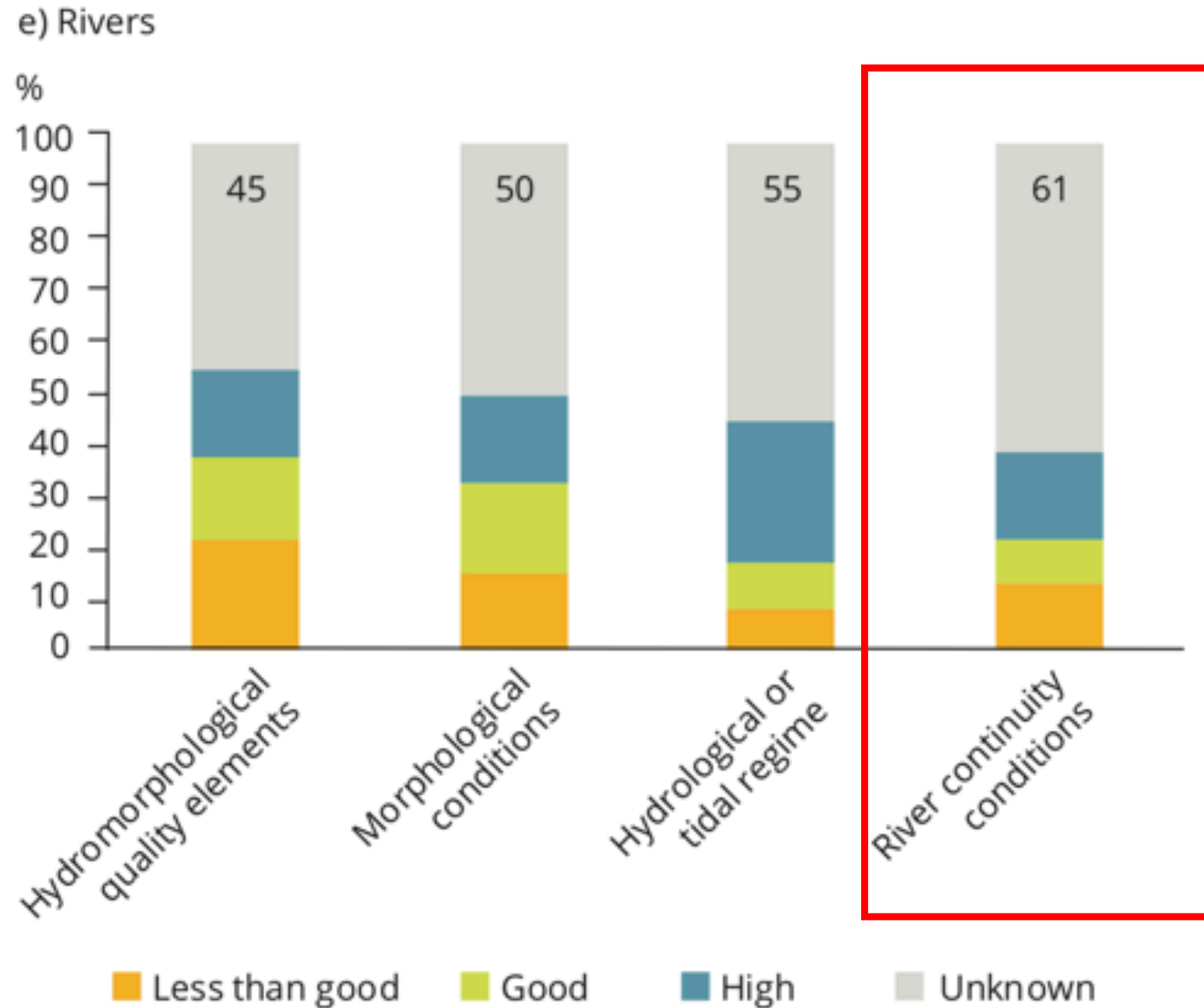


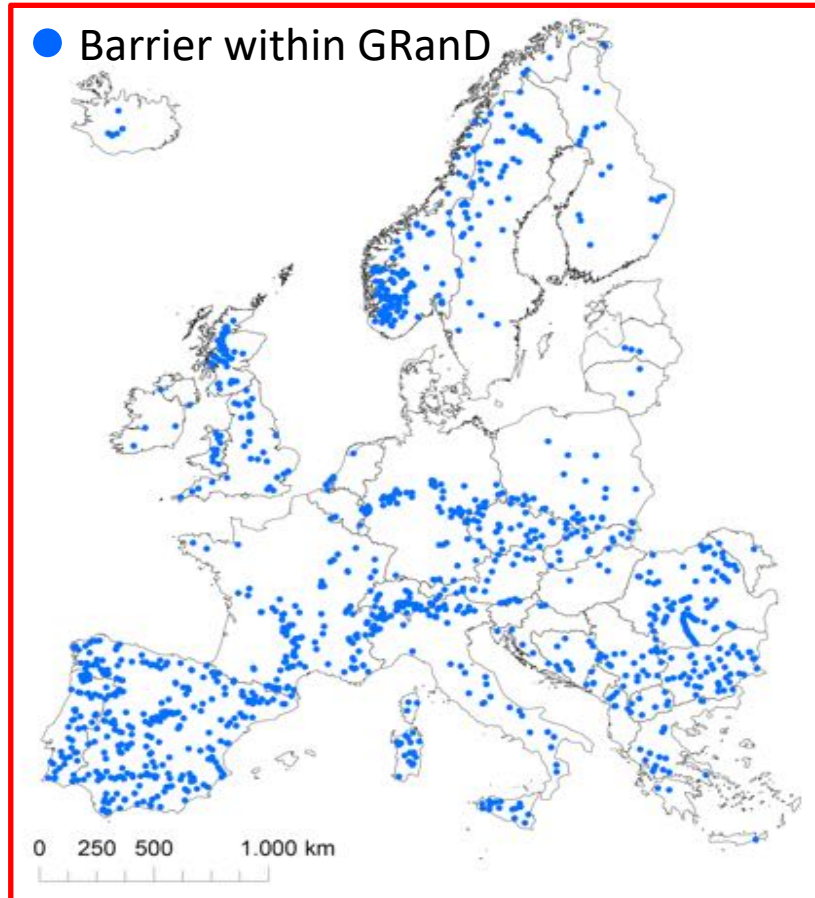
Large-scale data for adaptive barrier management: the AMBER Atlas



EU Water Framework Directive reporting: continuity conditions unknown in 61% of river ‘water bodies’

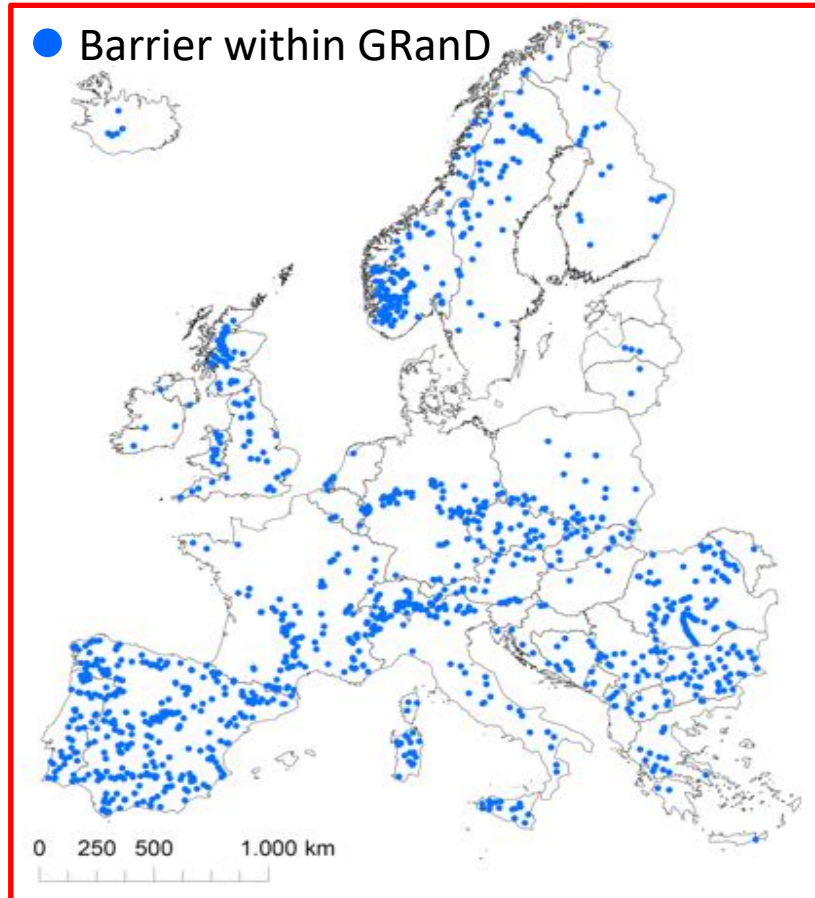


Extent of river fragmentation on EU rivers



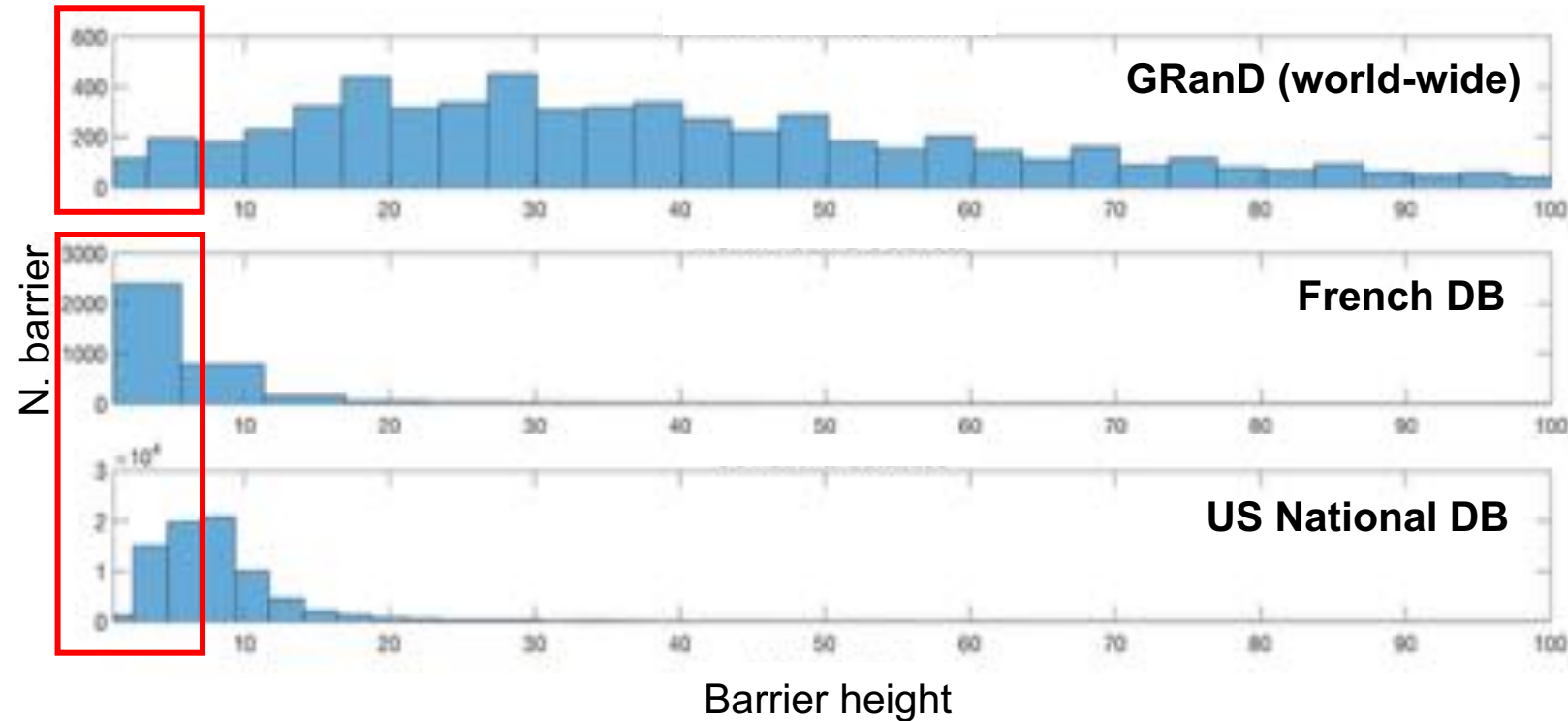
- GRanD Database: about **1200** in EU
- GRanD + ICOLDS: **4823** in EU

Extent of river fragmentation on EU rivers



WHERE ARE ALL THE SMALLER BARRIERS?

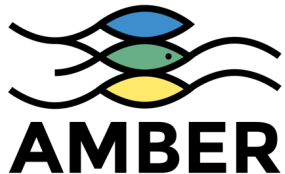
- GRanD Database: about **1200** in EU
- GRanD + ICOLDS: **4823** in EU



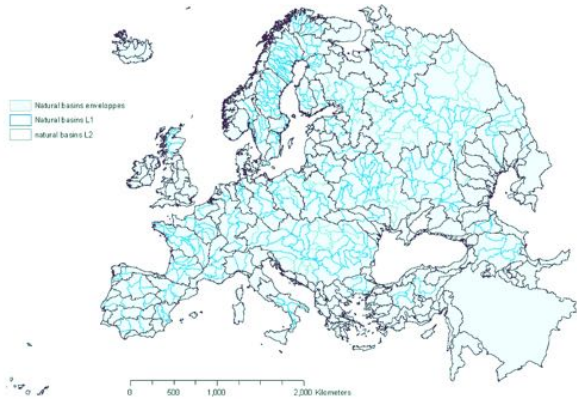
AMBER project: building a pan-European river barrier atlas



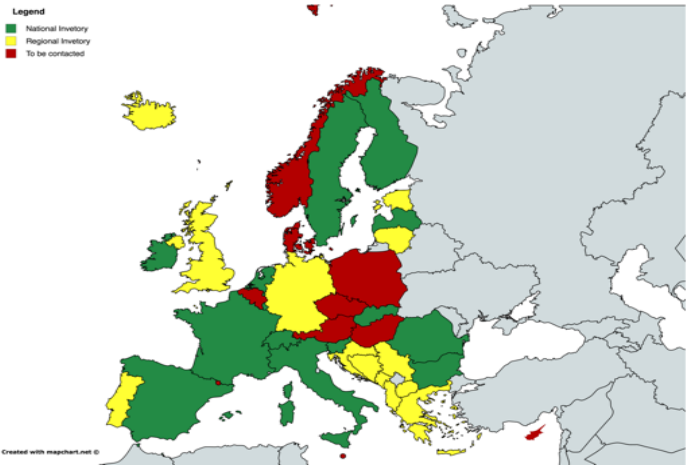
All barriers
matter



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 689682.



European barrier
ATLAS



All existing institutional
databases

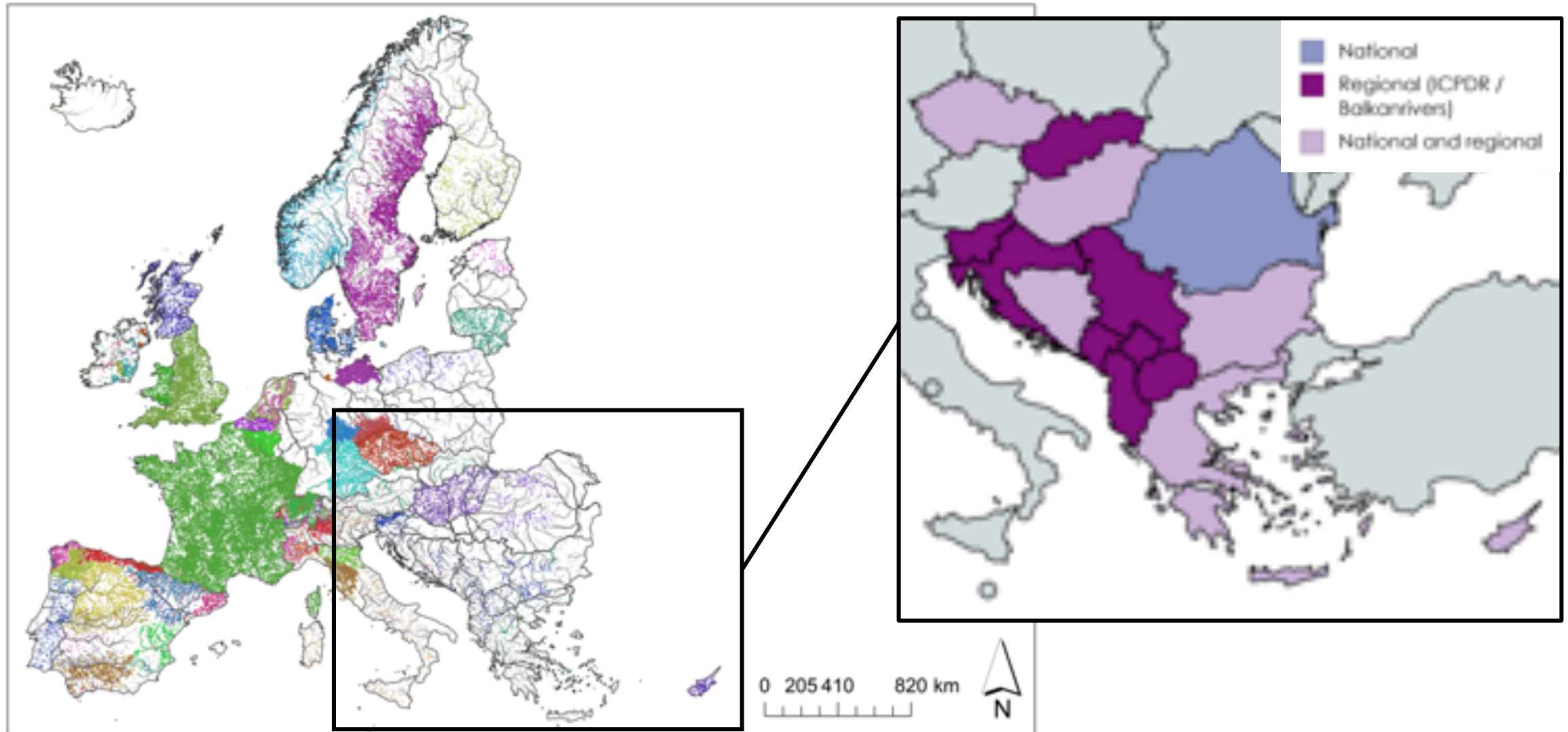
Barrier ID-card

ATLAS_ID	New ID defined within AMBER
Source_ID	ID of the source database
URL	Link to data source
Country	EU country
X_coord	Latitude (WGS84)
Y_coord	Longitude (WGS84)
River	Name of the river
Basin	Name of river basin
Height	Barrier height (m)
Type	Dam, weir, spillway, etc.
Year	Date of building (end)

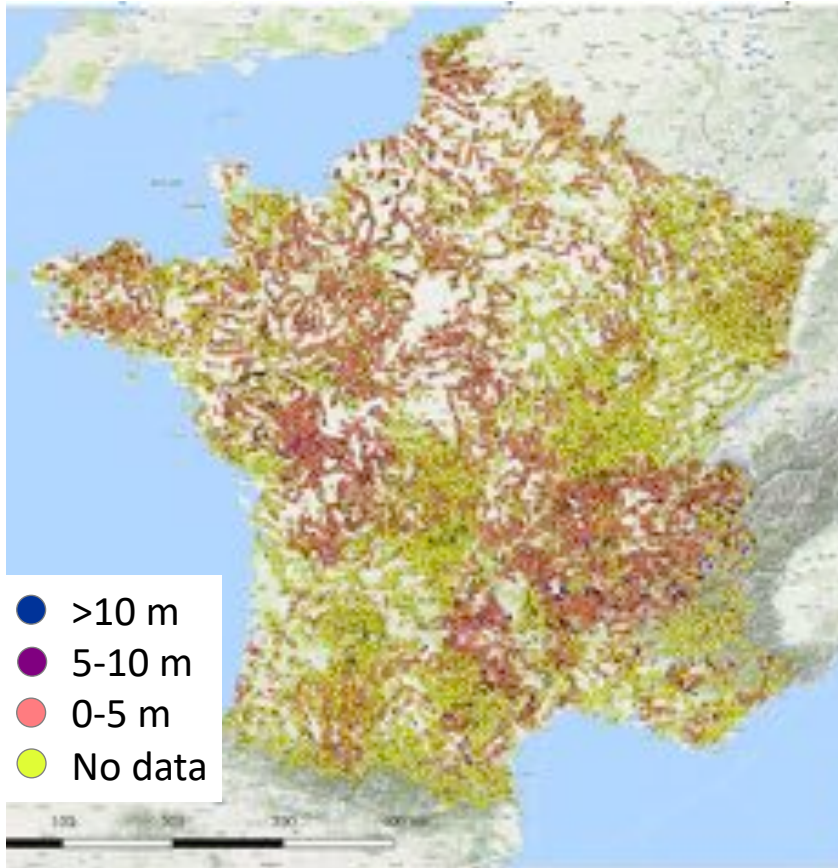
Compiling and merging **existing national or regional data sets**
>460.000 data points are included so far



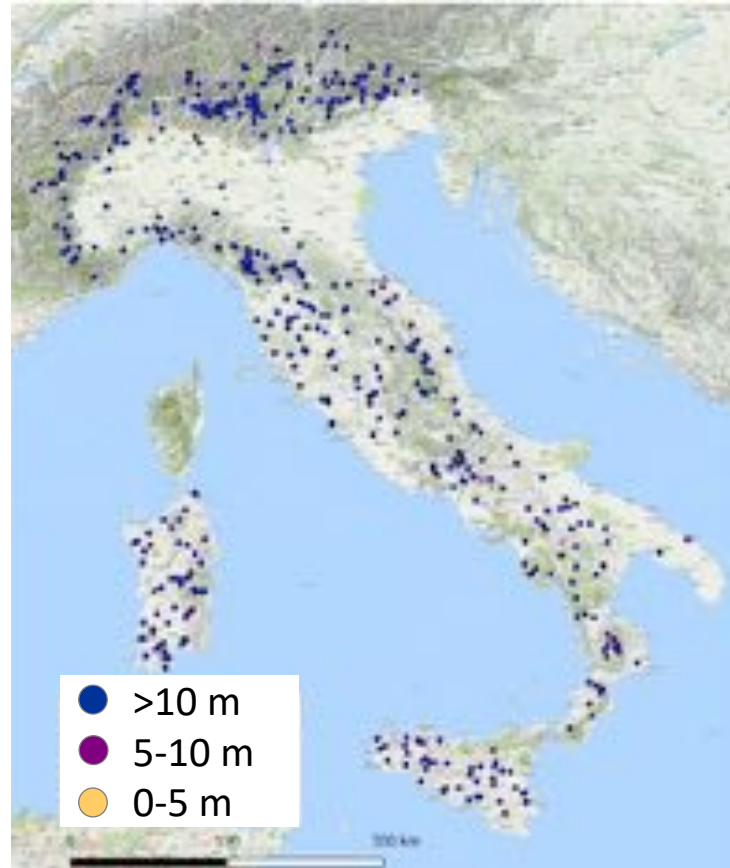
Existing data are inconsistent among countries and data quality is far from being satisfactory



Existing data are inconsistent among countries and data quality is far from being satisfactory



Very detailed and consistent database



Only main dams recorded at national scale

- barrier height data often lacking
- >290 different types of barriers
- No barrier age

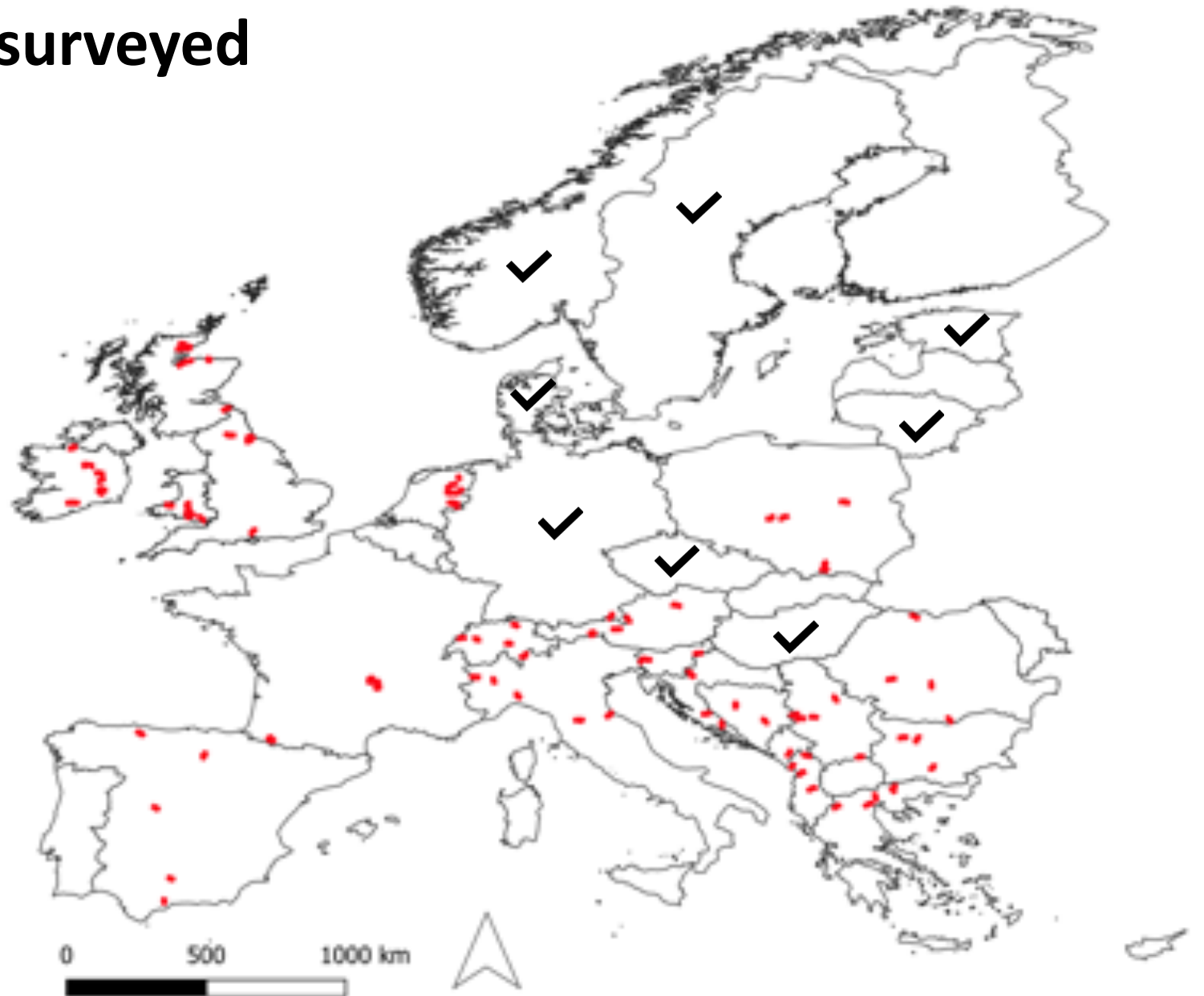
How to quantify the real fragmentation of EU rivers?

- Completing the picture and homogenizing datasets
- Ground truthing
- Building realistic models of barrier density and river fragmentation

Ground-truthing river barriers across Europe: >1650 km of river length surveyed

- Surveyed river stretches
- ✓ Ongoing field survey (summer 2019)

Surveyed so far:
18 countries
86 rivers



Ground Truthing: A field-based procedure to check the quality of ATLAS data

5 rivers x 20 km each = 100 km river network / country



Representative of a wide range of river types



Mountain, mid altitude, lowland



High vs. low slopes



Single-thread vs. multi-thread

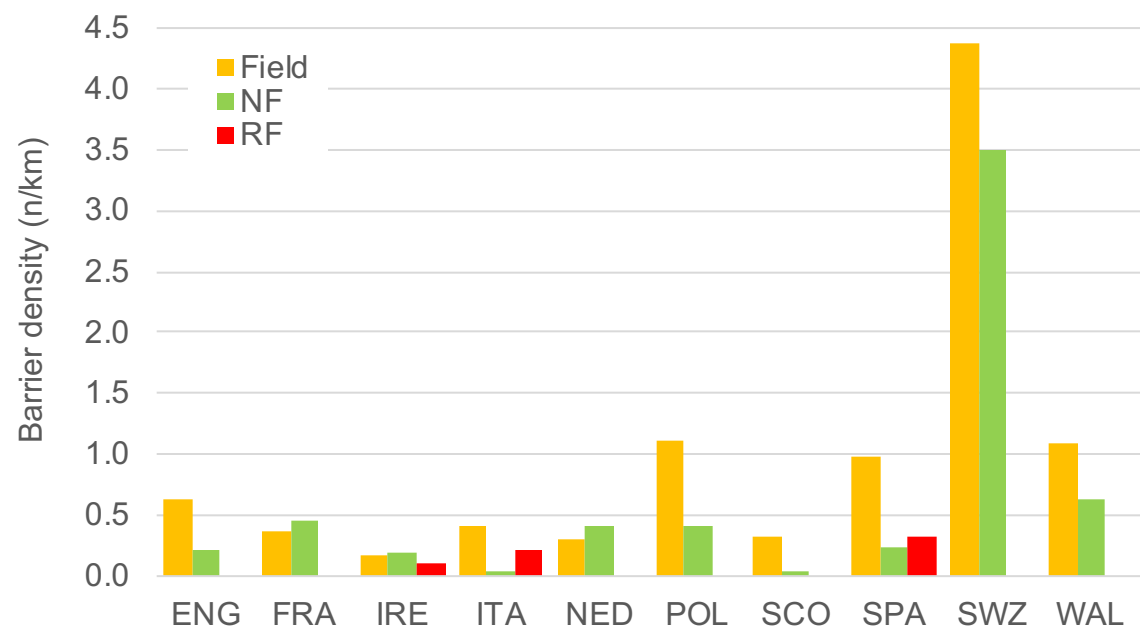


Walking along river banks and recording some features

Name	Description
Picture	A photo of the barrier – provide a reference for the picture
Location	Lat/Long coordinates for e.g. via GPS chipset on phone
Date	Date of record in format day/month/year
Barrier type	Dam, weir, culvert, ford, ramp and bed sill, sluice, unknown
Barrier height	<0.5 m, 0.5 - 1.0 m, 1.0 – 2.0 m, 2.0 – 5.0 m, 5.0 – 10.0 m, >10.0 m
Barrier use	Barrier still useful/in-use, Y/N/don't know
Barrier width	Full width, Y/N

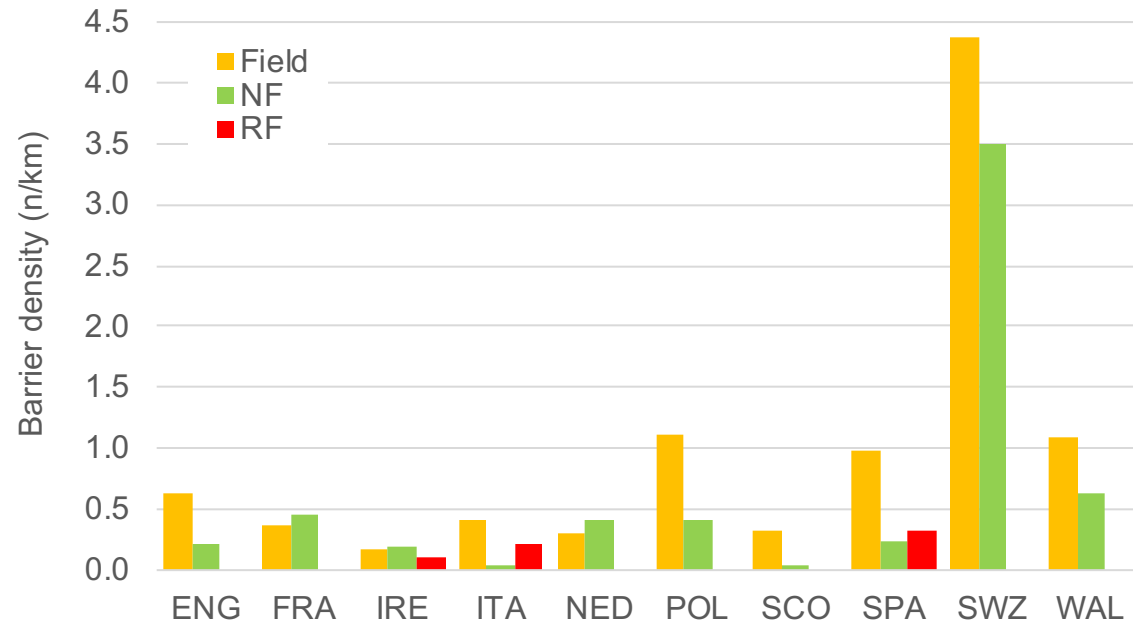


First results: almost one barrier every 1 km in EU rivers



10 countries, 58 rivers, 1098 km

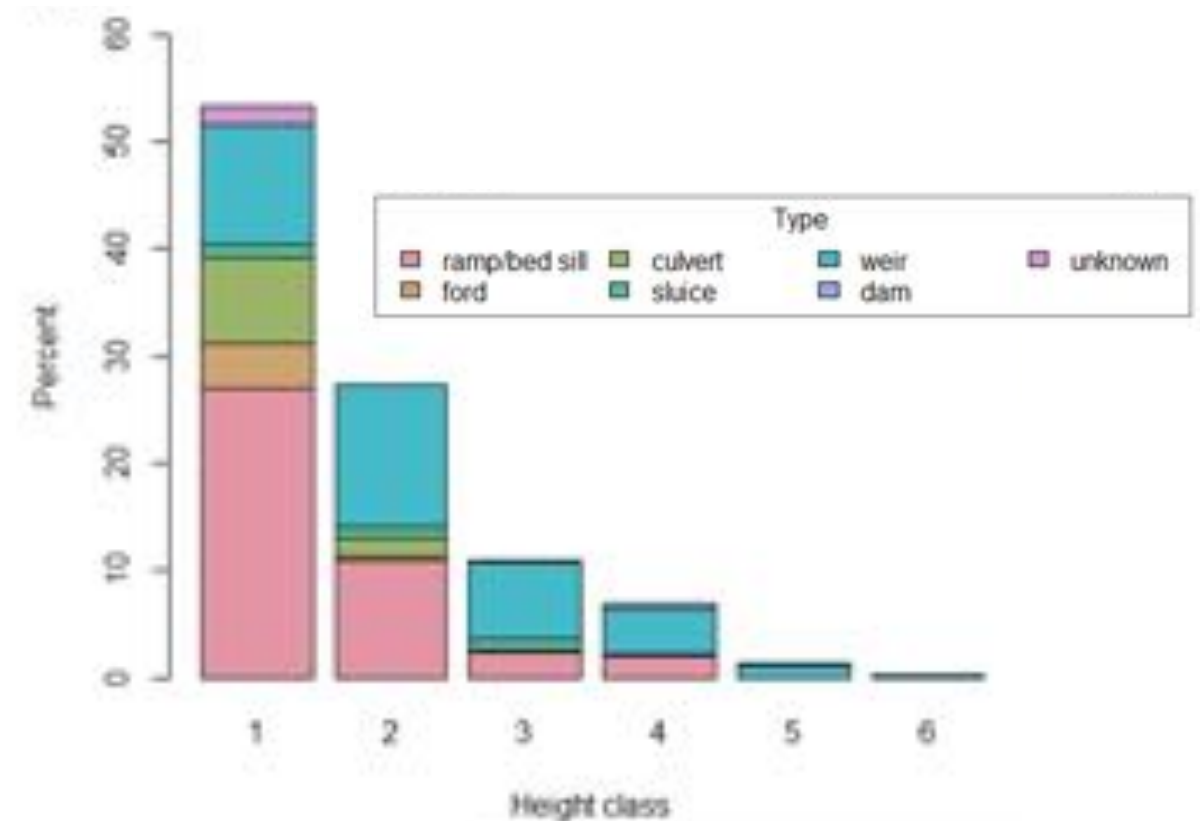
First results: almost one barrier every 1 km in EU rivers



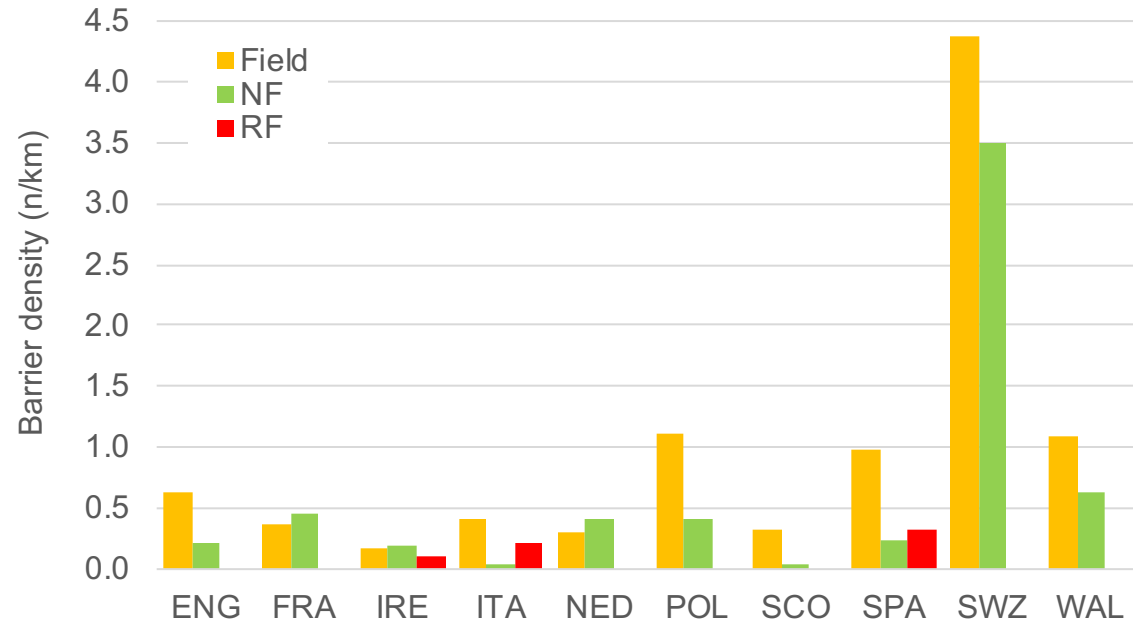
10 countries, 58 rivers, 1098 km

> 85% barriers < than 2 m

> 62% barriers < 1 m



First results: almost one barrier every 1 km in EU rivers



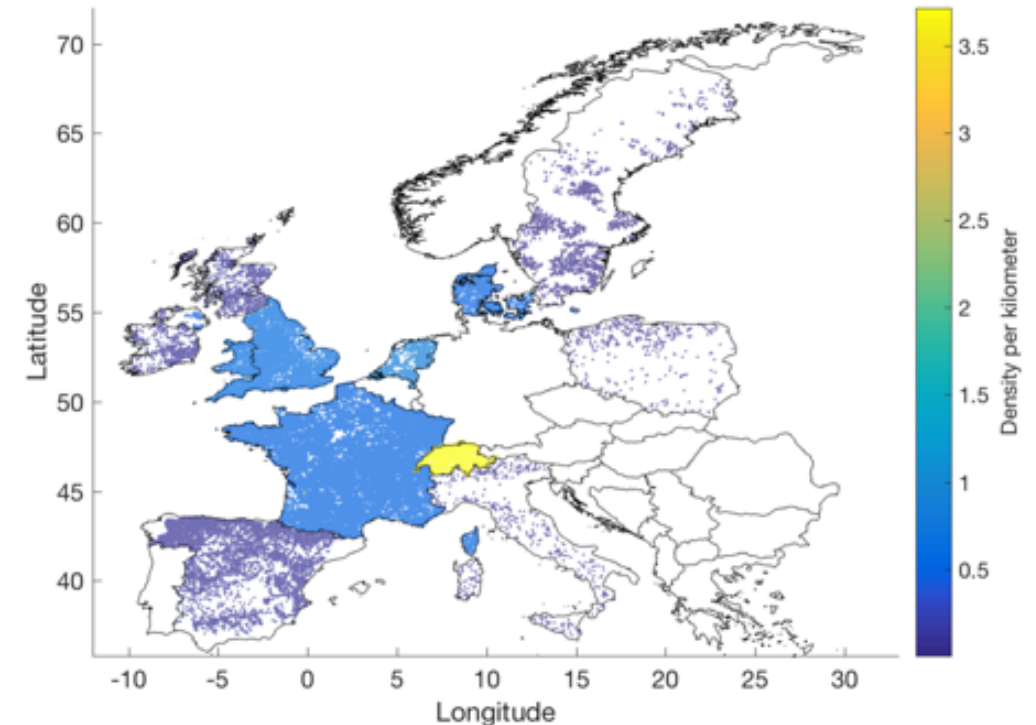
10 countries, 58 rivers, 1098 km

> 85% barriers < than 2 m

> 62% barriers < 1 m

Some institutional databases are very accurate (France, Ireland, Switzerland)

National scale barrier density



AMBER Barrier Atlas: the European map

Hypothesis :

Barrier density in a basin is correlated with some of its anthropological, demographic and geomorphological factors.

Objective:

To estimate the amount of barriers in european catchments and their spatial density through anthropological, demographic and geomorphological factors.

Modelling barriers in data poor areas

Data compilation at sub-catchment scale

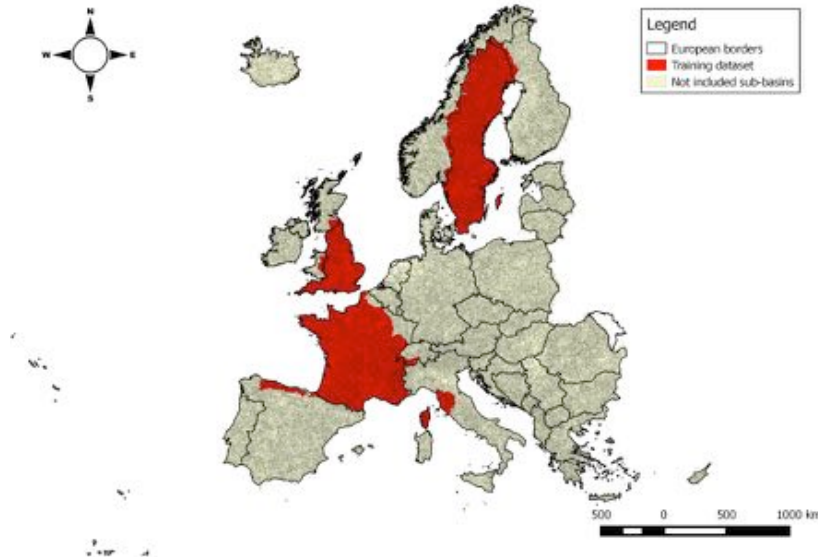
Model calibration and validation over countries and regions with good quality ATLAS

Output for every european sub-catchment

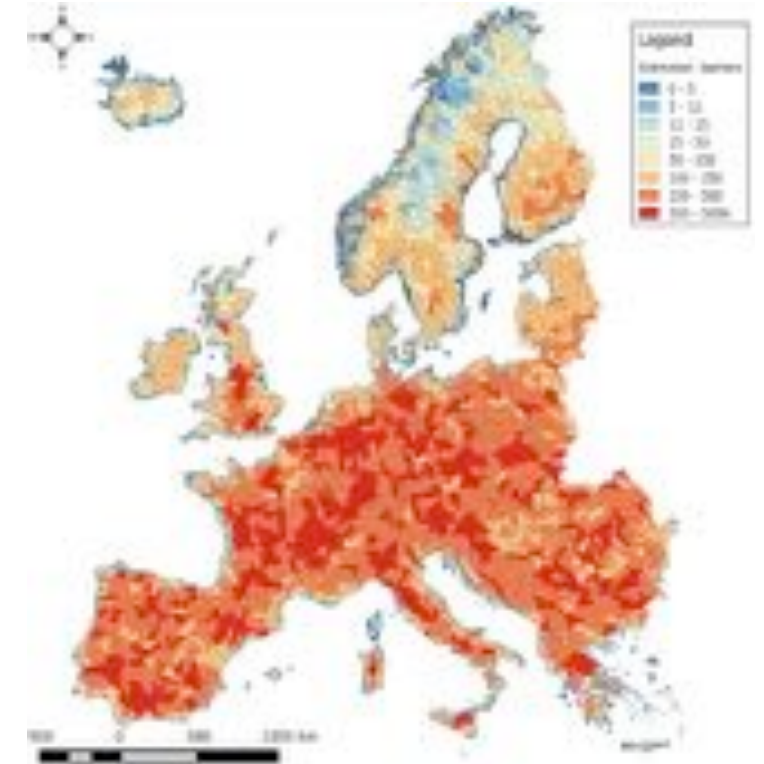
ATLAS Pan-EU layers



Forest of Extra-Trees with Iterative Input Selection (Galelli & Castelletti, 2013)



Number of barriers



Sub-catchment model



Source: Ecrins

Sub-catchment model



Source: Ecrins

Derived variables:

1. Sub-catchment area [Km^2]
2. River length [Km]
3. Dendricity [Km]

Sub-catchment model

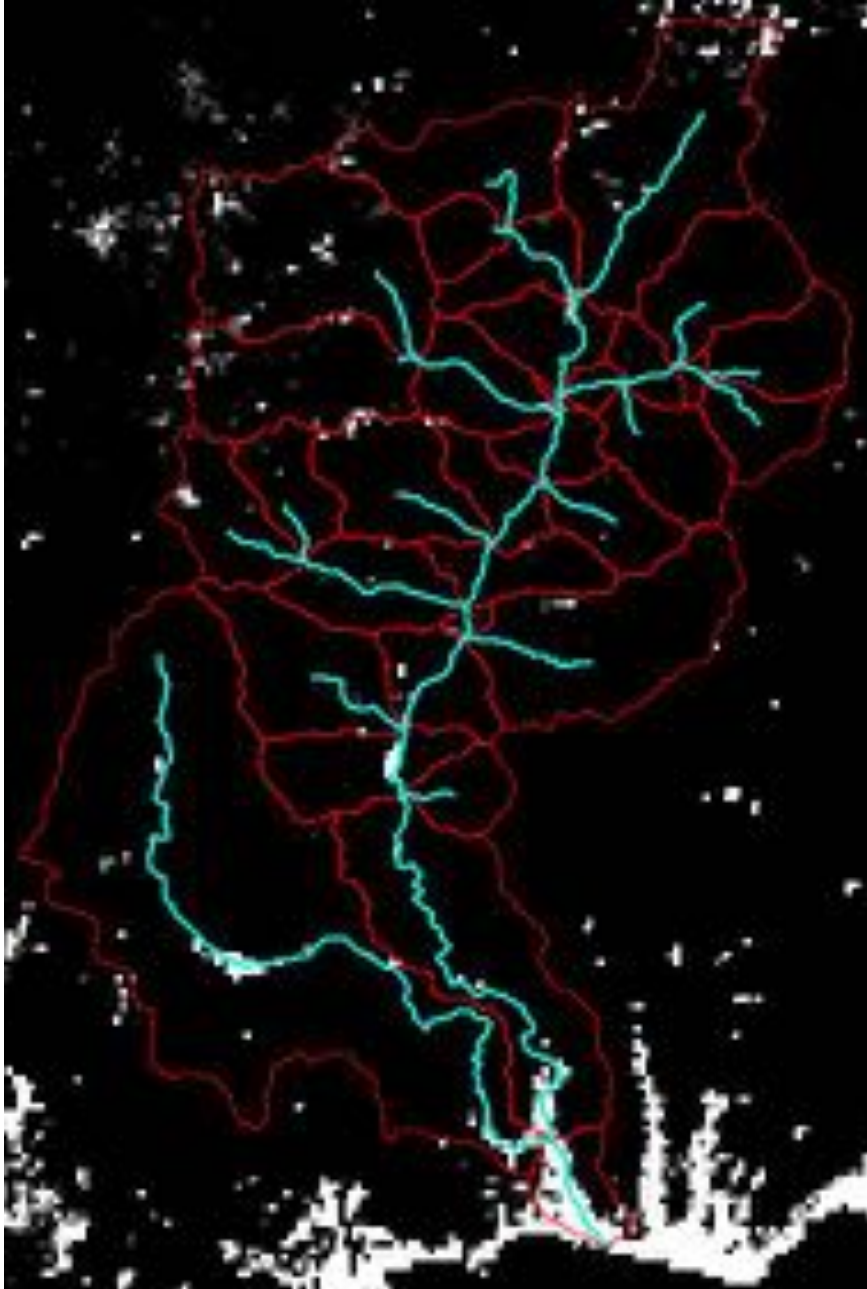


Source: CORINE

Derived variables:

1. Urban land cover [Km² & %]
2. Agricultural land cover [Km² & %]
3. Natural land cover [Km² & %]
4. Wetland [Km² & %]
5. Water [Km² & %]

Sub-catchment model

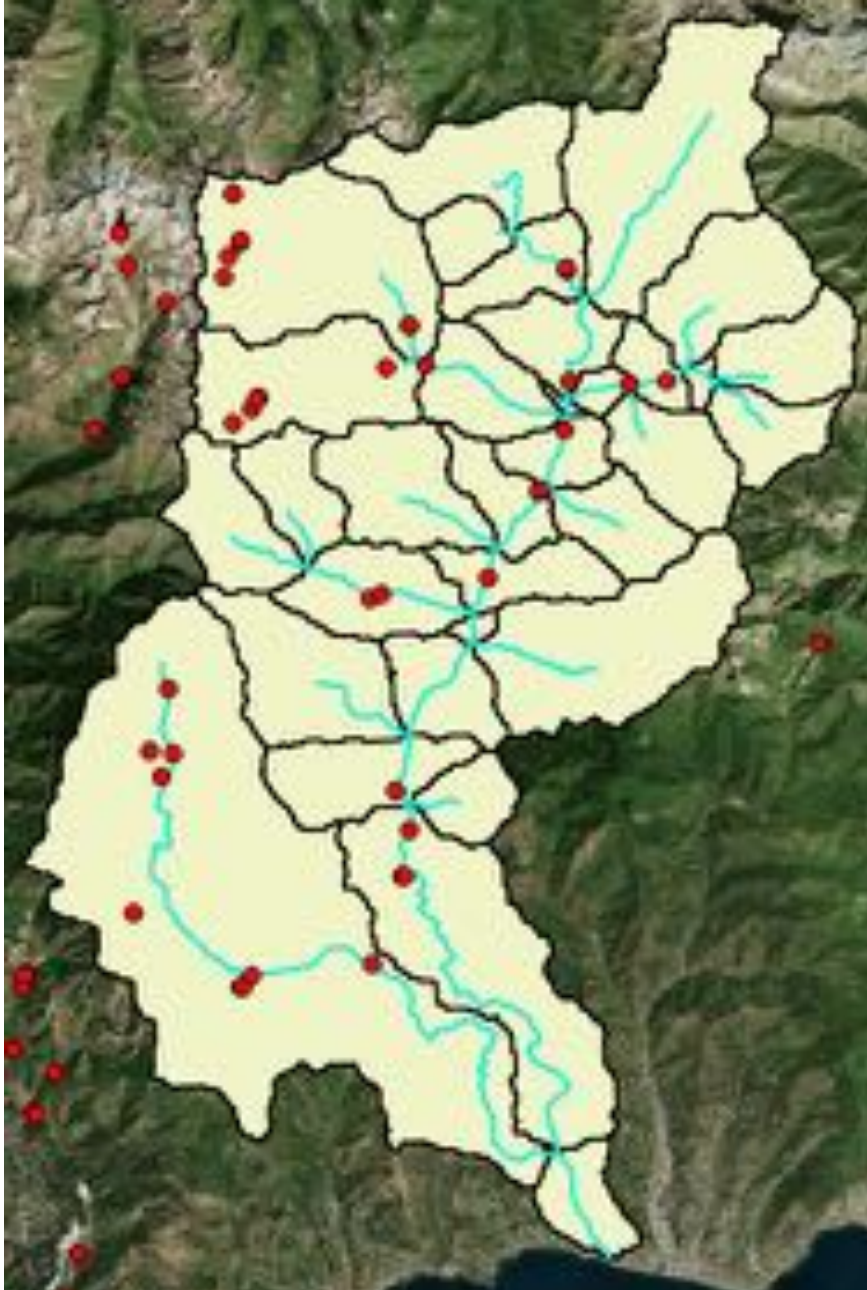


Source: GHSL

Derived variables:

1. Inhabitants
2. Population density [people/ Km²]

Sub-catchment model



Source: Amber ATLAS from
selected countries where data
quality is good

1. Number of barriers

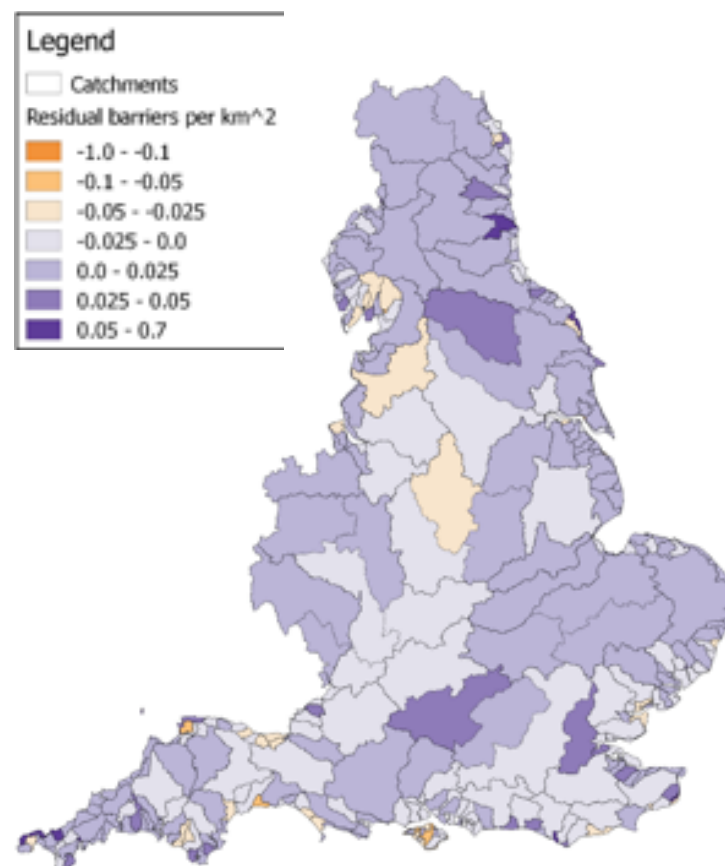
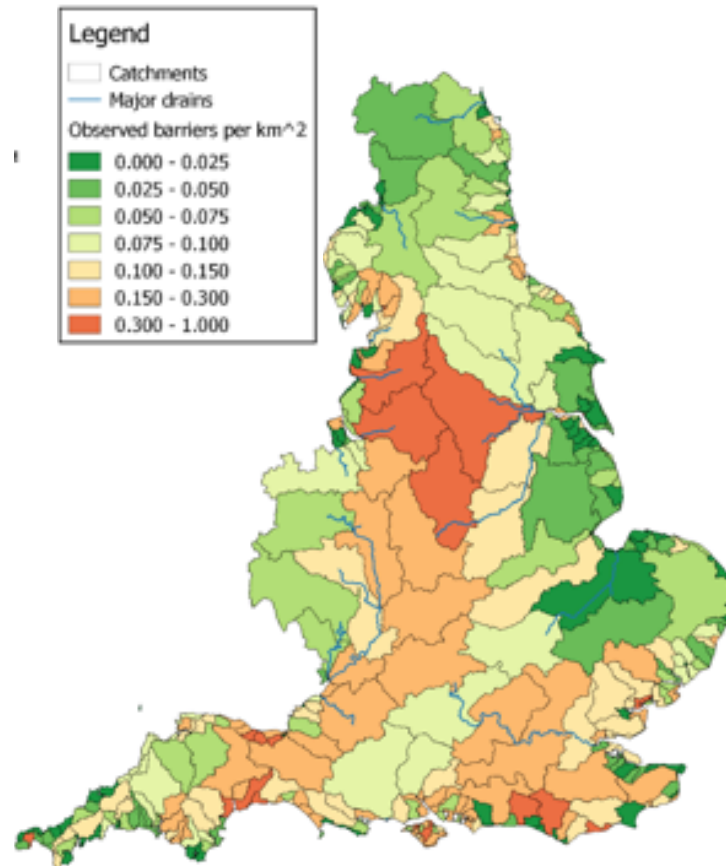
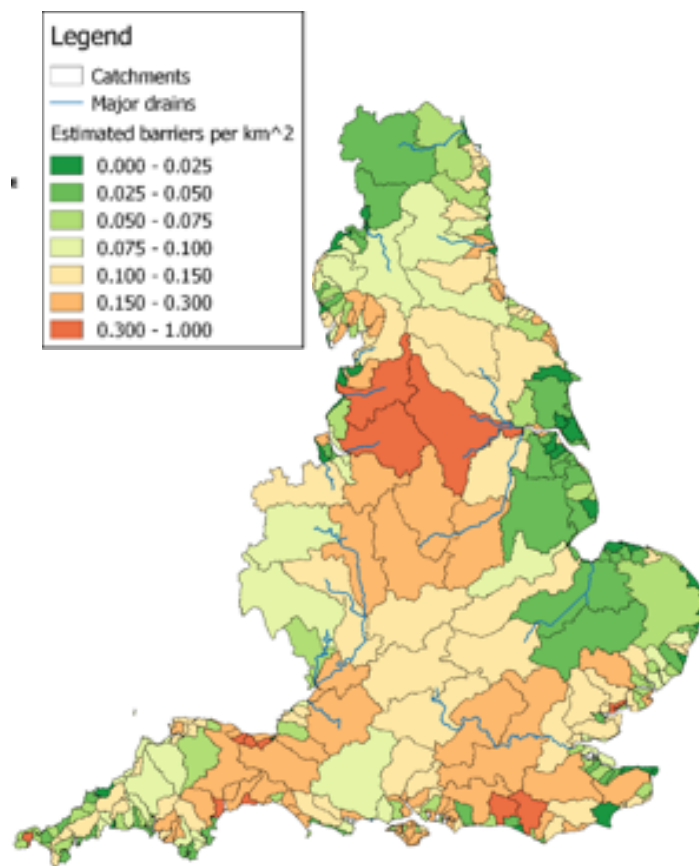
Selected model

Predictors:

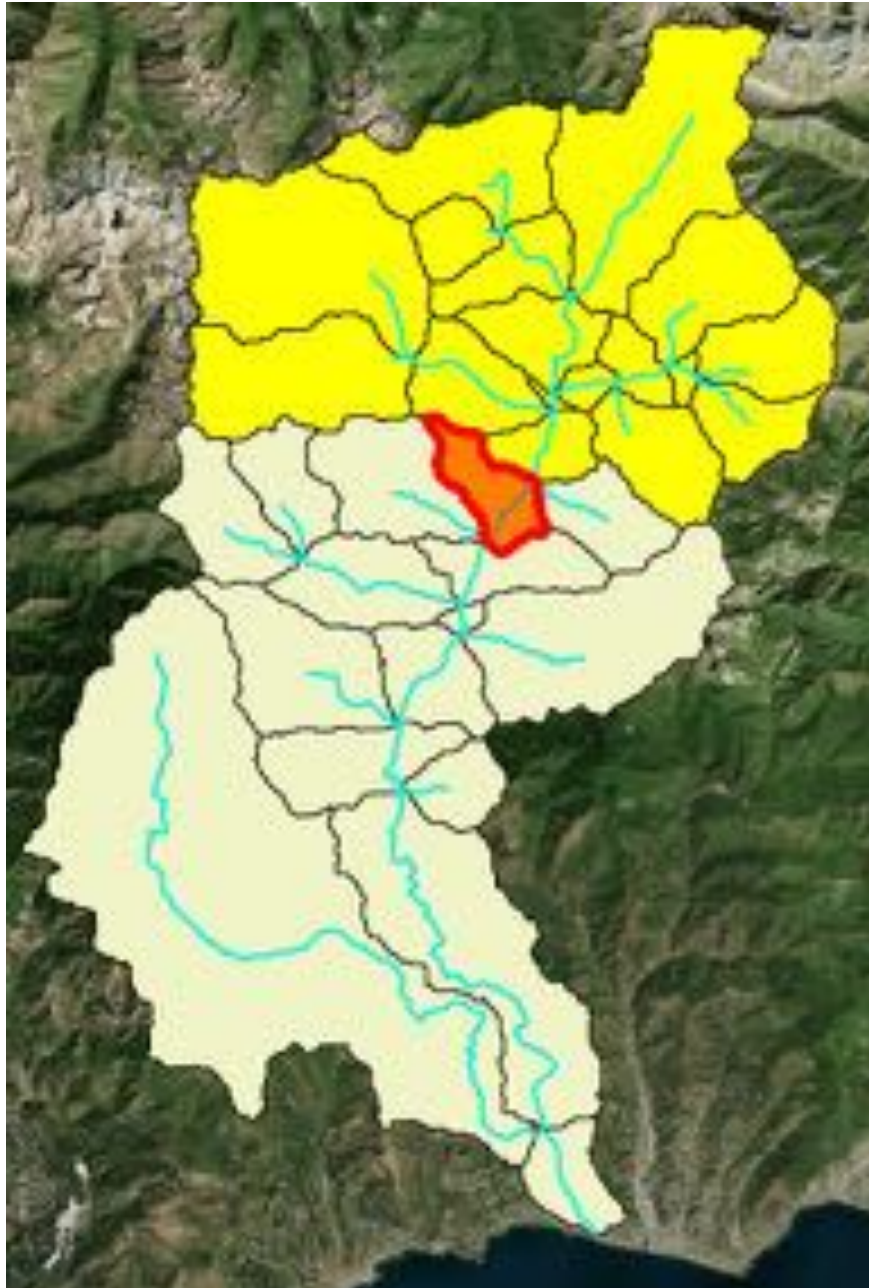
- Population
- Drain length [m]
- Agricultural area [km²]
- Urban area [km²]
- Wetland area [km²]

Performance:

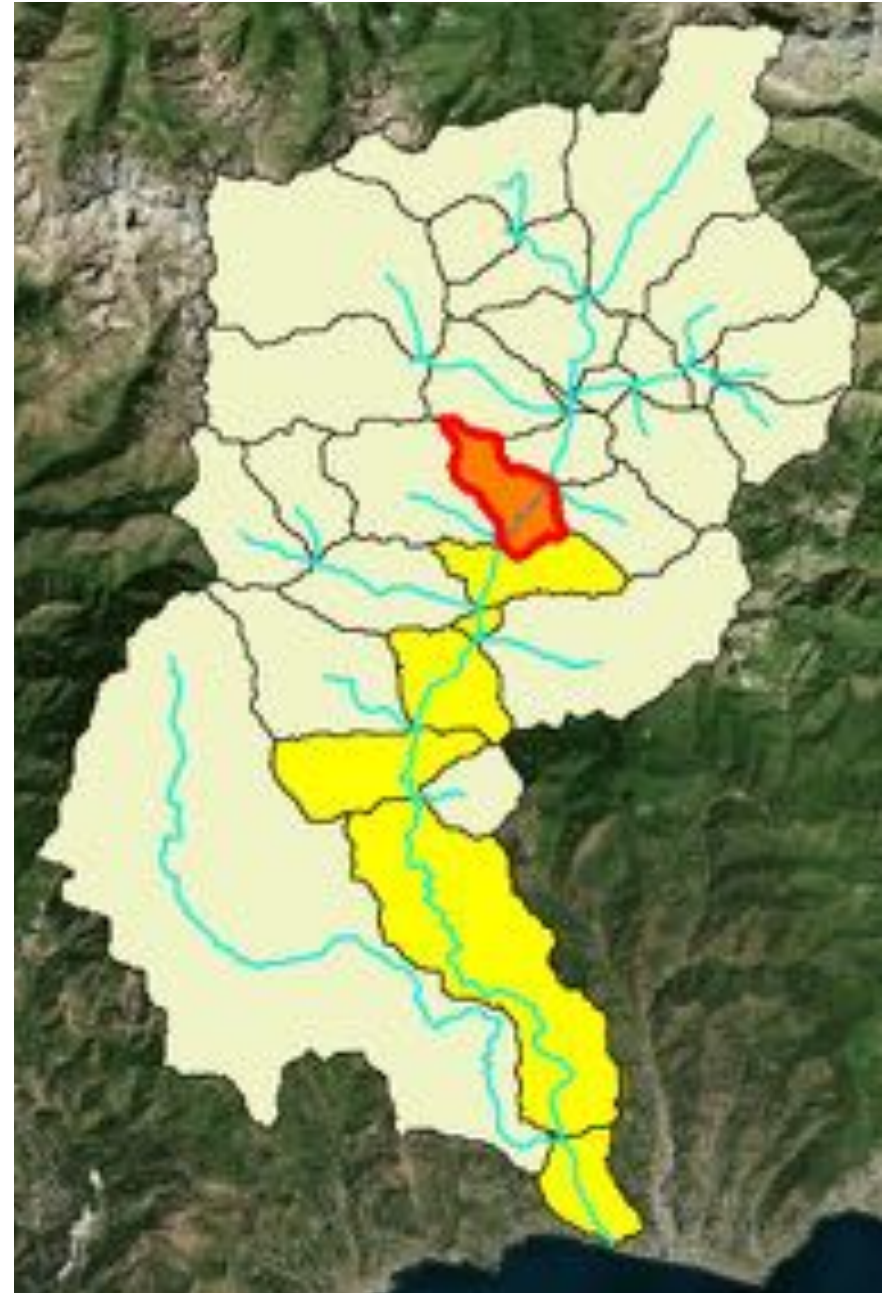
- $R^2=0.63$
- RMSE=15
- RMSEkm² =0.04

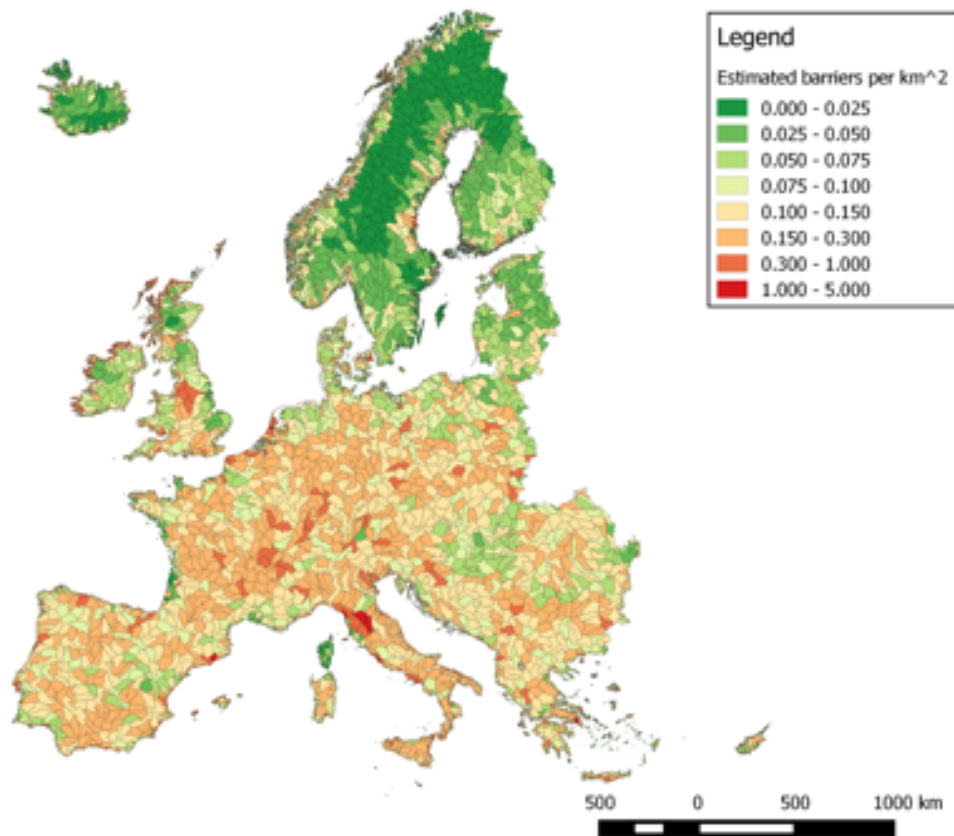


Upstream cumulation



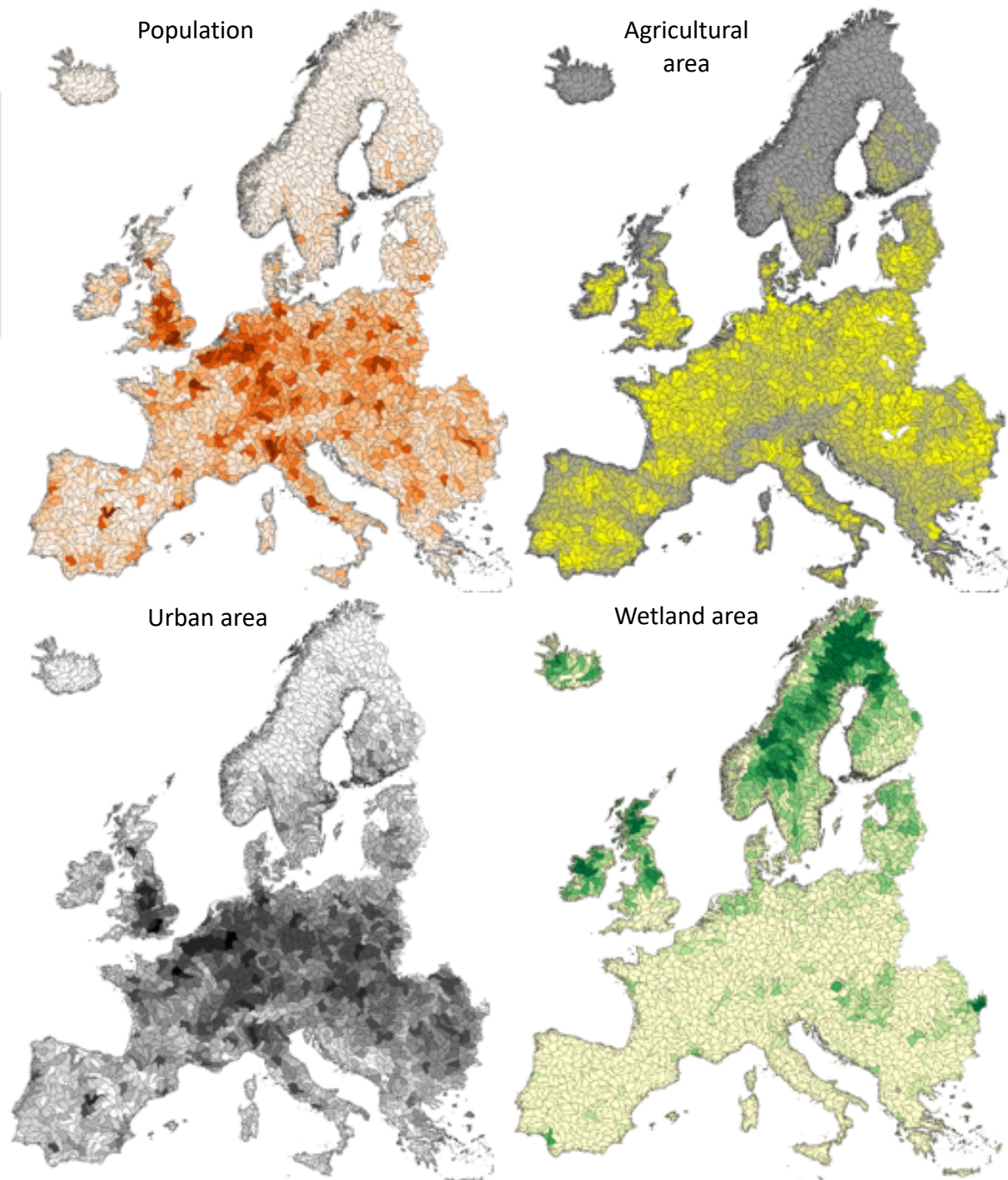
Downstream cumulation





European maps for:

- Barrier density
- Upstream cumulation
- Downstream cumulation



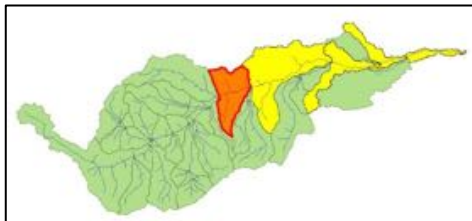


Aspermer naccarii

Fish migration



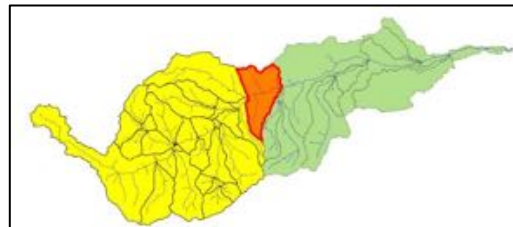
Downstream model



Sediment transport



Upstream model



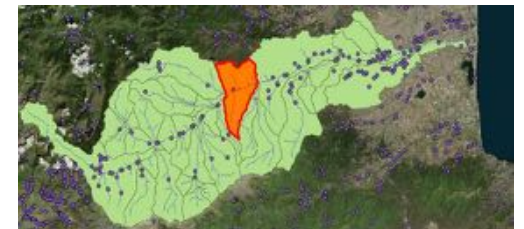
Habitats and
local biota



Small scale

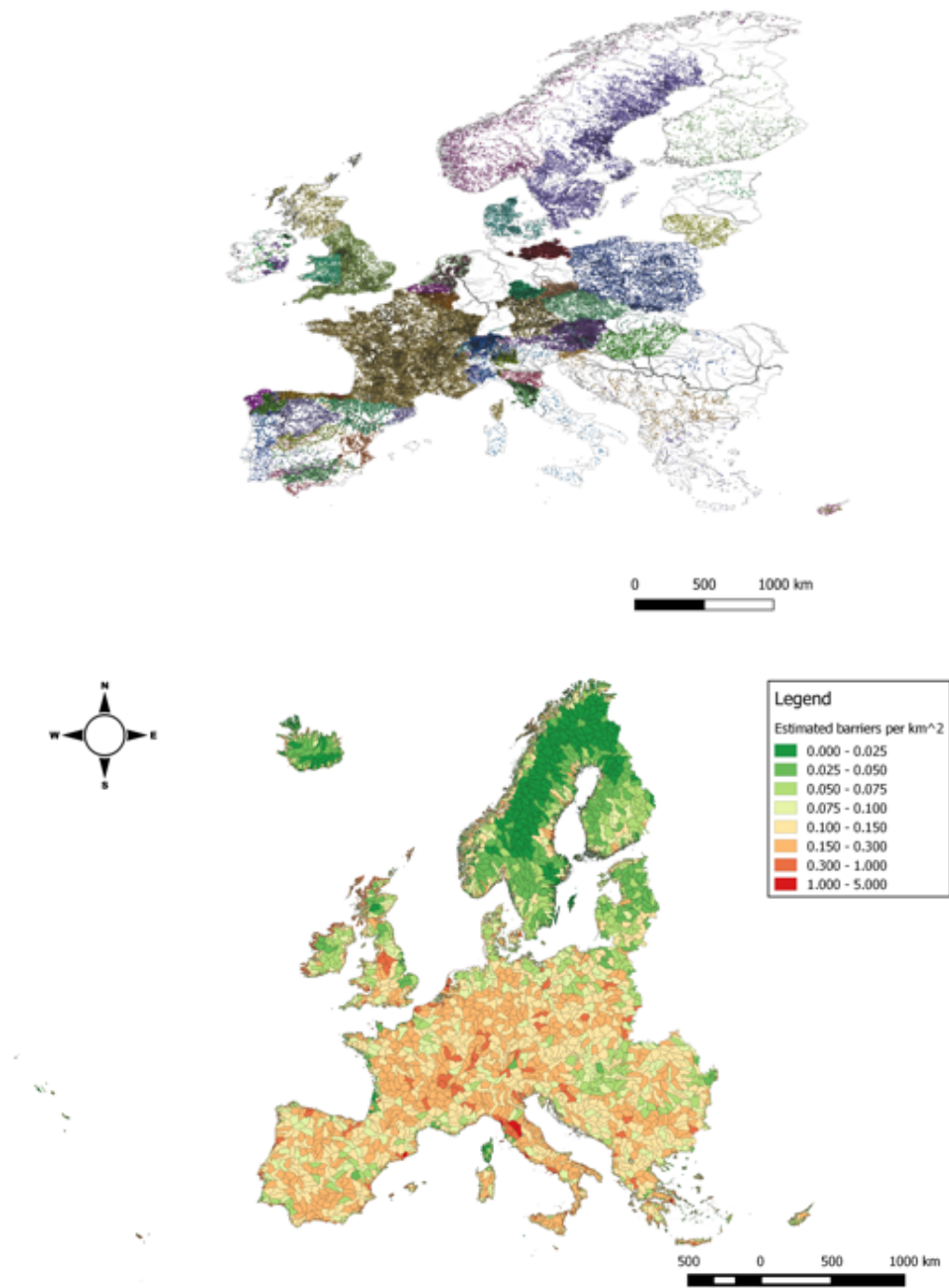
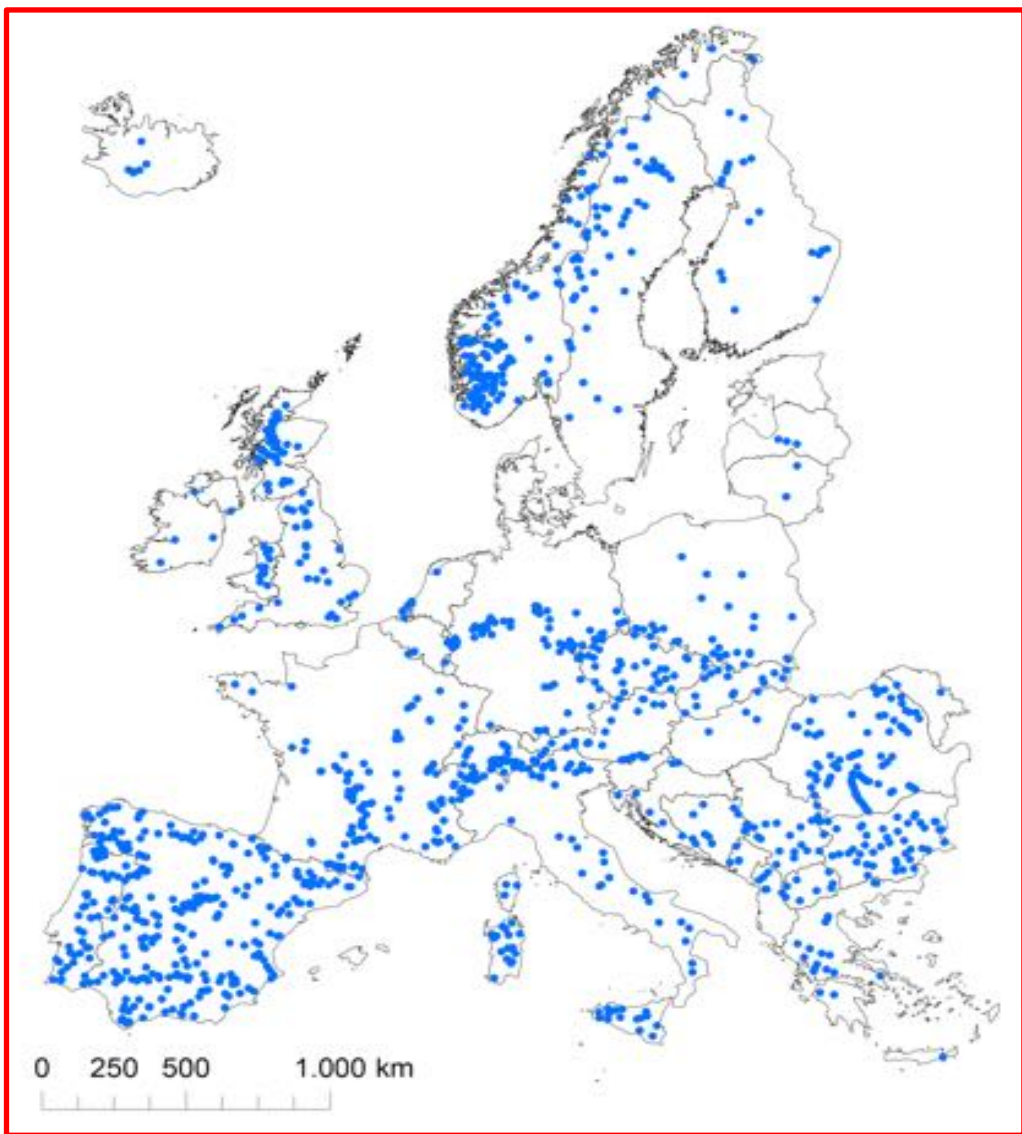


Barrier density at sub-
catchment scale



Possible applications of the AMBER Atlas: studies/comparisons at continental scale

For studies at smaller scales AMBER may not be less suitable – better data may be available



AMBER Barrier Atlas: Key messages

- AMBER Atlas will be the first methodologically consistent overview of barrier density in Europe taking into account all barriers
- Small barriers are important
 - Because they are almost everywhere (1 barrier/river km)
 - Because each barrier has an impact on continuity
- AMBER barrier Atlas is meant to provide the big picture, not to be a tool for management at local/catchment level
- AMBER barrier Atlas and GRanD database are complementary

AMBER Barrier Atlas: Key messages

- AMBER barrier Atlas has combined all available existing data from national and regional databases
- Several EU countries have very good data sets, most have not
- Information on all barriers (including small barriers) is needed to address continuity in rivers ('adaptive barrier management')
- Gap needs to be filled
 - Not possible for AMBER to map every single barrier
 - Common methodology would be beneficial (→ AMBER barrier assessment protocol)