

Identifying hotspots of GHG emissions from drained peatlands in the European Union (EU+)

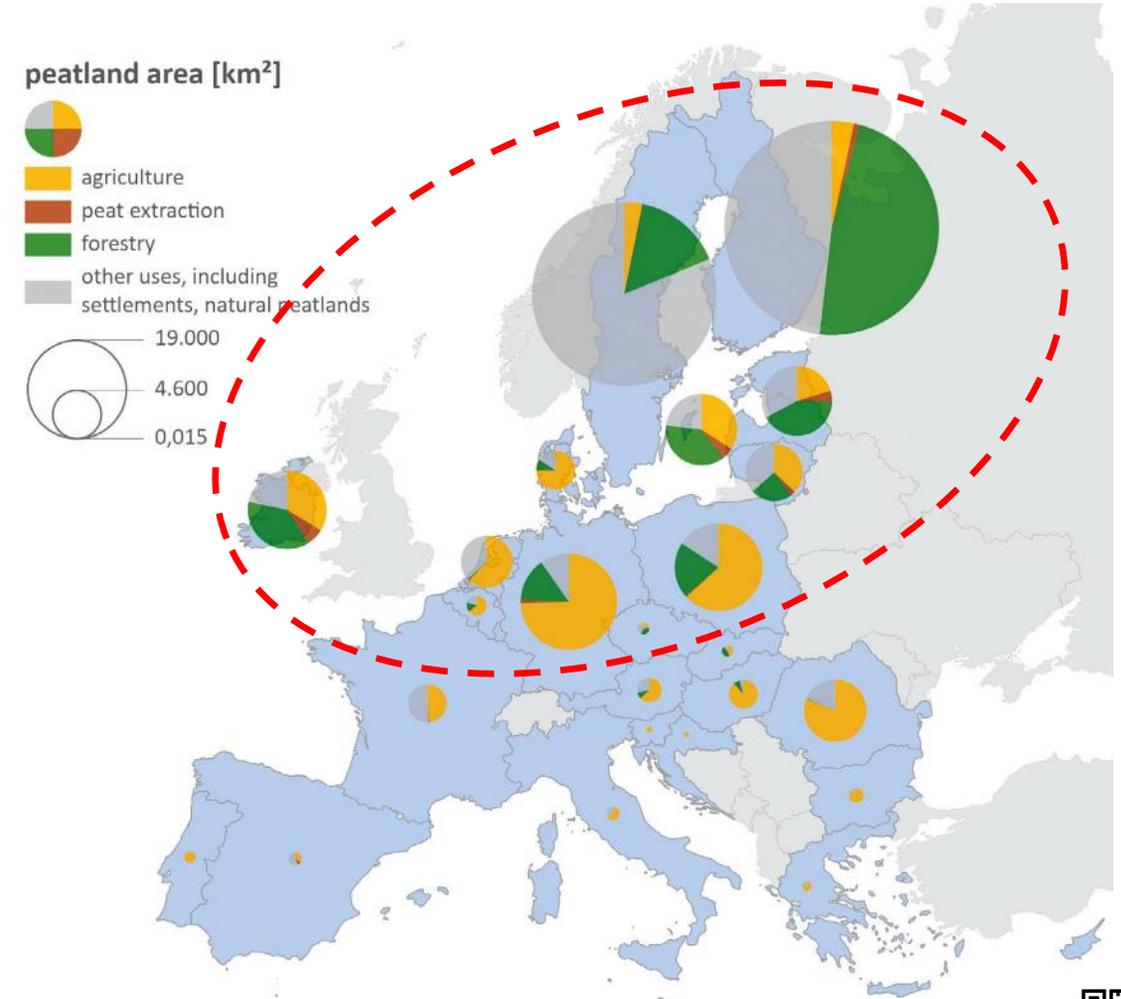


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Peatland use in the EU

⇒ Peatlands in the EU are **drained and used** for agriculture forestry and peat extraction

⇒ Peatland rich countries of the EU are in **Northern-Central Europe**.



Data: Global Peatland Database 2022
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Source: GMC/WI Policy Briefing: <https://europe.wetlands.org/download/6860/>

Peatland use in the EU

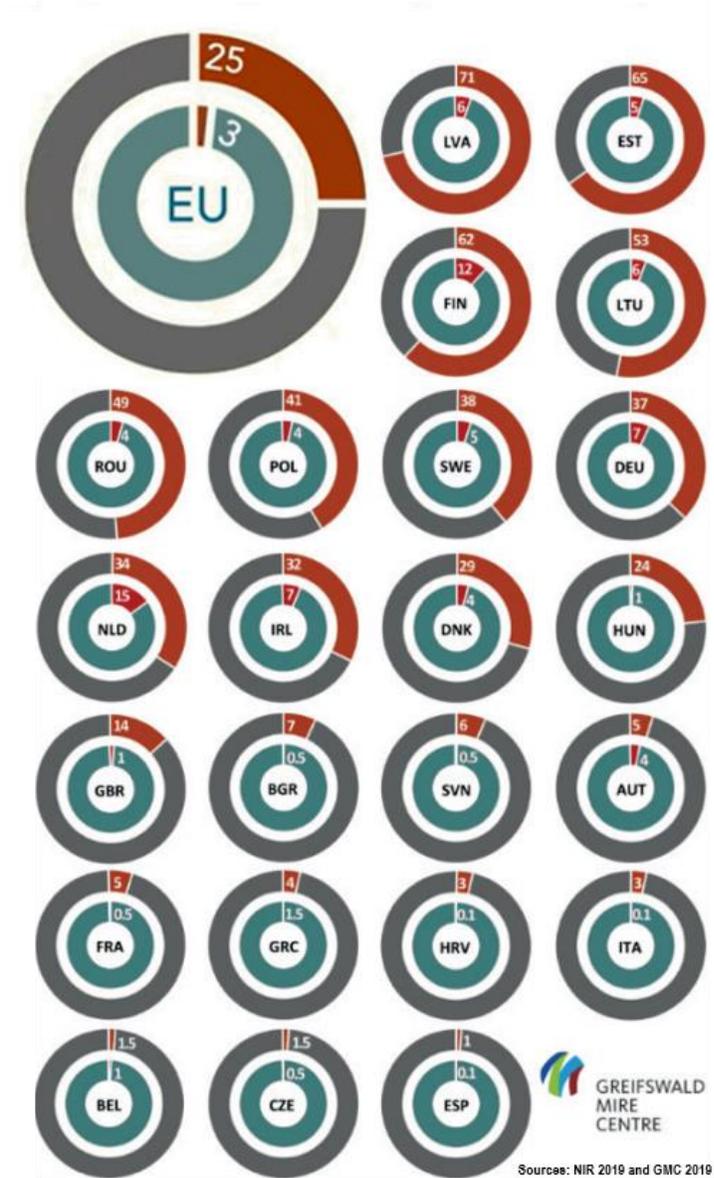
⇒ EU is the **2nd largest** emitter of GHG from drained peatlands globally.

⇒ Disproportional high emissions in some sectors e.g. **agriculture land use:**

EU: 25% of agricultural emissions,

⇒ from **3%** of the production area.

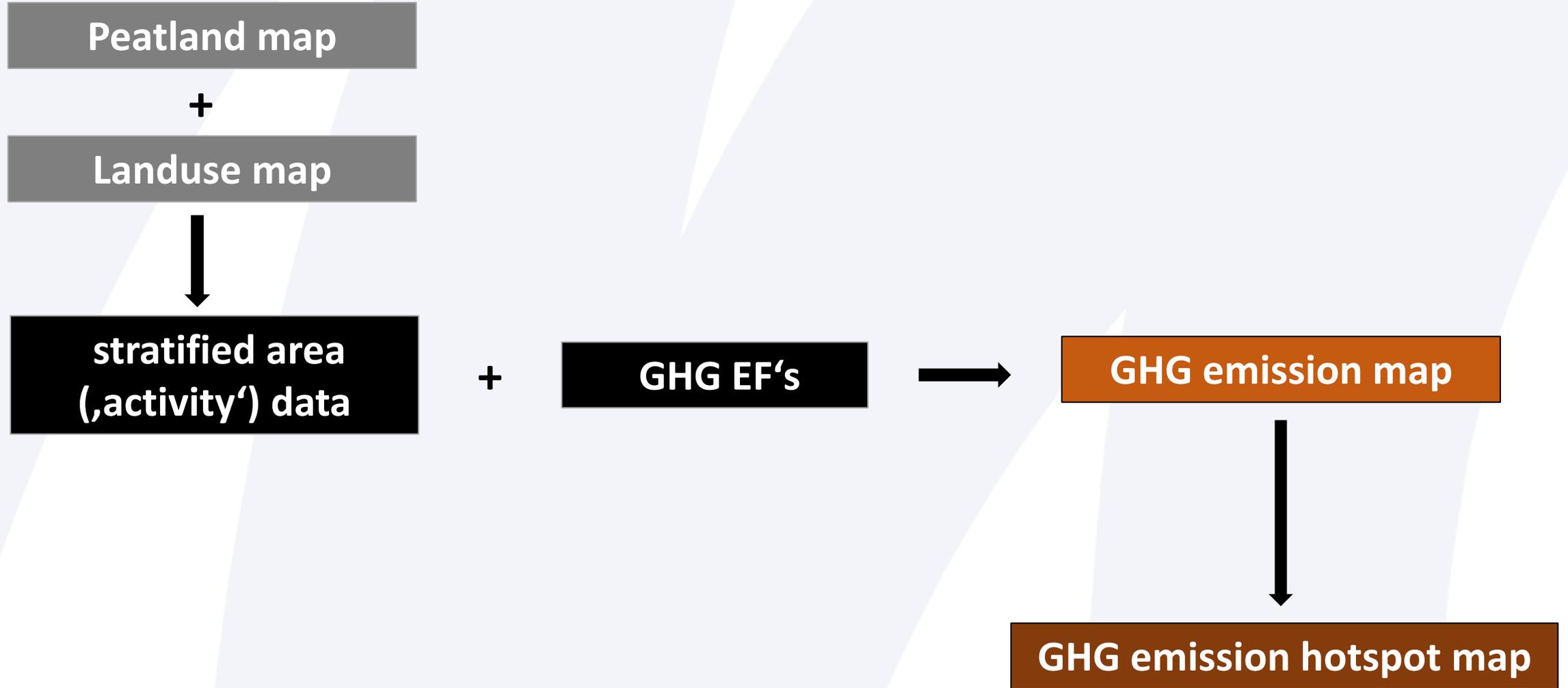
Where are the hotspots of GHG emissions?



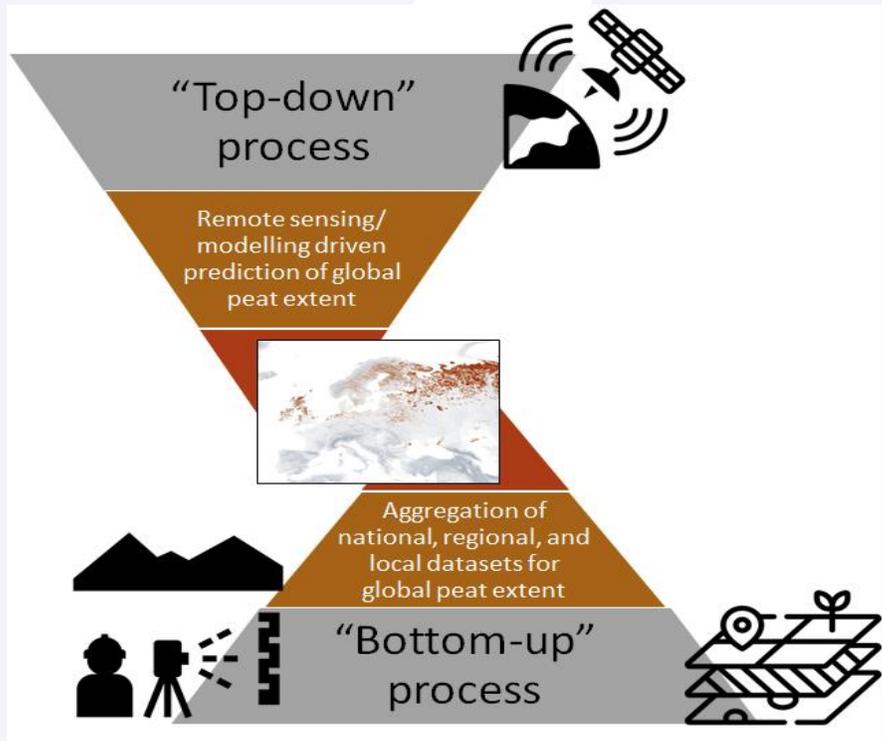
Source: Position paper 2020: [Peatlands in the EUv4.8.indd \(greifswaldmoor.de\)](#)

Fig: % of agricultural land on organic soils (inner circle) and % of their GHG emissions of total agricultural emissions (incl. LULUCF - outer circle)

Mapping GHG emissions from drained peatlands



Updated European Peatland Map



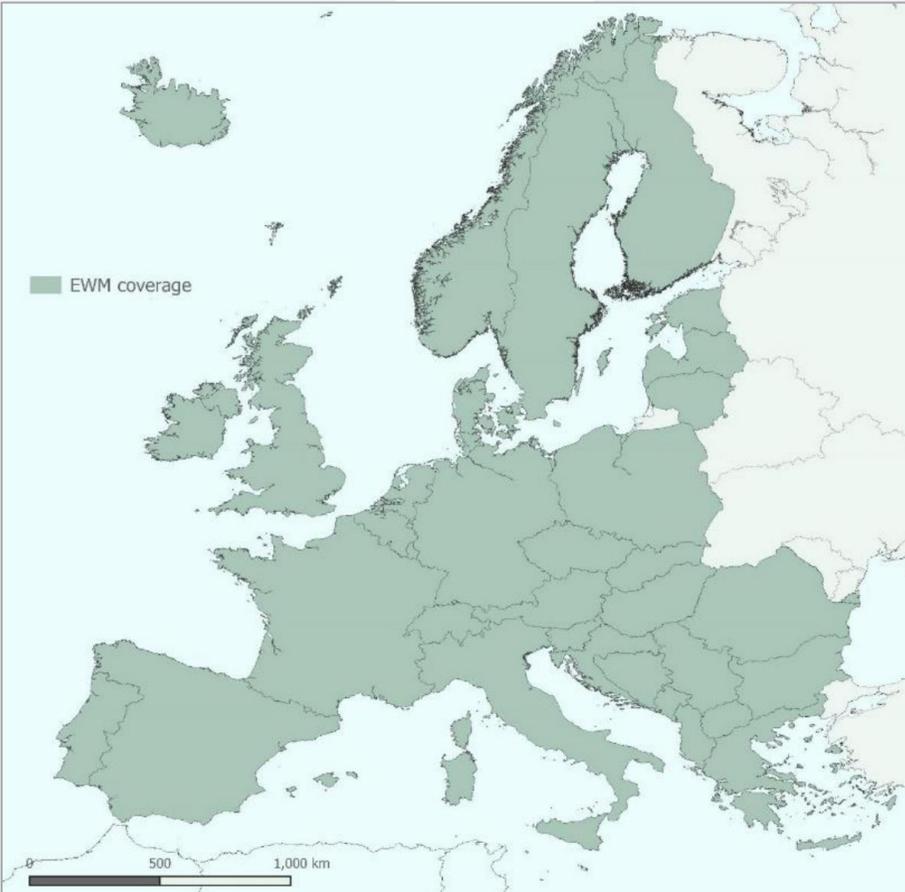
stratified area ('activity') data

Multiple methodologies have been employed to date, basically follow either a **Top-down approach** or a **Bottom-up approach**.

The peatland map is bottom-up amalgamated, spatial mosaic layer and is based on > 100 single input datasets. The definitions are in line with IPCC (2006) and IPCC (2014) definition of 'organic soils'.

Updated European Peatland Map

...is part of the European Wetland Map (Tegetmeyer et al., 2025) and has EU+ coverage.



stratified area ('activity') data

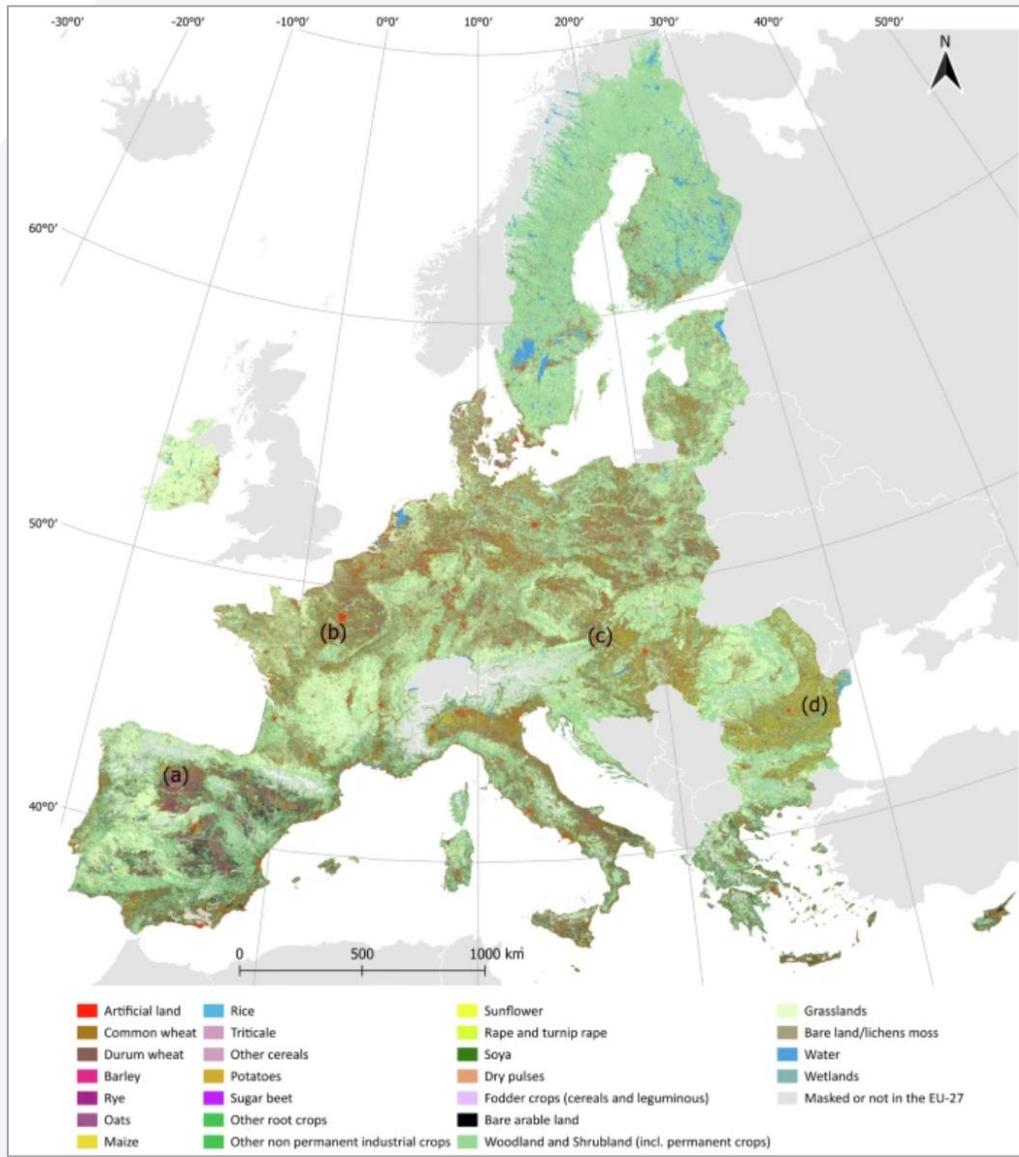


Mapping land use on peatland (dataset 1)

stratified area ('activity') data

EU crop map (JRC, Ghassemi et al., 2024)

- based on satellite images of 2022
 - spatial resolution: 10 meters
 - delineates the most common (19) crops grown on EU agricultural parcels
- no non-agricultural areas
- no grasslands within crop rotation
- nor includes countries outside the EU

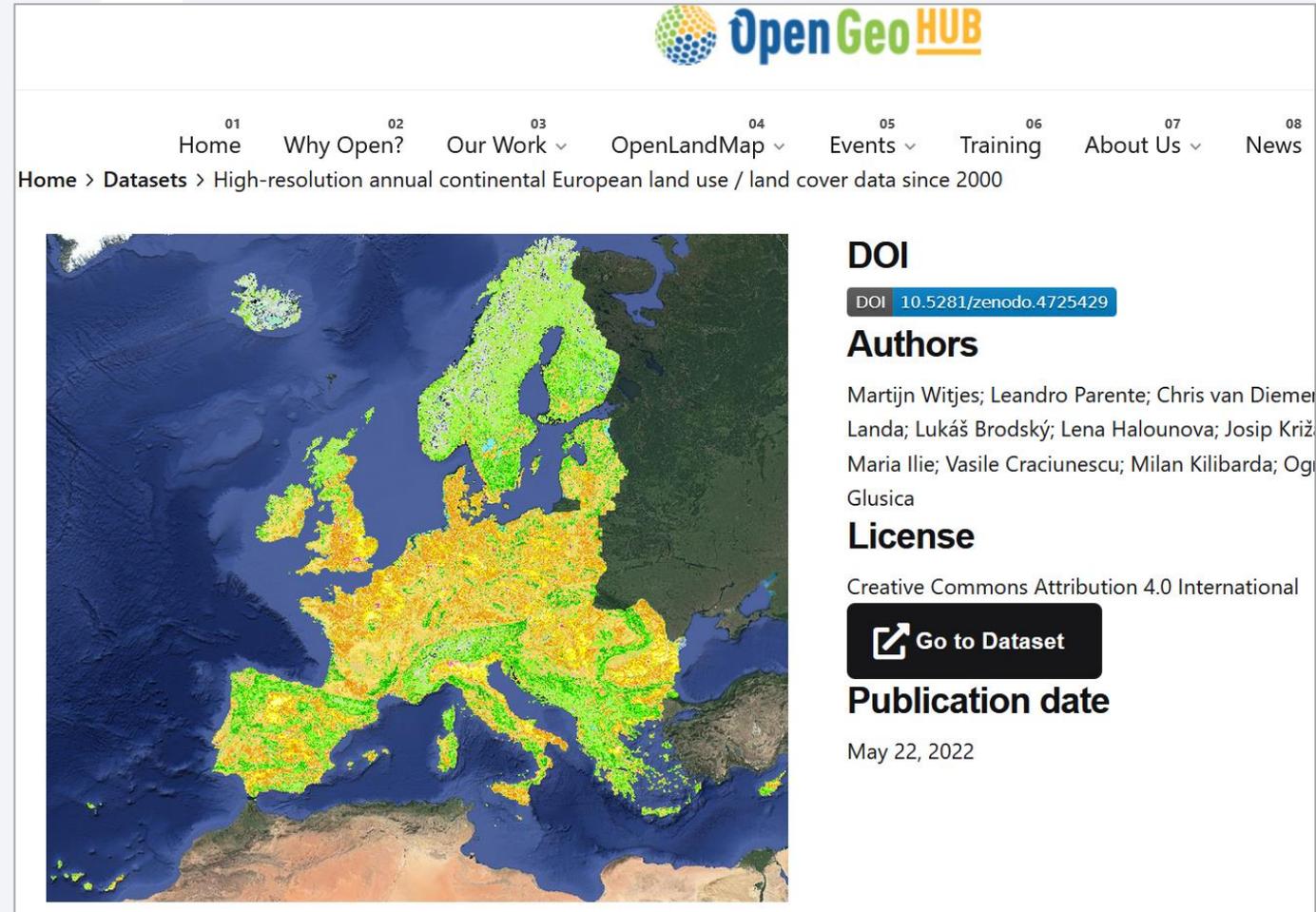


Mapping land use on peatland (dataset 2)

stratified area ('activity') data

Continental Europe land cover mapping at 30m resolution based CORINE and LUCAS on samples ('EML'; Parent et al., 2021)

- annual consistent for 2000-2019
- resolution of 30 m
- used for gap filling of EU Crop map



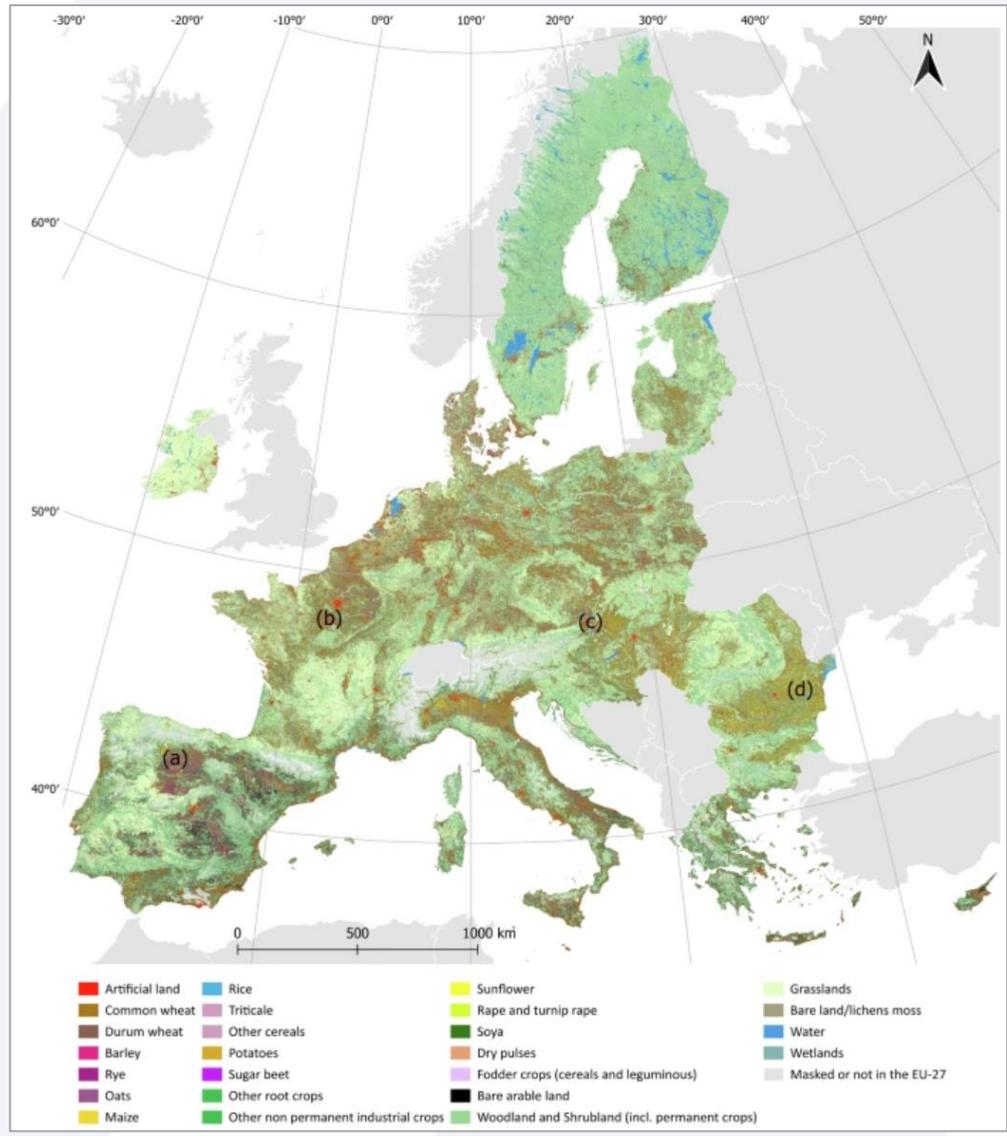
The screenshot shows the OpenGeoHUB website interface. At the top, the OpenGeoHUB logo is visible. Below it is a navigation menu with items: Home (01), Why Open? (02), Our Work (03), OpenLandMap (04), Events (05), Training (06), About Us (07), and News (08). The breadcrumb trail reads: Home > Datasets > High-resolution annual continental European land use / land cover data since 2000. The main content area features a map of Europe with a color-coded land use overlay. To the right of the map, the following information is displayed: DOI: 10.5281/zenodo.4725429; Authors: Martijn Witjes; Leandro Parente; Chris van Diemen Landa; Lukáš Brodský; Lena Halounova; Josip Križ; Maria Ilie; Vasile Craciunescu; Milan Kilibarda; Oglusica; License: Creative Commons Attribution 4.0 International; a 'Go to Dataset' button; and Publication date: May 22, 2022.

Mapping land use on peatland (dataset 3)

stratified area ('activity') data

earlier EU crop map of (Andrimont et al., 2021)

- is based on satellite images of 2018
- extracted class 'grasslands within crop rotation'



Mapping land use on peatland

stratified area ('activity') data

Peatland map

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**Landuse
datasets 1, 2, 3**

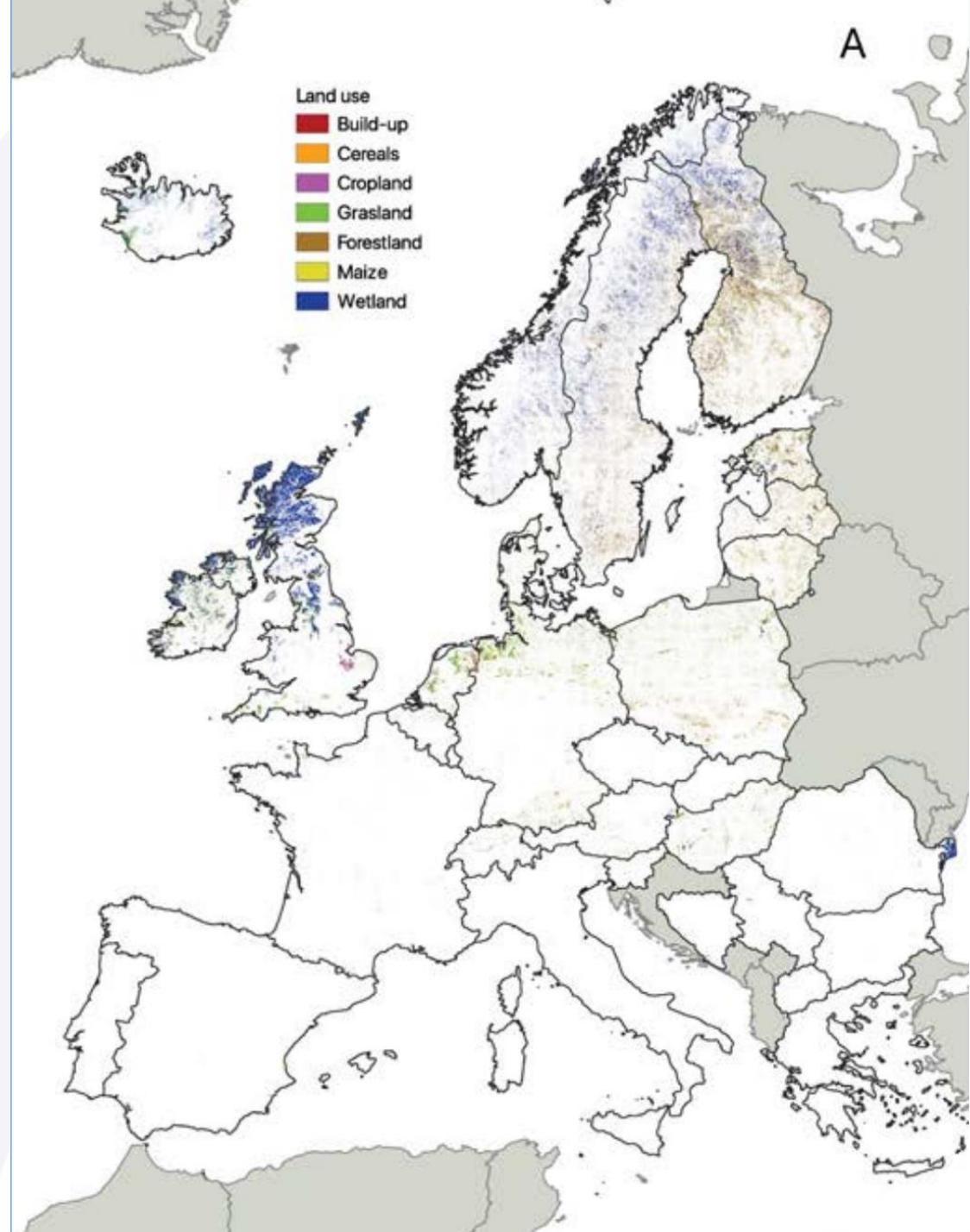


Resulting 80 single land use types on peatlands are aggregated into 5 main classes: Grassland, Cropland, Forest Land, Wetlands (Peat extraction), and Build-up.



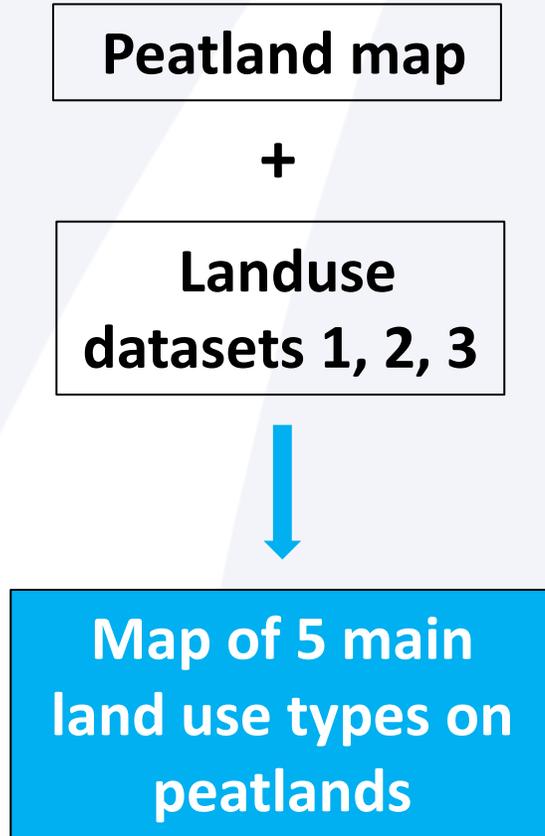
EU+ land use map on peatland

- **75% of all Croplands** (1,302 kha) on peatland are located in Germany, the UK, Lithuania, Poland, Finland, Hungary and the Netherlands
- **75% of all Grasslands** (3,201 kha) occur in Germany, the UK, Poland, Ireland, Iceland and the Netherlands
- **>85% of Forest Land** (11,680 kha) is located in Finland, Sweden, Poland, Estonia, Lithuania and Latvia
- **>85% of undisturbed peatland** is found in N-Europe countries, together with the UK, Ireland and Iceland



Mapping GHG emissions from drained peatlands

stratified area ('activity') data



Additionally allocating drainage & nutrient levels

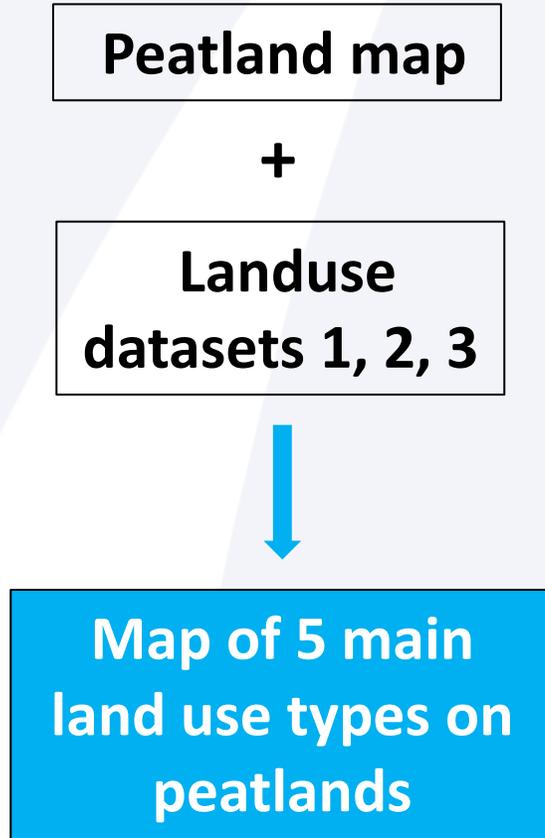
- used *Biomass productivity map* (Tóth et al., 2013) as proxy
- Basic assumptions:
 - biomass productivity has not changed from 2013-2022 as nutrient content in peat soils does not change in short term (Heuts et al., 2024)
 - **Grassland with...**

'high biomass production'
= 'deep drained' (DD)
= 'nutrient-rich' (NR)

'low biomass production'
= 'shallow drained' (SD)
= 'nutrient-poor' (NP)

Mapping GHG emissions from drained peatlands

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- Basic assumptions:
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 - **Forest Land area with...**

'high biomass production'
= 'nutrient-rich' (NR)

'low biomass production'
= 'nutrient-poor'

Mapping GHG emissions from drained peatlands

GHG emission factors

Emission factors used in this study (t CO₂e ha⁻¹ annually⁻¹) ± standard error of each EF and number of sites (n; IPCC 2014).

	Land use category	CO ₂	CH ₄	N ₂ O	DOC	Ditch	GWP
B o r e a l	Forest Land NP	0.92 ± 0.88 (n=59)	0.33 ± 0.09 (n=47)	0.09 ± 0.04 (n=43)	0.44 ± 0.1 (n=10)	0.15 ± 0.09 (n=11)	1.79 ± 0.9
	Forest Land NR	3.41 ± 1.39 (n=62)	0.20 ± 0.09 (n=83)	1.37 ± 0.6 (n=75)	0.44 ± 0.1 (n=10)	0.15 ± 0.09 (n=11)	5.42 ± 1.72
	Cropland	28.97 ± 5.31 (n=39)	0 ± 0 (n=38)	5.57 ± 2.42 (n=36)	0.44 ± 0.1 (n=10)	0.79 ± 0.74 (n=6)	35.75 ± 7.51
	Grassland	20.89 ± 10.44 (n=8)	0.04 ± 0.02 (n=12)	4.06 ± 1.85 (n=16)	0.44 ± 0.1 (n=10)	0.79 ± 0.74 (n=6)	27.03 ± 13.45
	Peat extraction	10.26 ± 5.68 (n=20)	0.16 ± 0.13 (n=15)	0.13 ± 0.05 (n=4)	0.44 ± 0.1 (n=10)	0.37 ± 0.37 (n=6)	11.36 ± 6.22
T e m p e r a t e	Forest Land	9.53 ± 2.38 (n=8)	0.07 ± 0.04 (n=13)	1.14 ± 0.5 (n=13)	1.14 ± 0.25 (n=12)	0.15 ± 0.09 (n=11)	12.93 ± 3.27
	Cropland	28.95 ± 5.31 (n=39)	0 ± 0 (n=38)	5.57 ± 2.42 (n=36)	0.44 ± 0.1 (n=10)	0.79 ± 0.74 (n=6)	35.75 ± 7.51
	Grassland NR, DD	22.35 ± 4.21 (n=39)	0.43 ± 0.41 (n=44)	3.51 ± 1.54 (n=47)	1.14 ± 0.25 (n=12)	0.79 ± 0.74 (n=6)	28.22 ± 5.95
	Grassland NR, SD	13.19 ± 1.65 (n=13)	1.05 ± 1.13 (n=16)	0.69 ± 0.3 (n=7)	1.14 ± 0.25 (n=12)	0.79 ± 0.74 (n=6)	16.42 ± 2.27
	Peat extraction	10.26 ± 5.68 (n=20)	0.16 ± 0.13 (n=15)	0.13 ± 0.05 (n=4)	1.14 ± 0.25 (n=12)	0.36 ± 0.32 (n=6)	12.05 ± 6.5

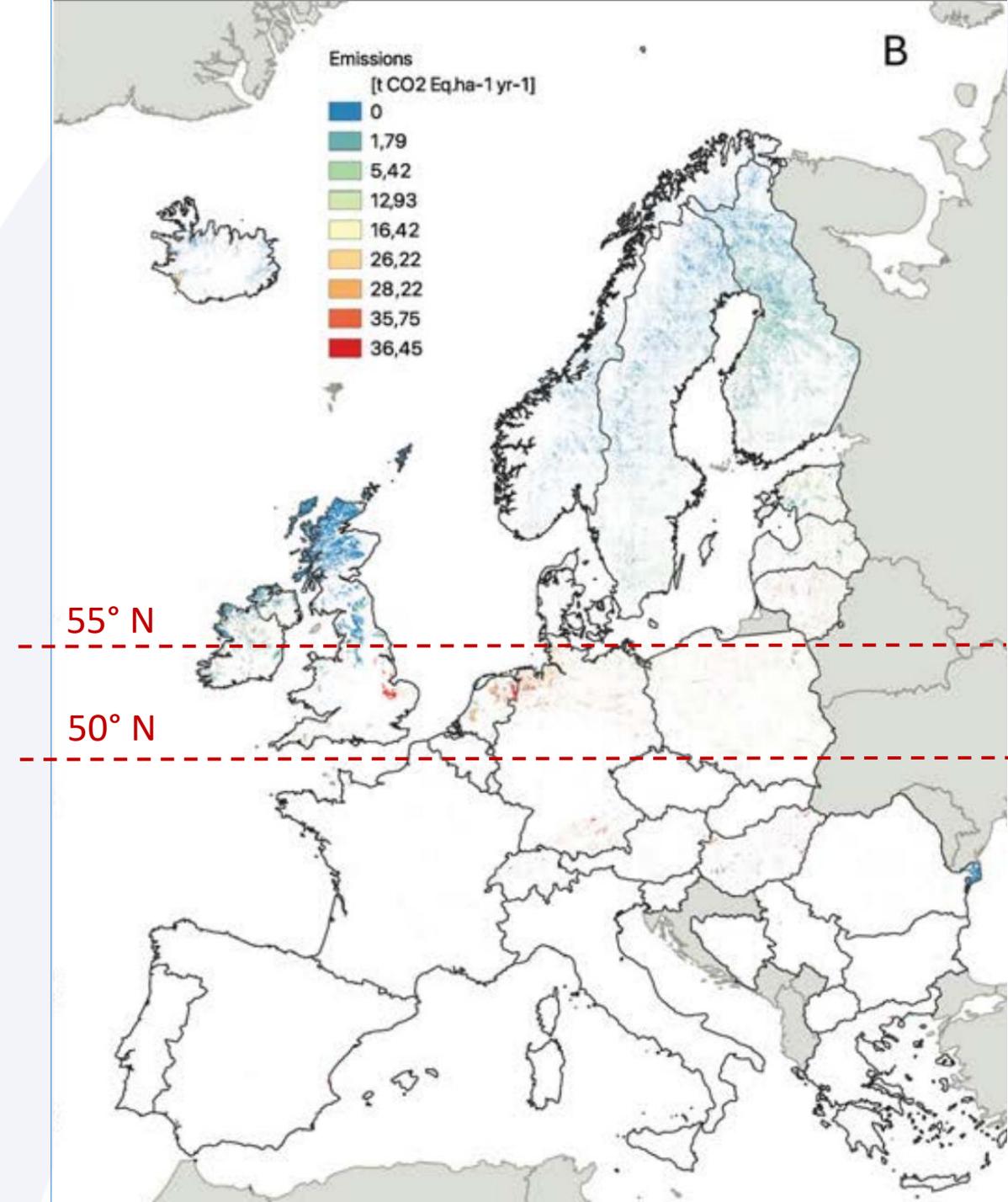
GWP=100 yr global warming potential (IPCC, AR6)

GHG emission map on peatland

Emissions (t CO₂e) were calculated for each 1 km grid cell by using R-4.4.1 (R Core Team, 2024).

We summed up the annual GHG emissions from drained peatland in the EU+ to 232 ± 56 Mt CO₂e.

- **highest GHG emissions from drained peatlands** are observed between latitudes 50° and 55° N
- **low-emitting, mostly undrained or boreal forested peatlands** are concentrated in Finland, Sweden, and Scotland
- **shallow-drained Grasslands** are mainly found in Estonia, Latvia, Lithuania, Ireland and the United Kingdom



Mapping *hotspots* of GHG emissions from drained peatlands

stratified area
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GHG EF's



GHG emission map

We used the 'biscale' package in R (Prener et al., 2022) to derive GHG hotspots. It created a 1 km resolution, colour map while analysing the variables:

1. *Peatland density (amount of peatland per area), and*
2. *Cumulative peatland GHG emissions per area.*

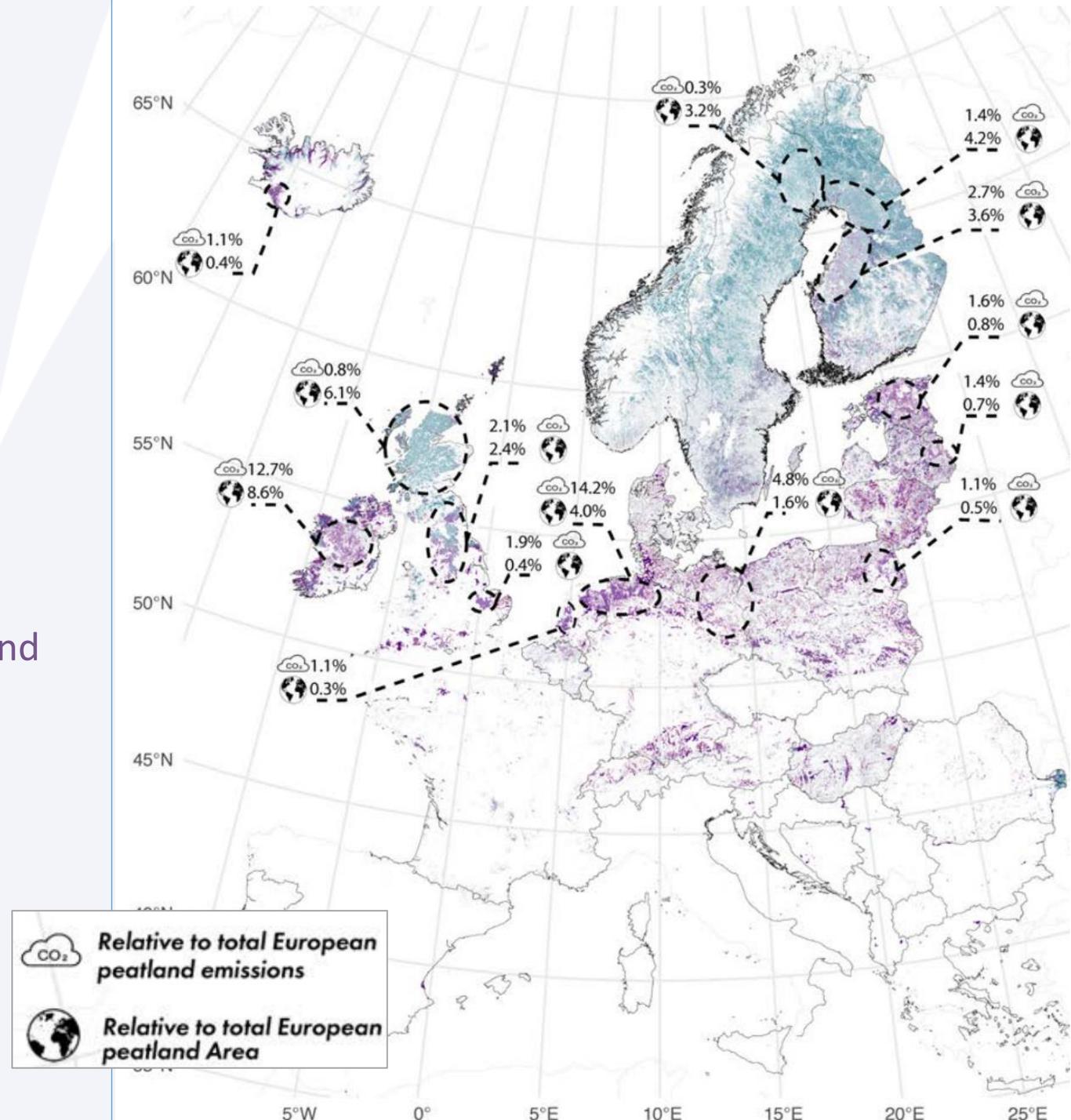


GHG emission hotspot map

Mapping *hotspots* of GHG emissions from drained peatlands

Hotspot map for drained peatland area and GHG emission density in the EU+ (1km² grid)

- high peatland density is depicted in blue colors,
- high emissions intensity in red, and
- simultaneous presence of a high peatland area and high emissions in purple.

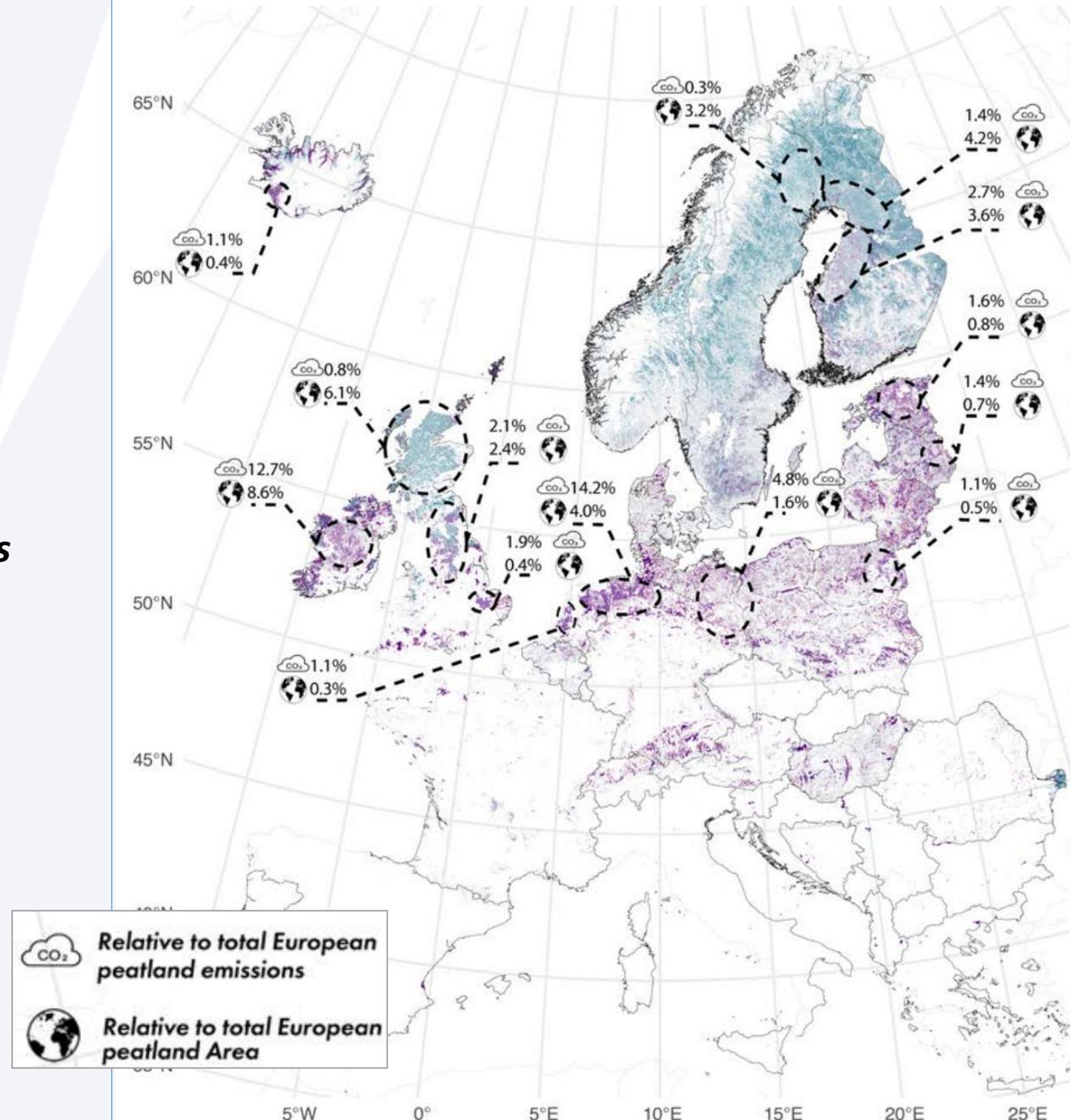


Mapping *hotspots* of GHG emissions from drained peatlands

Overall, peatland GHG emission hotspots are responsible for 39% of the total peatland GHG emissions, despite covering only 17% of the total peatland area of the EU+.

Highest relative emissions (*high emissions from less area*) found in:

- NW-Germany and NE-Netherlands (14.2% of EU+ peatland emissions)
- NE-Germany (4.8%)
- SE-England (1.9%)
- W-Netherlands (1.1%)

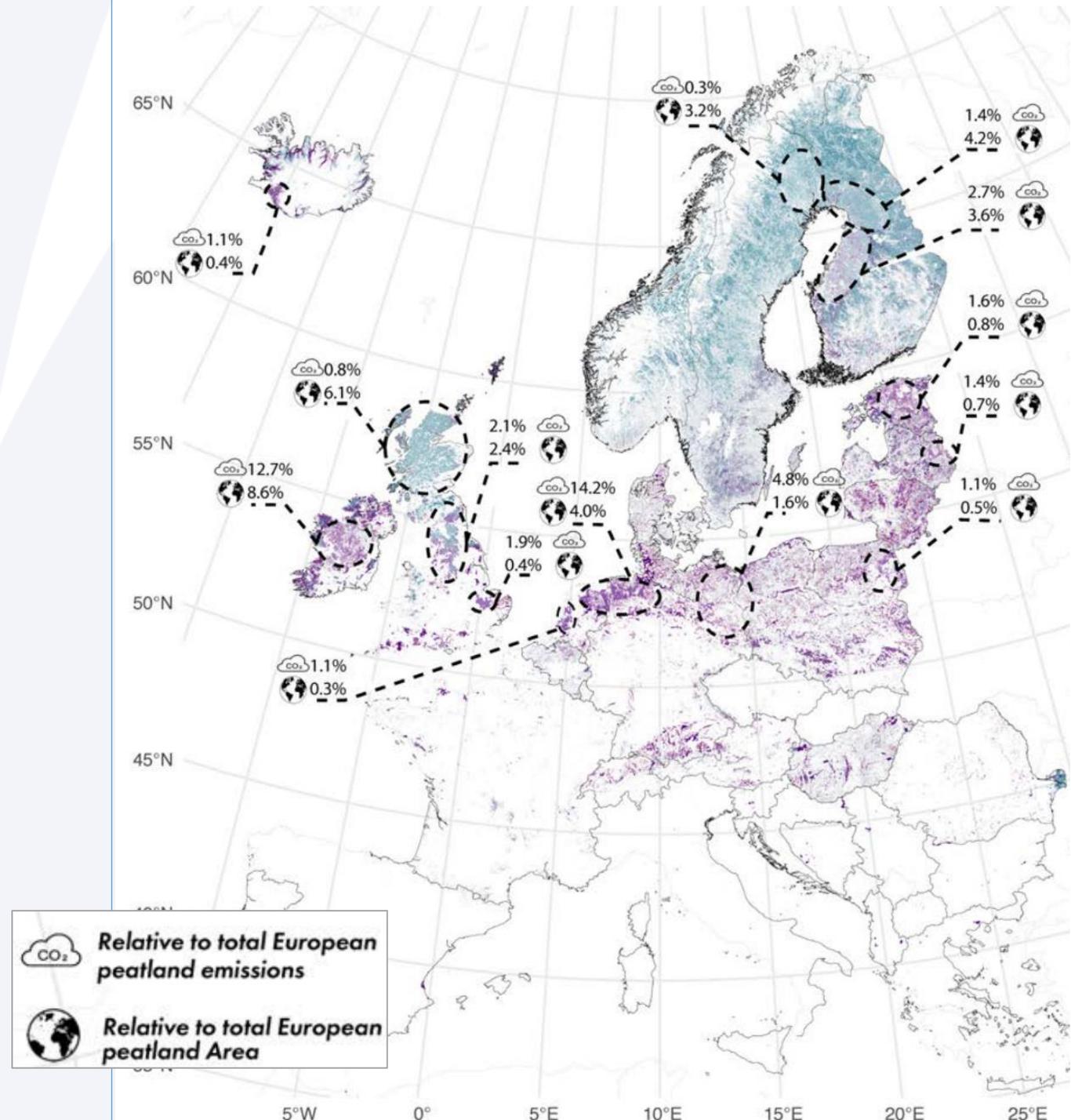


Mapping *hotspots* of GHG emissions from drained peatlands

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Further emissions hotspots are located in:

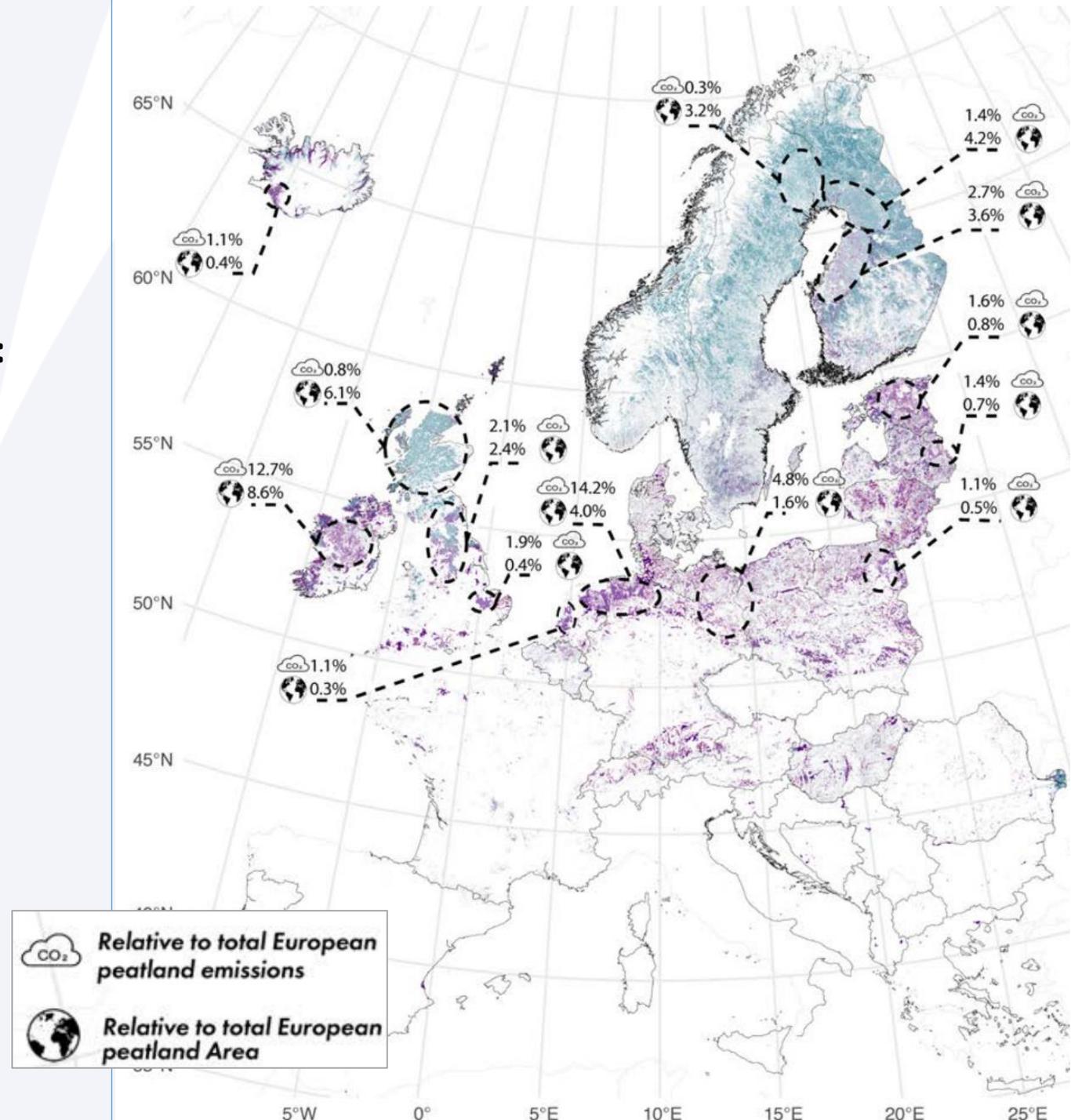
- E-Poland,
- N-England (UK),
- NW-Ireland, and
- the Baltic states.



Mapping *hotspots* of GHG emissions from drained peatlands

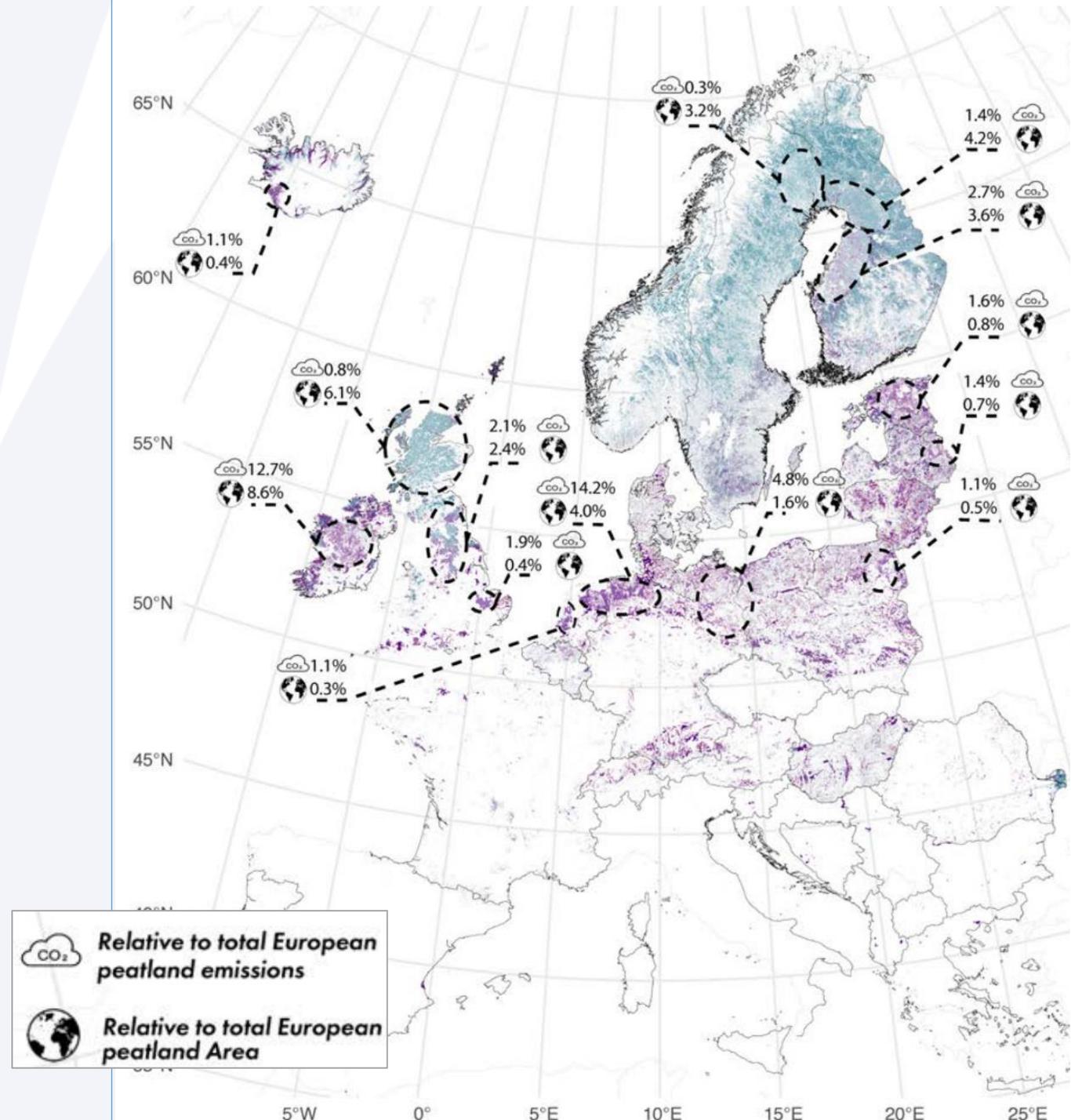
Regions with high GHG emissions from peatlands - because there is a large area of peatlands - include:

- Central European Plain,
- Alpine foreland in Germany, and
- the Pannonian Basin.



Mapping *hotspots* of undrained peatlands

Blue colors indicate peatland area hotspots, especially in Finland, Sweden and Scotland.



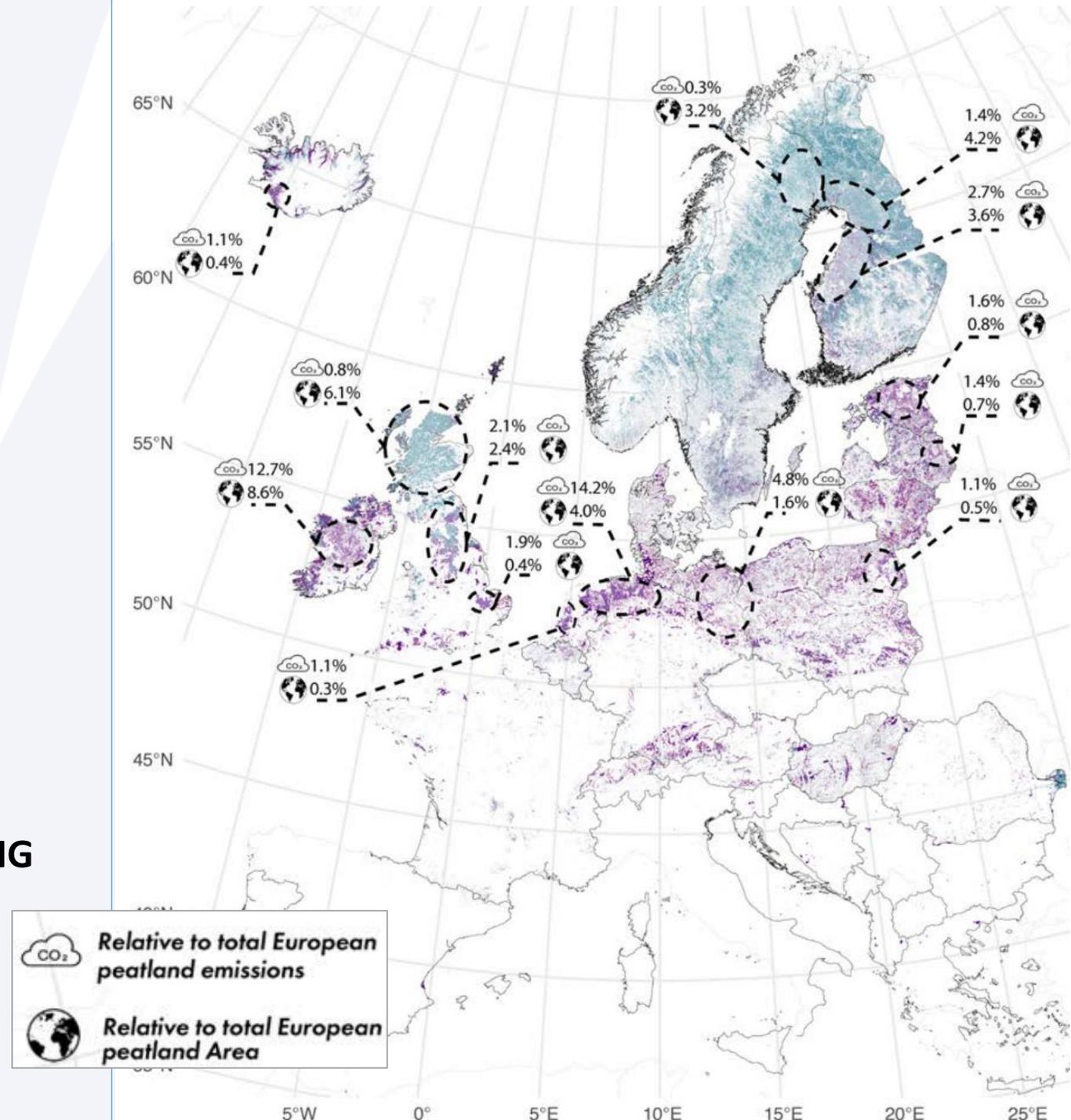
Conclusions & Outlook

Spatial explicit GHG emission maps from drained peatlands can be produced by combining available data.

In the EU+, the temperate regions (50-55°N) are emitting most GHGs from drained peatlands.

Regional GHG emission hotspots can be identified and be used to guide targeted mitigation action.

Upcoming results from ongoing HORIZON projects will further qualify critical input variables as e.g., a spatial drainage datasets and more regionalized GHG Emission Factors.





THANKS to Quint van Giersbergen

Thank you & looking forward to collaborate on European Peatlands!



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WET HORIZONS

