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Central
Statistics
Office

Peatland mapping using Sentinel-2 in Ireland - a use case in Ecosystem Accounting

6th May 2026

StatEO26

CSO Ecosystem Accounts, CSO Data Science



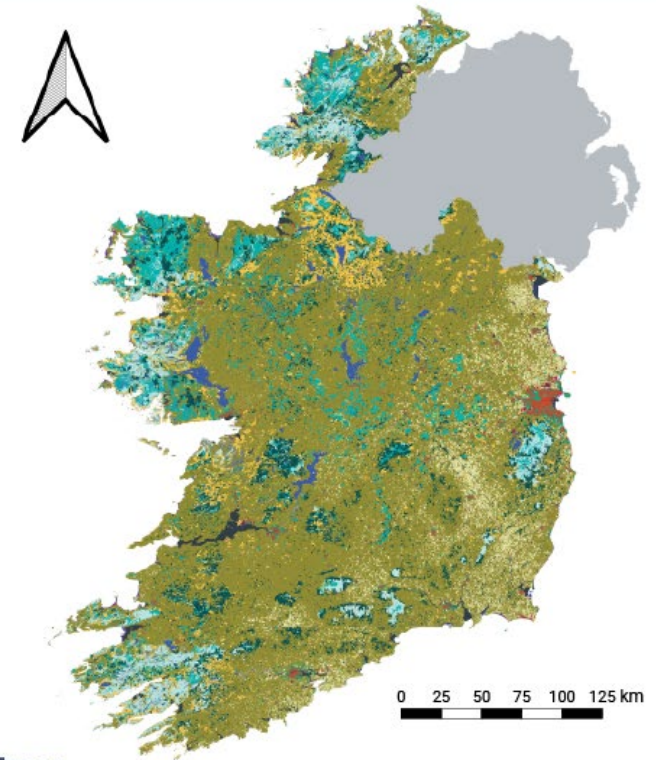
EU Regulation 2024/3024

Amendment to **Regulation No (EU) 691/2011** on European environmental economic accounts includes a module on **ecosystem accounts**:

- **Extent** accounts – one account **every three years**
- **Condition** accounts – nine indicators **every three years**
- **Services accounts** (physical flow) – seven accounts **annually**

First transmission year → **2026**

For reference year → **2024**



Ecosystem Types

1.1 Continuous Settlement Area	5.2 Scrub & Heathland
1.2 Discontinuous Settlement Area	6.1 Bare Rock
1.3 Infrastructure & Industrial Areas	6.2 Semi-Desert, Desert & Other Sparsely Vegetated Areas
1.4 Urban Greenspace	7.1 Inland Marshes and Other Wetlands on Mineral Soil
1.5 Other Artificial Areas	7.2 Mires, Bogs and Fens
2.1 Annual Cropland	8.1 Rivers & Streams
2.3 Permanent Cropland	8.2 Canals, Ditches & Drains
2.6 Other Farmland	9.1 Lakes & Ponds
3.1 Sown Pastures & Other Grass	9.2 Artificial Reservoirs
3.2 Natural & Semi-Natural Grassland	10.1 Coastal Lagoons
4.1 Broadleaved Deciduous Woodland	10.2 Estuaries & Bays
4.2 Coniferous Forest	10.3 Intertidal Flats
4.4 Mixed Forest	11.2 Coastal Dunes, Beaches & Sandy & Muddy Shores
4.5 Transitional Forest & Woodland Shrub	11.3 Rocky Shores
4.6 Plantations	11.4 Coastal Saltmarshes & Salines





Mires, Bogs & Fens ecosystem type (also known as peatlands)

- Ireland’s 3rd largest ecosystem
- Current source is the 2018 National Land Cover Map (NLCM) from national mapping agency
- NLCM is effectively a once-off dataset
- Can report **reductions** based on overlaying with other geospatial data



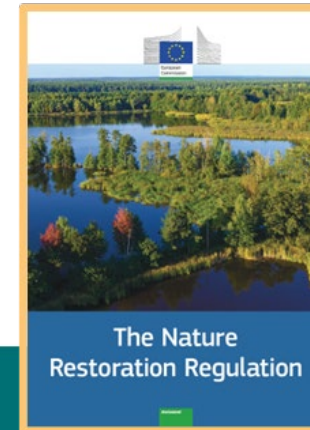
- **Additions** beyond 2018 NLCM peatland extent **not** detectable
- This is a problem because peatland additions are a clear **policy objective**

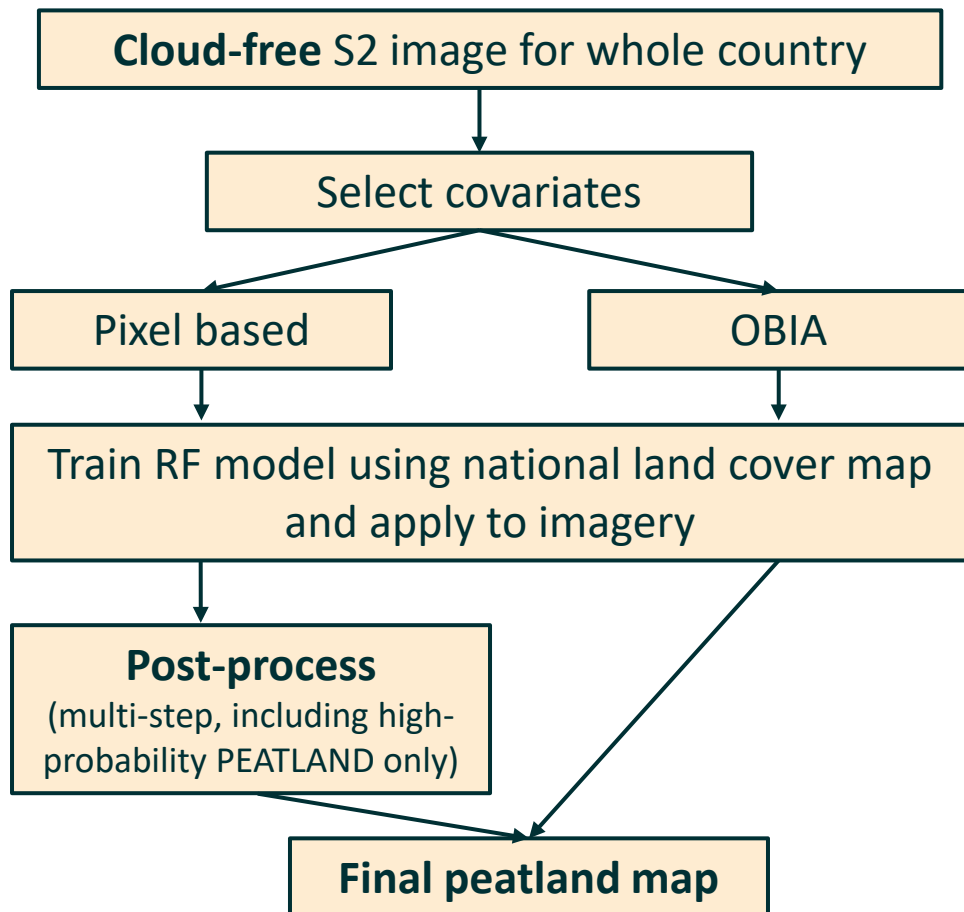
NRR target → restore:

- 30% of peatlands under agricultural use by 2030
- 50% by 2040
- 70% by 2050

National forestry target → 30,000 hectares of forest land restored to peatland by 2050

National peatland target → rehabilitate and restore ~33,000 hectares of its bogs by 2025



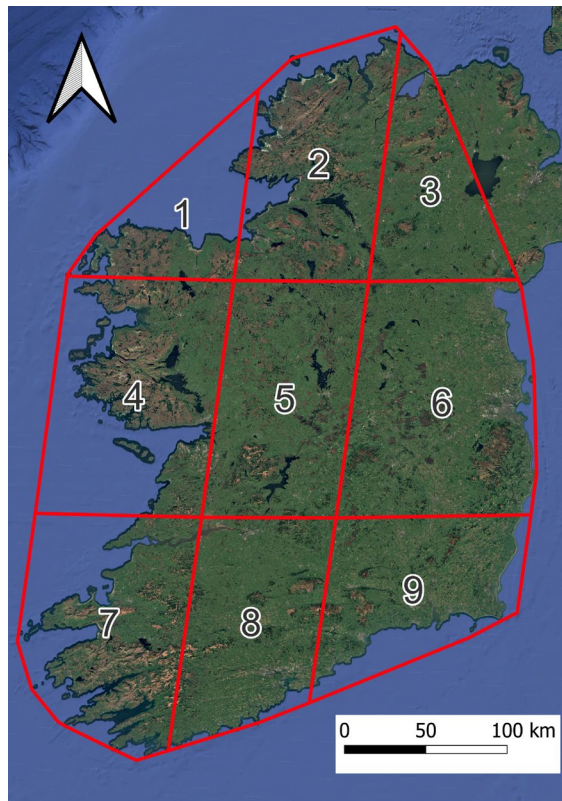


Cloud-free S2 image

RStudio → OpenEO → CDSE

Job parameters

- **Collection** = Sentinel-2 Level-2A
- **Period** = 1 year
- **Max tile cloud cover** = 70%
- **Mask** (Scene Classification Layer)
 - shadow, cloud (med + high prob), cirrus
- **Bands** = B02, B03, B04, B08, B12
- **Time reducer statistic** = median
- **Spatial extent** = Terrestrial-transitional ecosystem accounting area for Ireland (EAA) 2025 (N = 9 tiles)



job process



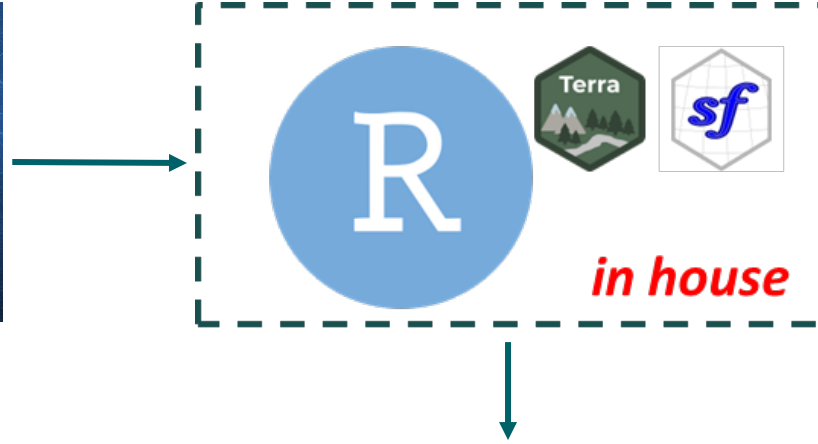
job process



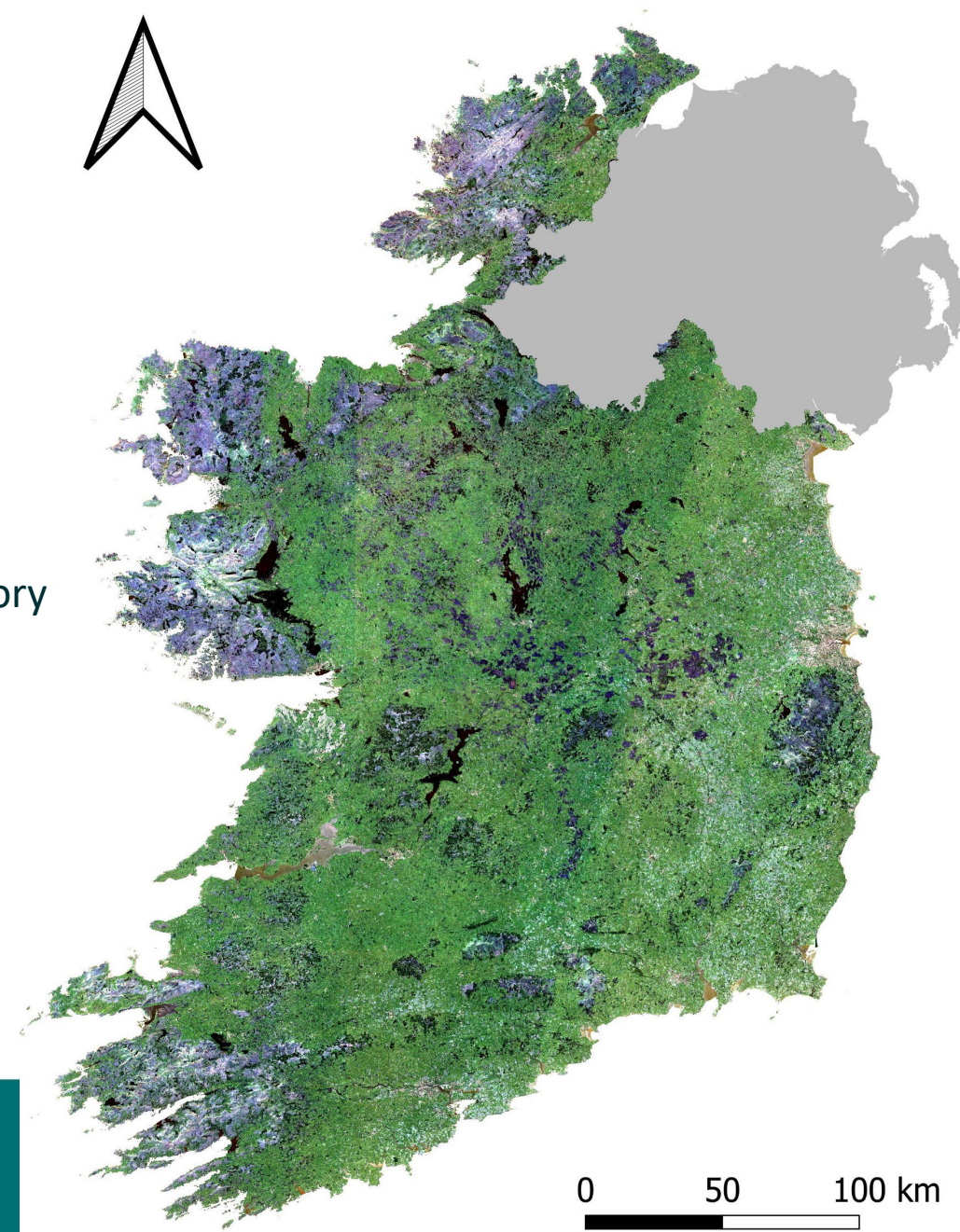
Cloud-free composite



Cloud-free S2 image



- 9 × tiles (~ 1.2 Gb each)
- Merge using **virtual raster** approach → full tiles never loaded into memory
 - Merge the metadata, not the data itself!
- Tiles clipped to terrestrial-transitional **ecosystem accounting area (EAA)**
- Final map:
 - 10 × 10 m resolution
 - ~ 9 Gb total size
 - ~ 7 hours from process graph to final map



2018 Sentinel-2 RGB



Select covariates



```
library(terra)
```

```
S2 <- rast(path_to_s2)
```

```

Console Terminal x
R 4.4.0 . ~ /
> s2
class       : SpatRaster
dimensions  : 45334, 32082, 5  (nrow, ncol, nlyr)
resolution  : 10, 10  (x, y)
extent      : 382340, 703160, 5693050, 6146390  (xmin, xmax, ymin, ymax)
coord. ref. : WGS 84 / UTM zone 29N (EPSG:32629)
source      : S2_02_03_04_08_12_tteaa_2018.tif
names       : B02, B03, B04, B08, B12
min values  : -49, -35, -23, -61, 13
max values  : 11520, 11584, 12348, 15720, 14037

```

```

ndvi_out <- file.path(peat_out, "ndvi.tif")
if(file.exists(ndvi_out)==F){
  ndvi <- (s2$B08-s2$B04)/(s2$B08+s2$B04)
  writeRaster(ndvi, ndvi_out)}
else{
  ndvi <- rast(ndvi_out)
}
names(ndvi) <- "NDVI"
gc()

```

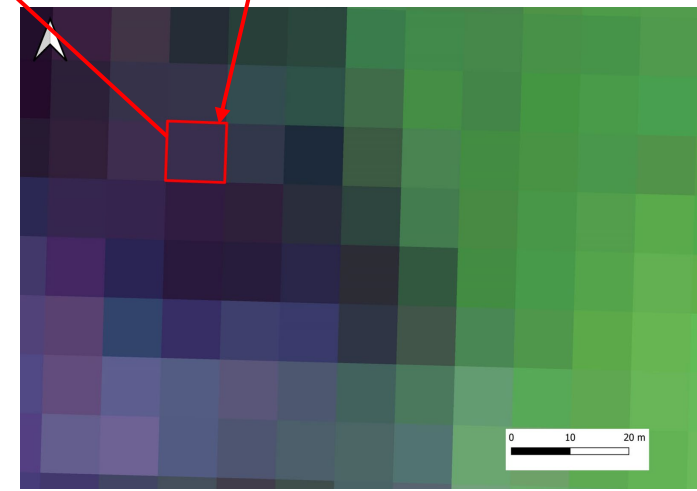
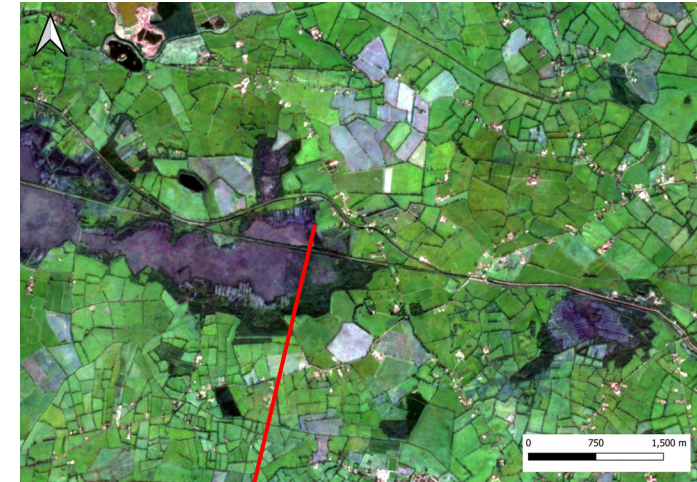
NDVI
-1
1



Random forest

Band	Value (16-bit)
B02	319
B03	418
B04	553
B08	2316
B12	1036

Layer	Value
NDVI	0.61
NDWI	-0.72
Homogeneity	0.16
DEM	75.44 (m)



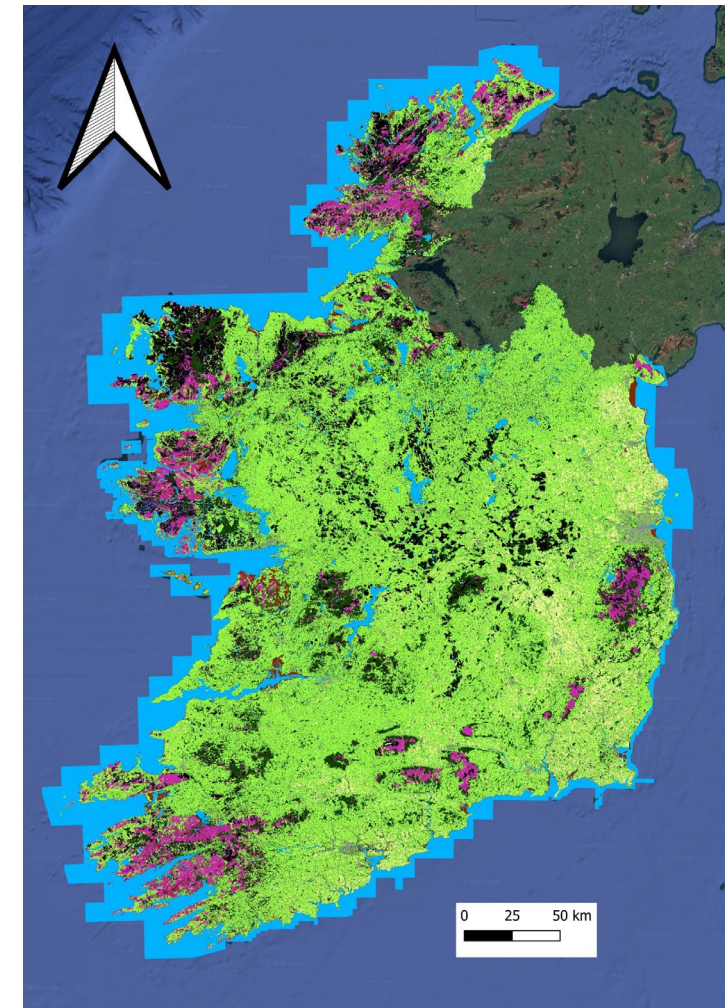
Train RF model



Tailte
Éireann

`library(caret)`

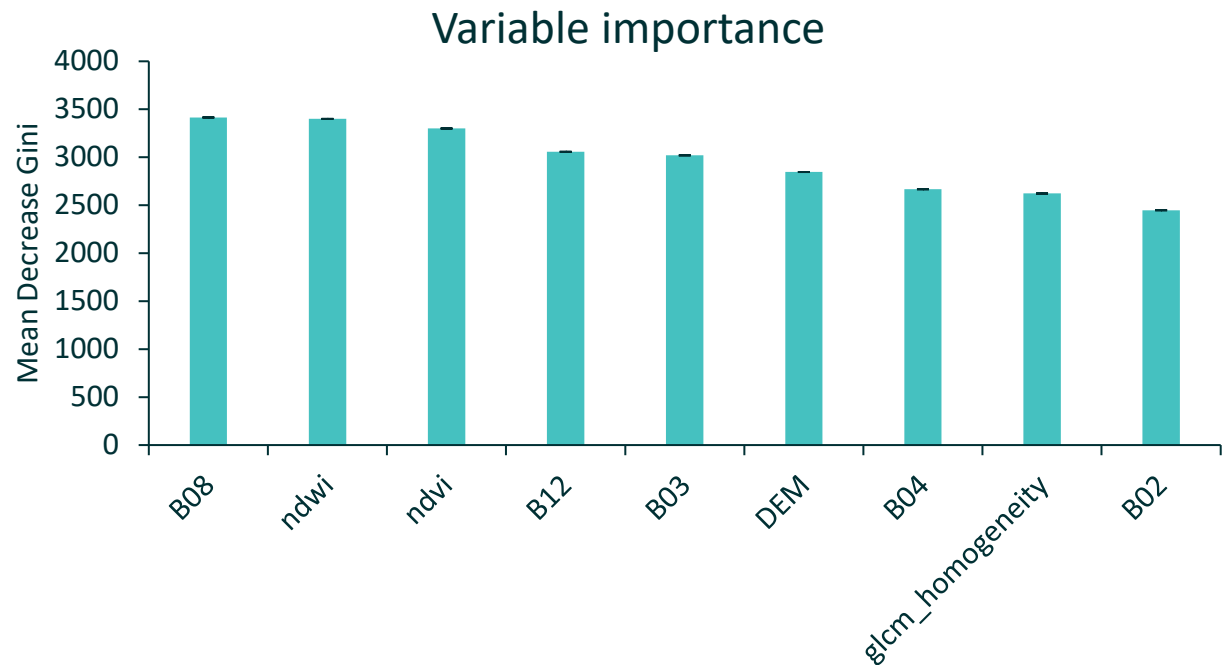
- Equal probability sample from 2018 **National Land Cover Map (NLCM)** →
- **Multiclass** model
- **Spatial cross validation** implemented using blockCV `library(blockCV)`
- Hyperparameter tuning → **mtry**
- Model trained **every three years**
- **NLCM updated** every three years to correct for below conversions:
 - Peatland → grassland
 - Peatland → forestry
 - Peatland → artificial surfaces
 - Peatland → Cropland



www.cso.ie

Train RF model

Model accuracy



2018 (peatland)

Statistic	Value	What does it tell us?
Precision	0.691	30.9% of predicted peatland pixels in testing sample are not peatland
Recall	0.702	29.8% of peatland pixels in testing sample were missed
F1	0.697	Harmonic mean of precision and recall

Salt & pepper effects; heath, bracken and wet grassland classified as peatland (blanket bog)

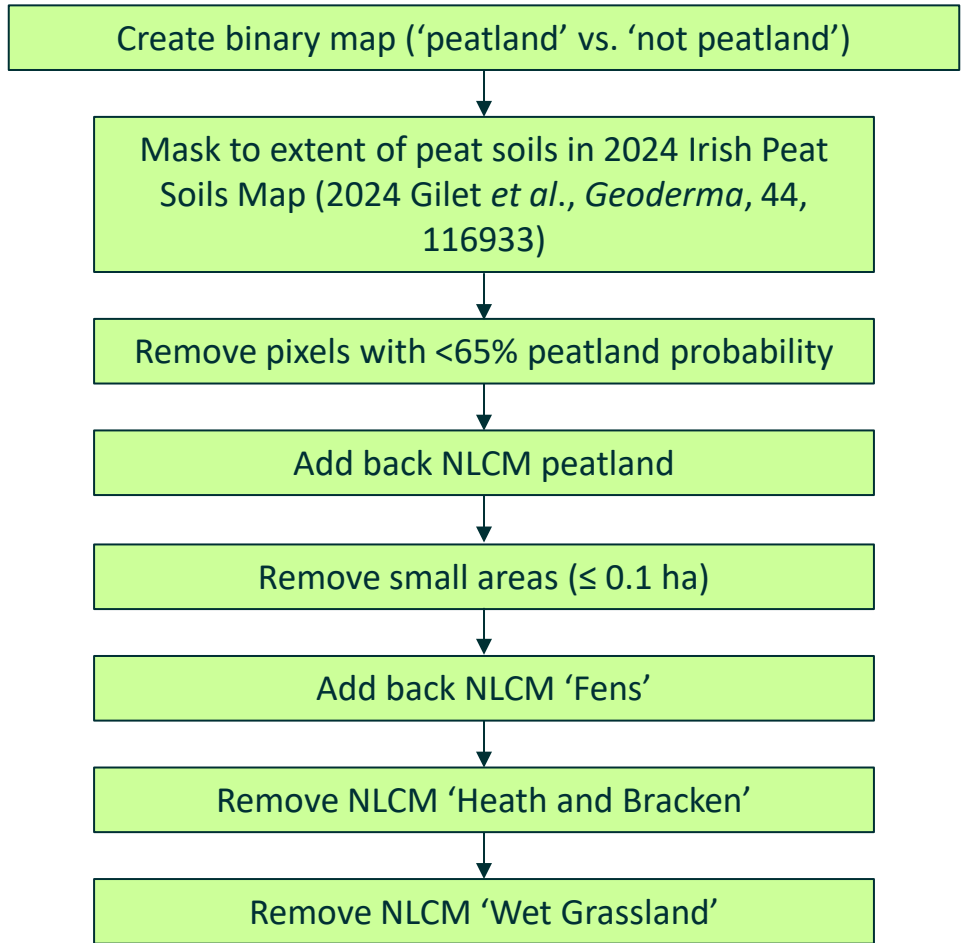
Fens classified as grassland; large areas of blanket bog classified as heath, bracken and wet grassland.

F1 for **2021** = 0.6930

F1 for **2024** = 0.6844



Post-processing

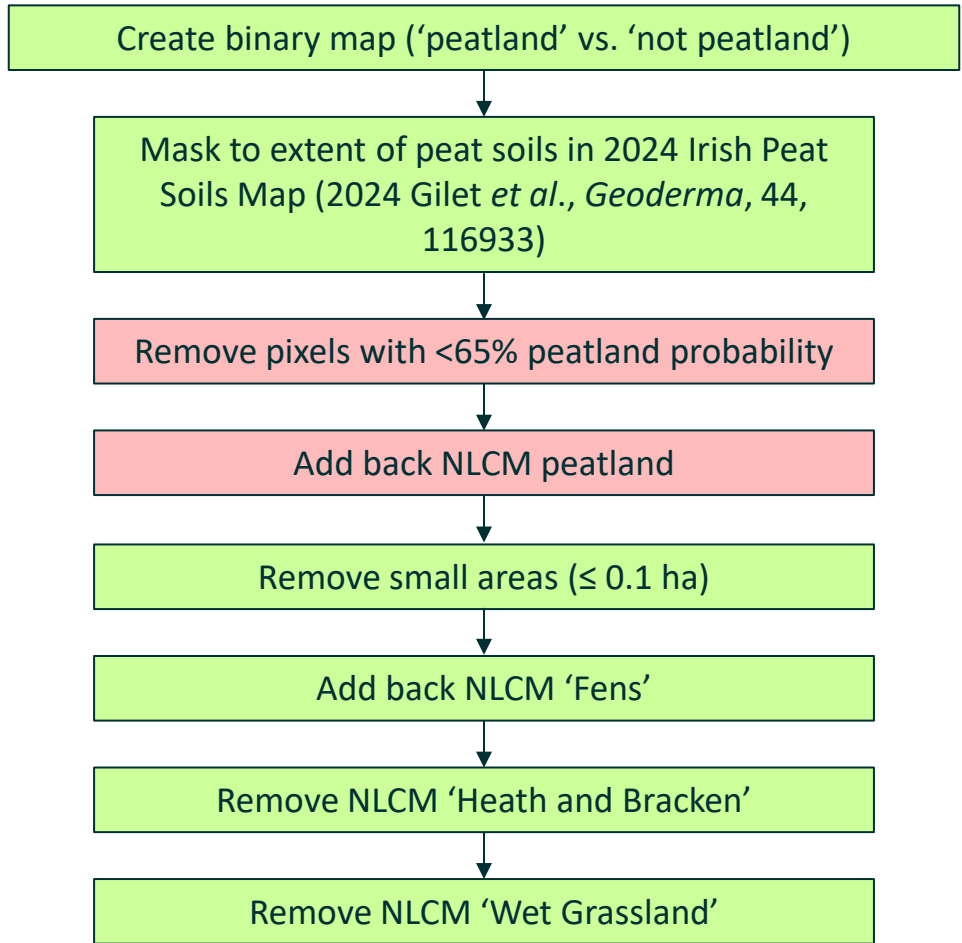


NLCM peatland

Raw predicted map



Post-processing



NLCM peatland

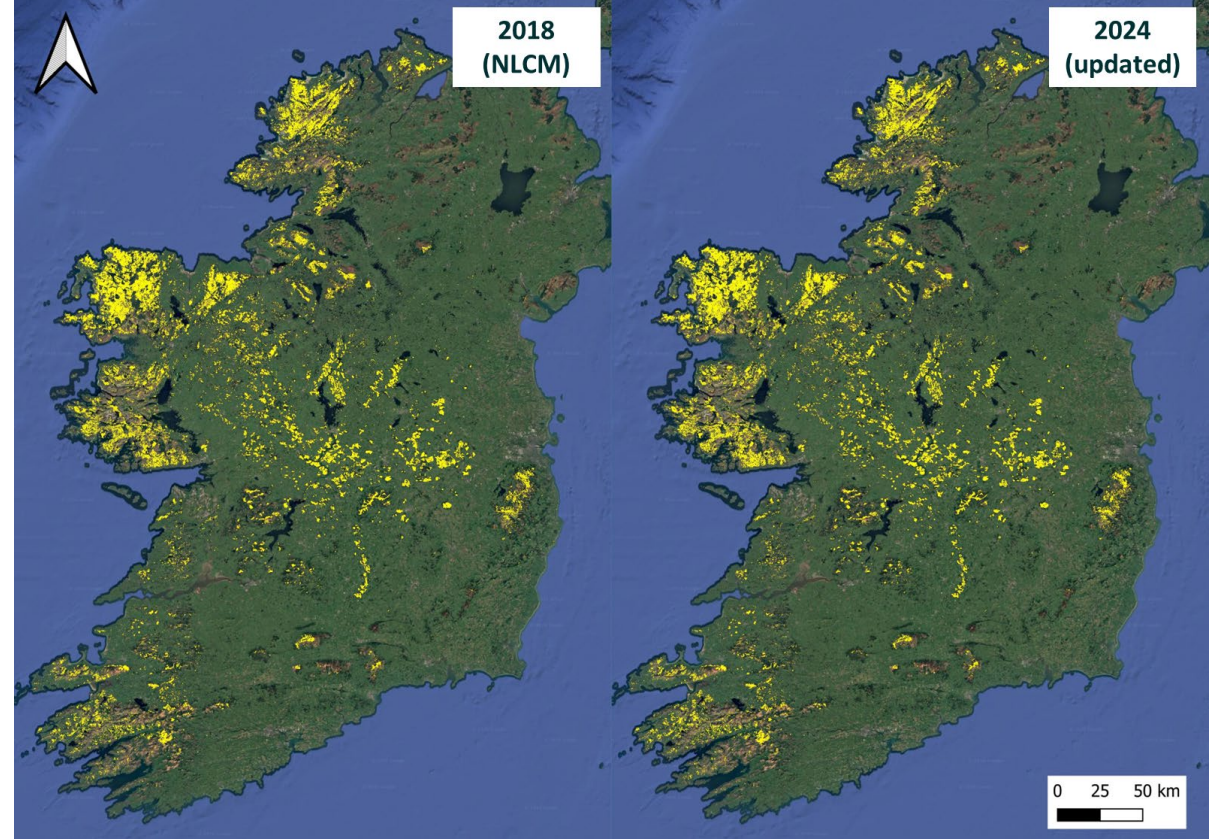
Post-processed map



How do we determine mapping accuracy?

Mapping validation by CSO staff: 🕒 ~36 hrs split between 5 people

- Validation sample points ($n = 1,000$) manually labelled by CSO Ecosystem Accounts staff.
 - Equal probability of peatland & non-peatland
- Each point labelled twice against Google Satellite imagery (+ additional layers).
- Used to produce mapping accuracy statistics.



Statistic	Value	What does it tell us?
Precision	0.887	11.3% of identified peatland pixels are not peatland
Recall	0.938	6.2% of peatland pixels were missed
F1	0.912	Harmonic mean of precision and recall

- **F1 >0.81** indicates ‘almost perfect’ observer agreement for categorical data (Landis and Koch, 1977. *Biometrics*, 33, 1)
- **F1 >0.85** for remote sensing is considered to be particularly good for remote sensing (Foody, 2008. *International Journal of Remote Sensing*, 29, 11).
- NLCM had an F1 for its level one classes of **0.887** (slightly lower for PEATLANDS)



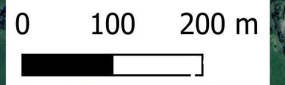
Results

Example

53.293879,-6.785964



Google Earth 2024

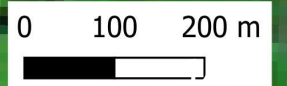


Example

53.293879,-6.785964



S2 RGB 2024



Results

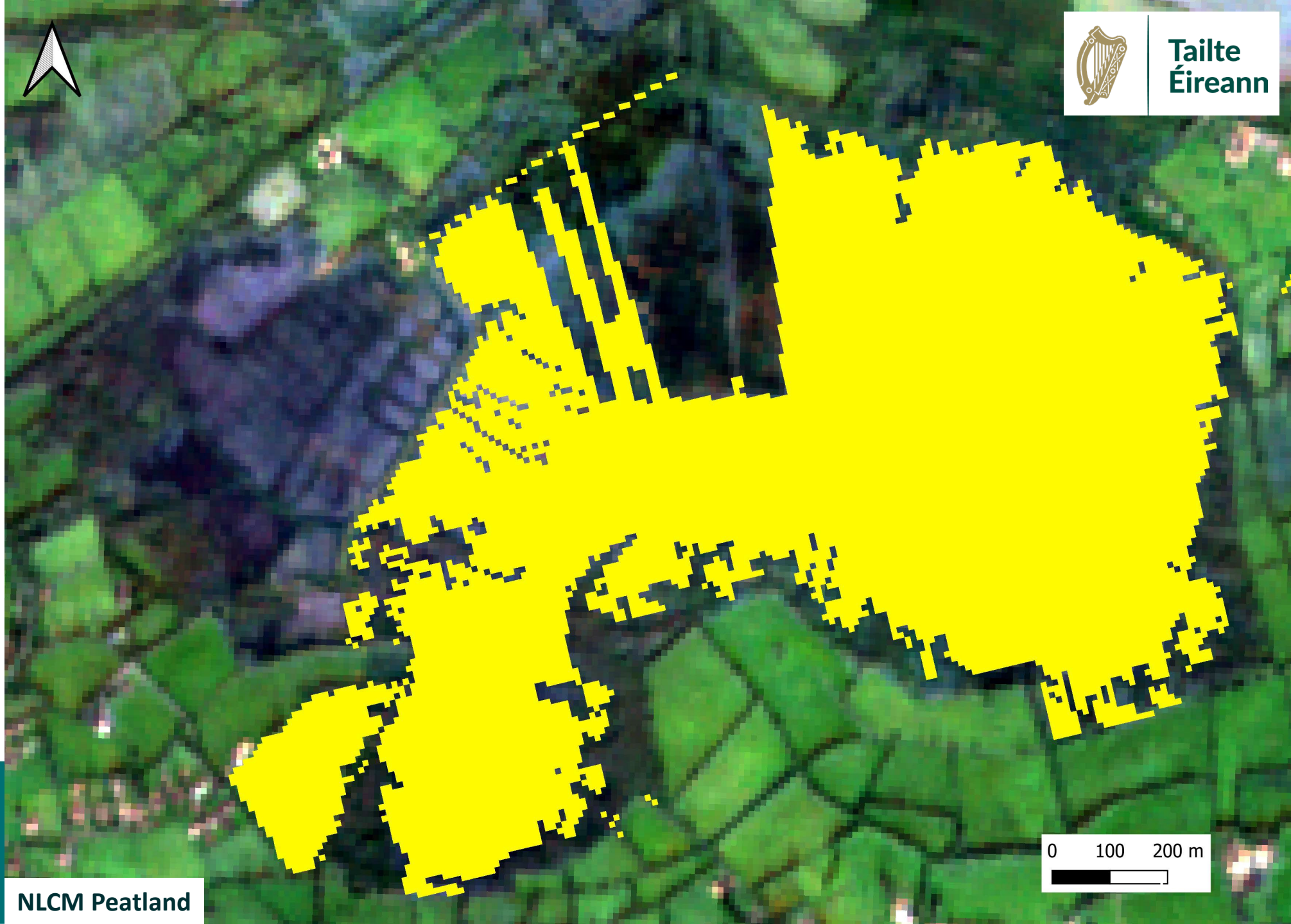


Tailte
Éireann

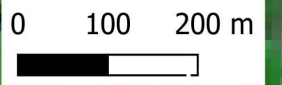
Example

53.293879,-6.785964

 Peatland



NLCM Peatland



Example

53.293879,-6.785964

 Peatland

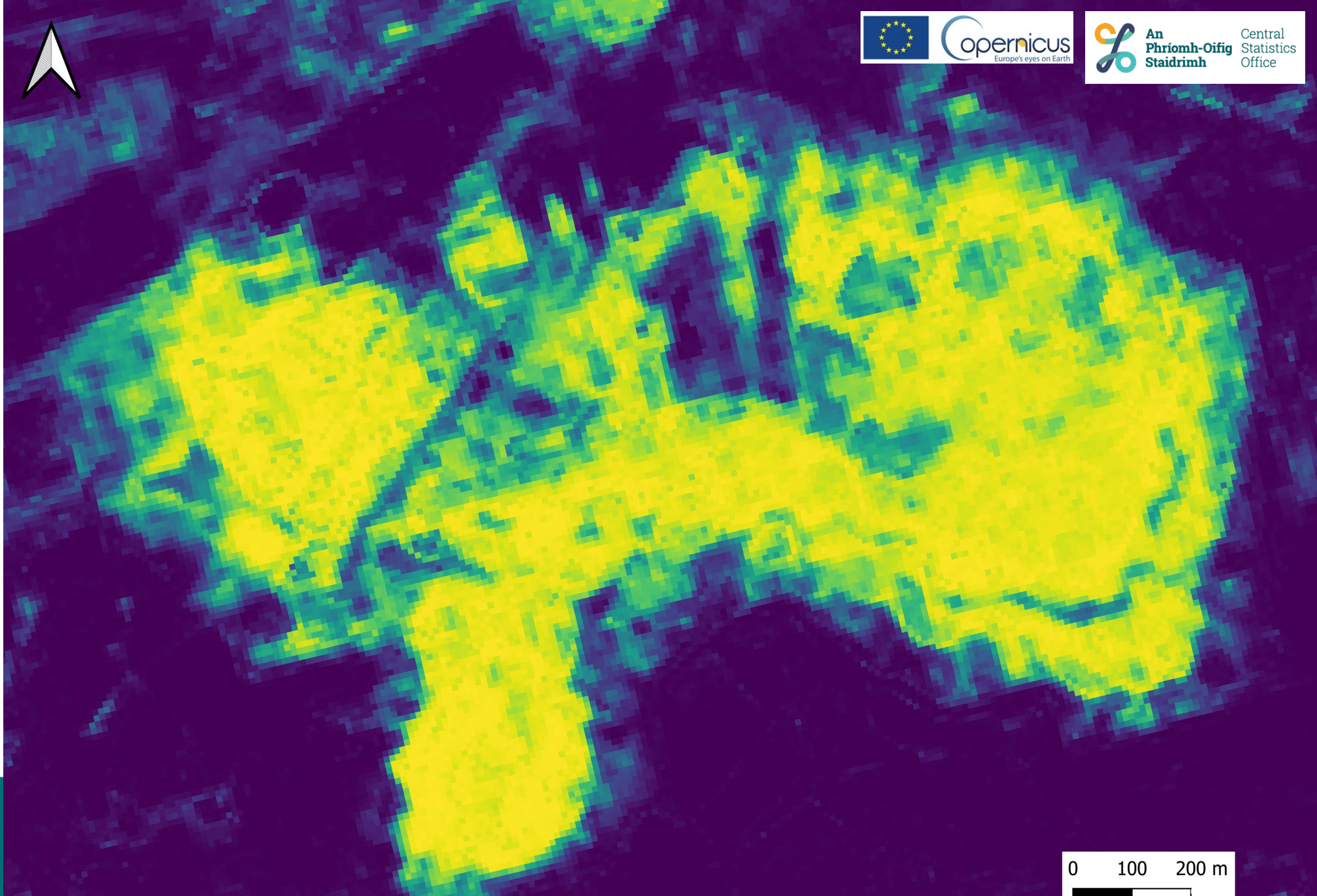


Post-processing Peatland 2024

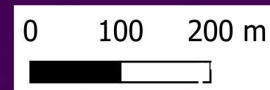


Example

53.293879,-6.785964



Peatland Probability 2024



Results and summary

Year	Area (hectares)
2018 NLCM	461,995
2018	454,463
2021	454,028
2024	453,253

Hectares of peatland (Mires, Bogs & Fens)

2018	Addition	Reduction	2024	Net change
454,463	2,936	4,145	453,253	-1,210 -0.27%



Source: Irish Peatland Conservation Council

Changes are **small** (as expected) **but important**

Correspond mainly to conversions between:

- Peatland ⇌ Grassland
- Peatland ⇌ Forest & Woodland
- Peatland → Artificial surfaces

Summary

- R based EO-ML pipeline developed to update peatland extent every 3 years
- Fills a data gap in CSO ecosystem accounts → data for Mires, Bogs & Fens
- Resources required are minimal (heavy lifting done on CDSE backend)
- Pipeline ready to be integrated into ecosystem extent account workflow for 2024 reporting
- Management Board approval ✓

Stakeholders and experts



An Roinn Aeráide,
Fuinnimh agus Comhshaoil
Department of Climate,
Energy and the Environment

