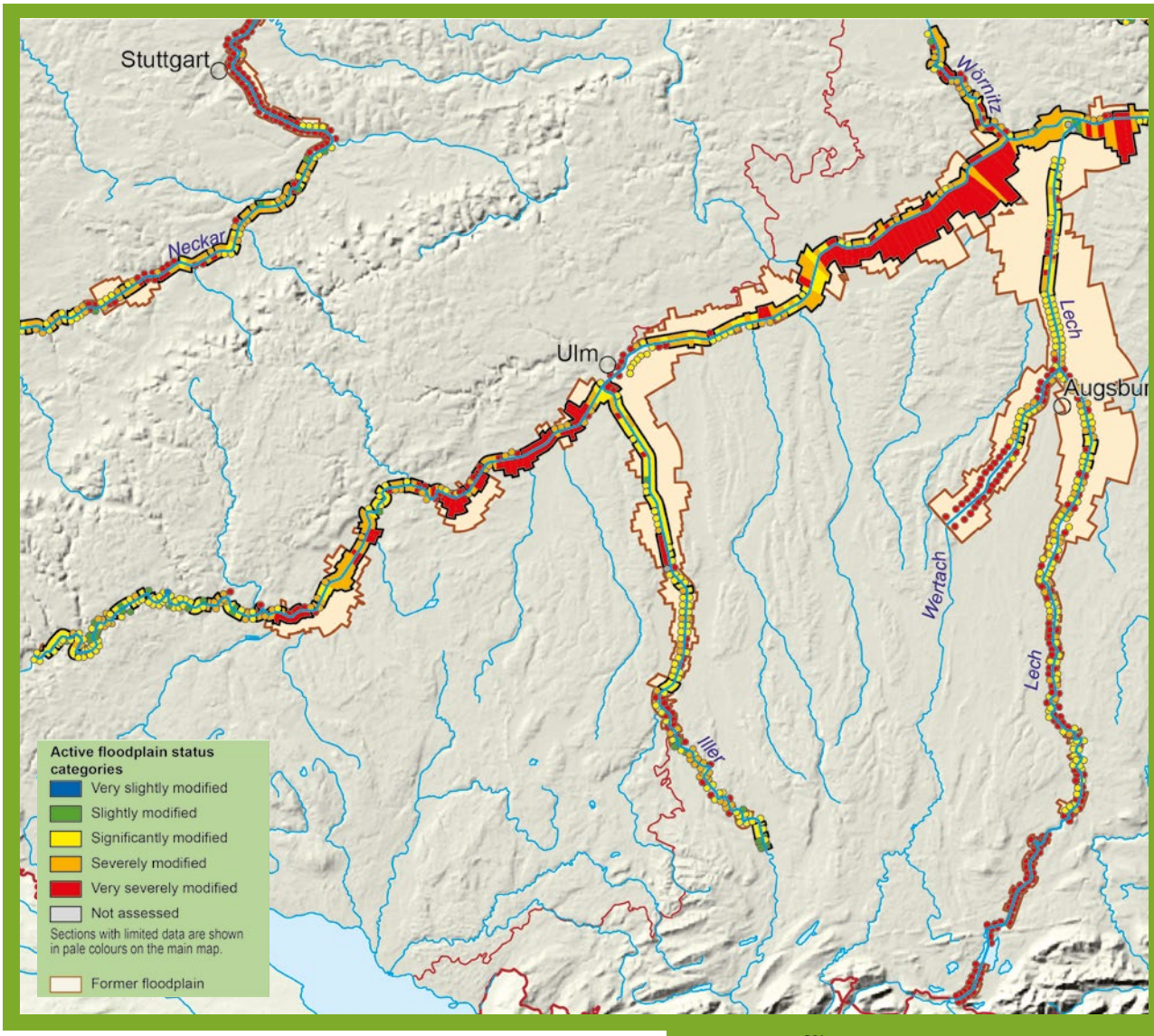
Along the Lech alone, more than 30,000 hectares of floodplains have been cut off from the river's inundation regime. On the very narrow active floodplains that remain, the proportion of forested land is usually greater than 70%, although the forests have been significantly impaired by massive watercourse engineering, combined with the intensive use of the river for hydropower generation.



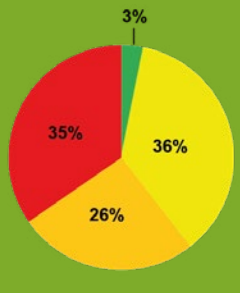
Loss of inundation areas on the Danube tributaries Iller, Lech and Wertach

Slightly modified segments (floodplain status category 2) – usually occupied by relicts of alluvial forest – take up a very small proportion of the floodplains on the Danube and its tributaries (3%), while categories 3 to 5 dominate. These floodplain areas have been heavily shaped by watercourse engineering, together with the intensive use of the rivers for hydropower generation and the large proportions of the land devoted to crop farming.

A section of a highly dynamic Alpine river with dead wood on its banks



Status of floodplains on the Danube and its tributaries upstream from the mouth of the Lech



Distribution of floodplain status categories

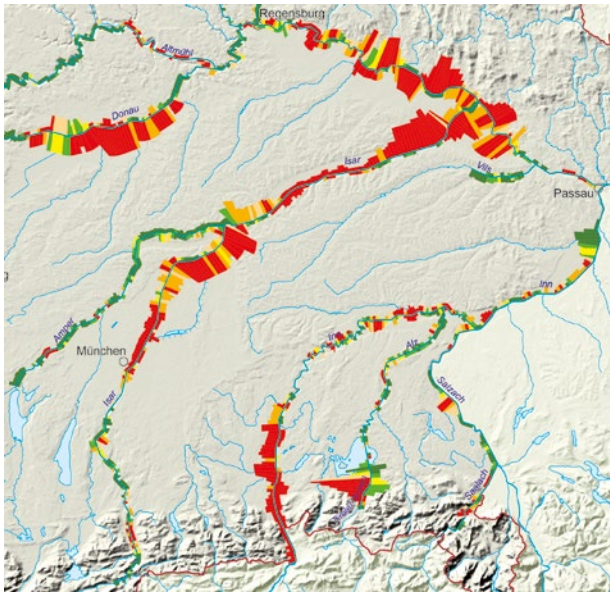
The Danube and its tributaries upstream from the mouth of the Lech

In many instances, the effects of impoundment result in severely or very severely modified conditions on active floodplains compared to their reference status (categories 4 and 5). Furthermore, the large proportions of arable land on the active floodplains of many sections of the Danube indicate that moderately elevated volumes of water are discharged within the river's profile, deepened as it has been by watercourse engineering and do not overflow its banks onto the floodplains.

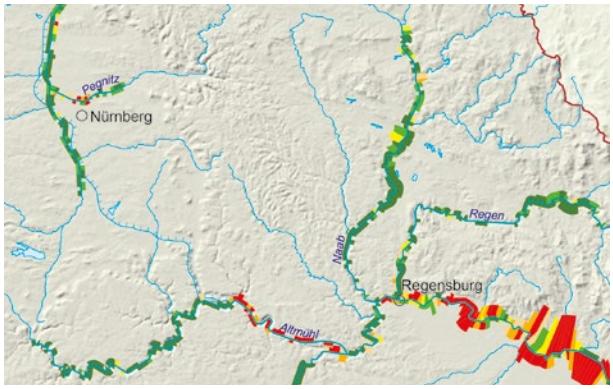
Some segments of the remaining, mostly very narrow active floodplains along the Iller, Lech and Wertach are covered by severely altered alluvial forests in some places, meaning they are characterised by significantly modified floodplain conditions (category 3) despite their large proportions of forested land.

By contrast, the narrow floodplains of the Wörnitz, a tributary that flows into the Danube from the north, are mainly used intensively as grassland and arable land. The channel of the winding River Wörnitz is trained, and long sections of it have standard profiles.

Downstream from the mouth of the Lech, inundation areas that have suffered smaller losses are only found along the Danube in locations where the valley floors are very narrow.

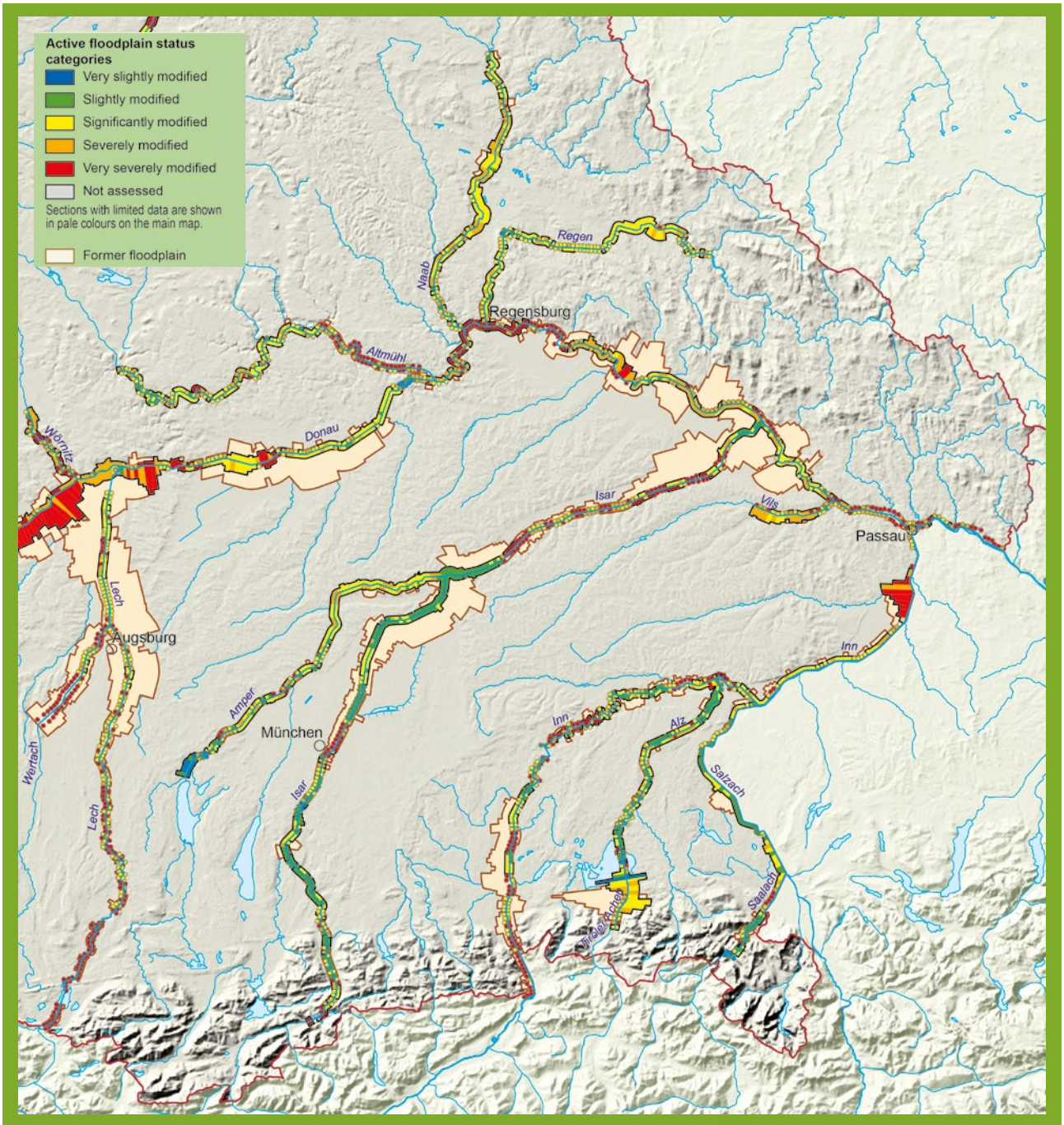


Loss of inundation areas on the Danube and its tributaries

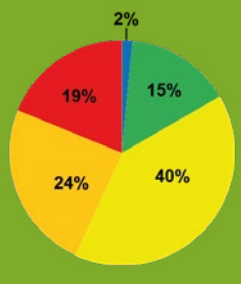


Loss of inundation areas on the Naab, Regen and Altmühl

Sections of the Iller, Lech and Wertach with narrow relicts of alluvial forest adjacent to intensively used land on former floodplains.



Status of floodplains on the Danube and its tributaries between the mouths of the Lech and the Inn



Distribution of floodplain status categories

The Danube and its tributaries between the mouths of the Lech and the Inn

By contrast, at least 90% of the area of the segments with broad morphological floodplains is usually taken up by dike-enclosed former floodplain.

Two of the Danube's Alpine tributaries, the Isar and Inn, have suffered large losses of inundation areas as well, in particular on their middle and lower reaches. The Amper is the river's only Alpine tributary to have merely lost a small part of its inundation areas.

The northern tributaries of the Danube, the Altmühl, Naab and Regen, have retained markedly greater proportions of their active floodplains. It is still possible for wide areas to be inundated when larger floods occur, but here to watercourse engineering has significantly reduced the frequency of inundations, so that the floodplains are dominated by agricultural use. On the middle reaches of the Naab and Altmühl, in particular, the proportion of arable land is now more than 30% due to increasingly drained floodplains.

The status of the Danube's floodplains downstream from the mouth of the Lech is determined by impounded sections where the groundwater and discharge dynamics have been considerably disrupted, whereas the freely flowing segments still feature floodplain-typical habitats on their narrow floodplains, including small forest stands with flood channels and alluvial waters.

The regulated Danube with its widened channel and nearby excavated waters

The little ringed plover breeds on vegetation-free gravel shoals.

The near-natural Isar floodplains with gravel flats and Alpine spring heath-Scots pine forests running alongside them

Like the Danube, its Alpine tributaries are significantly affected by their use for hydropower generation and the resulting modifications. At the same time, slightly modified floodplain sections (floodplain status category 2) can be found, especially on the Alpine tributaries of this section of the Danube. The 15% of their floodplains in category 2 and 2% in category 1, in particular on the middle reaches of the Isar, but also on the Inn, Alz and Salzach, show clearly that large, near-natural floodplain areas of very great nature conservation significance are still present. In the lower Alpine Foreland, by contrast, severely and very severely modified floodplain segments (categories 4 and 5) predominate. The area around the mouth of the Isar is the only near-natural river mouth where large areas of floodplain have been preserved (category 2) and is also of national significance. Furthermore, the delta of the Tyrolean Achen where it flows into Lake Chiemsee deserves mention on account of its good conservation status and the near-natural dynamics that can still be encountered there. Some parts of the delta have a very slightly modified floodplain status (category 1).

The Tyrolean Achen flows into Lake Chiemsee through an inland delta that has developed very near-natural features.

The northern tributaries of the Danube, the Altmühl, Naab and Regen, have narrower floodplains that are overwhelmingly used for grassland and farming, and are largely assigned floodplain status category 3. There are very wide variations in the extent to which these watercourses have been engineered, and consequently the inundation conditions along them.

Floodplains used as grassland on the Regen

Non-natural pre-Alpine floodplains that have become isolated from the rivers Inn and Isar

The Danube between Hundersingen and Binzwangen (white lines: floodplain delineation with 1-km floodplain sections); inset map: status of floodplains around the project area.

The Danube before (bottom left) and after restoration (bottom right). Several bifurcations developed in the river after the measures were implemented in 2011.

The lower Altmühl Valley has been particularly transformed by the river's upgrade to a federal waterway, while other sections of the Altmühl, as well as the Naab and Regen have less modified water body and floodplain structures. Some segments appear nearly natural with riverbeds that are comparatively shallow even though they have been deepened. The adjacent floodplain areas are also influenced by impoundments on account of the rivers' use for hydropower generation, even if to a lesser extent than the impounded sections of the Danube and its Alpine tributaries.

Since the early 2000s, many comprehensive measures have been implemented on the upper Danube and its tributaries to improve the rivers and the floodplains that run alongside them. Two examples are discussed below.

Restoration of the Danube between Hundersingen and Binzwangen

From 2009 to 2011, a near-natural channel was created for the Danube between Hundersingen and Binzwangen. This meant raising the riverbed, which made it possible to improve inundation conditions and activate floodplain structures.

Some floodplains are no longer being used or used more extensively in order to encourage

The Wertach close to where the dike was relocated at Göggingen (white lines: floodplain delineation with 1-km floodplain sections)

Inset map: status of floodplains around the project area (bottom left) Dynamic riverbed and shoal structures on the Wertach (bottom right)

floodplain-typical vegetation structures along the rivers.

The area, in which the measures were implemented, the “new” Danube now features numerous undercut riverbanks and slip-off slopes, extensive shoal structures and gravel flats, which improved the status of its floodplains by one status category.

Dike relocation on the Wertach at Göggingen

Work began on the Wertach Vital project in 2000. Since then, measures have gradually been carried out to enhance the ecology of the Wertach in combination with flood defence measures. The steps taken have included relocating dikes, widening the river and flattening long sections of previously steep slopes along its banks. Alluvial forests have been inundated in order to raise and maintain the groundwater level again.

Most of the floodplain segments where the measures have been implemented reach floodplain status category 3 on account of the intensively used land that adjoins them and the comparatively low proportion of reactivated former floodplains.

4.2.2 The Rhine and the North Sea tributaries

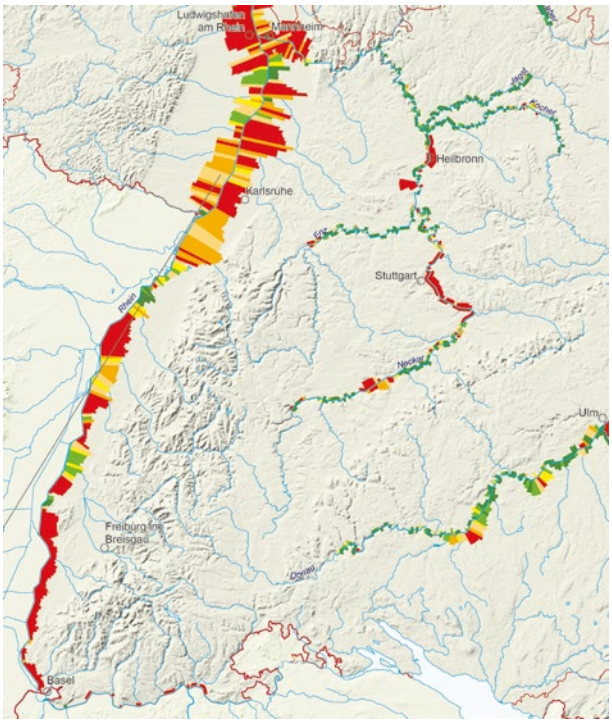
In view of its size and the number of tributaries in the Rhine catchment, the Upper Rhine, Middle Rhine and Lower Rhine are dealt with separately in the discussion that follows. This section also covers the tributaries of the Maas system.

More than 80%, and in many cases more than 90%, of the naturally very extensive floodplains on the Upper Rhine have been isolated from its inundation regime by massive engineering and comprehensive flood defence measures. There are only occasional sections where more than 50% of the floodplain can still be inundated.

The few sections of the Neckar where the valley bottom broadens out have overwhelmingly lost more than 90% of their inundation areas. The losses are noticeably less on its narrow upland floodplains, but these too are only very rarely inundated, if at all, due to the heavy engineering of the Neckar. The Neckar is predominately assessed in floodplain status category 5 in view of the significant influence impoundments have had, as well as the transport infrastructure and settlements that have been built close to its banks in many places.

On the narrow upland floodplains of the Enz, Kocher and Jagst, many segments have remained preserved with large proportions of active floodplain. However, it is very rare for these floodplains to still be inundated because the rivers' profiles have been engineered and deepened. Together with the construction of buildings close to their banks and the influence of impoundments on some sections, the training of these watercourses has resulted in a total of just 1% of the floodplain segments in the Neckar catchment being preserved as slightly modified (category 2). Given that over 40% of their active floodplains are very severely modified (category 5), the intensive use of the valley bottoms in this region is readily apparent.

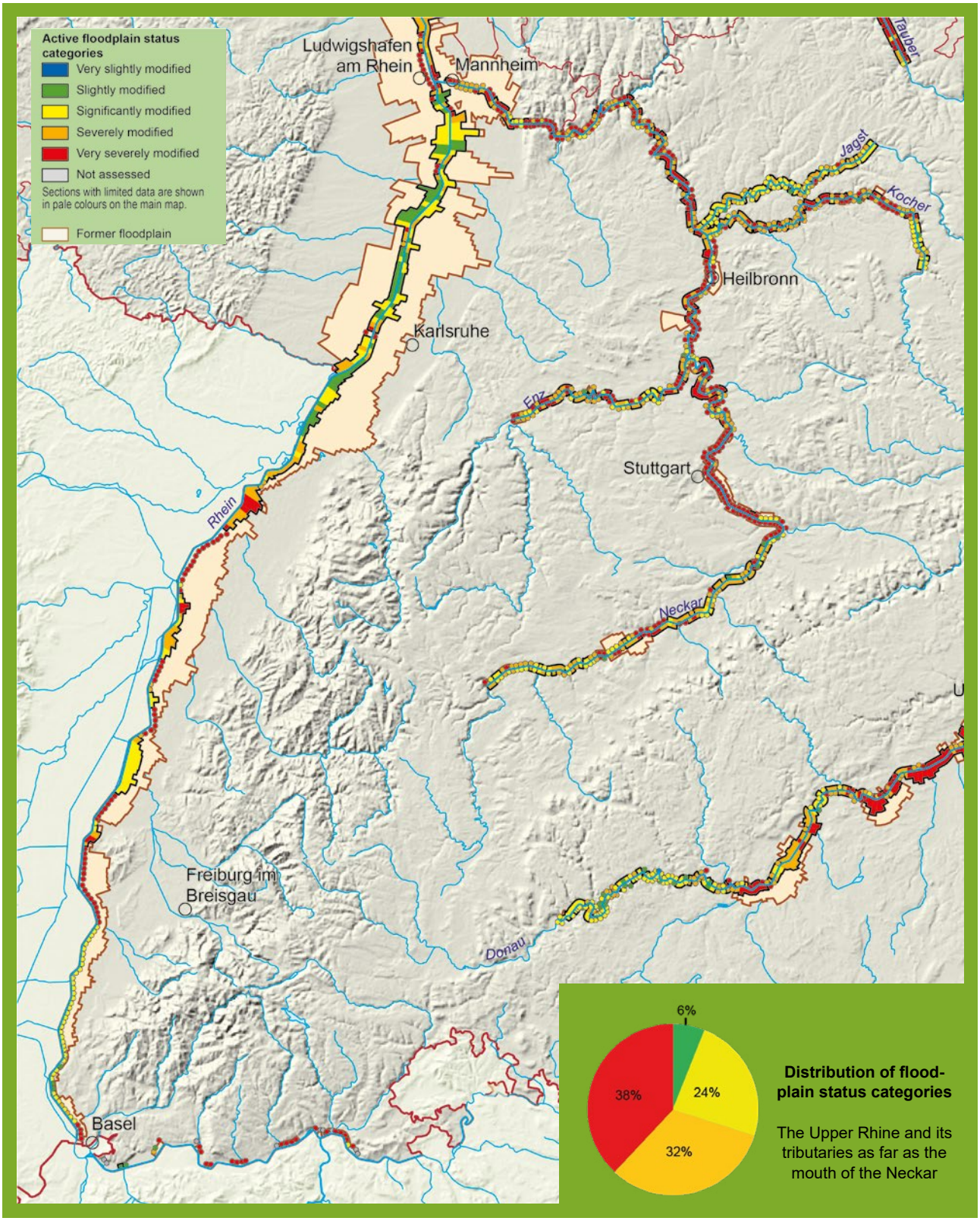
As far as the status of its floodplains is concerned, the Upper Rhine can be divided in two



Loss of inundation areas on the Upper Rhine and in the Neckar catchment

south of its confluence with the Neckar. Along the impounded sections on the southern Upper Rhine and the High Rhine, the inundation conditions on large parts of the remaining, only very narrow active floodplains have been considerably degraded by regulation with impoundments and massive watercourse engineering. Apart from significantly modified segments (floodplain status category 3), lengthy, very severely modified sections (category 5) are also encountered.

Sites preserved with near-natural features, such as the Taubergiessen nature conservation area, are only found locally. Slightly to significantly modified floodplain areas (categories 2 and 3) predominate on the free-flowing Upper Rhine between Iffezheim and the mouth of the Neckar. These floodplains too are overwhelmingly forested and feature numerous standing waters that vary very widely in terms of their characteristics and how natural they are (oxbow lakes, excavated waters). They are among



Status of floodplains on the Upper Rhine and its tributaries as far as the mouth of the Neckar

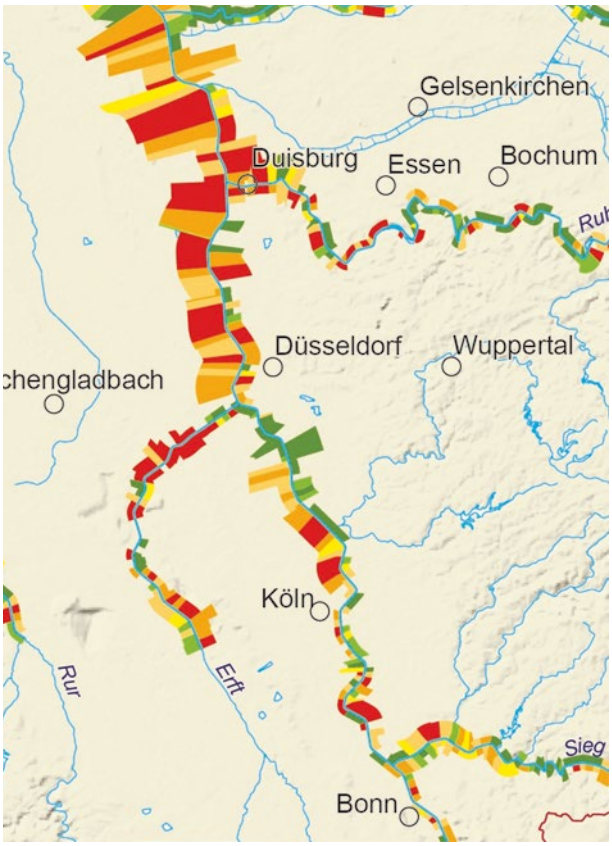
the most significant floodplain areas in Germany, even though wide active floodplains have only continued to be preserved on the section of the Rhine where the river used to run in a series of bends.

As a result of massive watercourse engineering and the way it has increased the hydraulic efficiency of the Rhine, its forests have substantially lost their floodplain-typical characteristics, although many of the forested floodplains still have tremendous potential for improvement. The proportions of inundation area lost are also very great on the extended morphological floodplains along the Upper Rhine north of the mouth of the Neckar and along the Lower Rhine, frequently more than 80% or 90%. Segments with broad active floodplains and near-natural inundation conditions have only been preserved locally on a few sections. The nature conservation areas “Kühkopf”, on the northern Upper Rhine, and the Urdenbacher Kämpe on the Lower Rhine south of Düsseldorf are good examples.

The active floodplains along the Upper Rhine north of the mouth of the Neckar and the Lower Rhine are overwhelmingly assessed in floodplain status categories 3 and 4. The significantly modified segments of floodplain there (category 3) are frequently used as grassland, whereas alluvial forests play a subordinate role. The detailed, updated data on land use and inundation conditions have led to assessments varying over short distances, especially on the Lower Rhine.

The Middle Rhine stands out clearly from the other parts of the river on account of its naturally very narrow floodplains. Although only small parts have been lost as inundation areas in many places, they have been heavily transformed by intensive uses, including railway lines and roads.

On the Rur, the only tributary of the Maas system surveyed here, the large losses of inundation areas are largely due to a high degree of engineering in lowland locations.

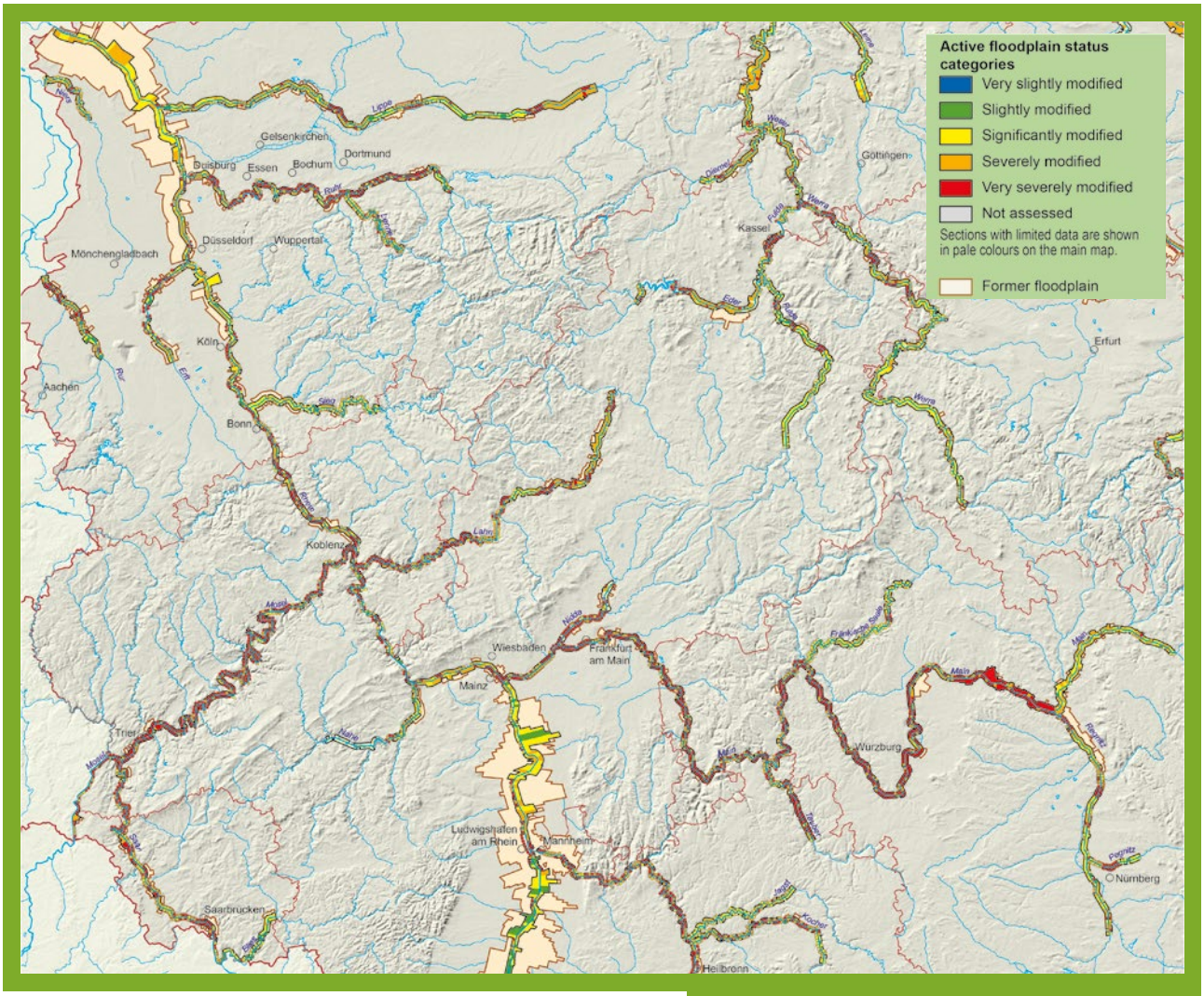


Loss of inundation areas on the Lower Rhine

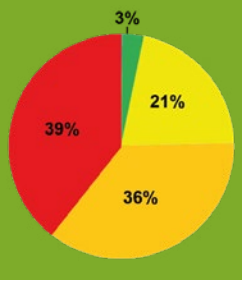
The exceptions are two sections around the mouth of the Inde and near Jülich. Over 80% of the floodplains in these places have been preserved as active floodplain with inundation conditions similar to those that would occur naturally.

The picture is multifaceted on the Rhine’s major tributaries. The Main, Nahe, Nidda, Moselle, Lahn, Sieg and Ruhr have comparatively narrow morphological floodplains where they run through upland areas.

In places where the valleys naturally broaden out, the floodplains have mostly been isolated from inundation processes by flood defences or massive watercourse engineering. Many of these upland tributaries are regulated with impoundments along some of their length, like the Ruhr and Lahn, or almost throughout, like the Moselle and the Main, which has considerably transformed their groundwater and inundation



Status of floodplains on the northern Upper Rhine, Middle Rhine, Lower Rhine and their tributaries



Distribution of floodplain status categories

The northern Upper Rhine, Middle Rhine, Lower Rhine and their tributaries

conditions. For example, the Moselle and Saar have undergone the most far-reaching modifications of all the rivers surveyed, which has left them with about 65% of their combined floodplains very severely modified (floodplain status category 5). Of the smaller rivers, the upper reaches of the Main, Franconian Saale, Nahe and Sieg also have lengthy sections in category 3 (significantly modified).

The lowland floodplains of the Erft and Lippe have suffered very different losses of their inundation areas. On the Lippe in particular, many longer floodplain sections have been developed near-naturally with comprehensive restoration measures so that, apart from significantly modified floodplain areas (category 3), slightly modified areas (category 2) are now found along the river as well.

The Nidda in the vicinity of the Krachenburg Dortelweil and Klein-Karben restoration projects (white lines: floodplain delineation with 1-km floodplain sections).

Inset map: status of floodplains around the project areas (bottom left). A newly redesigned section of the Nidda immediately after restoration (bottom right); the relocated dike is visible in the background.

On the Rur, categories 3 and 4 dominate in the lowlands, but unengineered sections have been preserved with slight modifications (category 2) in two nature conservation areas.

The following projects are described as examples of measures that have been carried out in the catchments of the Rhine and Maas, most of which have been implemented on tributaries of the two major rivers. They provide an overview of the diversity of feasible approaches.

Restoration of the Nidda between Krachenburg and Dortelweil and restoration at Klein-Karben

The Nidda – a tributary of the Main – had been massively engineered in the past, but was redesigned along near-natural lines between Krachenburg and Dortelweil from 2009 on. The dismantling of bank reinforcements and removal of levees made it possible for the river to develop dynamically again. Furthermore, the relocation of the flood protection dike allowed the floodplain to be designed with flood channels and standing waters. The floodplain is grazed extensively in order to preserve its open

The mouth of the Lippe (white lines: floodplain delineation with 1-km floodplain sections); inset map: status of floodplains around the project area.

The Lippe before the measures were implemented (bottom left) – the riverbanks are completely reinforced, while the river itself flows several metres below the level of the floodplains. The Lippe and its floodplains immediately after the measures were implemented (bottom right)

land character with feeding and breeding habitats for the *Charadriidae* family of small- and medium-sized birds. Engineered sections of the Nidda have been restored at Klein-Karben as well.

Restoration of the mouth of the Lippe

The restoration of the mouth of the Lippe was a complex undertaking on account of the conditions at the site – with excavations, recently built roads and bridges and nearby port facilities. Furthermore, the far-advanced deepening of the Rhine made it virtually impossible to directly reactivate the Lippe's primary floodplains. As a result, surface soil was removed and used to fill former excavations, making it possible for floodplain-typical inundations to cover the area on more than 60 days in the year. The dynamic, widened river channel is now connected closely with its new floodplains via numerous channel systems, allowing a filigree mosaic of extremely varied habitats to develop. The Lippe used to run in a very non-natural channel with floodplains that had been disconnected from it hydromorphologically. After it was redesigned to its current state, the floodplain status improved by as many as two categories.

The Rhine in the vicinity of the restoration project at Bislich-Vahnum (white lines: floodplain delineation with 1-km floodplain sections).

Inset map: status of floodplains around the project area (bottom left). The side channel at Bislich-Vahnum with flowering vegetation growing on its banks and a margin of willow trees alongside it (bottom right).

Rhine side channel at Bislich-Vahnum

This project involved the creation of a side channel on the Rhine floodplain with the intention of connecting the river and floodplain. The side channel was deliberately created on a section of the dike foreland that had been heavily transformed by excavations and included previously excavated waters in order to minimise interference in the foreland. On account of the far-reaching requirements for shipping on the Rhine, it was necessary to build an intake structure to regulate the volume of water flowing into the side channel.

Inundated shallow water zones are now present once again on the banks of the side channel – where they are protected from the wave action of the Rhine. Mudflats and flooded grassland that dry out periodically enhance the site as a feeding habitat for wading birds and waterfowl such as the common redshank. The side channel forms temporary islands from the grassland on the dike foreland – the insularity of these areas benefits the numerous Arctic wild geese that overwinter there.

The Rur in the vicinity of the restoration project at Körrenzig (white lines: floodplain delineation with 1-km floodplain sections)

Inset map: status of floodplains (bottom left). The secondary floodplains of the Rur – progressively developing alluvial forest surrounded by intensive farmland (bottom right)

Restoration of the Rur at Körrenzig

The Rur – a tributary of the Maas – retains its upland character far into the lowlands. The restoration site is located immediately below the waste water treatment plant for the small town of Linnich. The demands consequent upon the drainage of waste water from the settlement, combined with the prevailing intensive land uses on the former floodplain meant it was merely possible to develop a high-quality secondary floodplain.

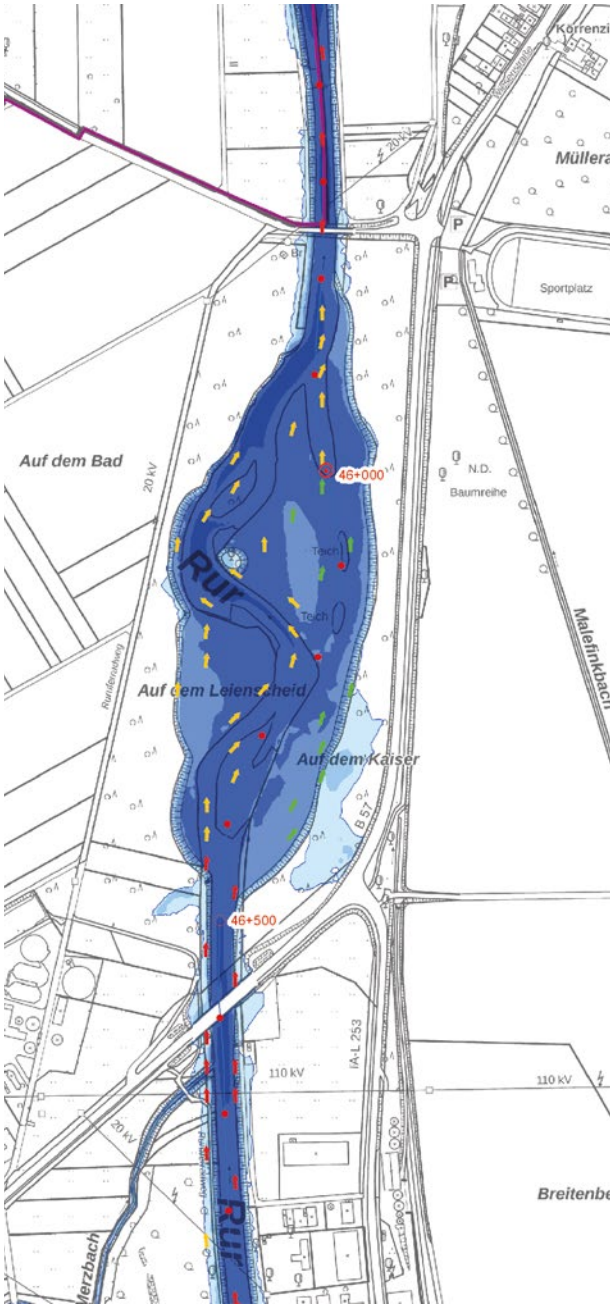
The Rur is so heavily engineered in the lowlands that even major floods (100-year recurrence interval) can be discharged in its agriculturally used surroundings with no flooding and the “floodplain” of the Rur is limited to its engineered profile.

Beavers are superb river engineers and have been creating diverse structures in the young alluvial willow forests on the redesigned Rur floodplain.

The lower-lying channels on the newly created secondary floodplain are inundated for about 120 days a year, while the higher floodplain areas are covered with water for about 60 days a year.

As a consequence of the progressive development of dense alluvial willow forests, a stable beaver population has emerged, ensuring diverse natural structures are created among the otherwise uniform softwood stands.

The common redshank is rare inland today, but was once a common breeding bird on wet meadows.



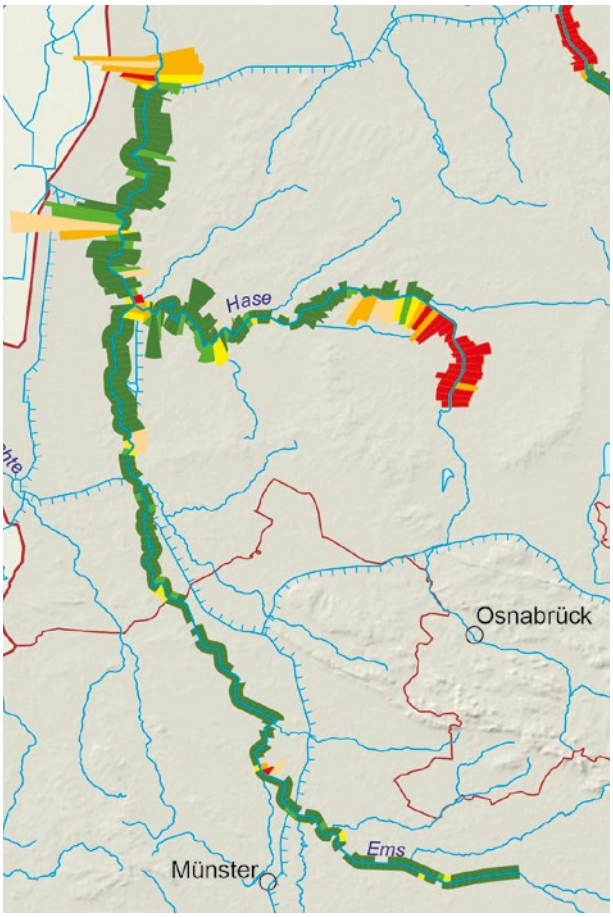
The lower-lying secondary floodplain of the restored Rur is frequently inundated at an early stage when water levels are high. Even very high volumes of water do not overflow the riverbanks above and below the area where the project is located. Blue-shading: the river channel and floodplain areas inundated when floods occur – excerpt from the Rur Flood Risk Map, medium probability scenario (Cologne District Authority)

4.2.3 The Ems

It is still possible for three-quarters of the floodplains on the Ems to be inundated when major flood events take place. Nevertheless, large parts of its active floodplains are cut off by summer dikes from the frequent inundations that are particularly important from an ecological point of view. In addition, the inundation regime of the floodplains, large areas of which naturally tend to be inundated frequently, has been severely disrupted by the high hydraulic efficiency of the Ems, with its very considerably deepened riverbed. This is one important reason why – despite the comparatively small losses to its inundation areas – the status of the Ems's floodplains is significantly or severely modified (floodplain status categories 3 and 4).

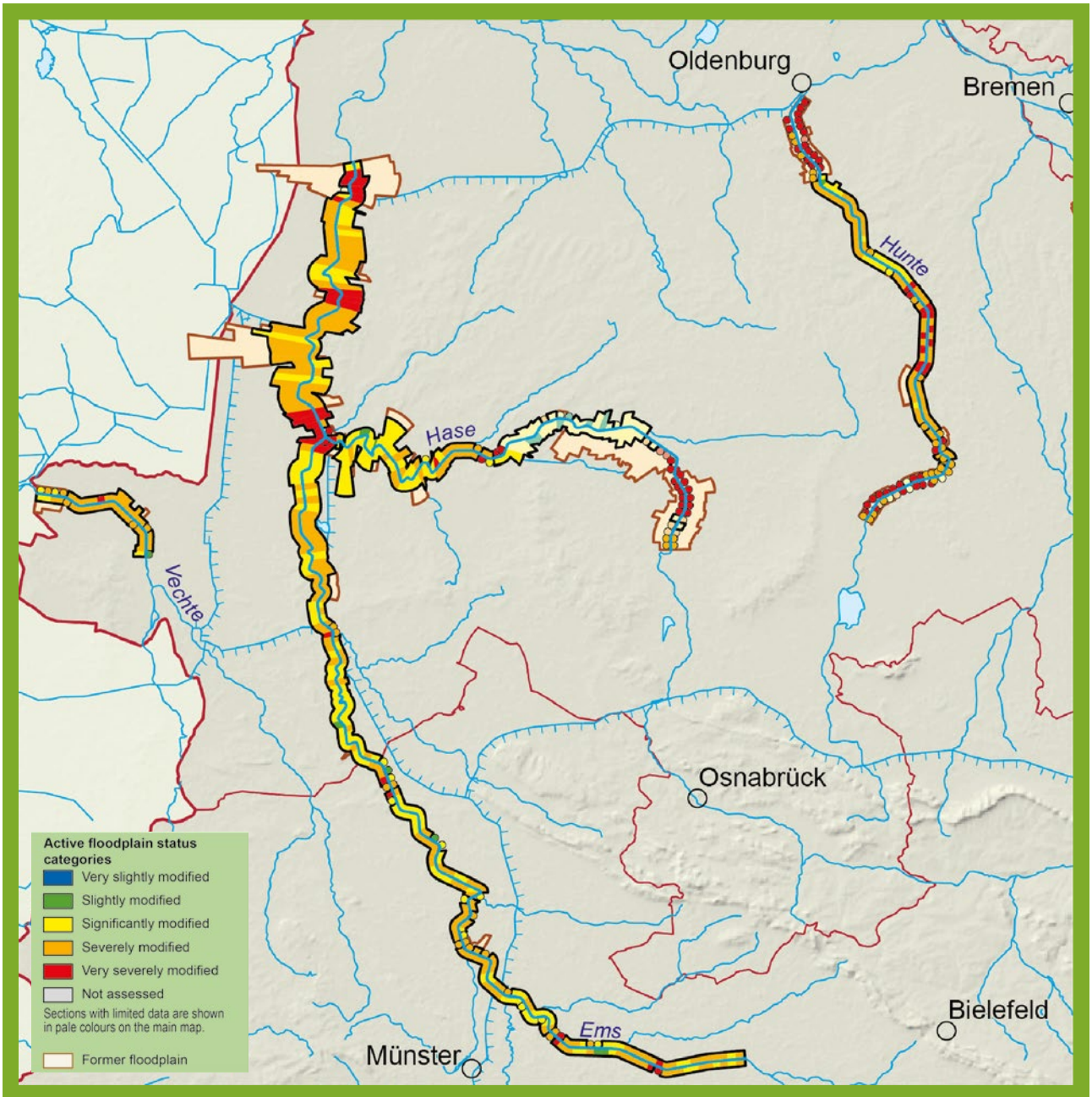
Unlike on its lower reaches, the losses of inundation areas are very far-reaching (more than 90%) on the middle reaches of the Hase, an eastern tributary of the Ems. The flood protection dikes there are almost directly adjacent to the watercourse, so that there are hardly any noteworthy active floodplains, and the few areas that are inundated for ecologically relevant periods are located completely within the engineered profile of the river. In contrast, large parts of the active floodplains on the lower reaches of the Hase have been preserved, although their status has been massively impaired by the major engineering carried out on its main channel.

Despite their comparatively extensive active floodplain areas, the status of 82% of the segments along the Ems and Hase that have been assessed is significantly or severely modified (floodplain status categories 3 and 4). This is essentially attributable to the combination of intensive agricultural use with significant engineering measures and highly efficient, reinforced, standard profiles. The proportion of active floodplains taken up by arable land is about 50%, while the proportion occupied by grassland – most of which is used intensively – is just under 30%. There are few slightly modified floodplain sections on the middle reaches of the Ems.

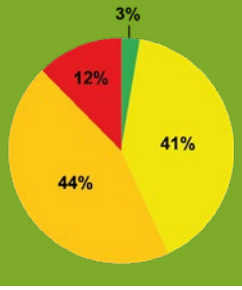


Loss of inundation areas on the Ems and Hase

The straightened Hase is lined by dikes that run close to the river; the extensive, dike-enclosed floodplain is used intensively for agriculture.

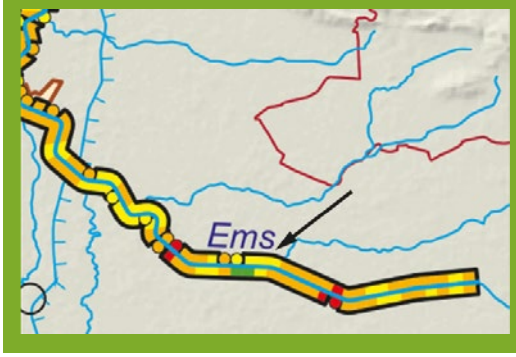


Status of floodplains on the Ems and Hase



Distribution of flood-plain status categories

The Ems and Hase



The Ems in the vicinity of the restoration project at Einen (white lines: floodplain delineation with 1-km floodplain sections)

Inset map: status of floodplains around the project area (bottom left). After the measures were implemented, natural changes to the course of the river were seen at the project site on the Ems at Einen (bottom right).

The areas mentioned above correspond to the 2% of the sections across the whole Ems catchment assessed in category 2. Small patches of forest and stands of woody plants are frequently found in these locations. To a large extent, however, their assessment can be explained by the implementation of restoration measures, some of which became possible in turn because the river had lost its status as a federal waterway.

Restoration of the Ems at Einen

At the village of Einen in North Rhine-Westphalia, the availability of suitable land made it possible for the dynamics of the Ems to be enhanced by creating initial channels with a total length of 6.5 kilometres. As a result of the flood defence and waste water drainage requirements that continued to apply outside the actual area of the measure, it was not possible to raise the very heavily deepened bed of the Ems to such an extent that the original morphological floodplain could be reactivated. Instead, starting from the existing position of the riverbed, steps were taken that allowed secondary floodplain habitats to develop. To begin with, lower and therefore more frequently inundated floodplain areas were created for this purpose by removing surface soil. The river and flood-

New shoal structures have developed on the secondary floodplains of the Ems following the subsidence of a flood.

Work being carried out to restore the Ems at the Dorbaum Military Training Area

plain were then allowed to develop naturally.

The strong lateral dynamics of the sandy lowland river led to the rapid development of characteristic, near-natural shoal and riverbed structures, which were absorbed into the dense alluvial willow forests as they developed further.

Any impacts on agricultural land outside the project area as a result of more frequent inundations were limited by low, gently sloping embankments. This encouraged greater acceptance for the project among land users.

Apart from the far-reaching redesign of project areas, maintenance activities are also well suited as ways of creating conditions for the development of watercourses and floodplains – as long as enough land is available. Comprehensive measures to enhance the river's dynamics outside the project area described above – here at the Dorbaum Military Training Area – are making crucial contributions to the progressive improvement of the hydromorphological conditions on the Ems floodplains.

Rippled sand on the restored bank of the Ems

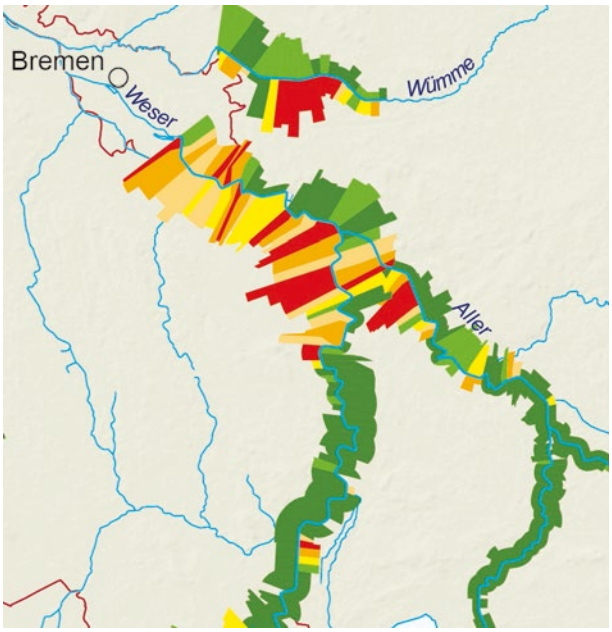
4.2.4 The Weser

The catchment of the Weser can be divided into an upland part fed by the Werra and Fulda, and a lowland part with the Aller and Leine as its main tributaries.

The inundation areas that have been lost varies along the length of the Weser. Greater losses of more than 50% have been recorded primarily above and below the confluence with the Aller, where the morphological floodplain is several kilometres wide. Far less of the river's inundation areas has been lost along the rest of its lowland sections and its course in the uplands. At the same time, inundations are restricted on some lowland sections, both by summer dikes and by the great deal of engineering that has been done on the river. Inundation areas have only been lost to a lesser extent on the Aller and the Leine.

The floodplains of the Diemel, Fulda, Eder and Werra are located completely in upland areas and exhibit the characteristic features of narrow valleys and broad valley expanses. In the wider valley sections, there are places where more than 50% of the inundation areas have been lost. Overall, however, floodplain sections with slight losses predominate. A reduction in the frequency and extent of inundations is mostly due to river engineering on upland rivers.

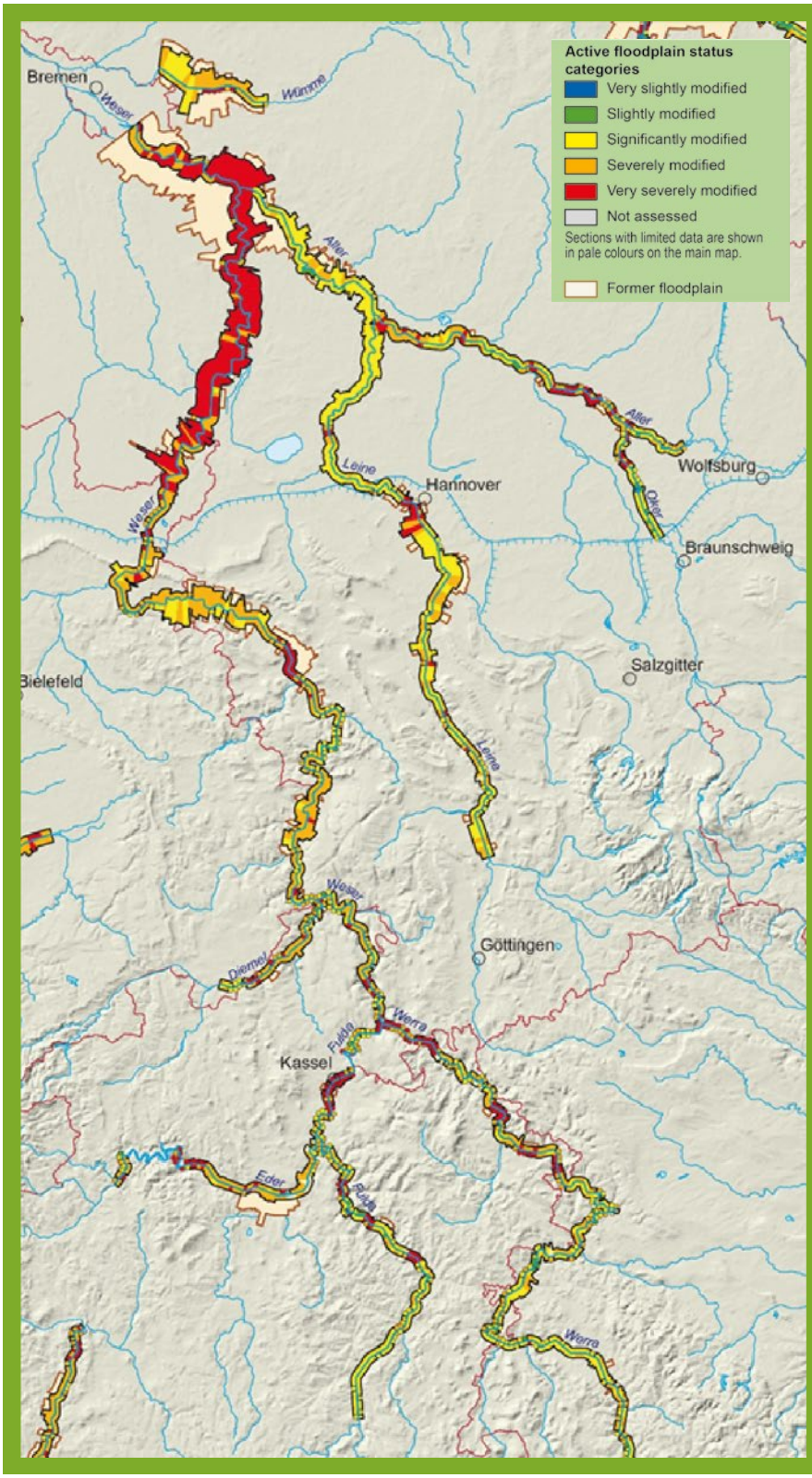
Due to the extensive engineering and intensive farming, the active floodplains along the sections of the Middle Weser north of Porta Westfalica that have been influenced by impounding are overwhelmingly assigned floodplain status category 5. Most of the floodplains on the river's free-flowing sections are severely modified (category 4). Extensive excavated waters are found on the floodplains there, while their agricultural use is characterised by crop farming in particular. Arable land dominates, with over 50% of the active floodplains being used for this purpose, so it can be assumed that inundations are rare occurrences.



Loss of inundation areas on the Weser, Aller and Wümme

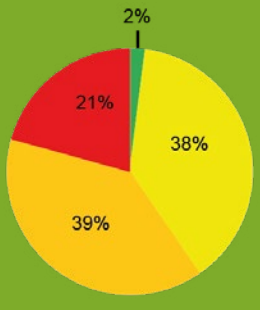
The floodplains of the engineered, impounded River Weser at Drakenburg are used intensively.

This is attributable to the summer dikes present in some places and the Weser's high hydraulic efficiency. Forests are only found in isolated patches on the active floodplains, taking up less than 1% of their area, and is therefore decidedly under-represented.



Distribution of floodplain status categories

The Weser and its tributaries



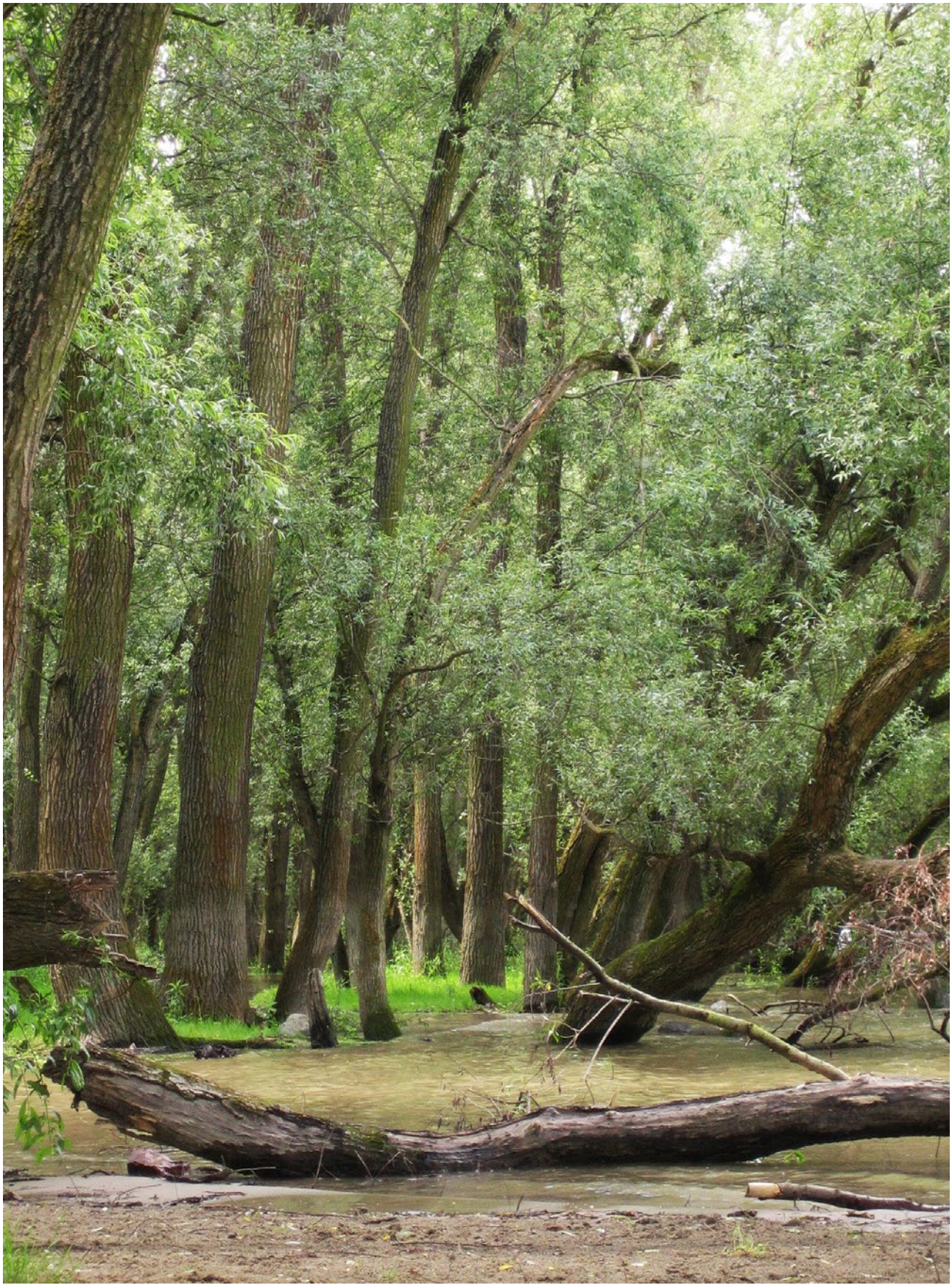
Status of floodplains on the Weser and its tributaries

The Fulda downstream from Rotenburg, where old flood channels have been reactivated and new ones laid out, also helping to improve flood prevention.

On the Middle Weser and, to a lesser extent, the Aller as well, impoundments have caused very far-reaching modifications to the specific characteristics of the floodplains. Impounding the rivers has either significantly or completely restricted the dynamics typical of floodplains, which has resulted in a far-reaching break-down of hydromorphological processes and the severe modification of groundwater conditions. The floodplains along the free-flowing sections of the Aller and Leine are significantly modified (floodplain status category 3) for the most part, and are overwhelmingly used as grassland. The large proportion of arable land, 42% of the active floodplains on the Leine, has been made possible by the high hydraulic efficiency of the river channel, and has resulted in some floodplain sections being very severely modified (category 5).

Near-natural river floodplains are home to a tremendous diversity of insects such as caddis flies, whose larvae live in water.

The middle reaches of the Werra and Fulda are overwhelmingly assigned to category 3, but the more intensively used floodplains of their partially impounded lower reaches are assessed in categories 4 and 5. Small areas of slightly modified floodplain (category 2) are found along the Werra and Fulda where the land is used extensively and where restoration measures have been carried out, downstream from Rotenburg for example. The floodplains – including the excavated waters that adjoin them – can undergo near-natural development at these locations.



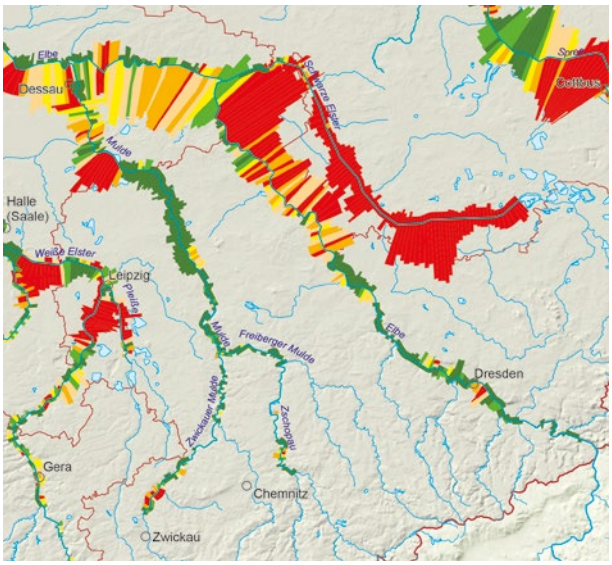
4.2.5 The Elbe

Large parts of the Elbe catchment are located on the North German Plain. Only its southern catchment extends far into upland areas, in particular along two of its tributaries, the Mulde and Saale.

The vast majority of the narrow floodplains on the Upper Elbe have suffered negligible losses to their inundation areas. The situation changes completely when the river flows onto the extensive lowland floodplains. The inundation areas lost all the way along the Middle Elbe range between 50% and more than 90%. Upstream from Magdeburg, many sections of the Elbe's several-kilometre-wide morphological floodplains have been reduced to narrow bands of active floodplain. Over the last few years, large expanses of floodplain have been reconnected to the inundation regime along the Middle Elbe. The three dike relocation projects at Lödderitz Forest (600 hectares), Lenzen (420 hectares) and Hohe Garbe (420 hectares) are among the largest of their kind in Germany.

The Black Elster, the Dosse, the middle reaches of the Unstrut and sections of the Pleisse and White Elster have lost more than 90% of their inundation areas. On some segments, the engineered profile of the river is only interrupted by a berm before it merges into the dike. Large proportions of the active floodplains along the Saale, Bode and lower Mulde can still be inundated – although mainly in narrow valley locations.

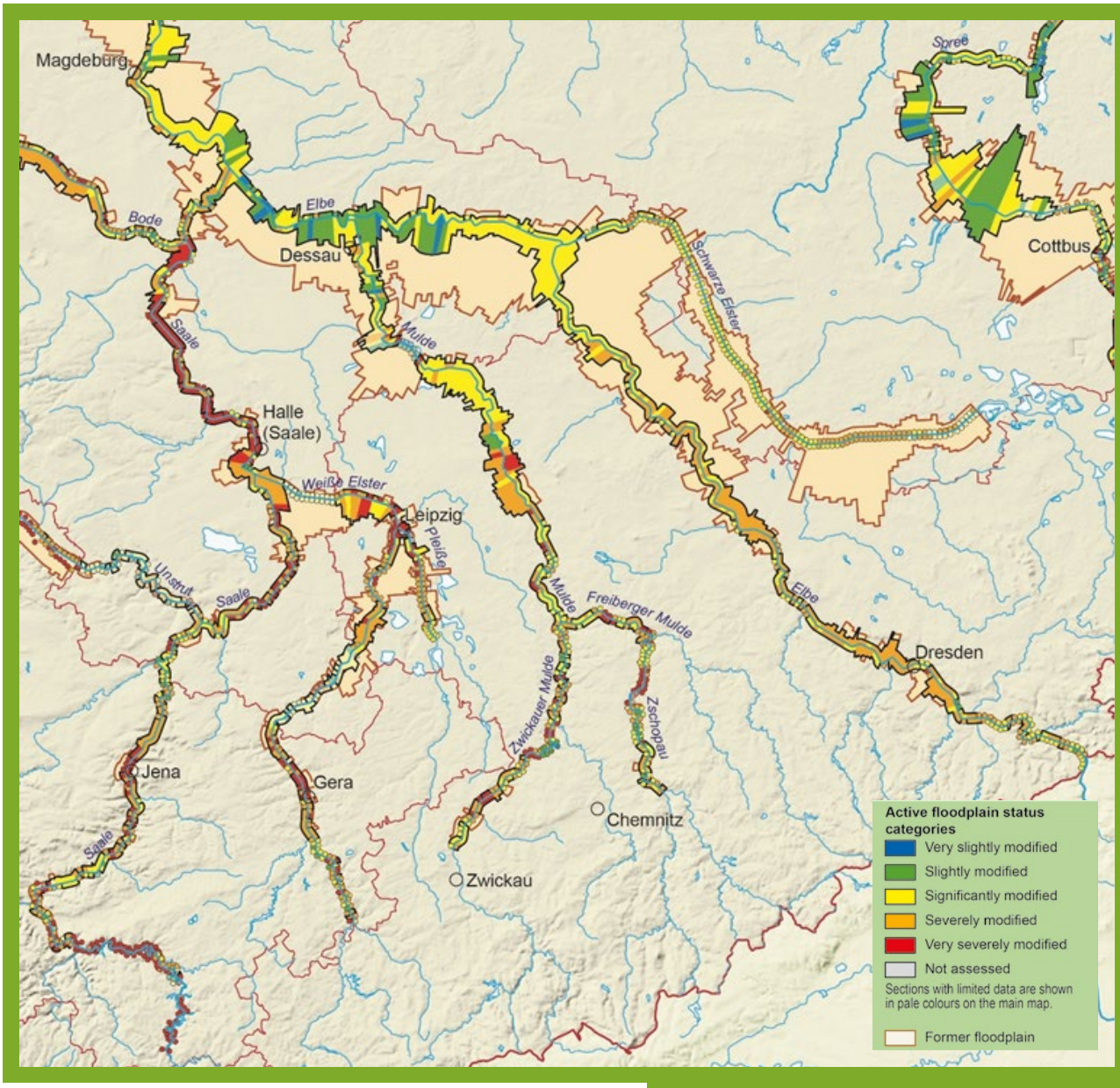
Where the Spree flows past the southern Lusatian opencast lignite mines, which significantly influence discharge conditions, more than 90% of its inundation areas have been lost due to the construction of flood defences close to the river. Floodplain areas that have not been isolated from inundations by dikes then predominate along its further course. On the Havel too, 50% or more of the floodplains have remained active on long sections of the river that feature numerous near-natural channel structures such as oxbow lakes.



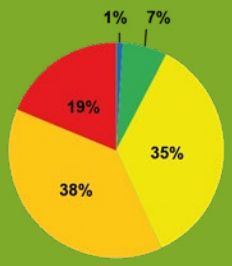
Loss of inundation areas on the Middle Elbe, Black Elster and Mulde

The dike foreland along the River Elbe is overwhelmingly used as grassland; the former, dike-enclosed floodplains are managed as arable land.

The Neue Luppe on the Elster-Luppe floodplains north of Leipzig is lined by dikes that run close to the river.



Status of floodplains on the Upper Elbe, Middle Elbe and their tributaries as far as Magdeburg



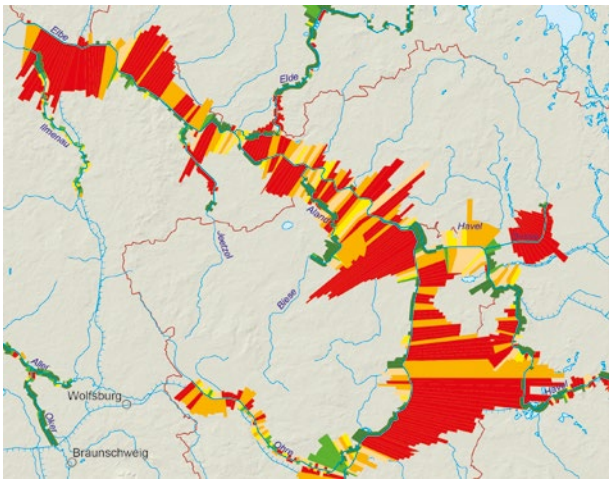
Distribution of flood-plain status categories

The Upper Elbe, Middle Elbe and their tributaries as far as Magdeburg

However, the losses amount to more than 65% across some segments on the particularly extensive floodplains of the Lower Havel. It is common for the former floodplains there to be managed as polders.

The status of the active Elbe floodplains is much less severely modified – especially in comparison to other federal waterways of a similar size – and can be represented with greater nuance now than in 2009 thanks to the more detailed basic data available. Along the Middle Elbe, especially, new data on habitats and updated data on water structure quality has led to improvements in the assessments for some sections. Particularly noteworthy here are the slightly modified sections (floodplain status category 2) with large, coherent riparian mixed forests on the Elbe between the mouths of the Mulde and Saale, as well as the wide-ranging, extensively farmed grassland communities on the dike foreland along the whole of the Middle Elbe. The occurrence of category 2 (slightly modified, 38%) on lengthy sections of the river and its very slightly modified sections (category 1) are great exceptions on rivers in Germany. Together with the lower reaches of the Mulde, Saale and Havel, the Middle Elbe is a significant axis in Germany's national biotope network – despite the large inundation areas that have been lost –, and is being enhanced yet further by large-scale restoration projects.

The floodplain status categories assigned along the sections of the Zschopau, Zwickauer Mulde, Freiberger Mulde, Pleisse, White Elster and Saale that run through upland landscapes tend to vary over very short distances. Categories 3 and 4 predominate. Very severe modifications (category 5) are usually attributable to reservoirs or settlements in the narrow upland valleys. Lengthy, slightly modified sections of floodplain (category 2) of the kind found on the lowland Mulde, Spree and Havel are rare across Germany and deserve special mention.

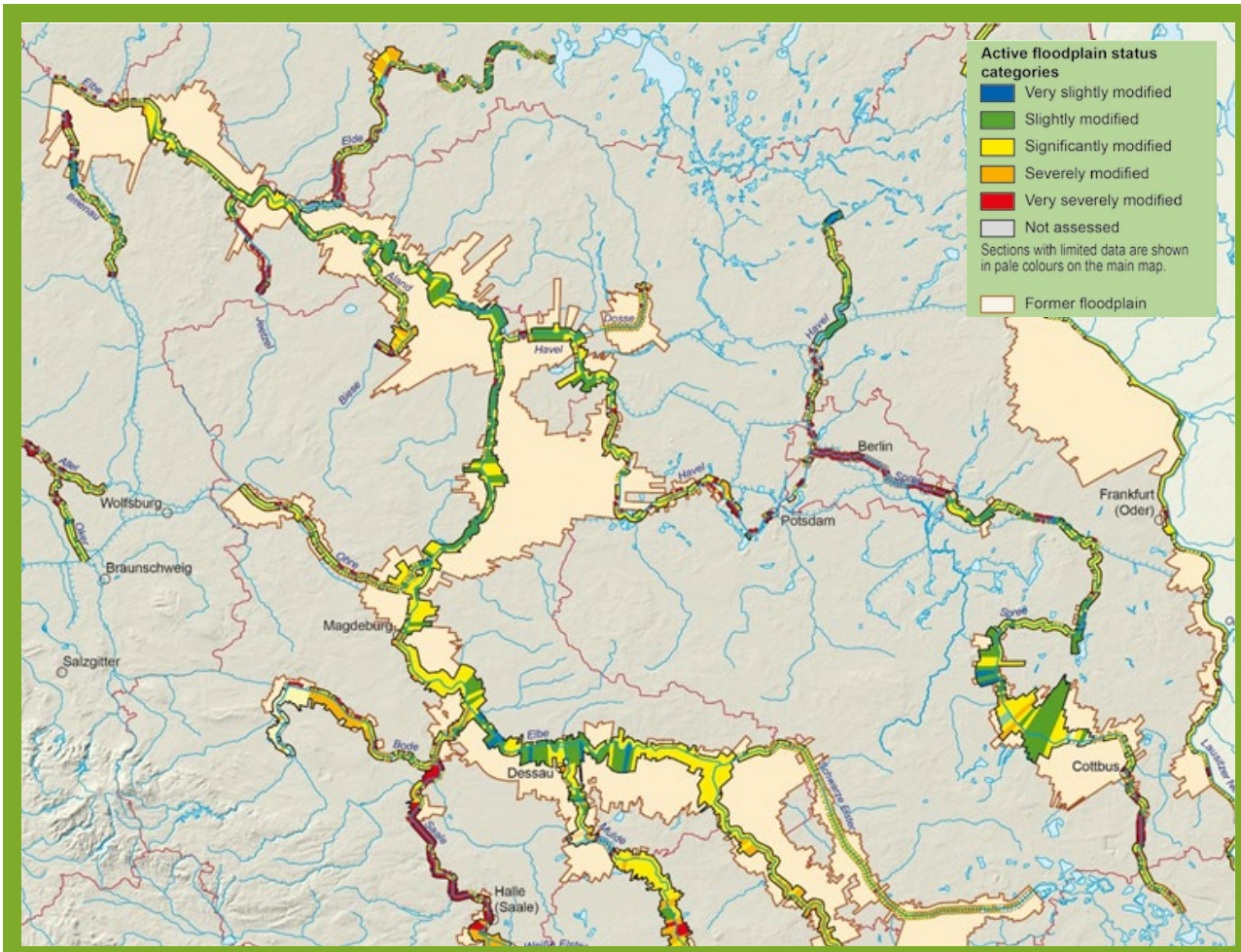


Loss of inundation areas on the lower Middle Elbe

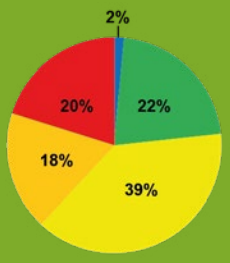
A floodplain on the Mulde with grassland and immediately adjoining arable fields protected by summer dikes

Conditions on the highly dynamic Mulde are very close to natural, although intensive arable farming – made possible in some places by low levees and summer dikes – takes up large parts of the active floodplains.

Numerous segments on the Ilmenau and upper Elde are also classified as slightly modified (category 2). Severely and very severely modified areas (category 4 and 5) dominate the lower Elde and the Jeetzel, where they are essentially attributable to significant engineering measures combined with impoundments.



Status of floodplains on the lower Middle Elbe and its tributaries



Distribution of floodplain status categories

The lower Middle Elbe and its tributaries

The Elbe in the vicinity of the dike relocation project at Lenzen (white lines: floodplain delineation with 1-km floodplain sections)

Inset map: status of floodplains around the project area (bottom left). Work being carried out as part of the dike relocation (bottom right).

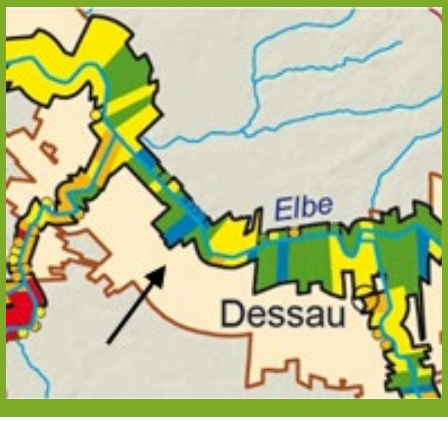
Three projects are described below as examples of measures implemented in the Elbe catchment: the relocation of a dike on the Elbe at Lenzen, the Lödderitz Forest dike relocation and the development of floodplains on the Lower Havel.

Dike relocation on the Elbe at Lenzen

With an area of 420 hectares, the dike relocation on the Elbe at Lenzen is one of the biggest floodplain restoration projects in Germany. The primary aim of the dike relocation carried out between 2005 and 2011 as part of a major nature conservation project was to restore a near-natural floodplain landscape that would be shaped by inundation dynamics and offer a diversity of habitats.

A mosaic of newly created flood channels, semi-enclosed pastureland and recently established alluvial forest has been created on the new dike foreland. Its area is expected to expand to about 300 hectares in future as a result of succession processes. The floodplain sections in the project area are almost entirely assessed with floodplain status category 2, and are therefore some of the least disrupted on the lower Middle Elbe.

The relocation of the dike brought about a clear lowering of the Elbe's flood peak by as much as 45 centimetres during the major flood events of 2011 and 2013, thus creating an important synergy effect between floodplain restoration and flood protection.

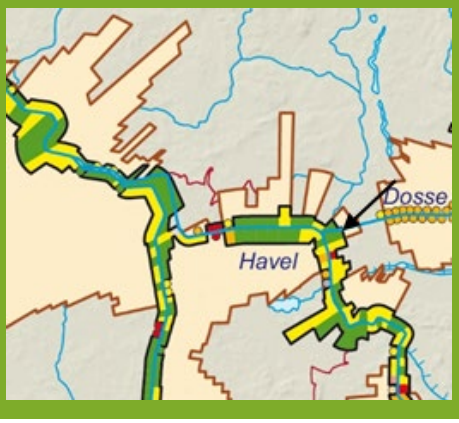


The old (white) and new (green) dike lines on the Elbe in the Lödderitz Forest. The relocation of the dike has made it possible for a large, coherent complex of alluvial forest to be inundated again.

Inset map: status of floodplains around the project area (bottom left). Apart from large expanses of alluvial forest, wetlands, grassland and standing waters are also found in the Lödderitz Forest (bottom right).

Dike relocation on the Elbe in the Lödderitz Forest

Reconnecting 600 hectares of floodplains to the Elbe's inundation regime, the dike relocation in the Lödderitz Forest is the biggest floodplain restoration project to have been implemented on the Middle Elbe. The project's primary aim was to reconnect extensive relicts of alluvial forest in order to create a densely wooded, near-natural inundated floodplain that would be as intact as possible and function as a habitat for floodplain-typical species of flora and fauna.



The Lower Havel in the vicinity of the restoration project at Havelberg (white lines: floodplain delineation with 1-km-floodplain sections)

Inset map: status of floodplains around the project area (bottom left). Waterlogged ground near reconnected side channels (bottom right)

Apart from the relocation of the dike, which formed the core of the project, flood channels and standing waters, some of them temporary, were reactivated in order to allow a floodplain-typical mosaic of small habitats to form.

Thanks to the very comprehensive measures that were carried out, the whole project area is assessed with floodplain status categories 1 and 2 – an extraordinarily good outcome for the active floodplains of a federal waterway. This is primarily explained by the large proportions of reactivated floodplain, combined with the extensive, well-structured woodlands of the Lödderitz Forest.

Restoration of the Lower Havel Lowlands

The restoration measures carried out on the Lower Havel have been very wide-ranging, both functionally and spatially, and consist of numerous interlocking packages of measures. They have been implemented since 2009 under the auspices of the Lower Havel Lowlands nature conservation project. Selected measures are described below.

Reactivation of the Alter Reimer

The aim of this package of measures was to reconnect the Alter Reimer – a system of former arms of the Havel – and three other oxbow lakes with the river. Thanks to the improved throughflow, natural dynamics have returned to the watercourses and floodplains of these previously disconnected side channel systems. In addition, the reinforcements were removed from about 6,800 metres of the Havel's banks, allowing near-natural bank structures with reeds to develop there again. The lowering of bank levees has now allowed the extensively used floodplain areas to be inundated earlier and for longer periods, thus improving their lateral connectivity.

Floods can still spread over wide areas of floodplain for long periods on the Lower Havel, as here in the Alter Reimer.

Breite Dunau

It also proved possible to clearly improve the links to the Havel and ensure better connectivity between water bodies and floodplains in the Breite Dunau – another system of channels that had become cut off from the river – by lowering bank levees and, above all, redesigning hydraulic bottlenecks

Furthermore, the establishment of new alluvial forests has created diverse, young habitats on the Havel floodplain landscape, which is otherwise dominated by open land and wetlands.

Water bodies and floodplains are linked together during floods.

Revitalisation of the Salzhavel meadows

The revitalisation of the Salzhavel meadows is intended to improve their quality as habitats for breeding waders and, thanks to their frequent inundation, is creating favourable site conditions for extensive flooded grassland communities, the size and distinctiveness of which have been declining rapidly.

The measures have resulted in a quantifiable enhancement of most of the floodplain segments, and therefore their classification in floodplain status category 2.

An oxbow lake was reconnected to the Havel in the Salzhavel meadows.

4.2.6 The Oder

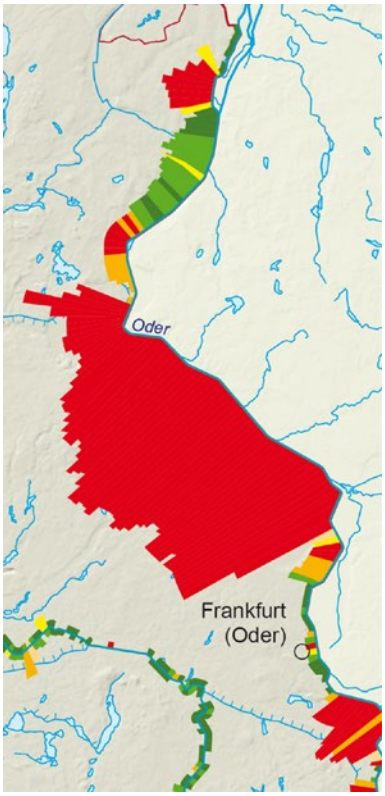
The floodplains of the Oder extend across both German and Polish territory and run along the border area from the upland, southern part of its catchment into the lowlands.

Large expanses of what were originally extensive inundation areas in the lowlands have been isolated from the influence of inundations by flood defences. This is true in particular of the Oder Marshes, which spread far to the west and where more than 90% of the inundation areas have been lost. Only around Schwedt has a large proportion of the active floodplain been preserved in the Lower Oder Valley National Park. These areas are predominantly farmed as extensive grassland.

A similar proportion of the inundation areas on the lower Lusatian Neisse has been lost as on the Oder, although the size of the area is much smaller. By contrast, it is still possible for inundations to cover large parts of the narrow morphological floodplains on the river's middle and upper reaches.

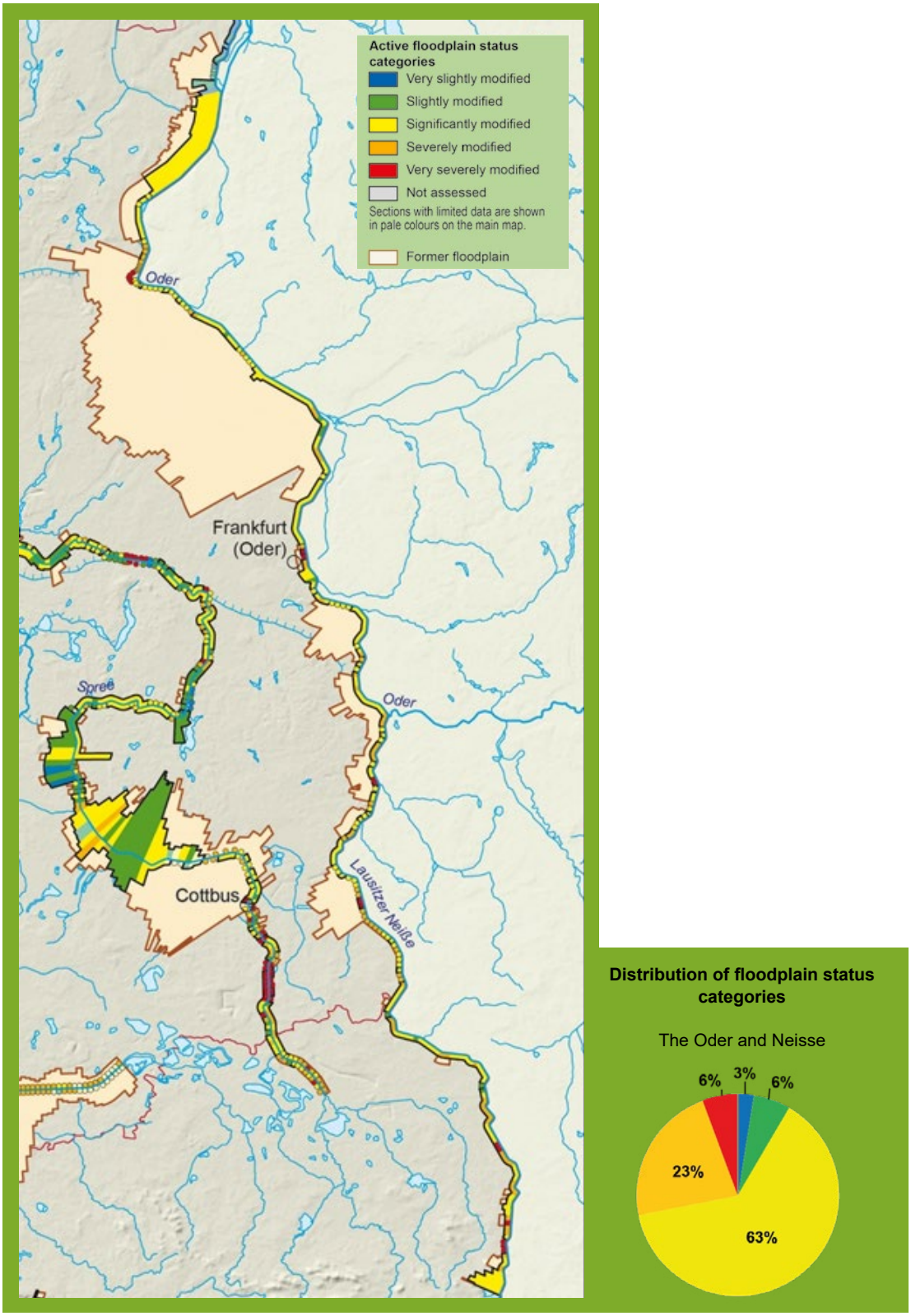
The status of large sections of the active Oder floodplains is significantly modified (floodplain status category 3) as a consequence of extensive engineering, which has heavily transformed the once sinuously meandering course of the river and its numerous side channels. This is compounded by the fact these areas are farmed relatively intensively, which influences the status of the floodplains. The former floodplain structures, watercourse channels and relict stands of woody plants that are still preserved in many places have a great deal of potential for development, especially in the wetlands protected by the National Park.

By contrast, the narrower active floodplains of the Lusatian Neisse are characterised by less severely disrupted hydromorphological conditions, especially on the sections located to the south with their narrow alluvial forest margins. The sections further to the north are dominated by land used for intensive farming, although many of their former floodplain structures and watercourse channels can still be identified.



Loss of inundation areas on the Oder

The Oder floodplains north of Schwedt with their many oxbow lakes



Status of floodplains on the Oder and Lusatian Neisse

By far the largest proportion of the German Oder and Neisse floodplains (63%) is assessed as significantly modified (floodplain status category 3).

Dike relocation on the Oder between Ratzdorf and Eisenhüttenstadt

During the 1997 floods it became apparent that the dike between Ratzdorf and Eisenhüttenstadt had suffered considerable damage and was not sufficiently stable. Apart from immediate repairs and work to reinforce the main dike line, studies were initiated on how to create additional inundation areas through dike relocations and polders. In order to improve the safety of the flood defences for the Neuzelle Lowlands, the main dike line has been rehabilitated since 2005 and sections of it moved further away from the river.

When the dike was relocated, approximately 40 hectares of retention area were gained, which also included a 33-hectare strip of riparian mixed forest, and have been connected to the Oder's inundation regime once again.

The active floodplain in the project area is primarily grassland interspersed with isolated trees and bushes, as well as groups of woody plants. This measure improved the hydrodynamic assessment parameters slightly where the dike was relocated, but was not enough to raise the site to a higher status category. This was hindered by the very large proportion of the floodplain that continued to be former, combined with the ways the land was being used and the lack of morphological structures on the narrow active floodplain.

The Lusatian Neisse with floodplains used as grassland and stands of woody plants on its German side

The Oder in the vicinity of the dike relocation project between Ratzdorf and Eisenhüttenstadt (white lines: floodplain delineation with 1-km floodplain sections); inset map: status of floodplains around the project area

The white-tailed eagle breeds on the Oder floodplains.

4.2.7 The Baltic Sea tributaries

The natural conditions on the Baltic Sea tributaries, the Warnow, Peene, Trebel, Tollense and Ucker, are unique in Germany. Reverse flows of water from the Baltic Sea create a drainage situation that causes difficulties for water management, as a result of which large parts of the floodplains – up to 60%, but in many places more than 90% – have been preserved as inundation areas. Only a few sections on the Peene, Trebel and Warnow have lost more than 50% of their floodplain.

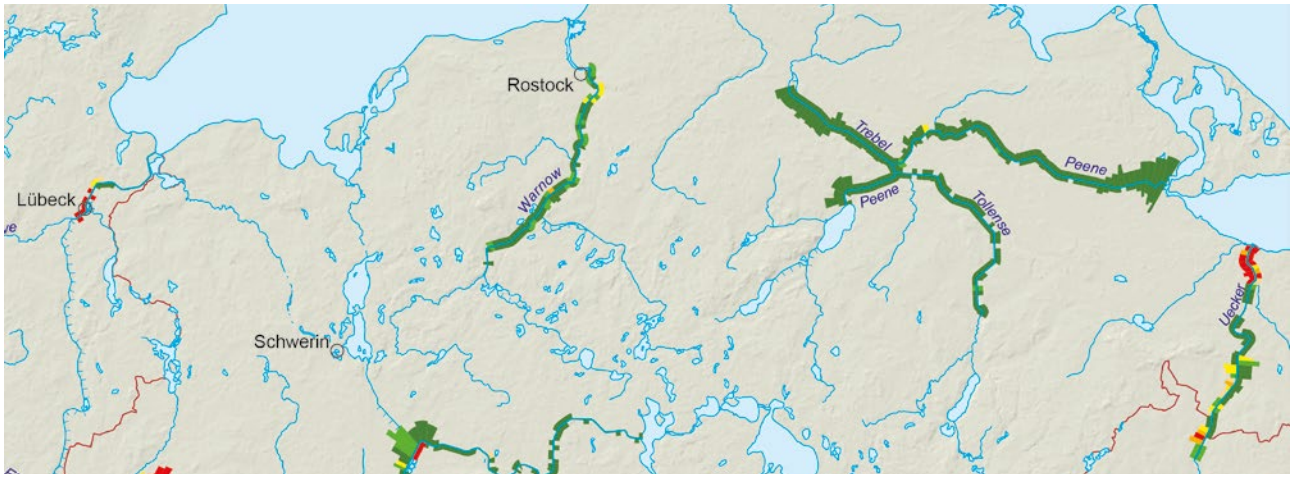
Thanks to the active peat formation processes taking place over wide areas in the valley bottoms and the comparatively low pressure from human uses, just under 30% of the active floodplains on the Baltic Sea tributaries are only slightly modified (floodplain status category 2), while 1% are even very slightly modified (category 1). More distinct modifications are found on the Tollense and parts of the Ucker and Warnow, where they are essentially consequences of the more wide-ranging river engineering that has been carried out and the more intensive use of these areas – mainly the larger proportion of the floodplains that is arable land. Where status categories have worsened here since the first floodplain status assessment, the reason is the availability of more detailed land use data, as well as new data on water body structures.

The large proportion of the Peene's morphological floodplains that consists of water bodies and wetlands (up to 30%), including both extensive reed banks and fluid transitions to historic peat pits with the characteristics of standing waters, is also unique in Germany. The tourist boat services operating on the lower reaches of the Peene and the resulting watercourse maintenance ensure there are relatively uniform structural conditions in the Peene itself.

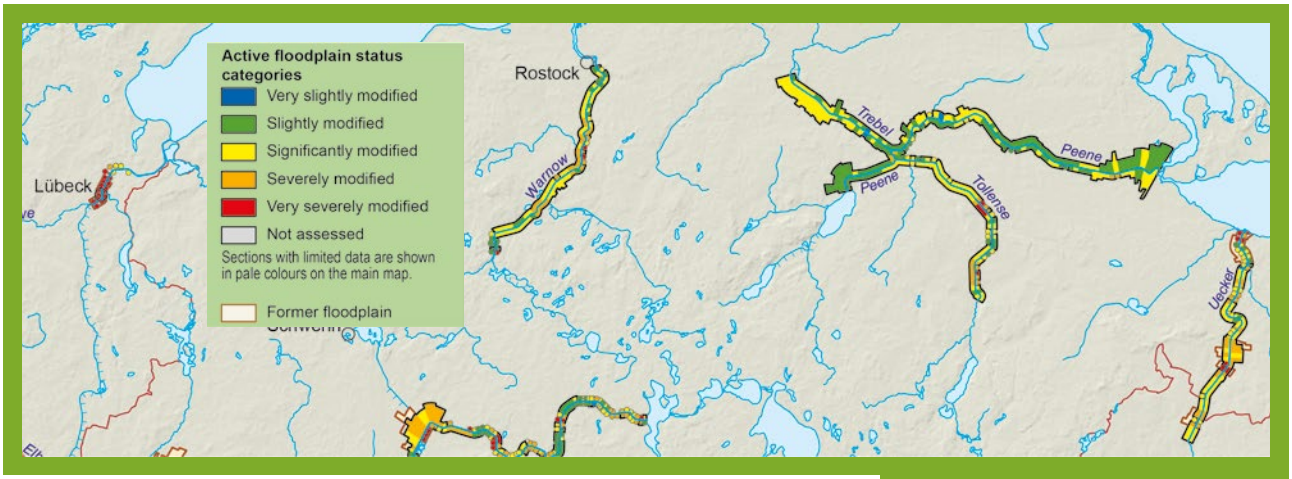
Restoration of the Peene Valley fluvial lowlands

Between 1992 and 2009 about 10,000 hectares of fens were hydrologically restored by the

Numerous water bodies and wetlands are located on the floodplains along the engineered River Peene.



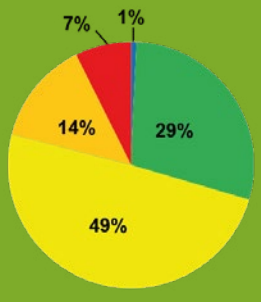
Loss of inundation areas on the Baltic Sea tributaries



Status of floodplains on the Baltic Sea tributaries

Distribution of floodplain status categories

The Baltic Sea tributaries



Peene Valley/Peene Haff Fen project. As a result, the hydrological regime of the Peene Valley fens has been returned to a very near-natural status almost everywhere today. Under the measures, pumping stations were dismantled, dikes lowered, and dams and weirs removed. More than half the land is currently unused or used extensively. This major nature conservation project has made it possible to stop the degradation of the fens and the breakdown of their peat stocks.

The diverse floodplain structures in the Peene Valley – a mosaic of shallow lakes, wet meadows, fens, oxbow lakes, silted ditches, extensive carr woodlands and reed beds – offer habitats for large numbers of animal and plant species. For instance, large populations of beaver and otter live in the area, as do numerous amphibian species such as the fire-bellied toad and the great crested newt. Apart from bitterns, spotted crakes and curlews, the white-tailed eagle, the osprey and the rare lesser spotted eagle breed there. About 750 ferns and flowering plants grow in the Peene Valley, including many rare species adapted to wet sites, such as the broad-leaved and narrow-leaved marsh orchids.

The extensive wet meadows and reed beds on the Peene have benefited from rewetting in the lowland areas the river runs through.

5 Outlook

The second comprehensive inventory of the size, use and status of active river floodplains presented in the 2021 Status Report on German Floodplains provides uniform and updated national data for the sustainable development of river floodplains in Germany. The findings are an important source of information for authorities, planners, nature conservation organisations and other stakeholders on issues related to floodplain protection, biotope networks and flood protection compatible with the natural environment. They are also incorporated into the Federal Green Infrastructure Concept.

The national overviews clearly show that the loss of inundation areas remains high and that the status of river floodplains is mainly severely to very severely modified. Floodplains continue to be subject to high pressure of use. The high degree of river engineering, drainage measures and the intensity of land use in floodplains are largely responsible for the critical status of floodplains, although there are significant regional differences. At present, there is no sign that the trend is reversing to improve the condition of floodplains nationwide. To bring about this reversal, the typical processes and naturally dynamic developments of near-natural river landscapes, such as sediment redistribution, waterlogging, and extensive and prolonged flooding would have to be reactivated in many places and uses would have to be thoroughly adapted. The establishment of characteristic species of flora and fauna depends on the continuous creation of new riparian zones, sand and gravel accretions and floodplain waters, as well as the permanent development of wet meadows and alluvial forests.

The current Status Report on German Floodplains, which presents several examples of measures, shows that extensive restoration often leads to a clearly measurable improvement in floodplain status at local or regional level and thus make an important contribution to biodiversity conservation and the establishment of a transboundary biotope network. These positive examples are based on long-term strategies and plans and adequate funding, as well as on mutual agreement on other uses such as shipping, agriculture and forestry, recreation and leisure. In addition to improving the status of floodplains, these integrative projects also promote the restoration of the water bodies themselves, thereby helping to achieve the objectives of the Water Framework Directive. By carrying out appropriate projects, Germany is also making an important contribution to the implementation of the EU Biodiversity Strategy, which envisions the restoration of at least 25,000 km of watercourses Europe-wide, including the restoration of floodplains, by 2030.

The conclusions of this Status Report on German Floodplains also show that the policy goal of giving more room to rivers is attainable. Since 2000, more and more dikes have been removed or relocated or gaps cut in them to reconnect formerly disconnected floodplain areas to the flooding patterns of rivers and to improve flood prevention. The National Flood Protection Programme of the German federal and state governments aims to leverage synergies between floodplain protection, watercourse status and adaptation to climate change when implementing flood protection measures that have a supraregional impact.

Due to the projected impacts of climate change with an expected rise in extreme events, the natural dynamics of floodplains must be understood and enhanced as part of the solution. Near-natural floodplains are adapted to changing water conditions and contribute to improving surface and groundwater quality through their natural filtering effect. In addition, river floodplains are used for recreation and leisure and are therefore highly valued by local residents. This general public's appreciation and support for near-natural development of river landscapes should be an incentive and justification for policymakers to invest in protecting watercourses and floodplains in the future.

The Federal Environment Ministry is already successfully supporting projects for floodplain development and flood protection compatible with the natural environment through various funding programmes. Since the launch of "chance.natur", a federal nature conservation funding programme, around 350 million euros have been made available for more than 30 projects related to water bodies and floodplains alone. With Germany's forward-looking Blue Belt programme, which is jointly supported by the Federal Transport Ministry and the Federal Environment Ministry, additional federal funds have been made available explicitly for the restoration of near-natural and attractive river landscapes in the floodplain funding programme since 2019. By the year 2050, a biotope network of national importance is to be developed along federal waterways and their floodplains that is compatible with shipping and promotes added regional value. Similar goals for the restoration of wetlands and river landscapes are also being pursued by the federal government's peatland protection strategy and various watercourse, floodplain and peatland protection programmes of the Länder.

Despite these strategies pursued by the federal government, the Länder and organisations and the successes achieved so far, there is still an enormous need for action to give room to rivers in Germany again and to turn river floodplains into biodiversity hotspots. In this context, it is important to harness the existing potential, which amounts to tens of thousands of hectares nationally solely for the reconnection of floodplain areas (Harms et al. 2018).

The Status Report on German Floodplains shows that efforts to protect floodplains pay off.

The goals of the National Strategy on Biological Diversity to safeguard the natural diversity of water bodies and floodplain habitats and to increase the retention areas by at least 10% can be achieved within a period of several decades if water body and floodplain restoration measures are systematically implemented. The successful implementation of this generational undertaking requires the active support of the various stakeholders from the federal government, the Länder, the municipalities and organisations, as well as cooperation based on trust.

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