Electronic Supplementary Material for the manuscript with the title: **How flood hazard maps improve our understanding of active floodplains.**

Specifications of methodology:

1. Flood Hazard Maps

Since the geographic reference and data structures of the maps were very different, data needed to be homogenized before being merged. All data were transformed according to the INSPIRE-compliant ETRS89 Lambert Azimuthal Equal Area Coordinate Reference System (ETRS-LAEA) (https://spatialreference.org/ref/epsg/etrs89-etrs-laea/) [1]. Rivers were then identified, selected and labelled. River name, federal state and flood frequency were stored in the attribute table. The final German flood map was then intersected with the NUTS dataset for federal state borders to affiliate FHM with the federal states in a reproducible way after having deleted the overlaps.

The intersection of the German T-frequent and T-medium datasets with Copernicus land use revealed a very good agreement. Only for T-medium, 6200ha were missing in the Copernicus dataset, which are considered negligible.

2. Preprocessing Copernicus land use in floodplains

This study follows the pre-defined nomenclature based on MAES typology (in this study, Levels 1 and 4 are used) and Corine Land Cover with a Minimum Mapping Unit of 0.5 ha and a Minimum Mapping Width of 10 m. Although a homogenization of legends has been published [2], a number of different legends still exist for the Basins analyzed in this study, namely the Rhine, Elbe, Danube, Odra, Ems, Weser, Meuse/Schelde and Baltic Sea Tributaries. Data needed to be homogenized, resulting in 109 different land uses found in floodplains in these river basins, in contrast to 58 reported by [2], because these authors did not consider the detailed information available on forest types in the MAES topology Level 4 (Table *S1*). For forest analysis, this level is important because it differentiates riparian forest from other forests. The land use dataset considering the most detailed land use classification scheme developed by [3] was intersected with the broad German FHM dataset (Figure 3).

To differentiate between area and static water volume (as a product of area and water depth) in the river and floodplain and compare their contributions for both FHM land use and water depth (Table *S2*), parameters were combined. This was necessary because the classification of Copernicus land use was not uniform for all basins.

Table S1 Final table with the applied legend for Copernicus land use within floodplains. This table is an extended version of the legend published by [2]. Additionally, this table summarizes 935 basin-specific land uses and aggregates where possible to 109 land uses, which is almost double the number reported by [2]. The reason for this can mainly be found in the detailed information on forest types, which is important for analyzing the status of floodplain forests and is the reason why this information was kept in this study instead of adding forests up into categories that differ between mixed, coniferous and broadleaved forests only.

Applied Level 4 Code	Applied Level 4 Description
1100	Continuous urban fabric (IM.D. <80%)
1111	Continuous urban fabric (IM.D ≥ 80%)
1112	Dense urban fabric (IM.D ≥ 30% - 80%)
1120	Industrial, commercial and military units
1113	Low-density urban fabric (IM.D < 30%)

1210	Road networks and associated land
1220	Railways and associated land
1230	Port areas and associated land
1240	Airports and associated land
1310	Mineral extraction, dump and construction sites
1320	Land without current use
1400	Green urban, sports and leisure facilities
2110	Arable irrigated and non-irrigated land
2120	Greenhouses
2210	UA - permanent crops
2210	Vineyards, fruit trees and berry plantations
2220	Olive groves
2310	Annual crops associated with permanent crops
2320	Complex cultivation patterns
2330	Land principally occupied by agriculture with significant areas of natural vegetation
2340	Agro-forestry
3000	UA - forest
3110	Natural & semi-natural broadleaved forest
3112	Broadleaved swamp forest (T.C.D. > 80%)
3113	Other natural and semi-natural broadleaved forest (T.C.D. > 80%)
3114	Broadleaved evergreen forest (T.C.D. > 80%)
3120	Highly artificial broadleaved plantations
3122	Broadleaved swamp forest (T.C.D. > 50 - 80%)
3123	Other natural and semi-natural broadleaved forest (T.C.D. > 50 - 80%)
3124	Broadleaved evergreen forest (T.C.D. > 50 - 80%)
3125	Highly artificial broadleaved plantations (T.C.D. > 50 -80%)
3132	Broadleaved swamp forest (T.C.D. > 30 - 50%)
3133	Other natural and semi-natural broadleaved forest (T.C.D. > 30 - 50%)
3134	Broadleaved evergreen forest (T.C.D. > 30 - 50%)
3135	Highly artificial broadleaved plantations (T.C.D. > 30 - 50)
3142	Broadleaved swamp forest (T.C.D. >=10-30%)
3143	Other natural and semi-natural broadleaved forest (T.C.D. >=10-30%)
3144	Broadleaved evergreen forest (T.C.D. >=30-50%)
3145	Highly artificial broadleaved plantations (T.C.D. >=10 - 30%)
3210	Natural & semi-natural coniferous forest
3212	Coniferous swamp forest (T.C.D. > 80%
3213	Other natural and semi-natural coniferous forest (T.C.D. >80%)
3214	Highly artificial coniferous plantations (T.C.D. > 80%)
3220	Highly artificial coniferous plantations
3222	Coniferous swamp forest (T.C.D. > 50 - 80%)
3223	Other natural and semi-natural coniferous forest (T.C.D. >80%)
3224	Highly artificial coniferous plantations (T.C.D. > 50 -80%)
3232	Coniferous swamp forest (T.C.D. > 30 - 50%)
3233	Other natural and semi-natural coniferous forest (T.C.D.-50%)
3234	Highly artificial coniferous plantations (T.C.D. > 30 -50%)
3242	Coniferous swamp forest (T.C.D. >= 10 - 30%)

3242	Coniferous swamp forest (T.C.D. >=10 - 30%)
3243	Other natural and semi-natural coniferous forest (T.C.D. 10-30%)
3244	Highly artificial coniferous plantations (T.C.D. >= 10 -30%)
3310	Natural & semi-natural mixed forest
3312	Mixed swamp forest (T.C.D. > 80%)
3313	Other natural and semi-natural mixed forest (T.C.D. >80%)
3314	Highly artificial mixed plantations
3322	Mixed swamp forest (T.C.D. > 50 - 80%)
3323	Other natural and semi-natural mixed forest (T.C.D. >50-80%)
3324	Highly artificial mixed plantations (T.C.D. > 50 -80%)
3332	Mixed swamp forest (T.C.D. > 30 - 50%)
3333	Other natural and semi-natural mixed forest (T.C.D. >30-50%)
3334	Highly artificial mixed plantations (T.C.D. > 30 -50%)
3320	Highly artificial mixed plantations
3342	Mixed swamp forest (T.C.D. > 10 - 30%)
3343	Other natural and semi-natural mixed forest (T.C.D. >10-30%)
3344	Highly artificial mixed plantations (T.C.D. >10 -30%)
3410	Transitional woodland and scrub
3420	Lines of trees and scrub
3500	Damaged forest
4000	UA - grassland
4100	Managed grassland
4210	Semi-natural grassland
4220	Alpine and sub-alpine natural grassland
5110	Heathland and moorland
5120	Other scrub land
5200	Sclerophyllous vegetation
6100	Sparsely vegetated areas
6210	Beaches and dunes
6220	River banks
6310	Bare rocks and rock debris
6320	Burnt areas (except burnt forest)
6330	Glaciers and perpetual snow
7000	UA - wetland
7100	Inland marshes
7112	Inland freshwater marshes with reeds
7210	Exploited peat bog
7220	Unexploited peat bog
8110	Coastal salt marshes
8120	Salines
8130	Intertidal flats
8220	Estuaries
9000	UA - rivers and lakes
9110	Interconnected water courses
9120	Highly modified natural water courses and canals
9130	Separated water bodies belonging to the river system
9210	Natural water bodies

9220	Artifical standing water bodies
9314	Intensively managed fish ponds
9240	Standing water bodies of extractive industrial sites
9311	Permanent natural water bodies
9312	Temporary natural water bodies
9313	Ponds and lakes with completely man-made structures
9314	Intensively managed fish ponds
9315	Standing water bodies of extractive industrial sites
9220	Artificial standing water bodies
9230	Intensively managed fish ponds
10000	Sea and ocean

Table S2 Transformation of water depth classes and applied average water depth to calculate static water volumes in inundated areas according to flood hazard maps for federal states in Germany

Water depth class	Average water depth [m]	Remark
0–0.5 m	0.25	All federal states except for Saxony
> 0.5–1 m	0.75	
> 1–2 m	1.5	
> 2–4 m	3	
> 4 m	4.5	
≤ 0.5	0.25	Saxony only
>0.5 to <2	1.25	
≥ 2	2.5	

3. Forest quality

The Bundeswaldinventur (BWI) 2012 is a comprehensive forest monitoring tool for investigating the status of forests in Germany. Standardized plots are therefore distributed all over Germany within a net of 16 km², which is condensed in several federal states to 4 km². Data are available as an access database (selected parameters are presented in Table *S3*), and the location of plots as a GIS shapefile. Data processing involved connecting data from the database and GIS to intersect the flood hazard map boundaries with the plots.

Table S3 Parameters from the forest inventory database investigated in this study

Forest inventory parameter (original name)	Floodplain relevance & indication
Restrictions in usage (Nutzungseinschränkung, Ursache Nutzungseinschränkung)	Restriction due to protection or terrain features (e.g. wetness)
Tree species (baeume, Baumart)	Occurrence of floodplain obligate species
Stocking (Bestockung)	Occurrence of floodplain obligate stocking
Habitats (Waldlebensraumtyp) according to Natura 2000	Occurrence of floodplain obligate habitats
Various evaluation criteria of Natura 2000 habitats	Quality of Natura 2000 forests

4. Hydrological catchments

More than 3000 German catchment boundaries (hydrological units) were applied in the nutrient emission model MONERIS from IGB [4] and requested for this project. Hydrological units can be combined via a flow net equation showing which catchment drains into the next. Since the original

flow net equation was developed for catchments by [4], a macro was developed in excel VBA to find all floodplains in their hydrological units belonging to the same gauge. 240 gauge units were defined, aggregating all hydrological units for which a certain discharge represented the frequent and medium flood discharge.

5. Gauging data

After collecting the selected discharges from official statistics from various sources (inquiries to Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV), offered by BfG or hydrological authorities of the federal states and lower levels or, if available, water-resource yearbooks - Gewässerkundliche Jahrbücher), the discharges were aggregated in the following way: long-term average discharges, very frequent small floods (T1 or T2, summarized as T1/T2 since in most cases only one of the two is available), T5-25 (T-frequent, aggregating T25 to T20 since in most cases only one of the two is available), T100 (T-medium). These 4 classes of discharges were compared with the current discharges of the last 20 years (2000-2019).

References

1. Burek, P., A. Bianchi, and A. Gentile, A Pan European Data Set for hydrological modelling - draft, in JRC technical reports, JRC, Editor. 2014.
2. Tamame, M., A. Lorenzo, and A. Lindmayer, Revision and maintenance of the Nomenclature Guideline, in Riparian Zones Nomenclature Guideline. 2018, European Environment Agency.
3. Maes, J., et al., Mapping and Assessment of Ecosystems and their Services - An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020., E. Union, Editor. 2013: Publications office of the European Union, Luxembourg.
4. Venohr, M., et al., Modelling of Nutrient Emissions in River Systems – MONERIS – Methods and Background. International Review of Hydrobiology, 2011. 96(5): p. 435-483. 10.1002/iroh.201111331.