# The State of European River Network Connectivity

**Tamara Leite**, Gonçalo Duarte, Pedro Segurado, Maria Teresa Ferreira, Paulo Branco

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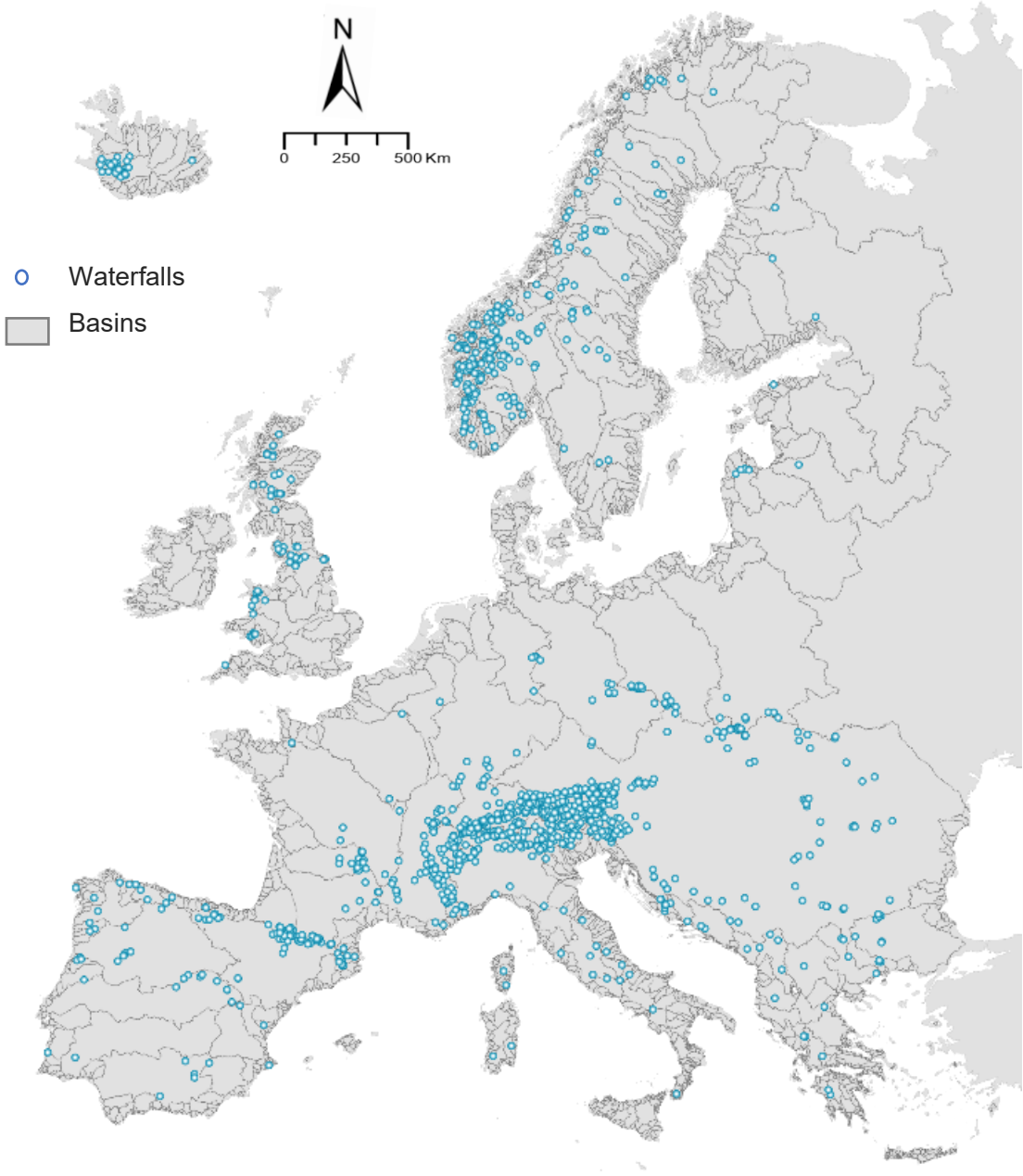
# The State of European River Network Connectivity

## Natural Fragmentation

- **Waterfalls compiled from :**
  - European Waterfalls (www.europeanwaterfalls.com/ , 2020)
  - World Waterfall Database (Swan and Gross, 2012)
  - Manually added locations after aerial imagery inspection (Google Earth, Google LLC., 2022)

- **Geographic location** of the waterfalls verified and integrated with CCM2 network (De Jager and Vogt, 2007)

- Total of **1343** natural barriers

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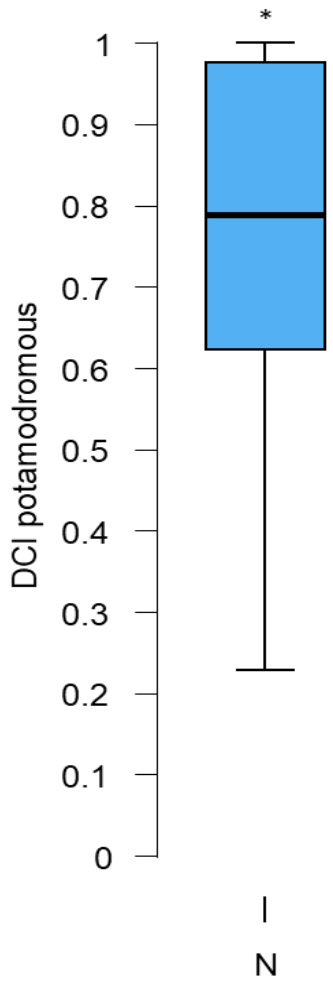
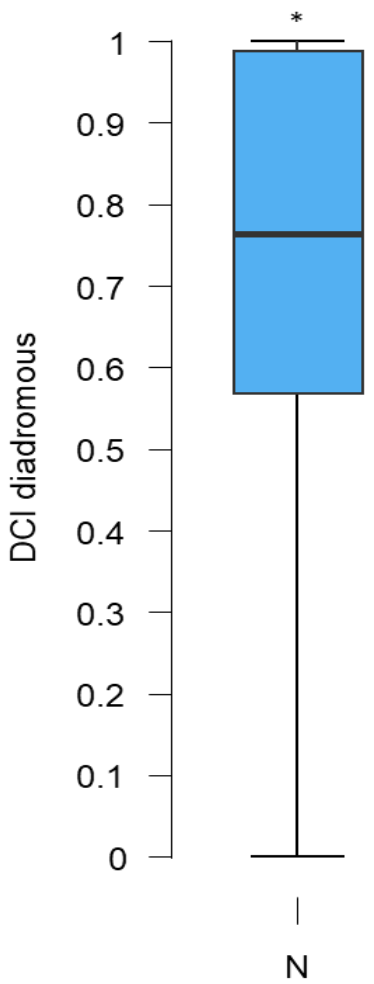
## potamodromous




## diadromous

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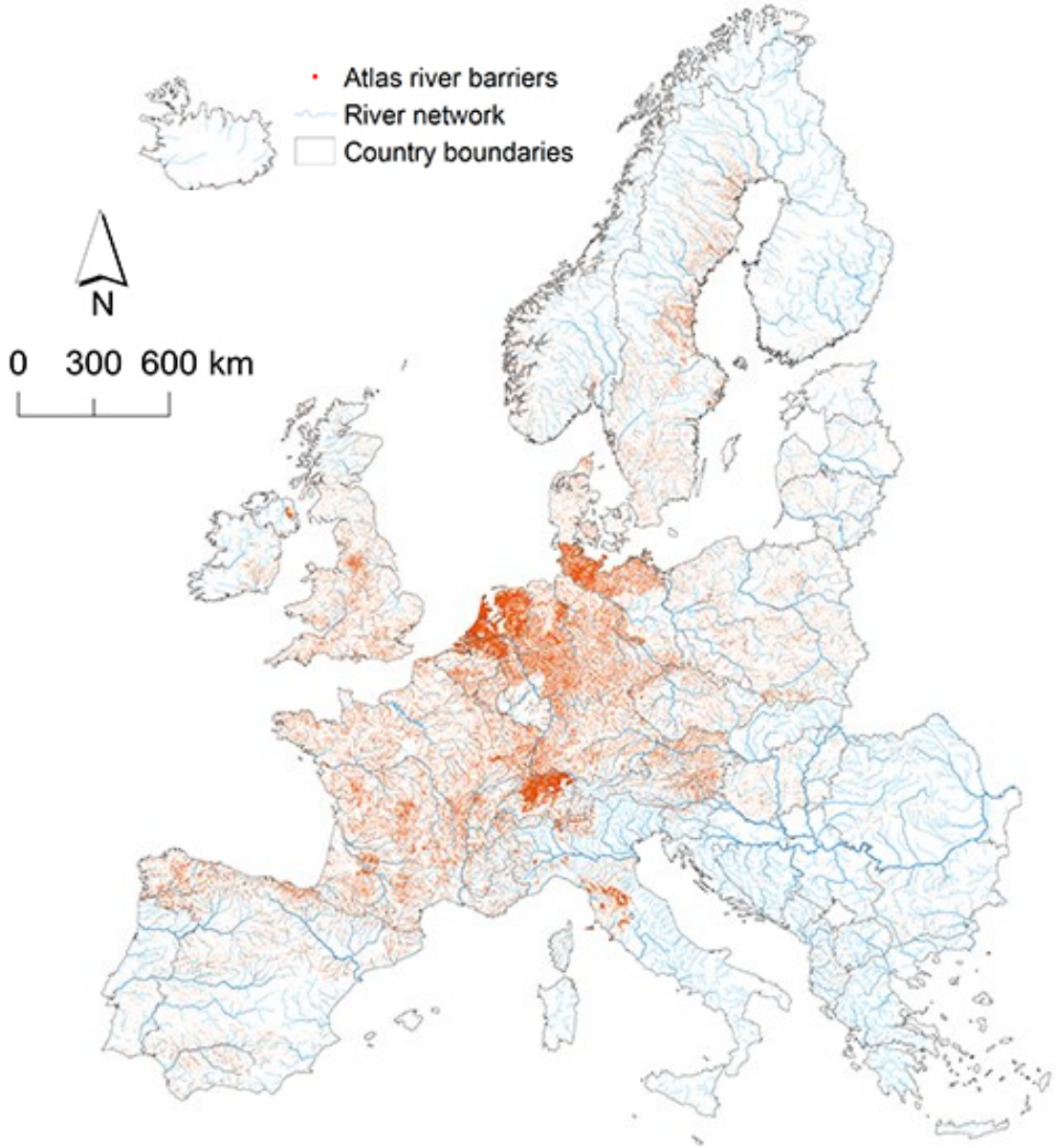
## Artificial Barriers

**AMBER Barrier Atlas** (AMBER Consortium, 2020)
630 000 barriers




AMBER

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

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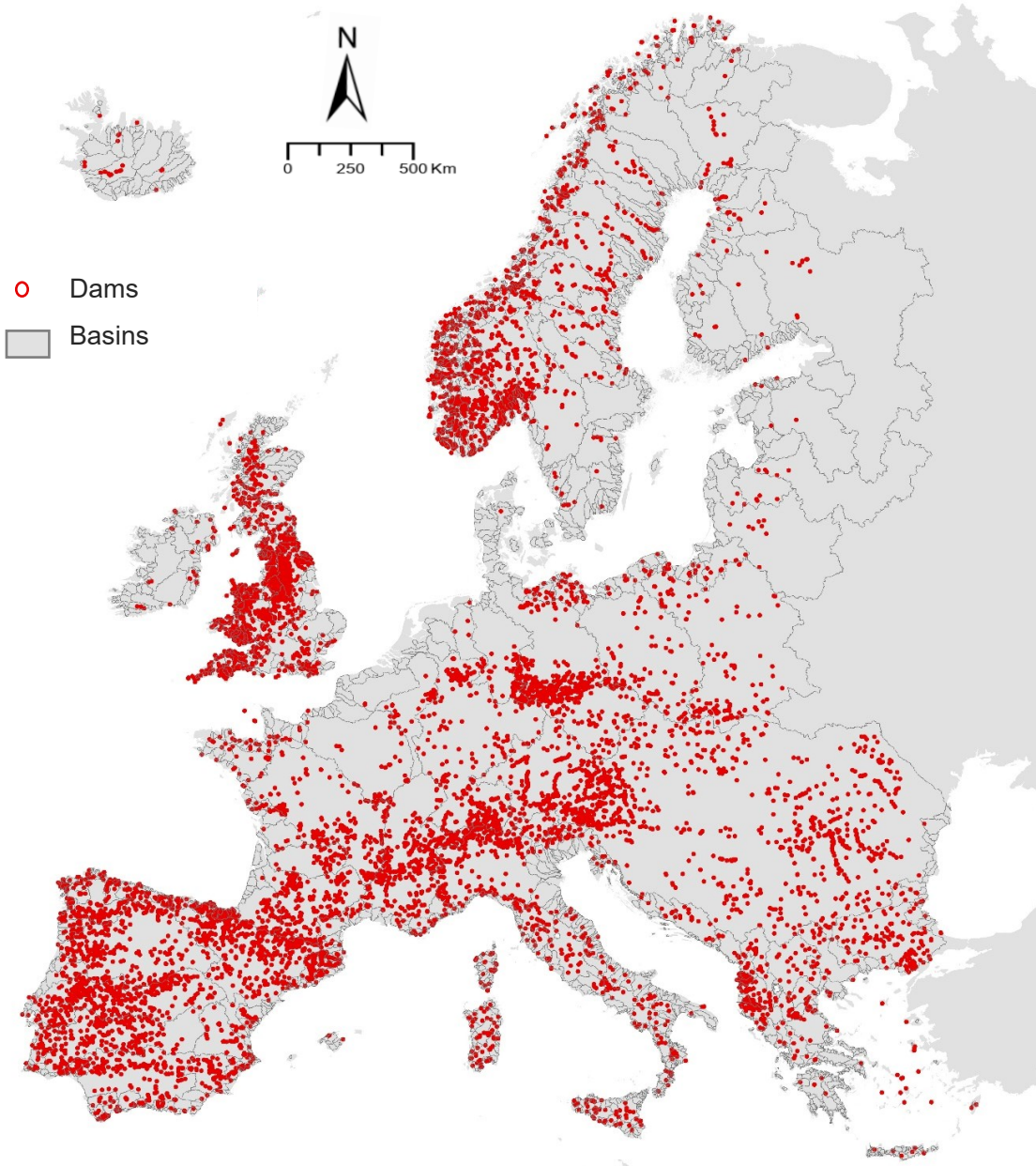
## Artificial Barriers

- **Barriers compiled from databases:**
  - **AMBER Barrier Atlas** (AMBER Consortium, 2020)
  - **Georeferenced Global Dams And Reservoirs** (GeoDAR v1.1, Wang et al., 2021)
  - **GlObal geOreferenced Database of Dams** (GOODD V1) (Mulligan et al., 2020)

- **Geographic location** of the dams verified and integrated with CCM2 network (De Jager and Vogt, 2007)

- Total of **12 656** artificial barriers in total, **9 212** affecting the network at the CCM2 resolution

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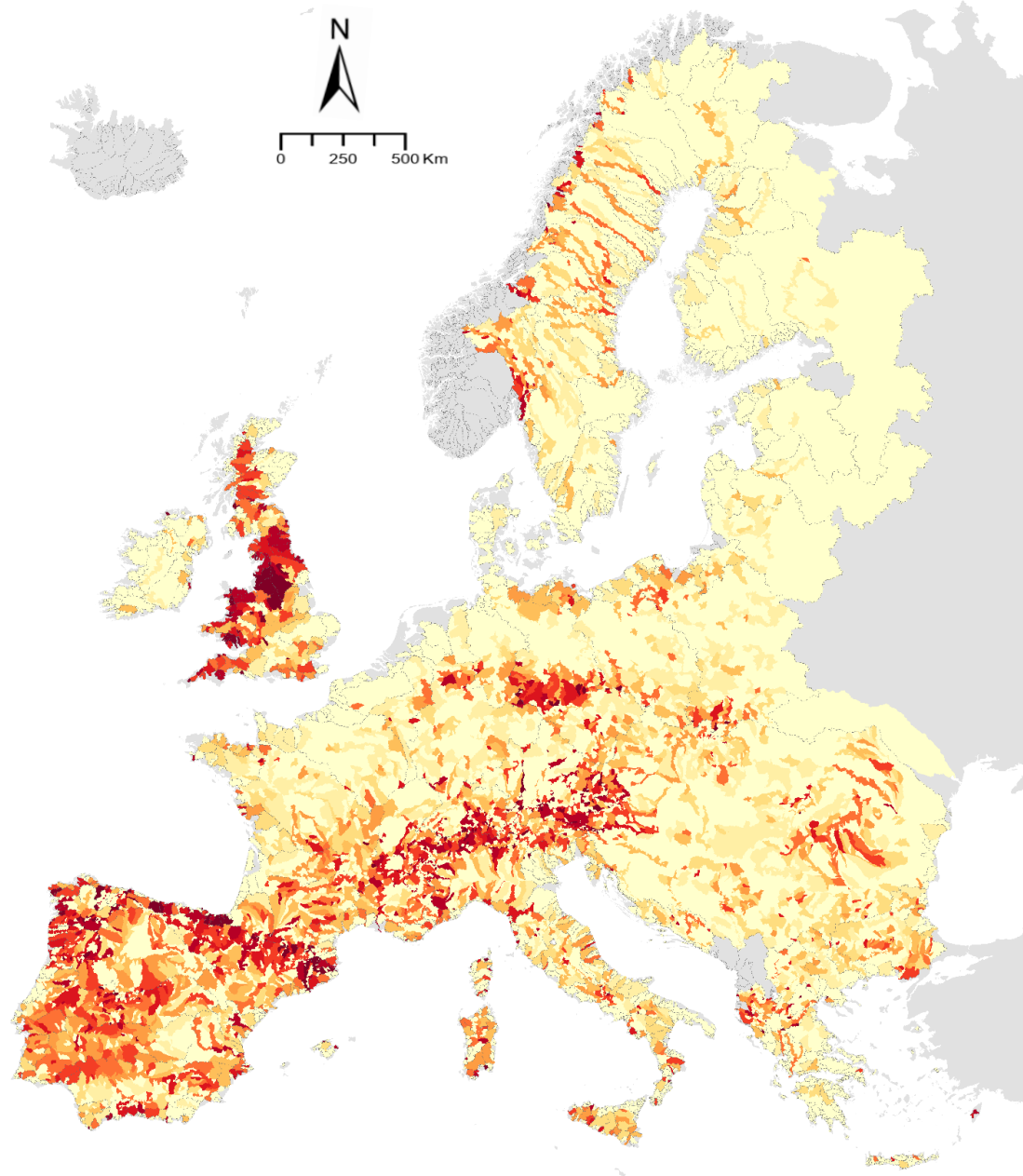
## Artificial Barriers

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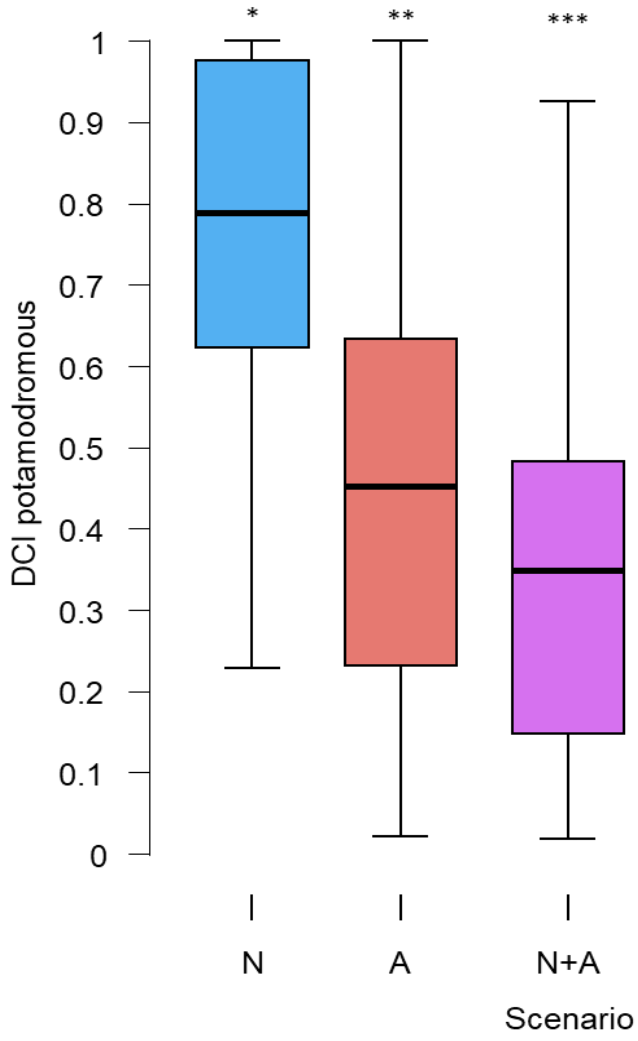


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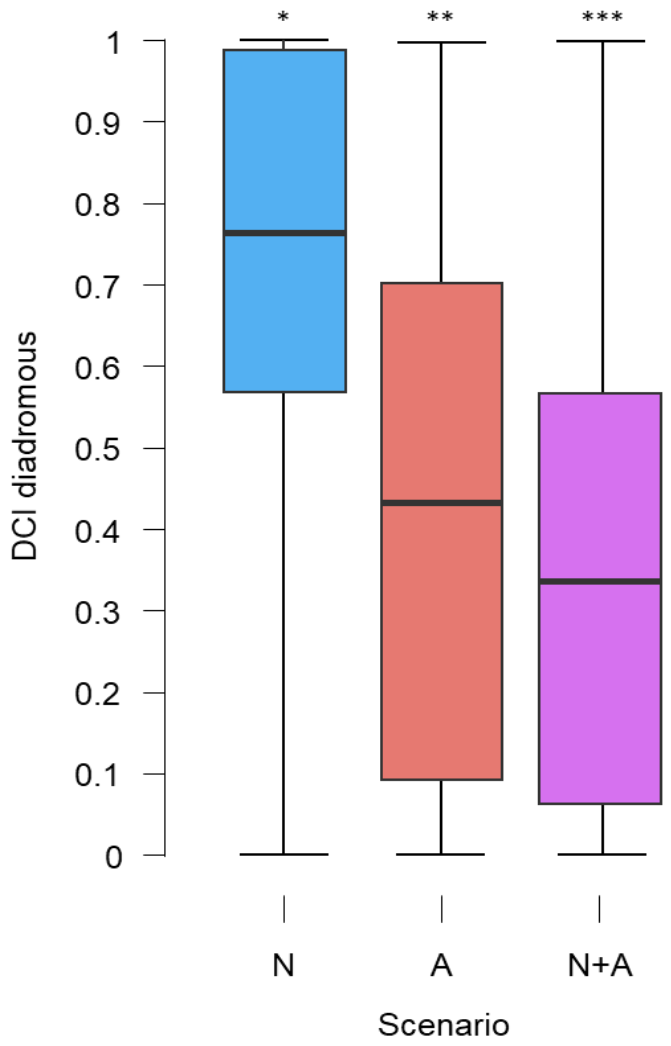


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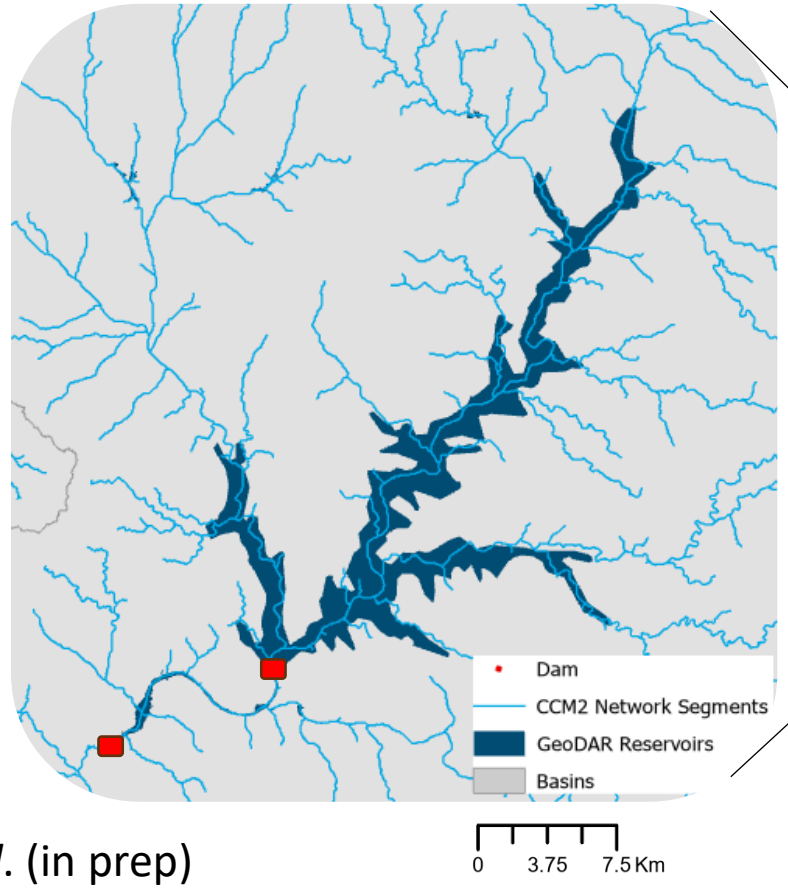
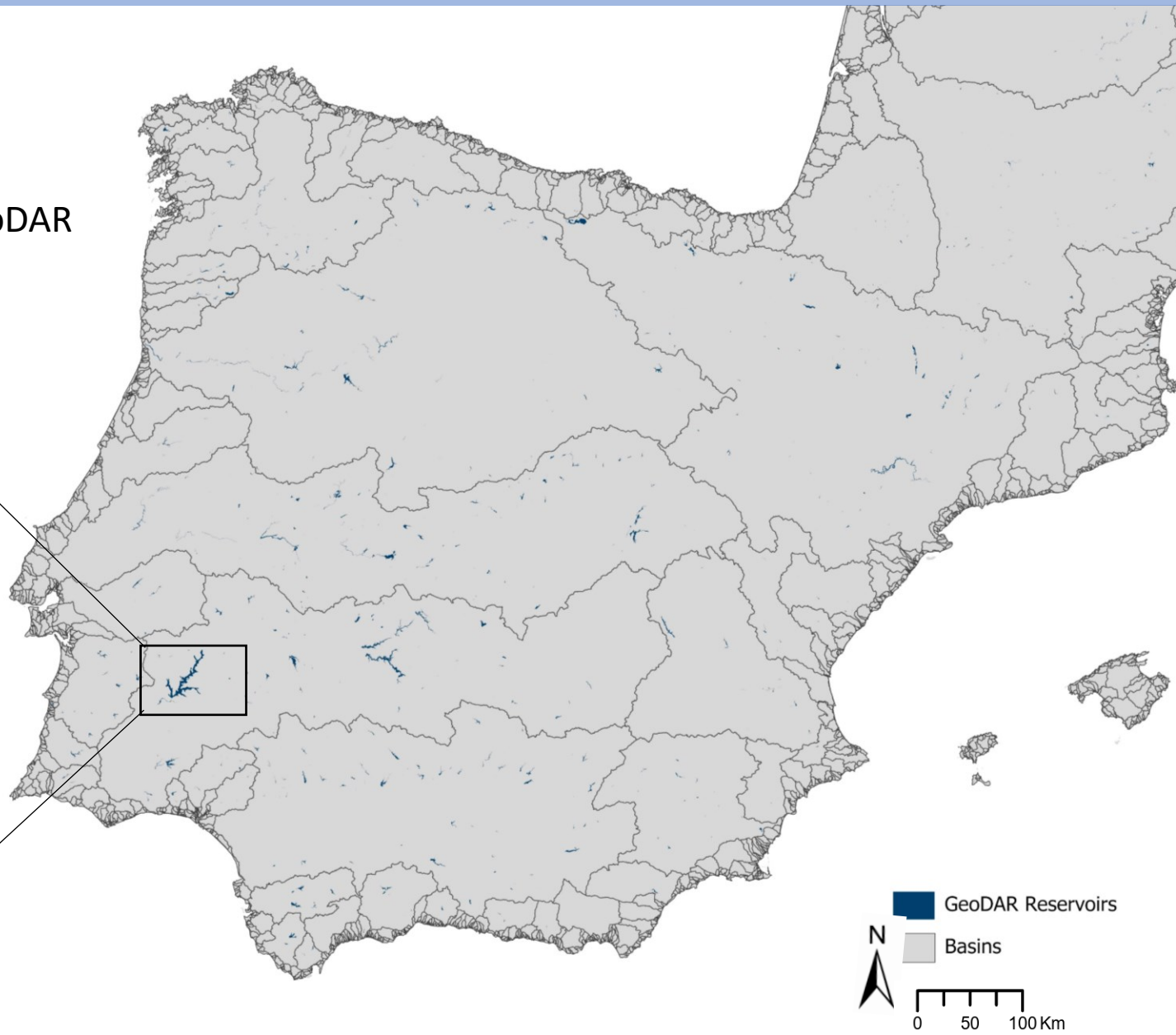
## Reservoirs

- **Georeferenced Global Dams And Reservoirs** (GeoDAR v1.1, Wang et al., 2021)

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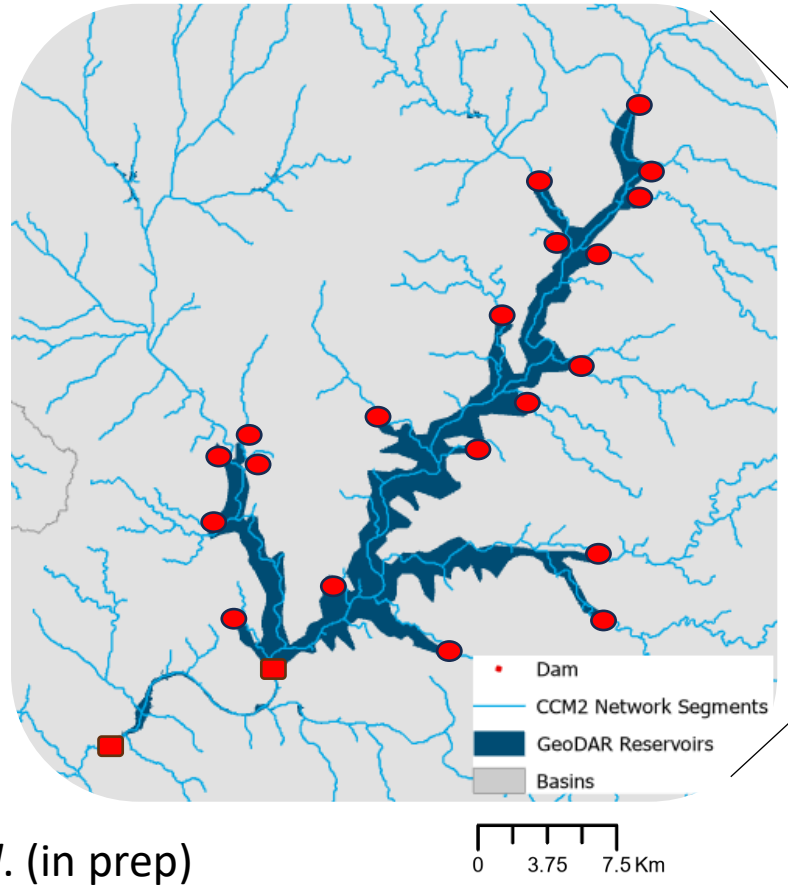


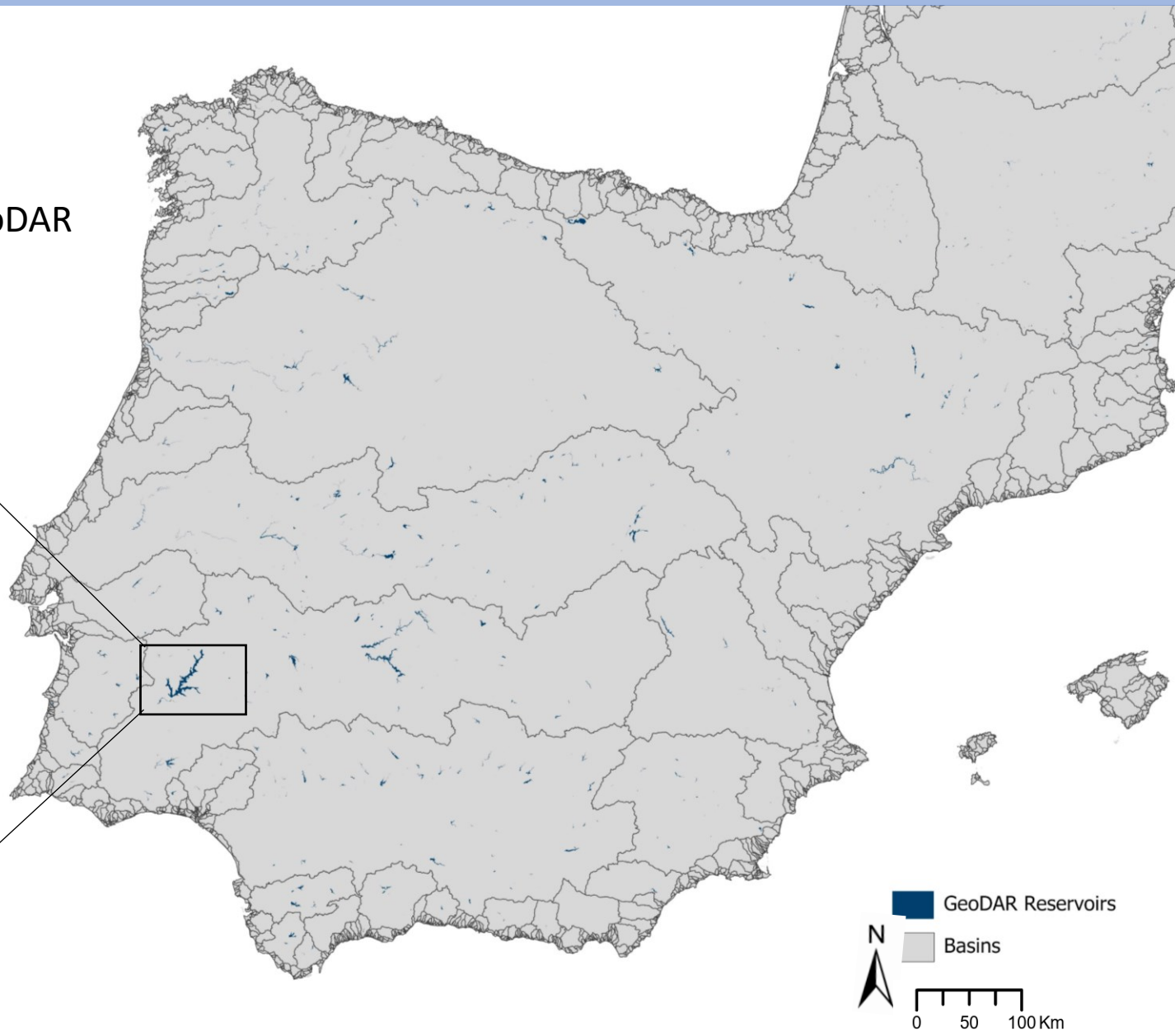


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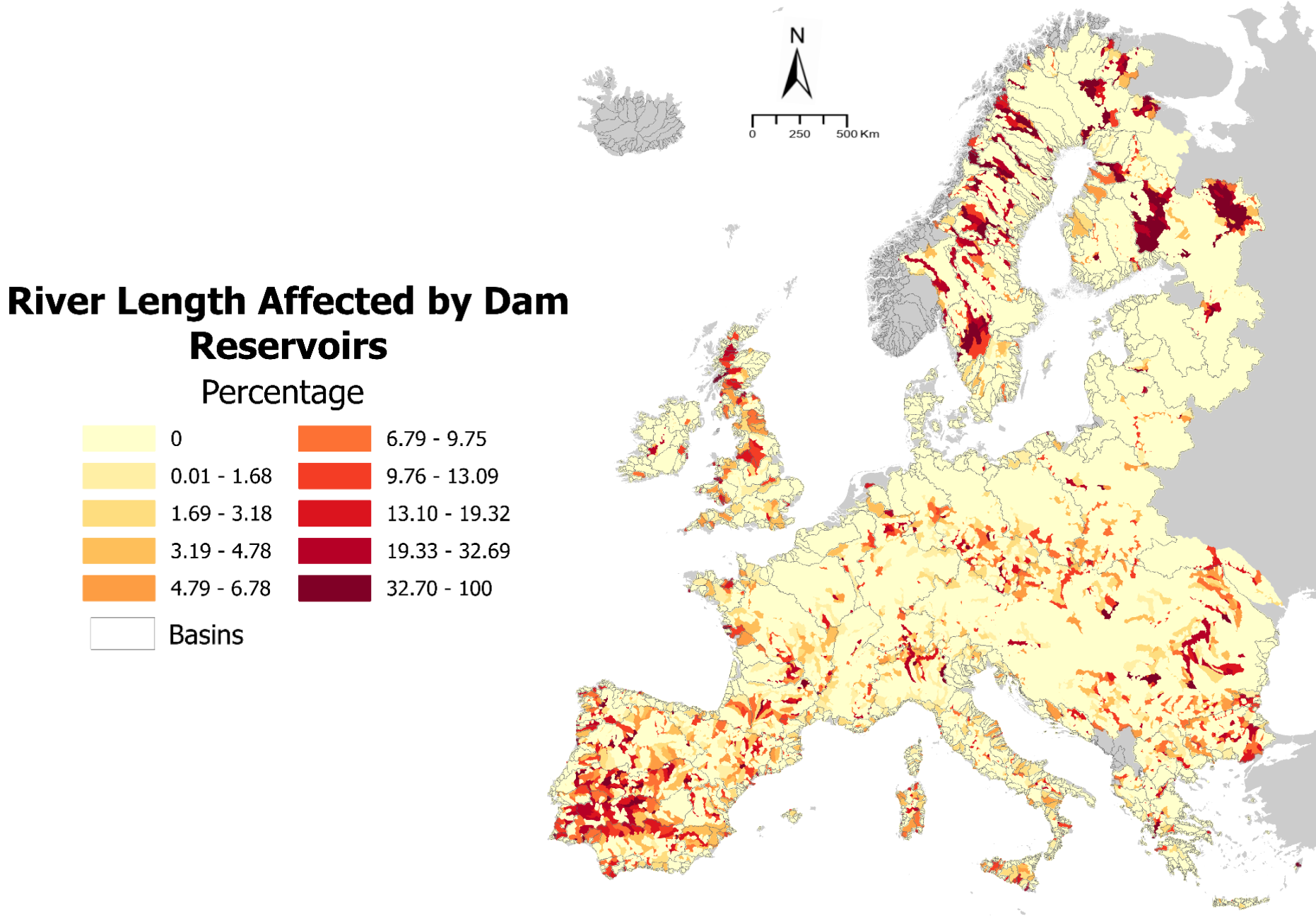
## Reservoirs

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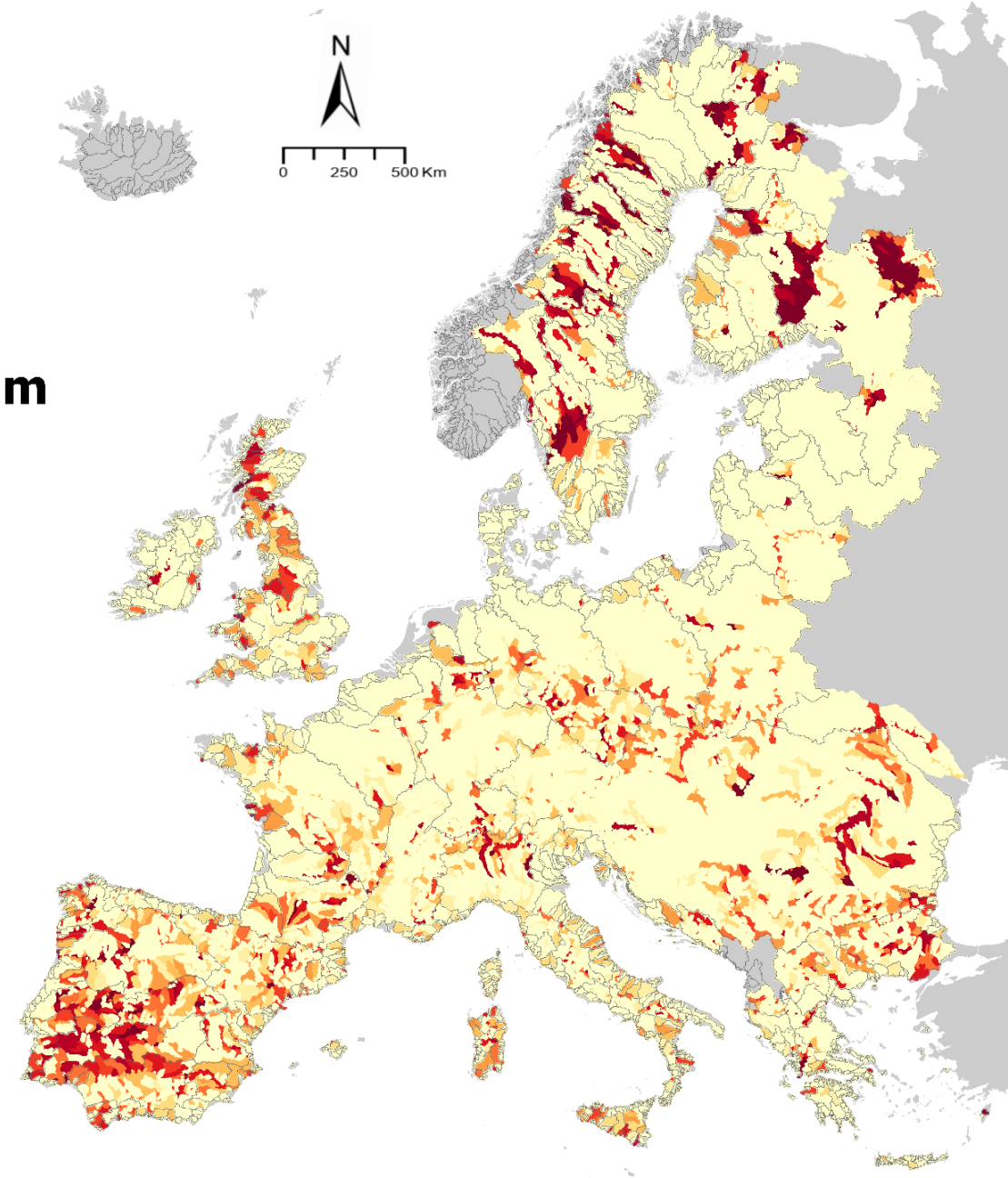
## Reservoirs

66 818 Km

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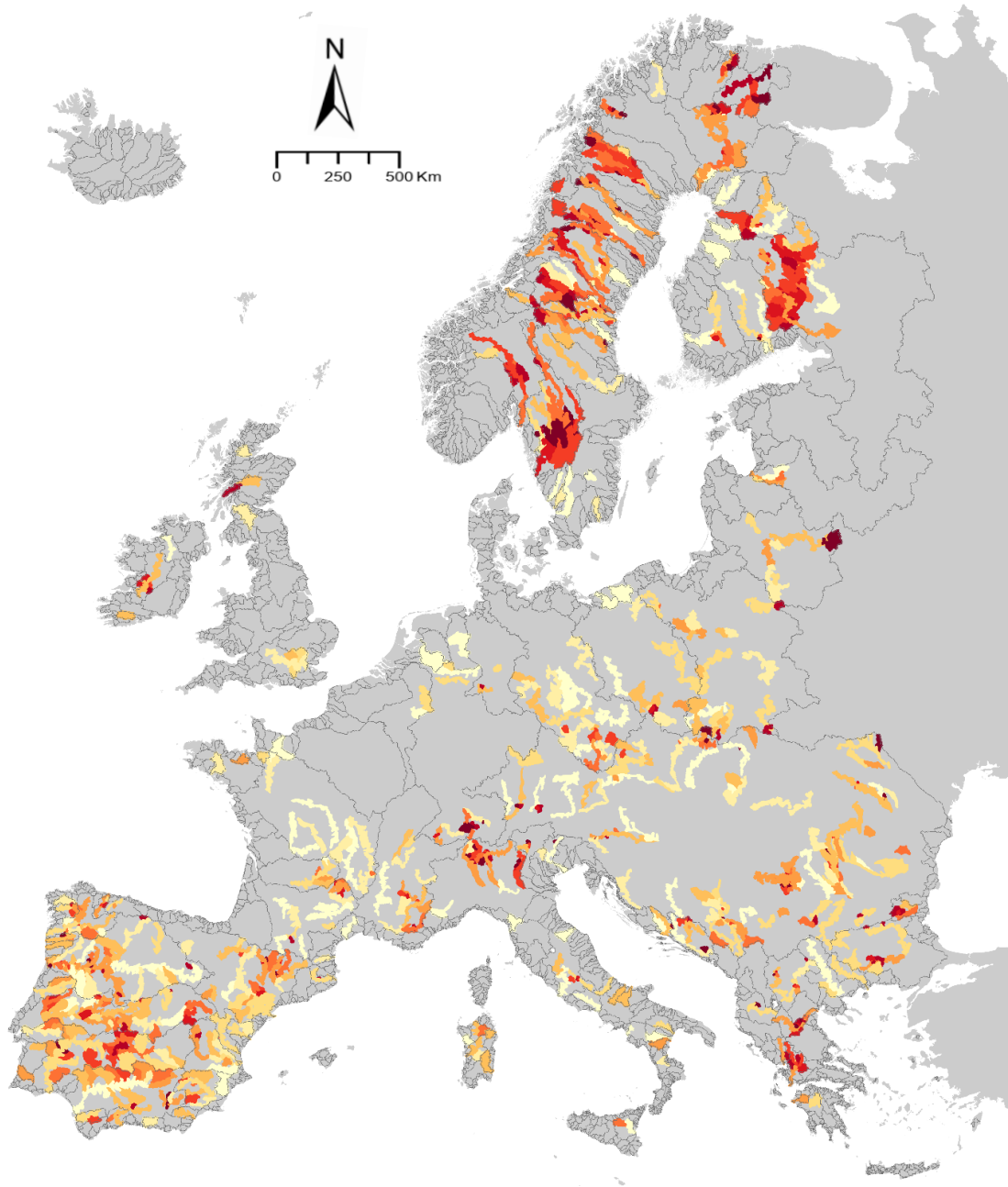
## Reservoirs

19 394 Km²

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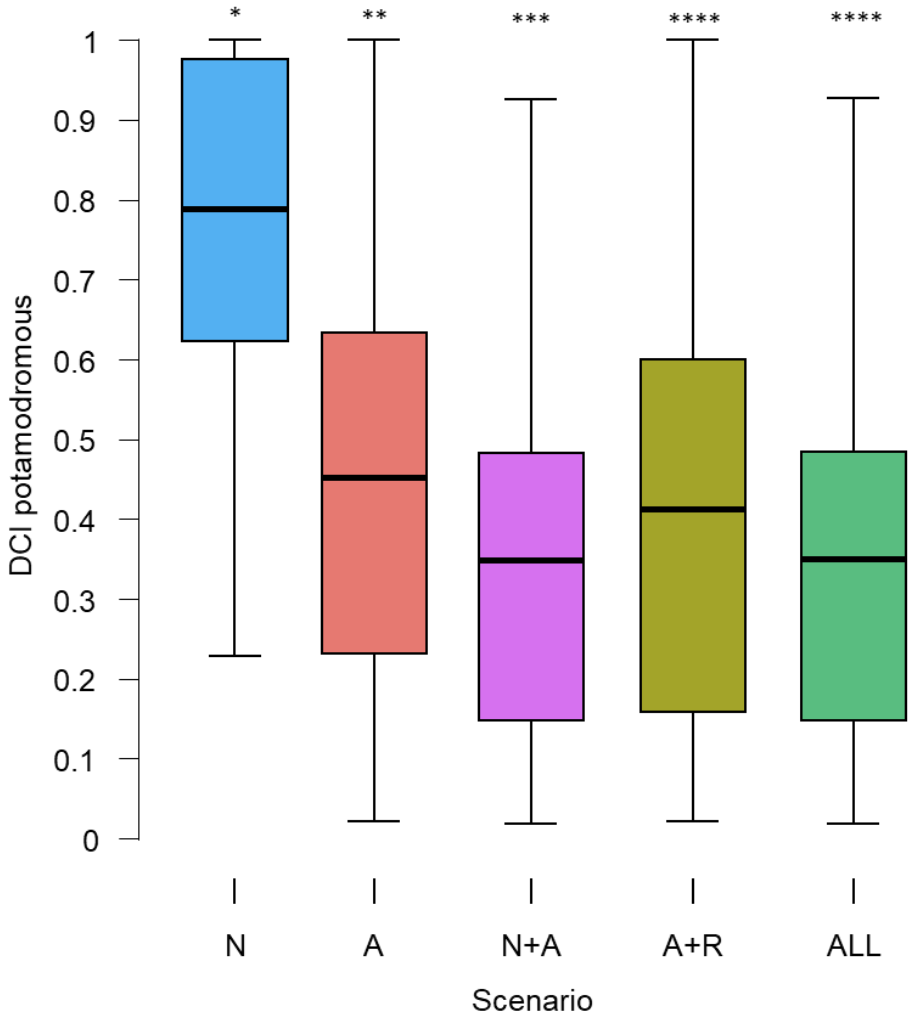
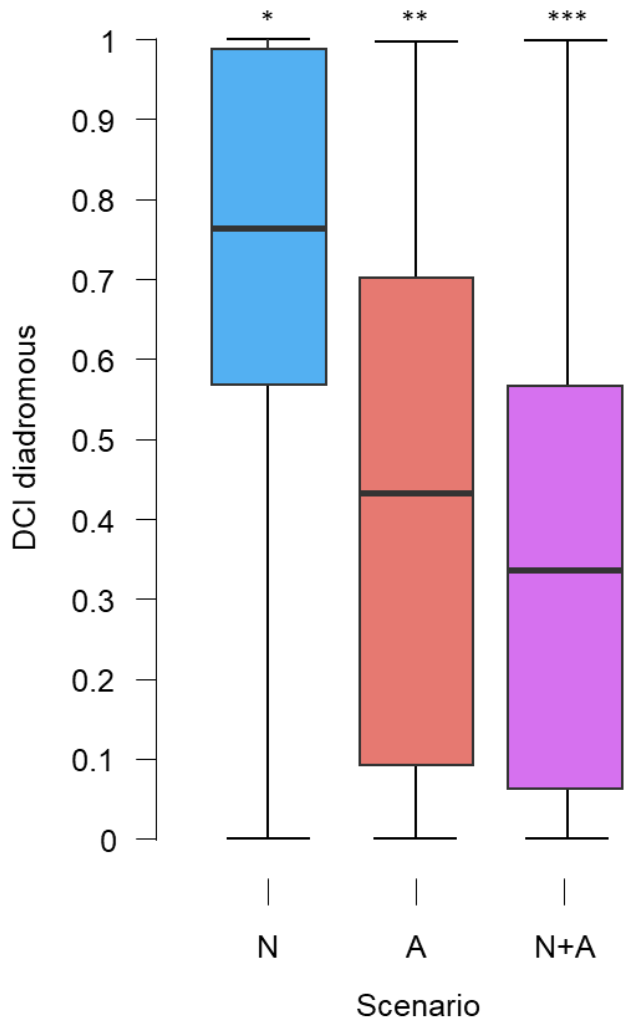



## diadromous

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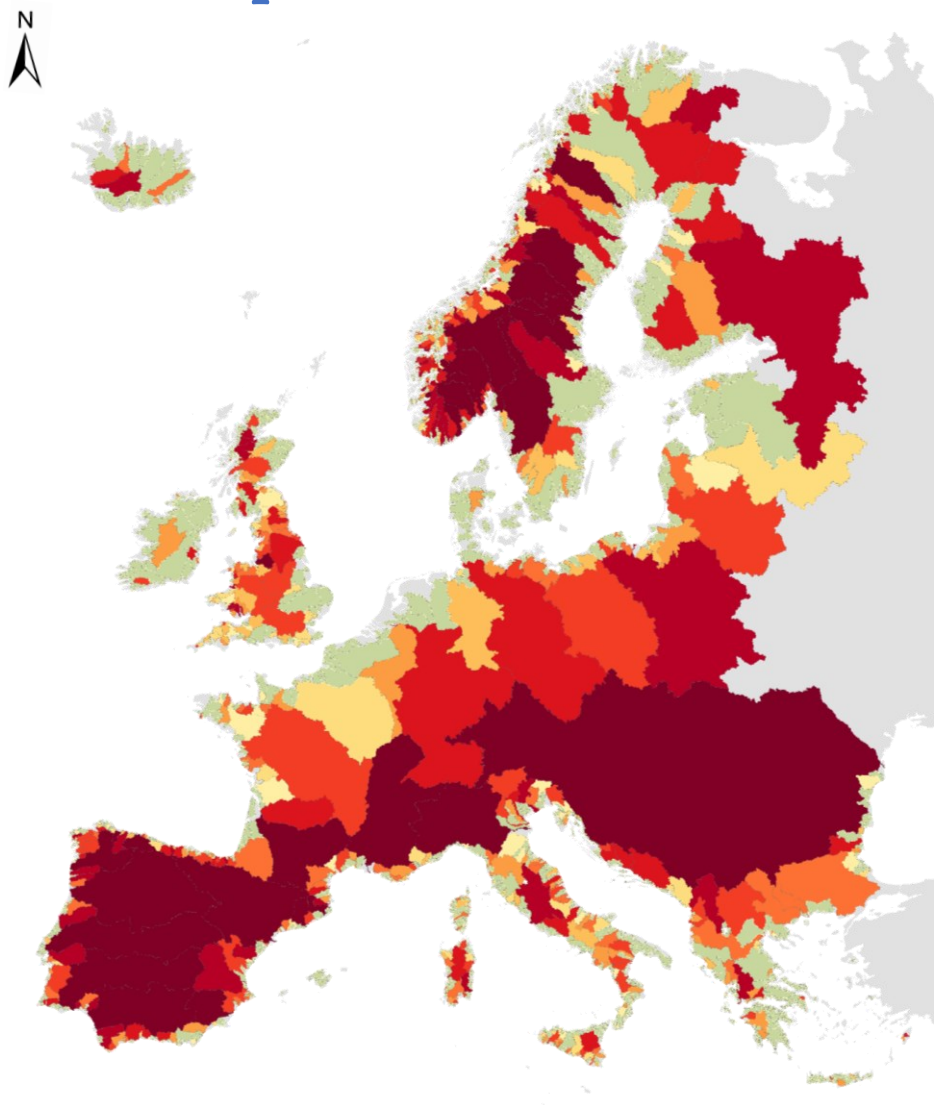


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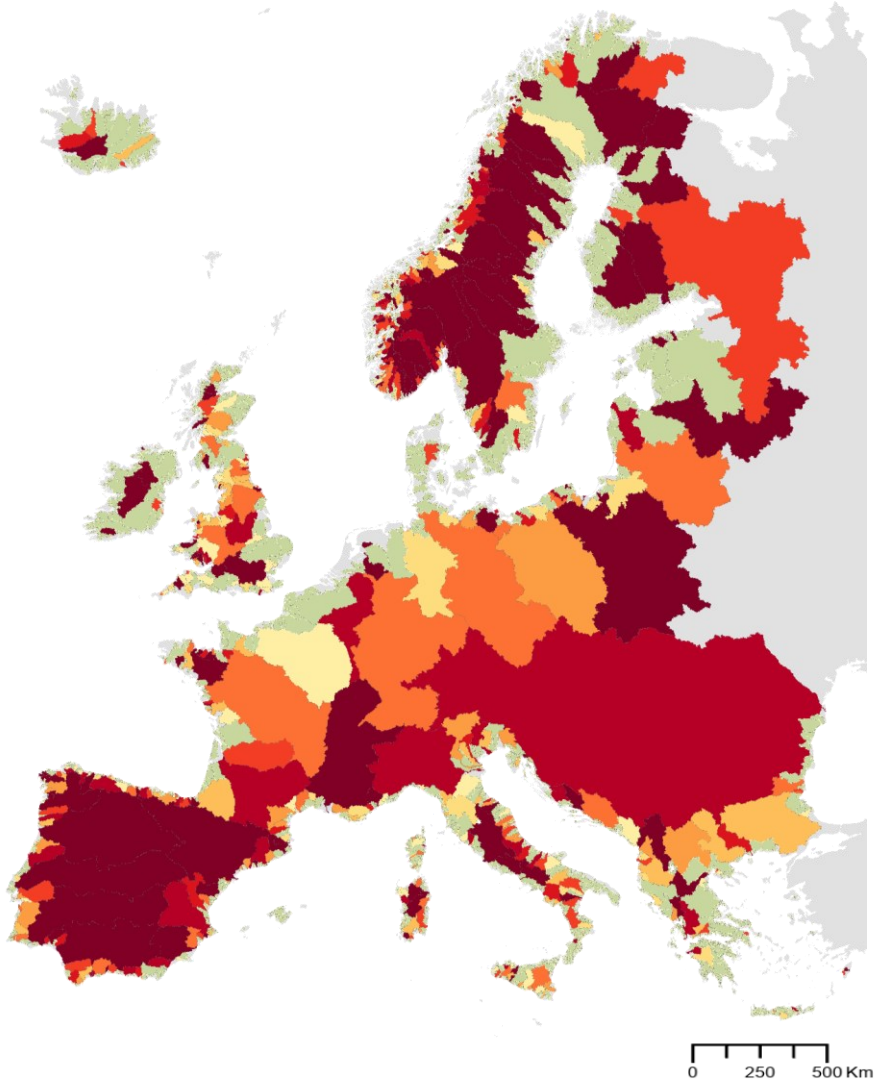


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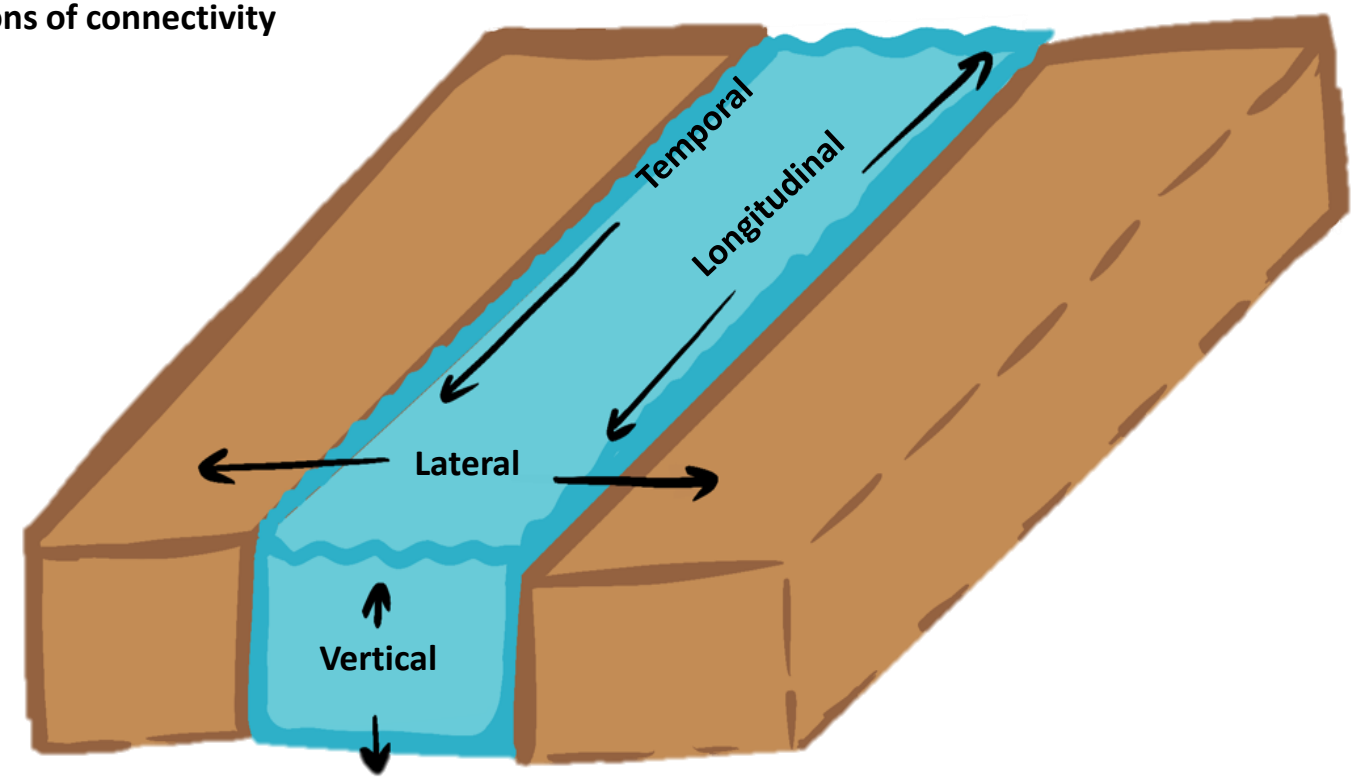
# Connectivity

"exchange pathways of water, resources and organisms between the channel, the aquifer, and the floodplain" (Ward, 1989)

**Dimensions of connectivity**



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## Other Connectivity Impairments

- Dams and Reservoirs
- Roads
- Railroads
- Navigational Waterways

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## Roads and Railroads

- Global Roads Inventory Project (**GRIP**) (Meijer et al., 2018)
  - T1- Highways
  - T2- Primary roads
  - T3- Secondary roads
  - T4- Tertiary roads
  - T5- Local roads
  - Railroads

- Calculated road width and added buffer to layer to determine river length affected by road intersections.

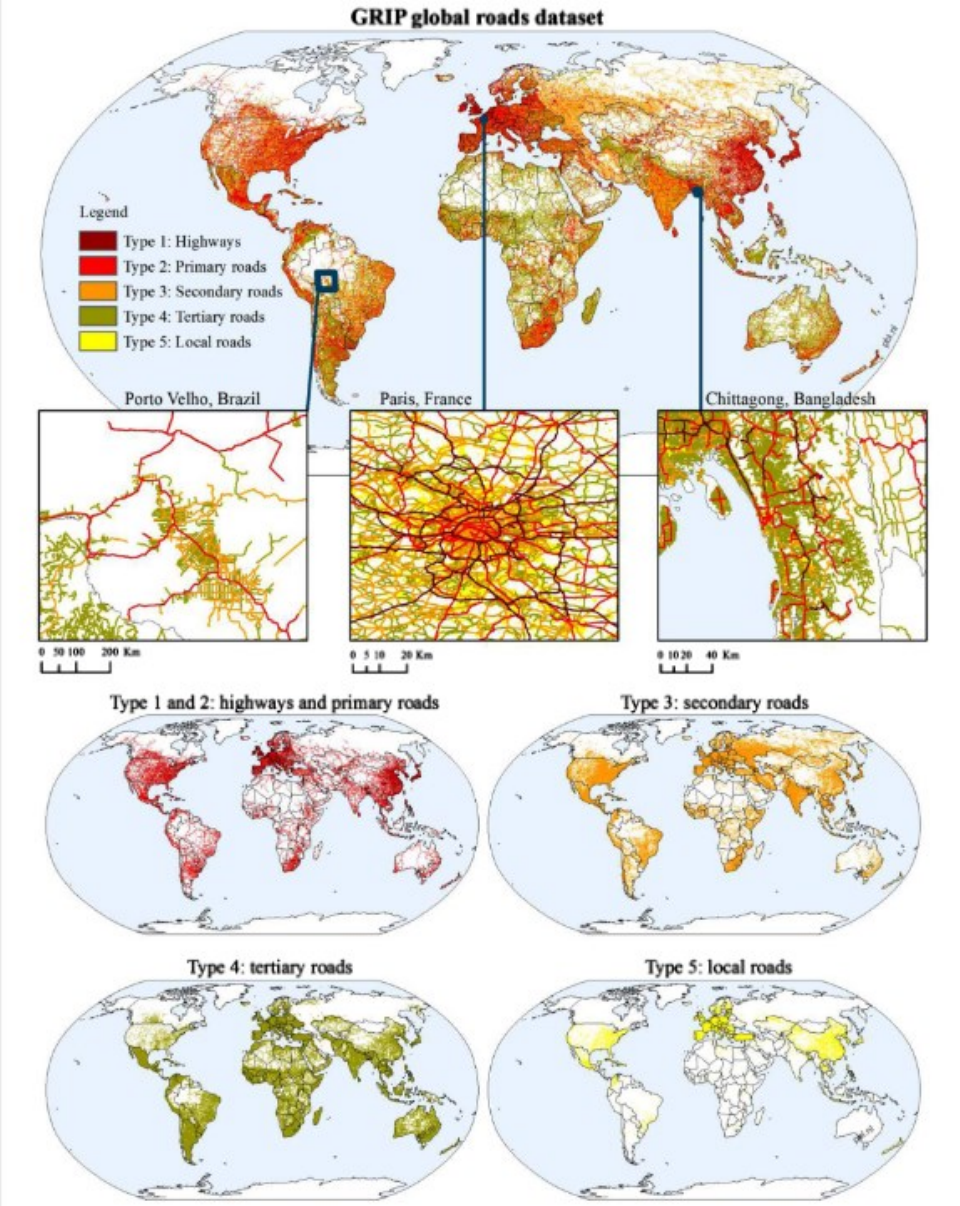


Figure 3. The GRIP global road maps, displaying the detailed and harmonized coverage over world regions and the coverage per individual road type.

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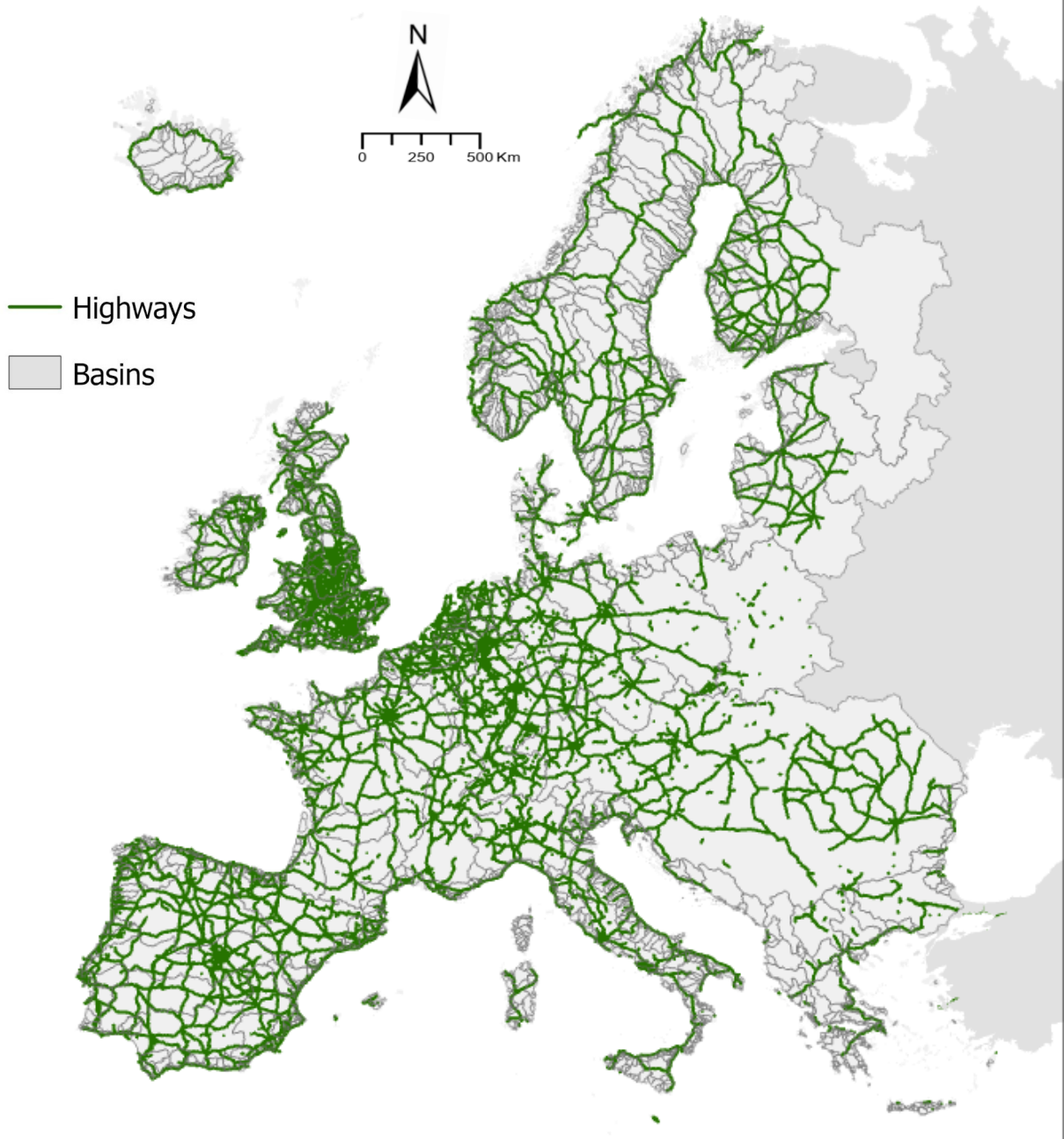
## Roads

- Global Roads Inventory Project (**GRIP**) (Meijer et al., 2018)




GLoBio
Global biodiversity model for policy support

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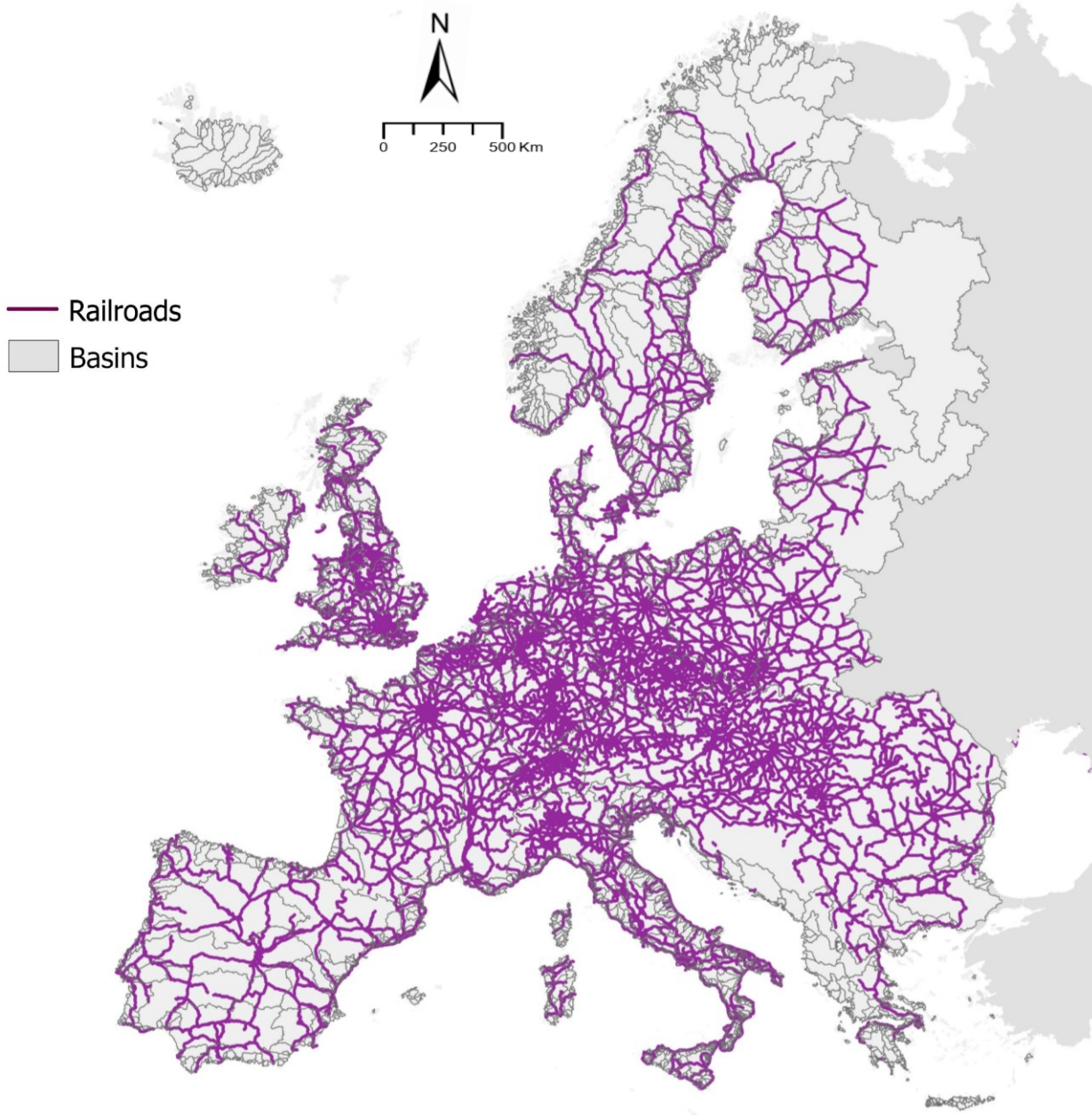
## Railroads

- © 2023 EuroGeographics



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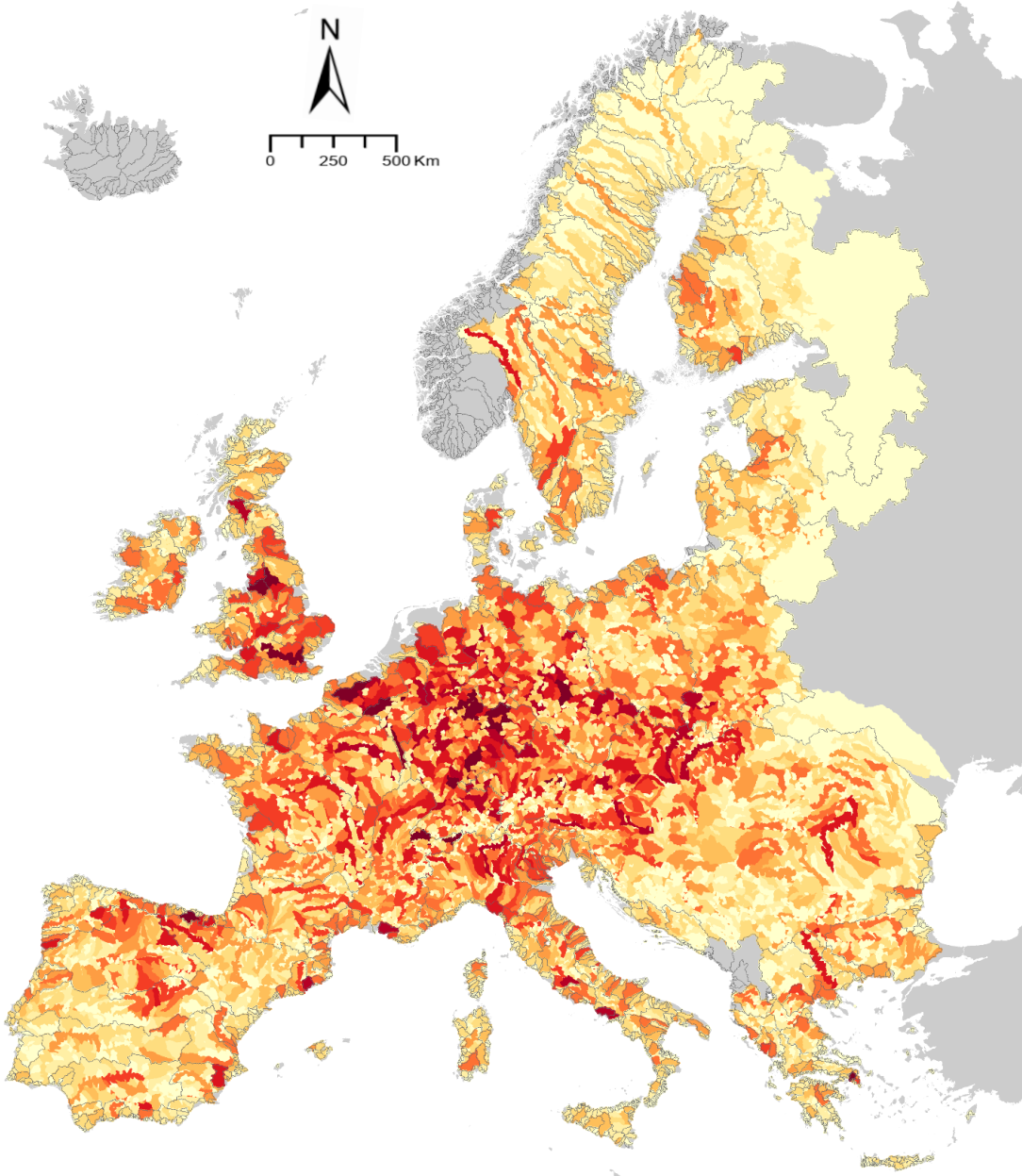
## Roads and Railroads

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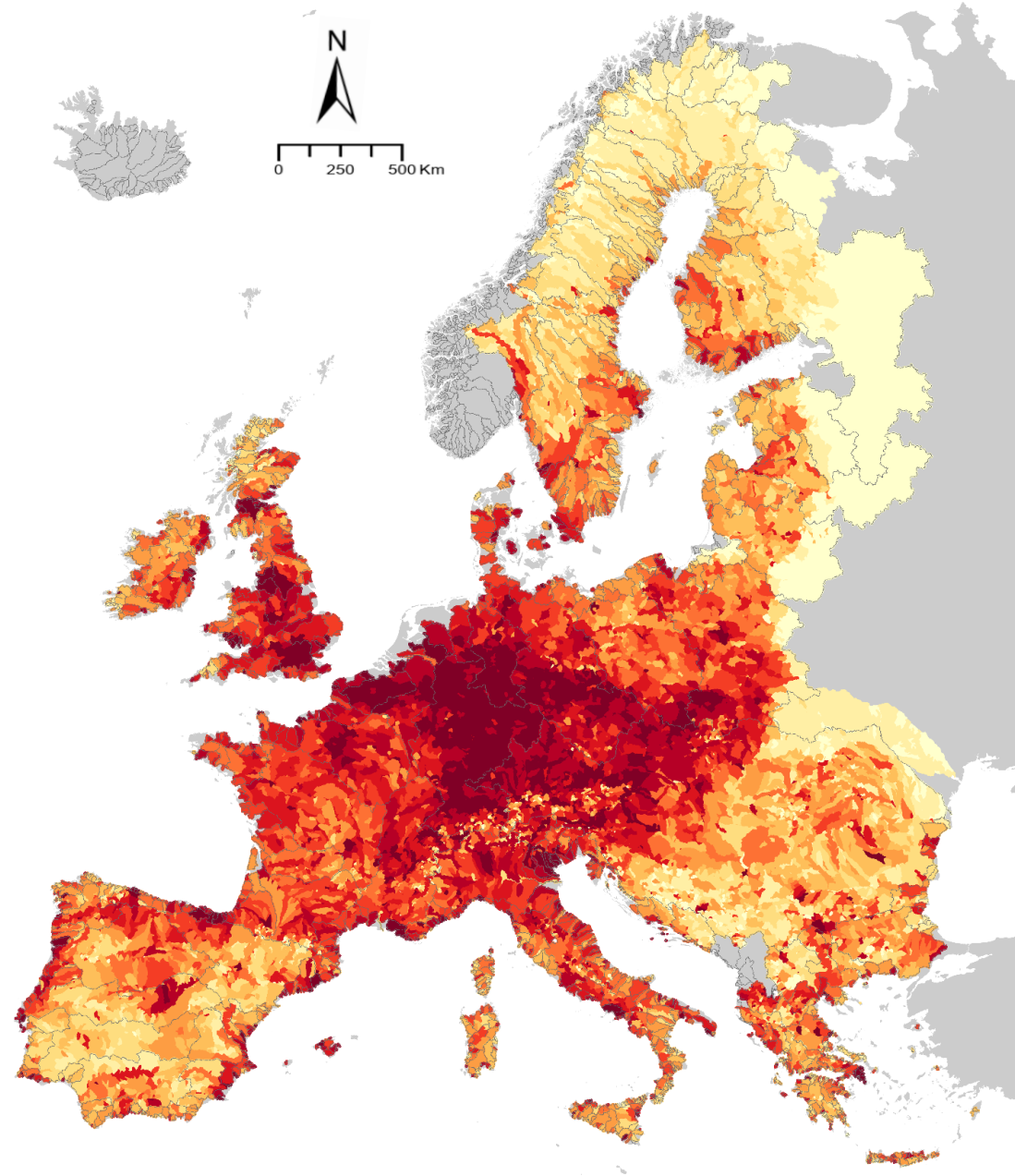
## Roads and Railroads

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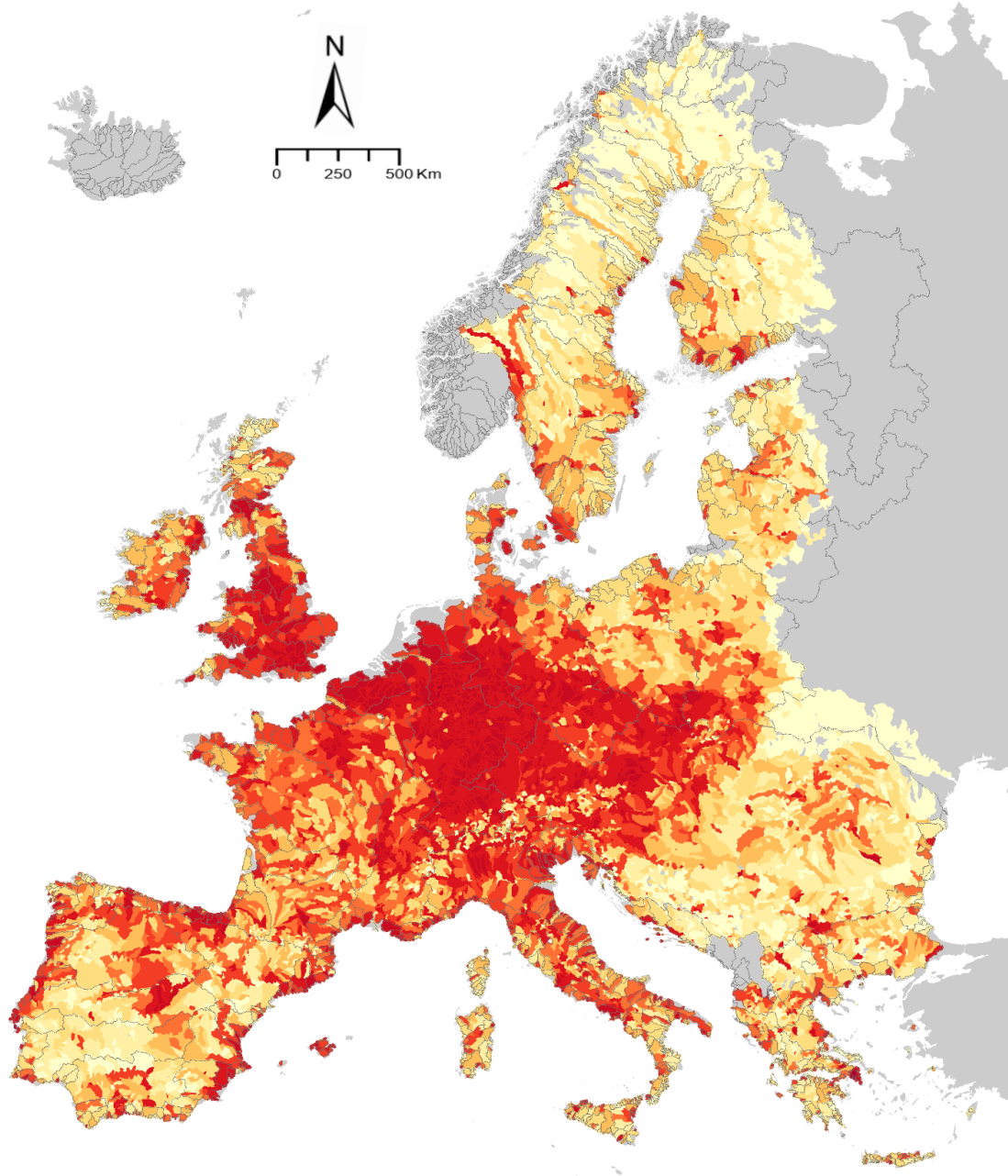
## Roads and Railroads

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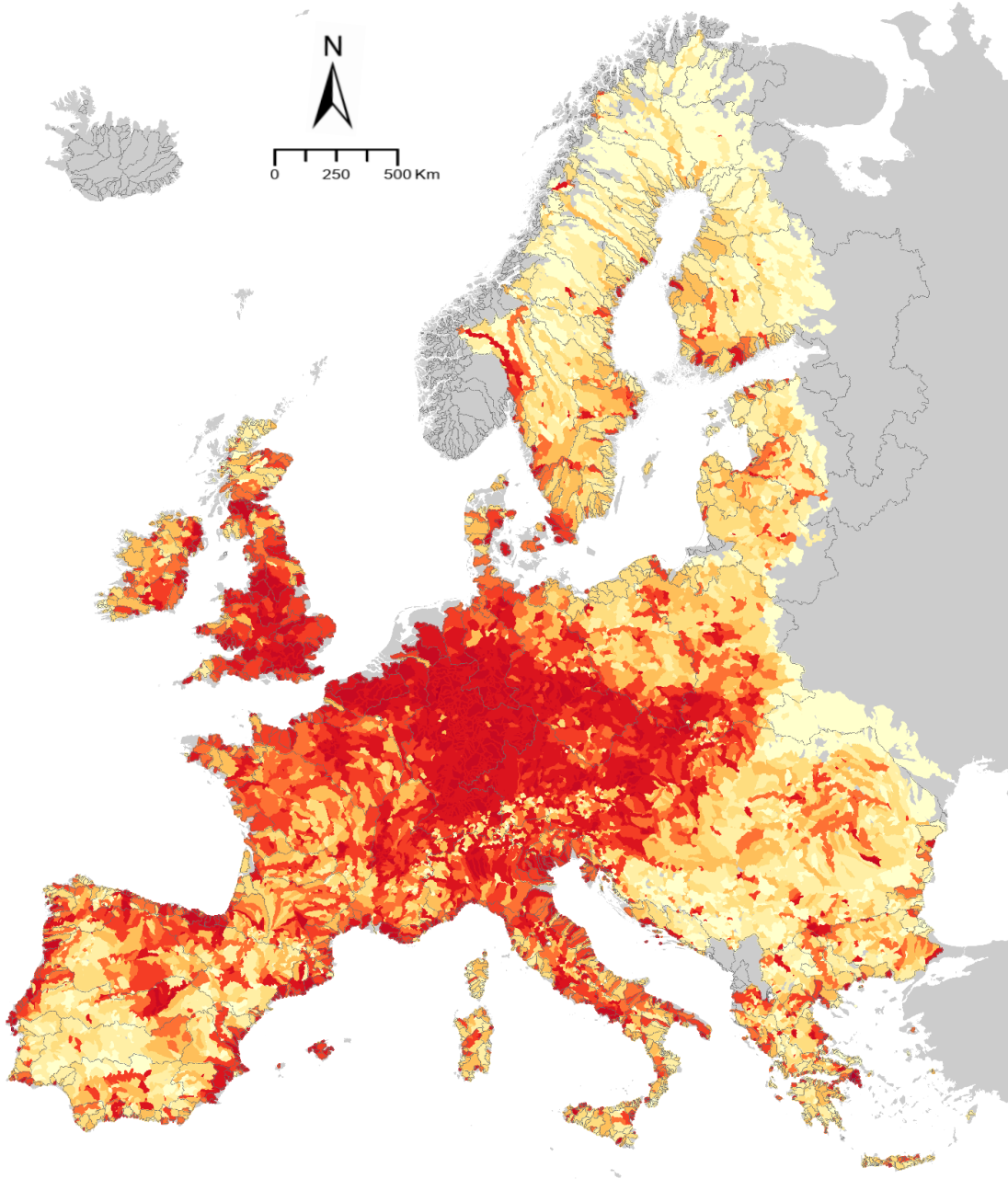
## Roads and Railroads

7 052 Km

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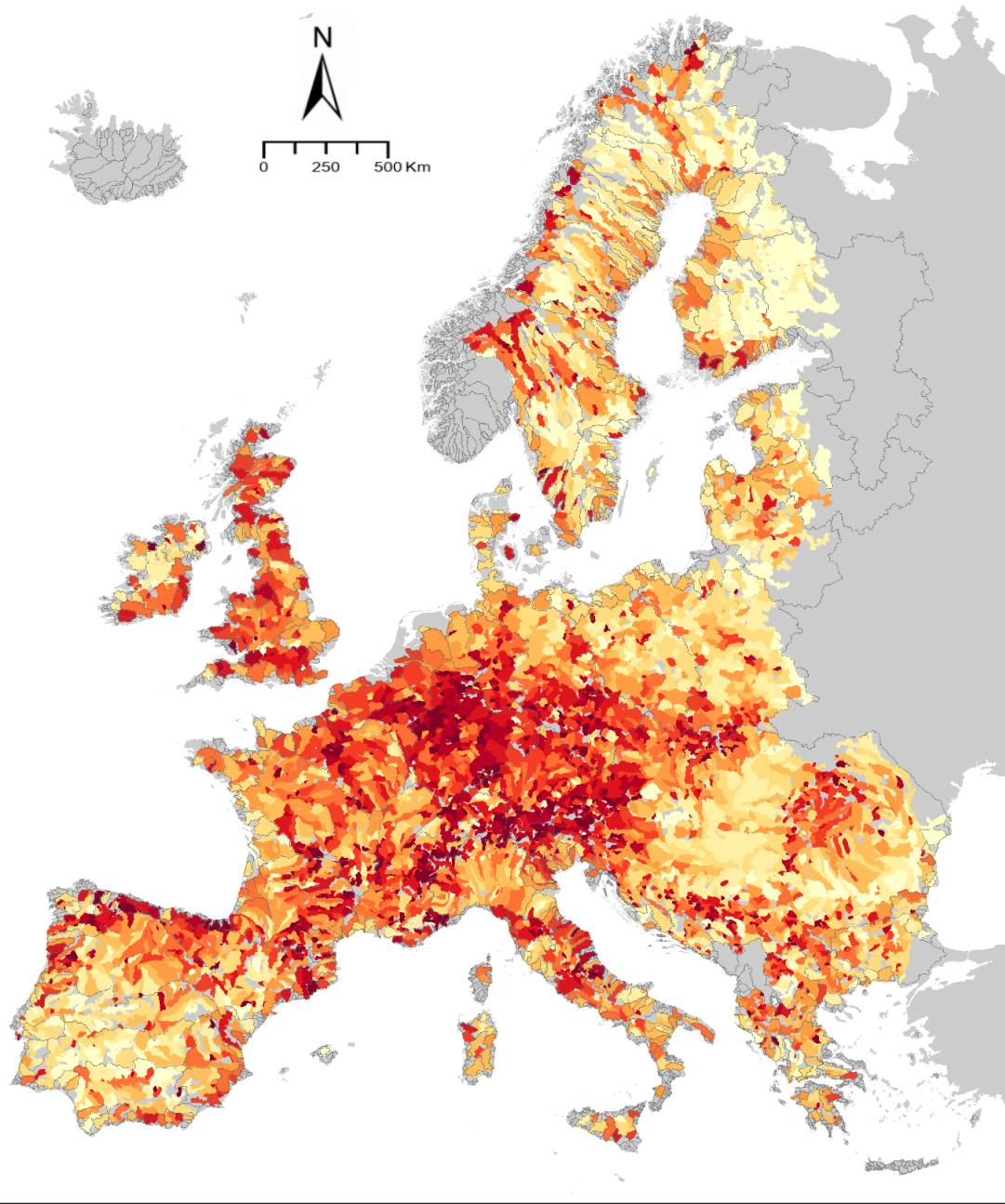
## Roads and Railroads

1 900 Km$^2$

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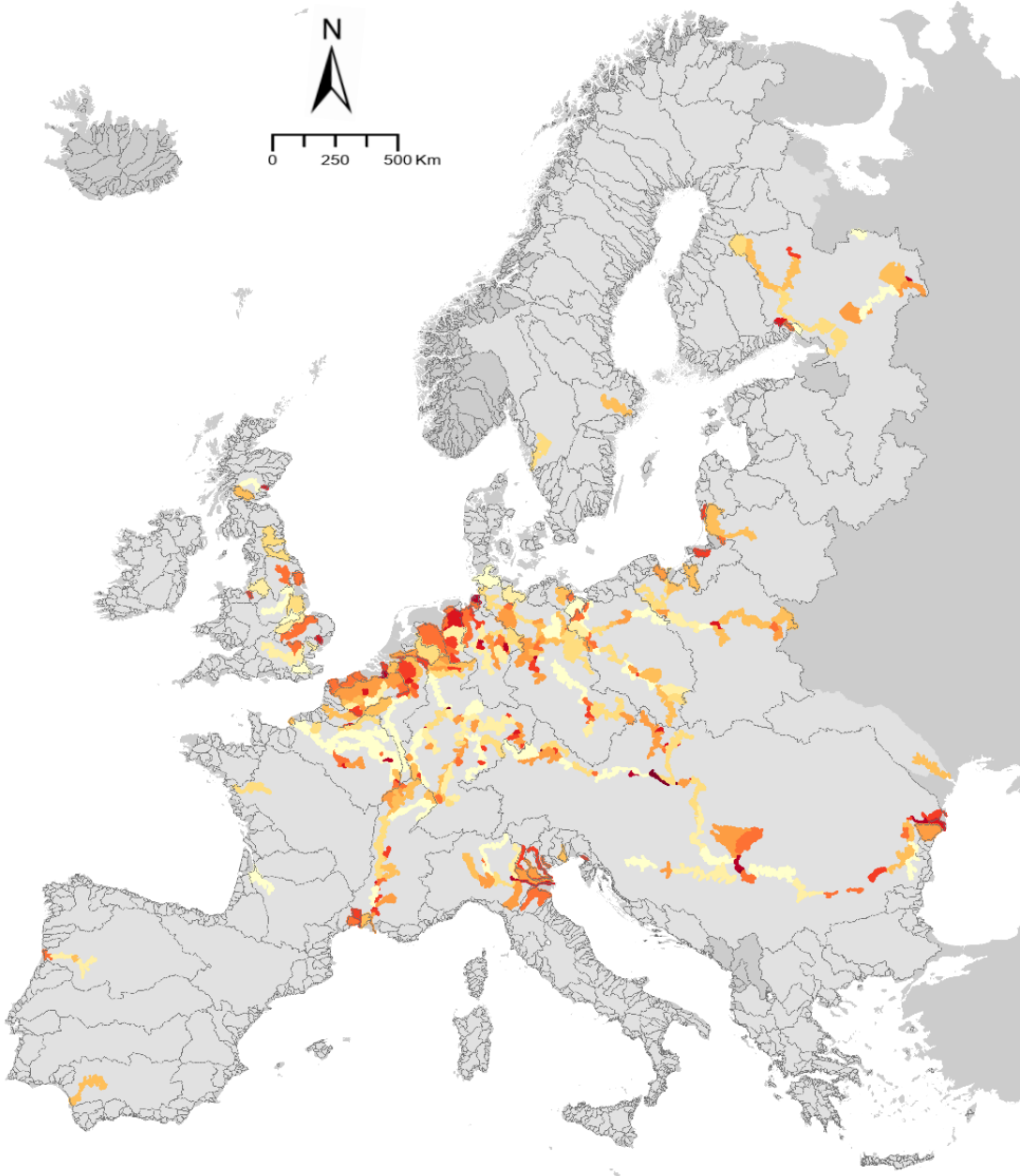
## Navigational Waterways

- United Nations Economic Commission for Europe


UNECE

# The State of European River Network Connectivity

## Navigational Waterways

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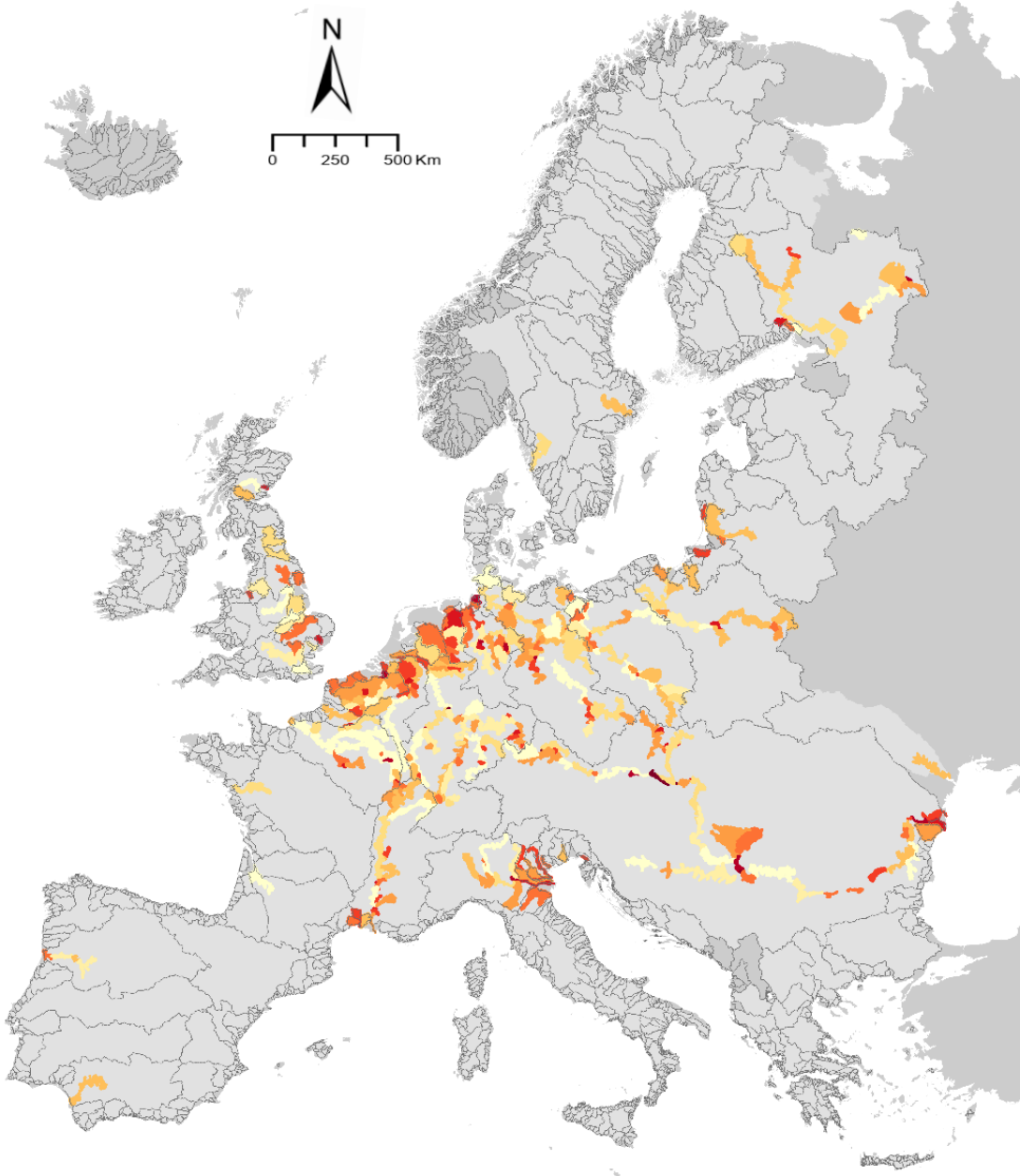
## Navigational Waterways

18 594 Km

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| Disturbance | River Length (Km) | Floodplain Area ($Km^2$) |
|---|---|---|
| Dams | - | - |
| Reservoirs | 66 818 | - |
| **Dams and Reservoirs** | 79 393 | 19 394 |
| **Roads and Railroads** | 7 052 | 1 900 |
| **Waterways** | 18 594* | - |

*estimation

**21 280 $Km^2$**

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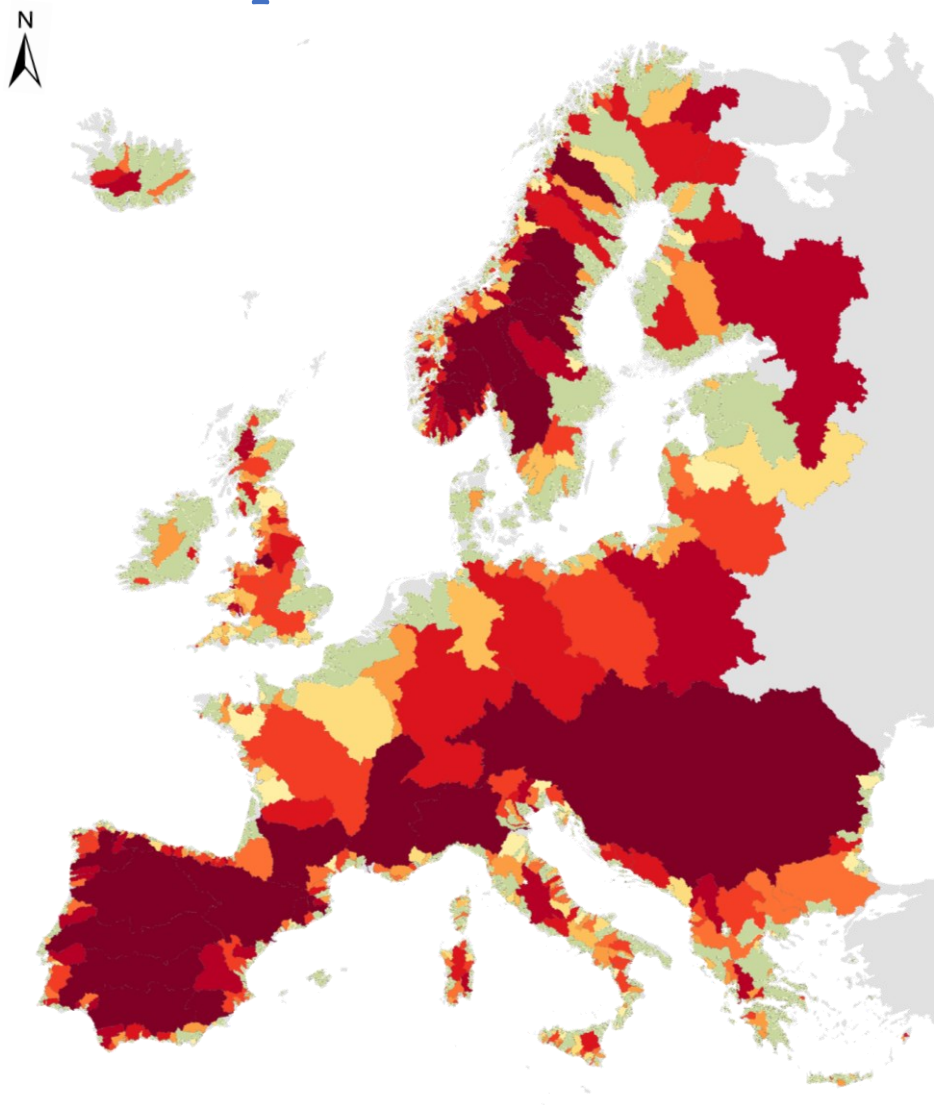


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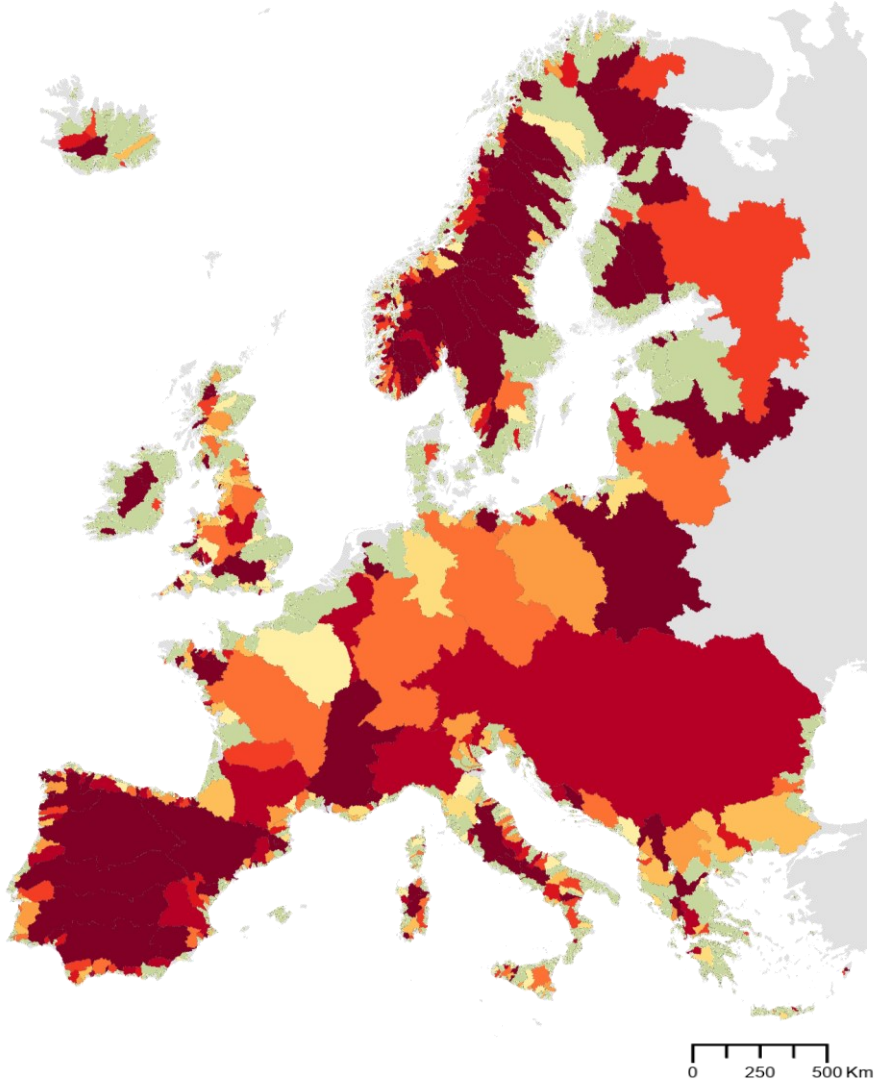


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# The State of European River Network Connectivity

## Take Home Message

- River networks are **naturally fragmented** (on average 18% of river network fragmentation is natural).

- Longitudinal connectivity is the most relevant dimension for fish species, nonetheless, **lateral disconnection** is recognized as a significant impact on ecological function in riverscapes, negatively affecting the development of **side-channel habitats, floodplain evolution, riparian ecosystem processes, and biodiversity.**

- Aggregation of these metrics allows the classification of the sub-basins regarding the overall effect on lateral connectivity.

- Assessing the extent of these disturbances is relevant in attaining goals placed by environmental policies like the **Water Framework Directive** or the **Nature Restoration Law**.

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## Thank you for your attention!

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TERRA Laboratory for sustainable land use and ecosystem services
DammedFish
fct Fundação para a Ciência e a Tecnologia