APPENDIX 1: STUDY AREA DESCRIPTIONS

The study area in northern Finland (2.8 million ha) is located in the northern boreal vegetation zone and covers Kemijoki, Oulujoki, Iijoki, Kiiminkijoki, Simojoki, Siikajoki and smaller catchments or parts of them. The climate is subarctic with cool summers and without dry seasons (Beck et al. 2018). In addition to forests, the area is dominated by peatlands, being one of the peatland-richest regions in Finland and Europe. The peatlands are predominantly minerotrophic Aapa mires ('fens') (Ruuhijärvi 1983) and roughly half of them have been drained for forestry while there are also peat extraction areas and peatland areas under agricultural use.

The southern Finland study area covers 1.5 million ha in the southwestern part of the country in the southern and middle boreal vegetation zones and in similar climate zone as northern Finland study area (Beck et al. 2018). The area located in parts of the Kokemäenjoki, Karjaanjoki, Kiskonjoki and smaller catchments and is dominated by forests and agricultural areas. The wetlands in the area are predominantly ombrotrophic raised 'bogs' (Ruuhijärvi 1983), and most of them have been drained for forestry.

The selected study area in Estonia consists of the river Matsalu, Pärnu, Emajõgi and Võrtsjärve sub-catchments, covers 2.4 million ha and is located in the hemiboreal vegetation zone and temperate humid continental climate (Beck et al. 2018). The prevailing LULC types are forests, wetlands, grasslands, and coastal habitats, whereas dominating wetland types are raised bogs, coastal meadows, and marshes.

Study area in Latvia covers 2.5 million ha and it consists of three separated regions: the western part consisting mainly the Bārta and Saka river basins, the middle part covering the Lielupe river basin, and the eastern the Gauja river basin, respectively. These areas are located in the hemiboreal vegetation zone, have a temperate humid continental climate (Beck et al. 2018), and are dominated by agriculture, forestry and the occurrence of wetlands, predominantly raised bogs and fens. A significant part of the peatlands has been drained for peat extraction.

The 1.0-million-ha study area in Germany is located in the catchment area of the Peene river and has a temperate, humid, continental to oceanic climate (Beck et al. 2018). More than half of the area is used for agriculture. Wide-spread wetlands in the region are valley mires, which are a mixture of spring mires on the valley slopes, percolation mires on the valley floor and some flooded mires near the river itself (all 'fens'). Along the coast, peatlands and mineral wetlands are connected to the Baltic Sea, and in the hilly landscapes in the southern part of the catchment, they are found in kettle holes and along the numerous lakes. From 1960 to 1980, almost all peatlands were drained, while since 1990 substantial areas were rewetted, especially in these valley mires.

The study area in Belgium encompasses 3.1 million ha of the Northern Flemish region, characterised by a temperate oceanic climate (Beck et al. 2018). The area partially covers the catchments of the Yser, Scheldt, and Meuse rivers and is dominated by intensive agriculture and forestry, and built-up areas (Poelmans et al. 2022). In the 1950s, around 244,000 hectares (19% of Flanders) were still classified as wetlands. However, today, the remaining wetlands cover approximately 68,000 hectares, constituting only 5% of the region, and suffer from issues such as eutrophication, pollution, and disrupted hydrological regimes.

The study area in the Pyrenees encompasses 3.9 million ha and has temperate oceanic and mediterranean climate but also colder climate in the high-altitude areas (Beck et al. 2018). The dominant LULC types include agriculture and forest areas. The area includes fragmented high mountain peat bogs, which are predominantly smaller than 5 hectares and are located at the southern extremity of their distribution. These peatlands represent relict ecosystems, accumulating organic matter since the last glaciation while functioning as carbon sink and offer vital water resources and diverse habitats. Nowadays, these ecosystems are threatened by climate change and overgrazing.

Table A1. Description of the auxiliary datasets used for all sites.

Dataset	Citation	Spatial resolution	Description	Status
JRC Global Surface Water	Pekel et al. (2016)	30 m	Information on the extent and dynamics of surface water bodies worldwide. We used the occurrence layer depicting the frequency with which water was present from 1984 to 2021.	Open
Hansen Forest Cover	Hansen et al. (2013)	30 m	Global information on tree cover and change over time (Hansen et al. 2013). We used the tree cover and loss layers, depicting the tree presence and absence from 2000 onwards.	Open
ESA WorldCover	Zanaga et al. (2022)	10 m	A global land cover map for the year 2021, derived from Sentinel-1 and Sentinel-2 data. The layer includes the following land cover classes: tree cover, shrubland, grassland, cropland, built-up areas, bare or sparse vegetation, snow and ice, permanent water bodies, herbaceous wetlands, mangroves, and moss and lichen.	Open
Coastal mask	Buchhorn et al. (2020)	100 m	We generated a coastal mask using the Copernicus Land Cover layer at 100 meters (Buchhorn et al. 2020). The coastal mask delineates land cover within a 10 km proximity to the coastline.	Open
Canopy height model	Liu et al. (2023)	3 m	Canopy height model developed for Europe using PlanetScope imagery.	Open
Global Peatland Database	Greifswald Mire Center (2023)	NA	The location and extent of peat soils globally. It is based on collation of national peatland datasets.	Open
Digital Elevation Model	European Space Agency (2024)	30 m	Represents the elevation of the Earth including the canopy of the vegetation and infrastructures. The product is based on the radar data from TanDEM-X Mission. We derived the following layers: slope, topographic position index, and topographic wetness index	Open

Table A2. Auxiliary datasets used in the Northern and Southern Finnish study areas.

Data	Provider	Spatial resolution	Purpose	Status
Topographic Database	National Land Survey of Finland	1:10,000	To delineate peatlands that are pristine or have been drained for forestry	Open
Peat production areas with after use category	Finnish Environment Institute	1:10,000	To find present and former peat production areas and their current status	Open
Peatland drainage status	Finnish Environment Institute	25 m	To identify forestry-drained peatland area	Open
Superficial deposits	Geological Survey of Finland	1:200,000	To delineate areas with peat soil, particularly for differentiating agricultural areas with and without peat soil	Open
Land Parcel Register	Finnish Food Authority	1:5,000	To delineate agricultural areas and differentiate croplands from grasslands	Open
Restored peatland patches	Metsähallitus	1:10,000	To find restored forestry-drained peatlands	Restricte d

Table A3. Auxiliary datasets used in the Estonian study area.

Data	Provider	Spatial resolution	Purpose	Status
Tree species type	Lang et al. (2018)	10 m	To delineate areas with coniferous, deciduous and mixed forests	Open
Peat soil type	Kmoch et al. (2021)	1:10 000	To identify peat soil areas	Open
Grassland/agriculture occurrence	Estonian Land Board	1:10,000	To identify agricultural areas and grasslands	Open
Wetland type	Estonian Land Board	1:10,000	To detect if a peatland is fen or bog	Open
Drainage areas	Estonian Land Board	1:10,000	To identify drained areas	Open

Table A4. Auxiliary datasets used in the Latvian study area.

Data	Provider	Spatial resolution	Purpose	Status
Forest areas	State Forest Service	NA	To delineate areas with coniferous, deciduous, and mixed forests on drained and pristine soils with and without peat	Open
Vegetation type	Rural Support Service of Latvia	1:5,000	To filter agricultural blocks with grasslands and croplands on mineral soils and drained peat soils	Open
Soil type	Ministry of Agriculture	1:10,000	To delineate areas with peat soil inside agricultural lands	Open
Peatlands	LLC "Envirotech"	1:500,000	To detect if a peatland is fen or bog	Open

Table A5. Auxiliary datasets used in the German study area.

Data	Provider	Spatial resolution	Purpose	Status
Rewetted wetlands	Greifswald Mire Centre	1:25,000	To filter rewetted peatland areas	Open
Organic soils	Greifswald Mire Centre	1:50,000	To find organic soils (incl. peatlands)	Open
Forested peatland	State Forestry M-V	1:5000	To find forested peatlands	Restricted

Table A6. Auxiliary datasets used in the Belgian study area.

Data	Provider	Spatial resolution	Purpose	Status
Actual wetland areas	Research Institute for Nature and Forest (INBO)	20m	To delineate different wetland types	Open
WRB Soil units	Flemish government, Department of Environmental and Spatial Planning	1:40,000	To delineate drainage classes	Open

Table A7. Relative cover (%) of each LULC class in each study area and the producer's accuracy (PA; the probability that a specific class area on the ground is classified as such in the map) and user's accuracy (UA; the probability that a specific area in the map belongs to the respective class area on the ground) for each class in the classification with the highest overall accuracy. The accuracies are calculated using a spatial block cross-validation.

			Northern Finland			Southern Finland			Estonia			Latvia			Germany			Belgium			Pyrenees		
Soil type		**Class name**	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)	Area (%)	PA (%)	UA (%)
	Peat / undrained	fen	7.3	94.4	87.4	0.4	71.7	83.5	1.2	89.1	81.2	5.7	71.1	58.1	1.1	72.2	50.5	0.2	63.9	58.2	-	-	-
		bog	2.9	61.3	85.6	0.4	81.0	84.5	2.0	91.8	90.7	0.5	86.6	86.5	0.2	41.7*	83.3*	-	-	-	0.3	86.4*	86.4*
		treed bog	4.3	73.9	87.0	0.7	93.1	87.2	1.2	86.7	71.2	1.8	81.3	67.1	0.5	46.8	73.5	-	-	-	-	-	-
		deciduous swamp forest	1.3	38.7	68.5	1.8	75.9	53.9	1.4	84.3	90.8	1.7	44.8	30.8	2.5	85.3	46.4	0.4	60.1	63.2	-	-	-
		coniferous swamp forest	2.5	66.0	86.5	0.6	81.0	81.9	0.8	77.5	83.7	1.5	59.7	59.9	-	-	-	-	-	-	-	-	-
		mixed swamp forest	-	-	-	-	-	-	0.1	-	-	1.7	38.1	59.8	0.1	33.1	84.4	-	-	-	-	-	-
		coastal wetland: grassland	-	-	-	-	-	-	0.2	72.9	100.0	-	-	-	0.4	45.1	42.1	-	-	-	-	-	-
	Peat / drained	drained pine bog	18.7	81.4	76.0	1.5	81.5	71.0	0.9	96.9	92.4	1.1	70.3	45.5	-	-	-	-	-	-	-	-	-
		drained deciduous swamp forest	4.2	68.6	68.2	1.4	58.7	70.8	6.8	89.4	74.8	0.3	39.9	36.2	0.3	50.9	70.8	0.0	5.3	33.3	-	-	-
		drained coniferous swamp forest	3.0	86.9	82.3	1.3	65.4	80.2	6.5	79.0	79.3	0.0	18.2*	42.1*	-	-	-	-	-	-	-	-	-
		drained mixed swamp forest	-	-	-	-	-	-	0.0	-	-	1.5	72.0	61.0	0.1	20.0*	87.5*	-	-	-	-	-	-
		forest clear-cut	3.3	70.0	76.1	1.0	92.1	83.7	2.9	94.8	81.8	1.3	90.3	85.7	-	-	-	0.0	50.0*	83.3*	-	-	-
		agriculture: cropland	0.9	98.3	97.4	0.7	99.7	100.0	2.1	79.4	58.1	12.8	62.5	52.1	2.0	46.6	79.6	-	-	-	-	-	-
		agriculture: grassland	0.3	97.8	100.0	0.1	98.1	99.6	2.4	57.3	74.7	9.2	68.4	56.0	6.9	66.8	47.6	3.1	66.7	64.8	-	-	-
		peat extraction	0.6	100.0	97.6	0.1	98.4	99.2	0.6	92.6	91.7	0.5	95.6	93.4	0.0	85.7*	100*	-	-	-	-	-	-
		coastal wetland: grassland	-	-	-	-	-	-	0.0	42.9*	100*	-	-	-	1.5	41.1	59.2	-	-	-	-	-	-
Peat / restored		revegetated peat extraction site	0.3	99.0	100.0	0.1	88.5	100.0	0.9	41.7	80.0	0.3	72.6	85.3	0.7	78.6*	84.6*	-	-	-	-	-	-
		rewetted for nature development	0.2	99.6	95.0	0.1	100.0	96.3	0.1	67.5*	96.4*	0.1	63.2	76.0	0.8	46.8	73.3	-	-	-	-	-	-
	Mineral soil	coastal wetland: grassland	1.2	88.5	100.0	6.0	95.2	88.5	-	-	-	-	-	-	0.3	20.8	58.8	-	-	-	0.3	90.2	100.0
		coniferous forest	18.3	92.4	88.2	22.2	75.5	96.5	10.3	100.0	91.6	14.9	85.3	75.5	5.9	67.6	74.6	2.4	80.2	80.5	19.0	98.8	98.4
		deciduous forest	15.6	98.0	87.6	24.2	90.5	84.3	19.3	86.6	95.5	16.3	51.3	51.2	12.8	86.1	64.4	8.7	85.0	70.1	20.6	100.0	100.0
		forest clear-cut	7.0	79.6	93.5	6.6	98.7	86.7	6.3	93.6	89.1	6.2	93.1	81.8	-	-	-	-	-	-	-	-	-
		mediterranean shrubland-forest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.2	90.1	91.7
		agriculture: cropland	3.0	97.6	98.0	22.7	99.4	100.0	24.6	93.7	65.6	13.2	62.5	86.9	46.8	94.3	67.9	45.8	74.4	67.3	26.2	97.4	84.6
		agriculture: grassland	0.6	93.5	96.7	1.0	99.5	96.9	4.0	100.0	94.3	5.6	72.8	66.7	8.4	59.8	66.1	12.4	69.7	76.2	15.1	97.3	94.6
NA		water	3.9	95.3	100.0	5.7	97.3	99.0	4.5	95.6	90.8	1.8	100.0	97.1	5.2	87.9	95.0	3.7	62.5	84.6	1.6	99.6	100.0
NA		built-up non-vegetated surface	0.8	94.7	95.4	1.4	95.4	100.0	0.9	89.9	95.0	2.1	89.1	95.9	3.9	72.8	92.9	23.3	83.4	89.0	3.6	98.9	93.8

*calculated using traditional 10-fold cross-validation because all the samples of the classes were in the same spatial block

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