Knowing peat, knowing you: meeting the peatland community's data needs

IUCN | National Committee United Kingdom

Peatland Programme

National Trust Peatland Monitoring Approach

Tia Crouch – Peat Ecologist

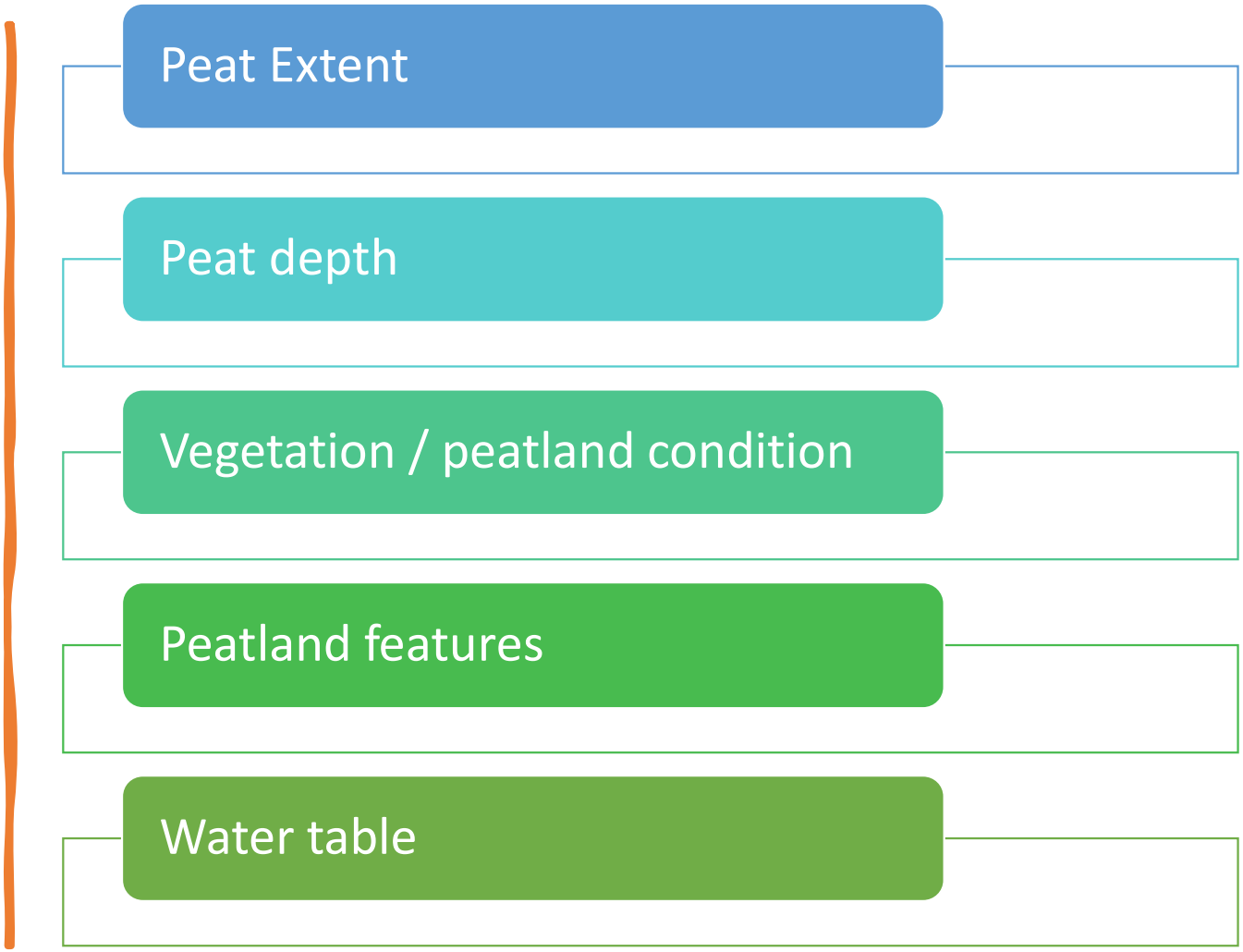
Our ambition for peatland

- NT own 25,000 ha peatlands
- 17,500 ha degraded
- 13,000 ha under restoration by 2030
- Remaining 4,500 ha by 2040
- Contributing towards
  - Carbon net zero by 2030
  - Improve the condition of our A/SSSIs and existing Priority Habitat
  - Restore or create new Priority Habitat

How we want to use the data

- Current condition of peatlands
- The work we need to do to restore our peatlands
- How condition changes because of peatland restoration interventions
- Data collected in a consistent way (methods, templates, apps)
- To evidence impact and progress against targets at the site/property, region/country, whole Trust level and externally

What data do we need to collect?

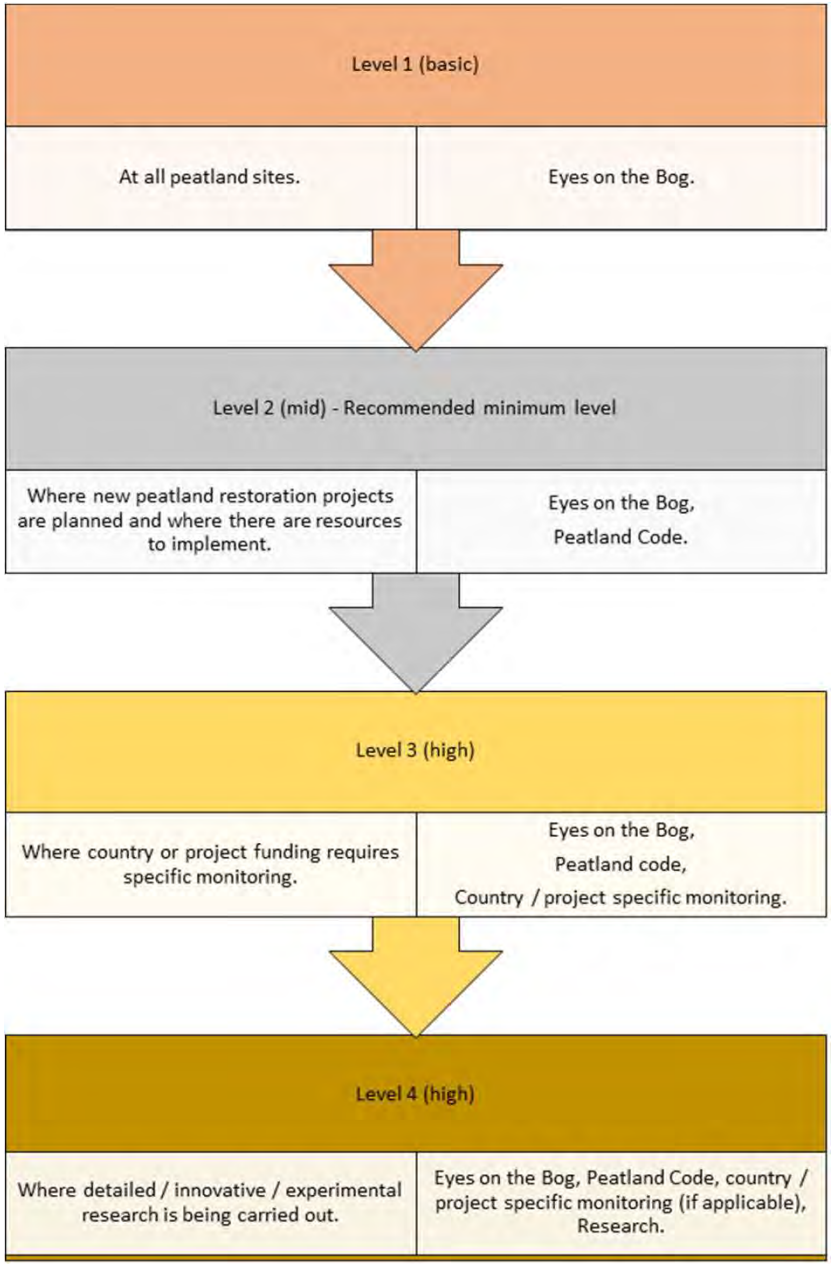


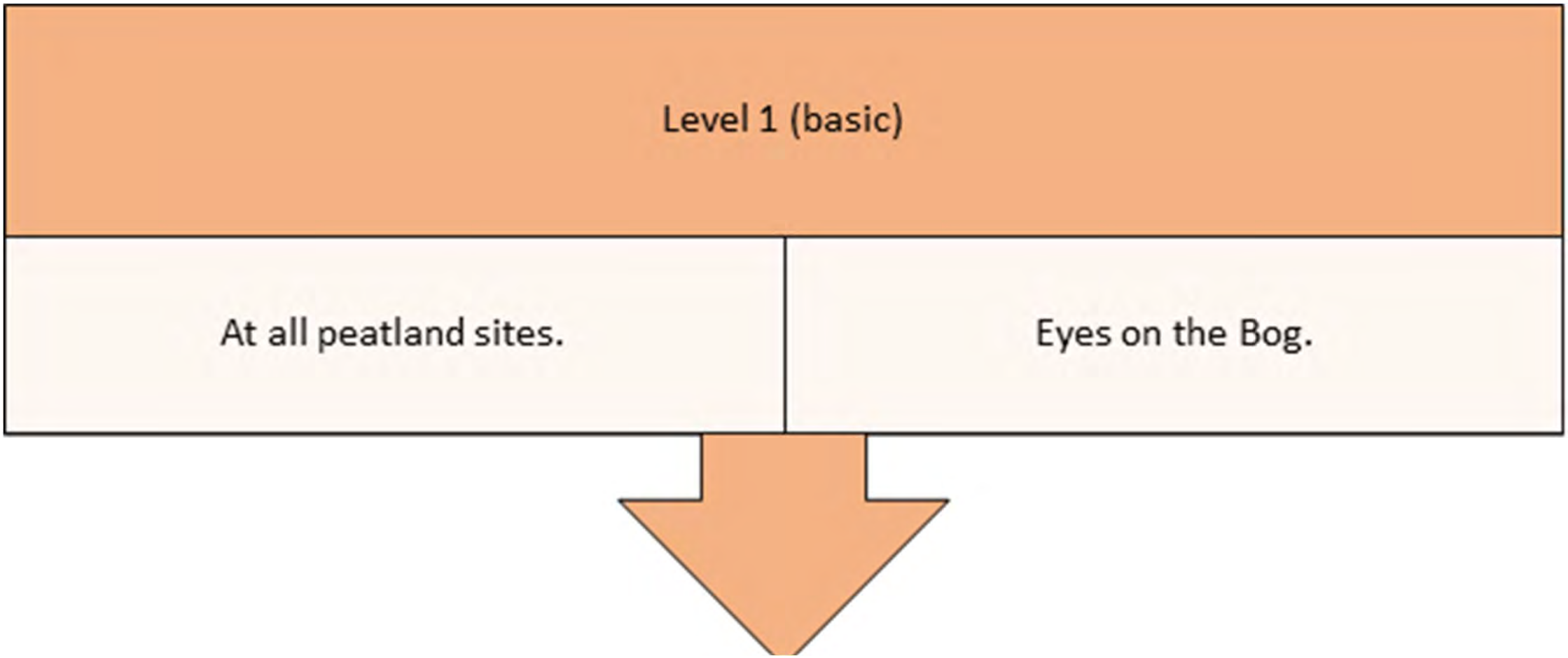
Existing methods

Metric	Eyes on the Bog	Peatland Code	Project / country specific monitoring, e.g., NCPGS or NPAP
Peat extent		Peat depth assessment on 100m x 100m grid	
Peat depth	Surface level markers	Peat depth assessment on 100m x 100m grid	
Peatland features		Desk mapping	
Habitat condition		Peatland Condition Category on 100m x 100m grid	
Vegetation		P/A of sphagnum & Calluna on 100m x 100m grid	Botanical quadrats
Water table	Rust rods	No for bog; Yes for fen	Dipwells

Monitoring Approach

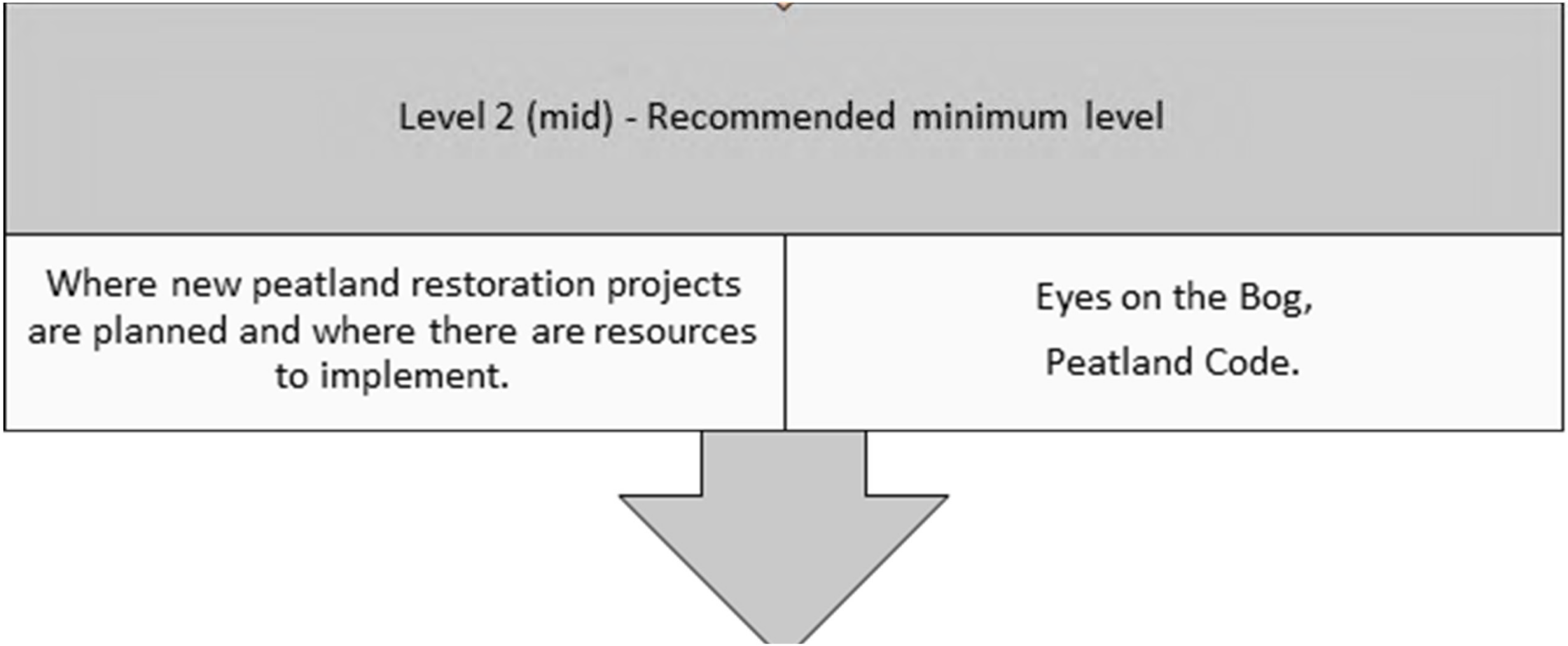
- Baseline & impact of intervention
- Tiered & layered approach
- Uses existing national monitoring schemes
- Does not prevent more detailed / innovative / experimental research





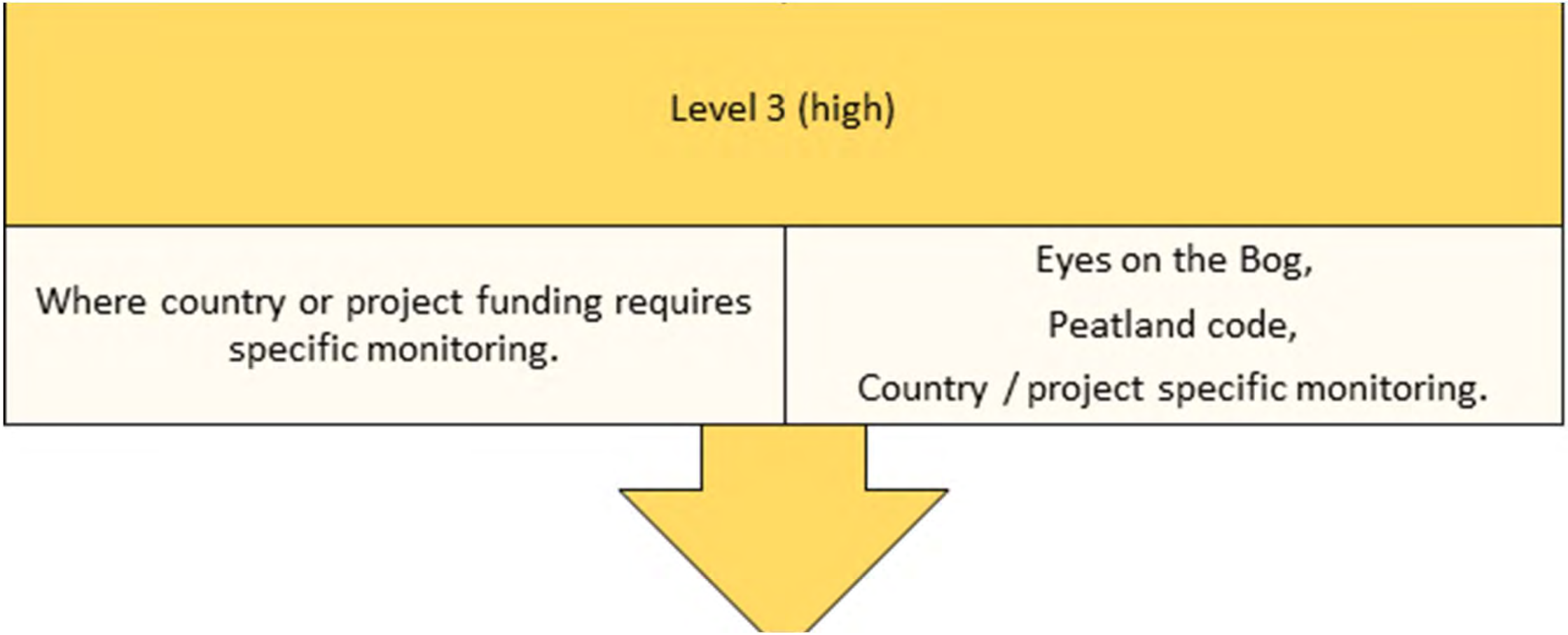
[Eyes on the Bog | IUCN UK Peatland Programme (iucn-uk-peatlandprogramme.org)]

Method	What this will tell you	Frequency	Scale
Surface level markers	Peat depth, peat subsidence, peat accumulation	Every year	Site, restoration project, or plot scale
Rust rods	Water table behaviour	Every 3, 6 or 12 months	
Von Post test	Peat soil condition	Every 10 years	
Fixed point photography	Vegetation structure & composition	Every year	
Optional quadrat: Presence / absence or % cover of species groups	Vegetation composition	Every 3-5 years	



[For Projects | IUCN UK Peatland Programme (iucn-uk-peatlandprogramme.org)]

Method	What this will tell you	Frequency	Scale
Eyes on the Bog	See level 1	See level 1	See level 1
Desk-based mapping using aerial photography	Location of erosion and drainage features and peatland code condition categories	Pre-restoration baseline only	Site or restoration project scale
Peat depth assessment	Peat depth on 100 m x 100 m grid *modified fen	Pre-restoration baseline only	
Peatland condition assessment	Peatland condition on 100 m x 100 m grid	Pre-restoration baseline, 5 years after restoration, then every 10 years	
Vegetation type	Relative abundance of specific species / vegetation types	Pre-restoration baseline, 5 years after restoration, then every 10 years	
Water table assessment (fen only)	Mean water table depth across the site.	Continuous monitoring of automated water level logger; monthly monitoring of manual dipwells, quarterly monitoring of rust rods.	
Optional Priority Habitat Condition Assessment	Habitat condition	Every 3-5 years	Site scale, based on SSSI units.


Level 3 (high)
Where country or project funding requires specific monitoring.
Eyes on the Bog,
Peatland code,
Country / project specific monitoring.

Method	What this will tell you	Frequency	Scale
Eyes on the Bog	See level 1	See level 1	See level 1
Peatland Code	See level 2	See level 2	See level 2
Country / project specific monitoring e.g., Nature for Climate Peatland Grant Scheme, Peatland Action Programme, Environmental Stewardship Agreements etc.	Country / Project specific objectives e.g., How the restoration activities have impacted the water levels of the site, or how the restoration activities have impacted the vegetation of the site.	Various	Restoration project scale

Level 4 (high)	
Where detailed / innovative / experimental research is being carried out.	Eyes on the Bog, Peatland Code, country / project specific monitoring (if applicable), Research.

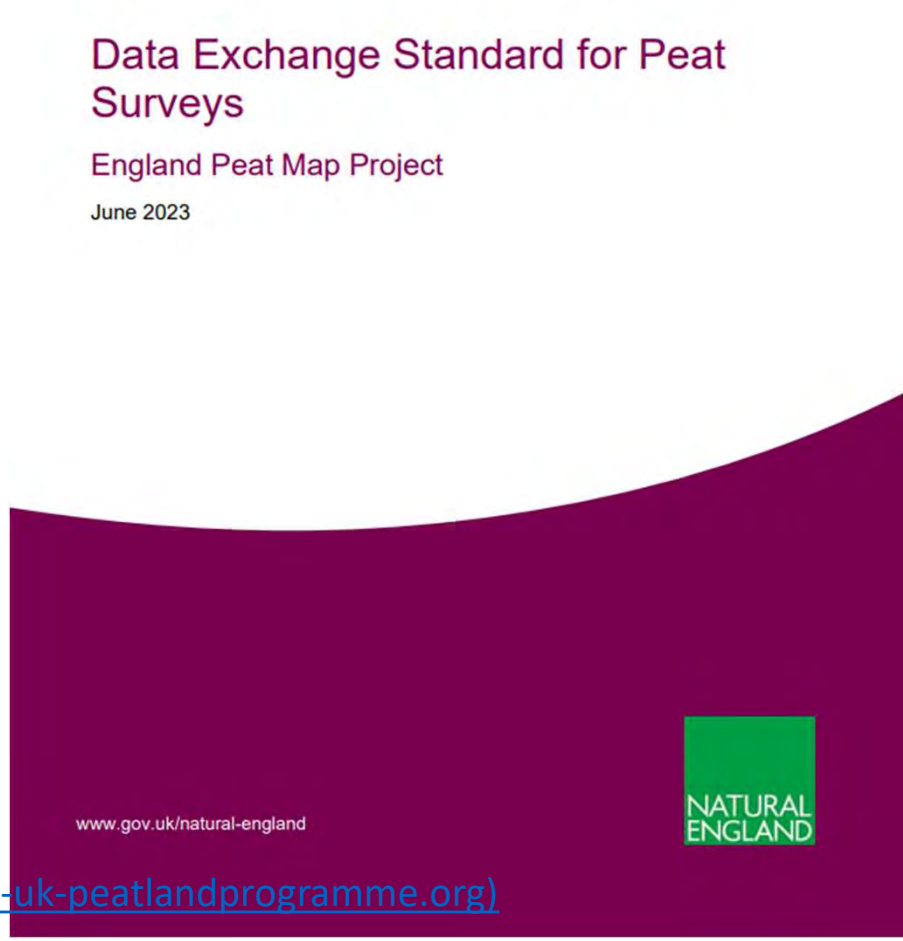
Method	What this will tell you	Frequency	Scale
Eyes on the Bog	See level 1	See level 1	See level 1
Peatland Code	See level 2	See level 2	See level 2
Country / project specific monitoring (if applicable)	See level 3	See level 3	See level 3
Research	Research specific objectives e.g., The impact of peatland restoration on runoff and channel flow; the impact of peatland restoration on the carbon balance; the impact of flailing Molinia on *Sphagnum* plug success.	Various	Mini-catchment; plot scale.

Collecting, managing, storing, and viewing data

- Data collection using apps
- Data from app uploads to ArcGIS Online where data can be viewed
- Can also be opened in ArcGIS Pro to be edited etc.
- Will be available in Web app for non-ArcGIS users

Data standards

- No agreed data standard for peat survey data
- NE developed standard for peat depth data
- Future versions are intended to cover other peat survey types, e.g., surface features, vegetation mapping, and peat condition
- NT have adopted peat depth data standard in our surveys



Data Exchange Standard for Peat Surveys v1.0.pdf (iucn-uk-peatlandprogramme.org)

What's next?

- Analyse data
- Answer questions
- Track progress
- Peat data standards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AI4Peat Partnership

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Department for Environment Food & Rural Affairs

Forestry Commission

NATURAL ENGLAND

Food Standards Agency food.gov.uk

Department for Business, Energy & Industrial Strategy

The AI4Peat Partnership

- Cross-government team of Civil Servants
- Won the Civil Service Data Challenge with our proposal to map peatland drains using Artificial Intelligence techniques
- Delivering our solution for Natural England's England Peat Map project funded by Defra's Nature for Climate fund.
- Working to build connections and share learning and expertise across Government to help promote the benefits of AI and machine learning.

CIVIL SERVICE DATA CHALLENGE

Our Restoration Target: Grips and Gullies

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Finding the drainage channels

From the ground

From the air

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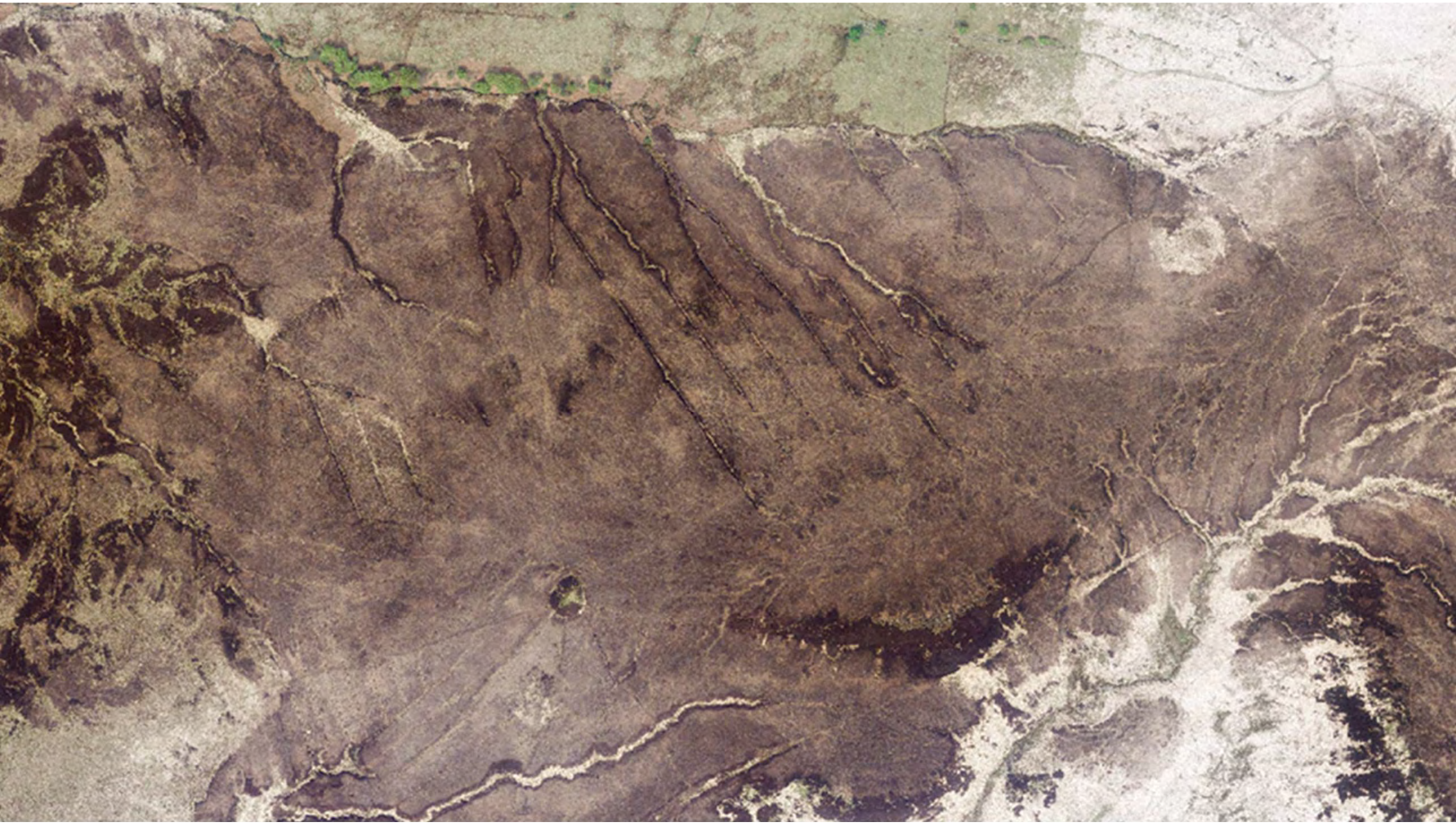
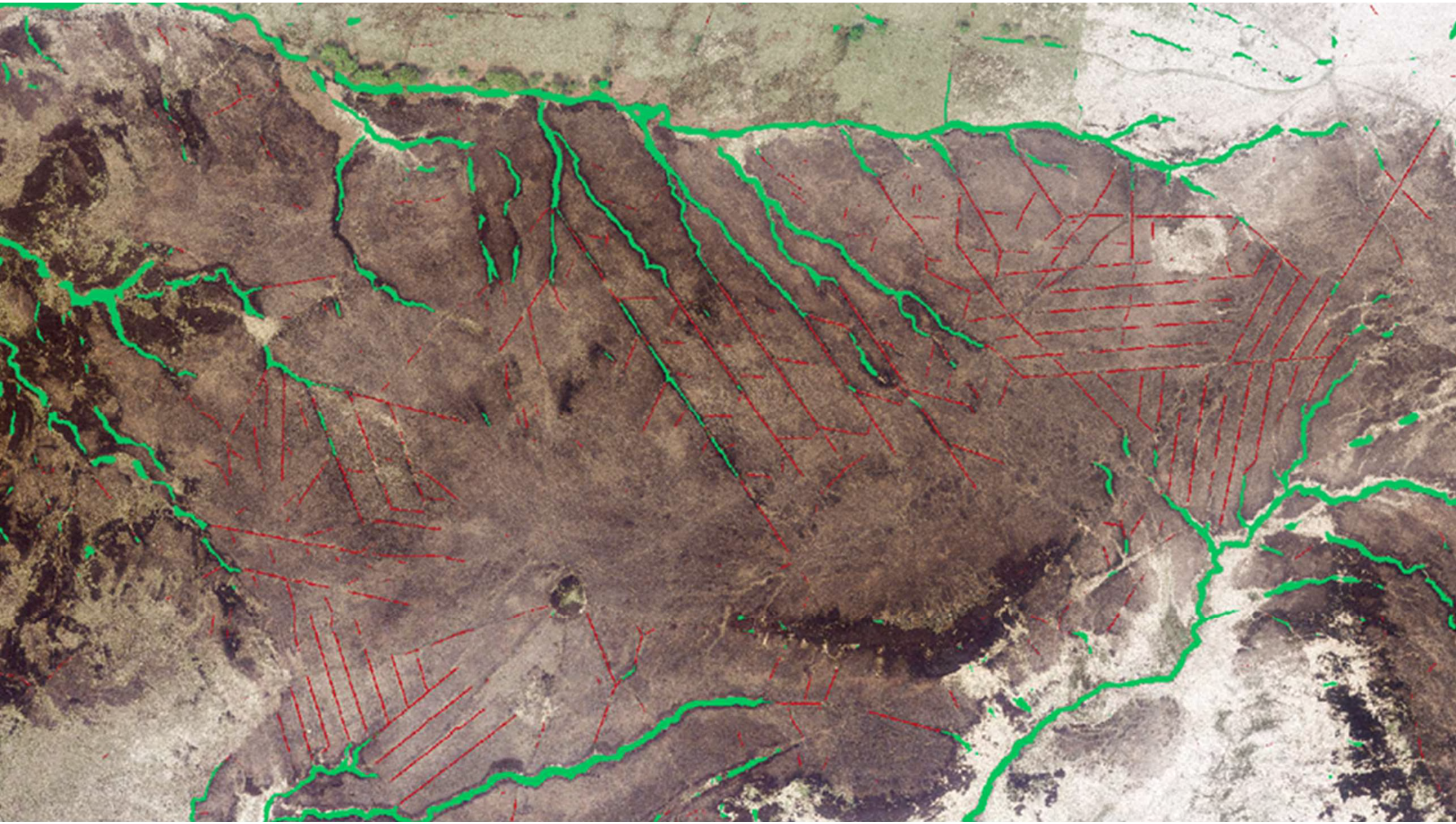
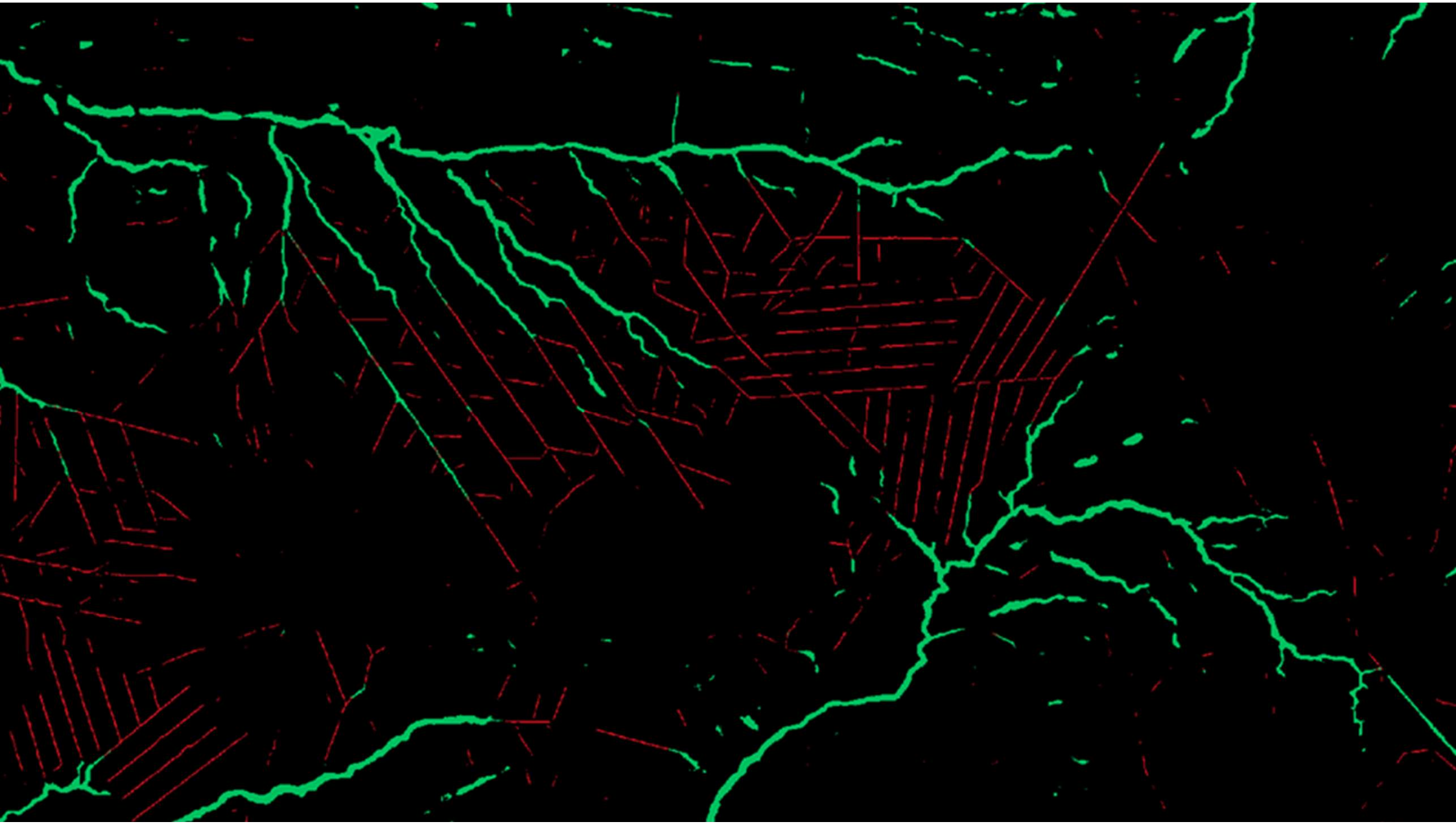
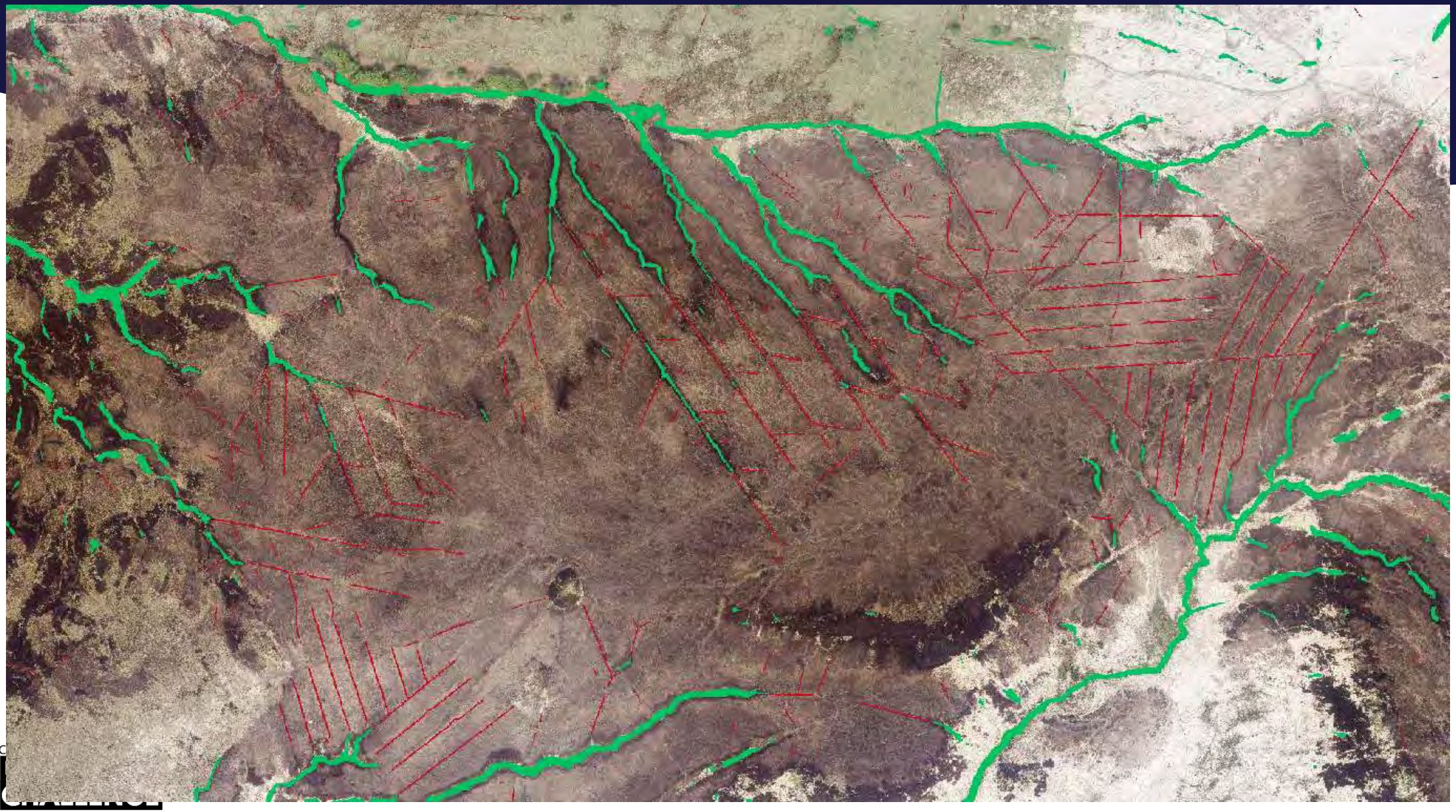
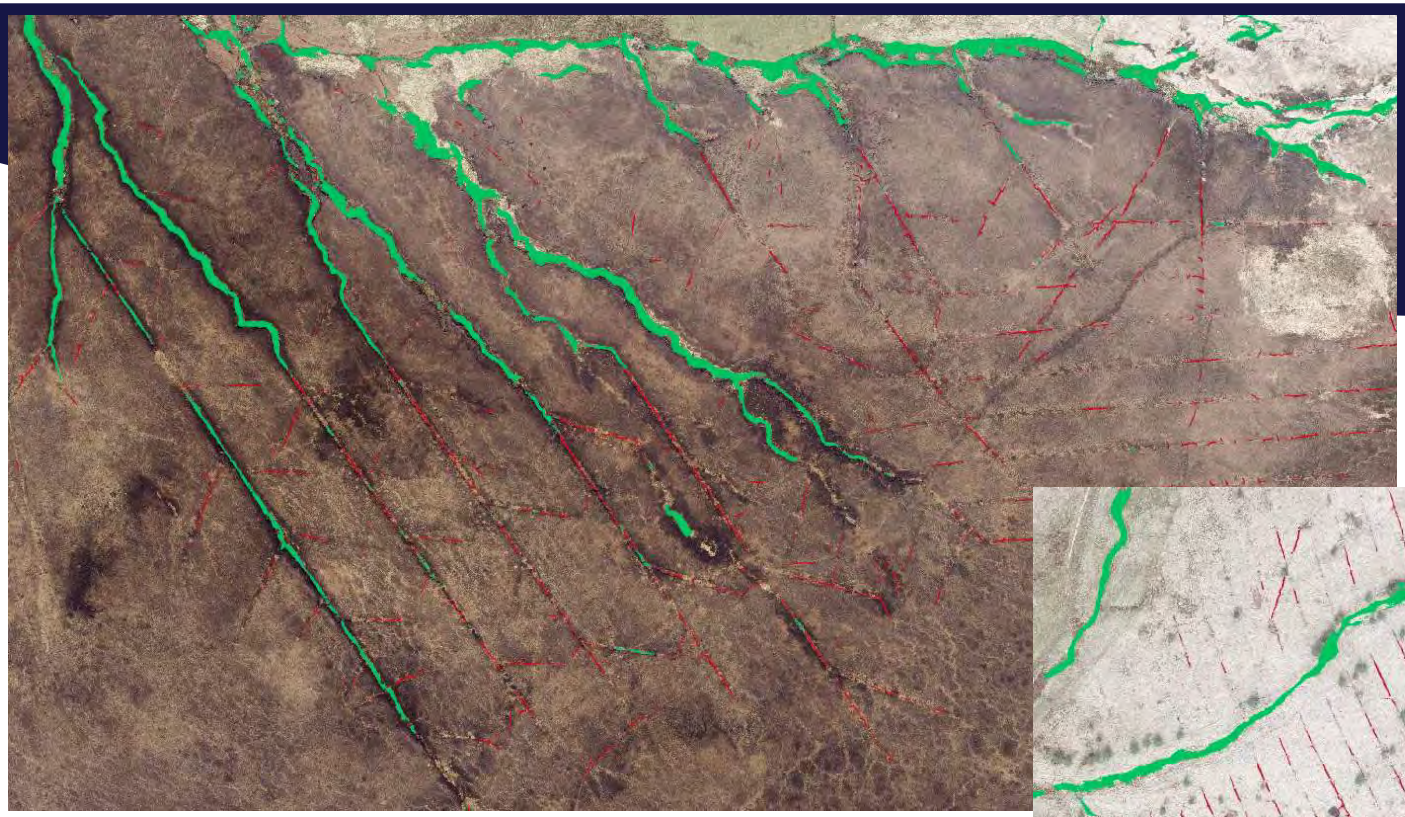


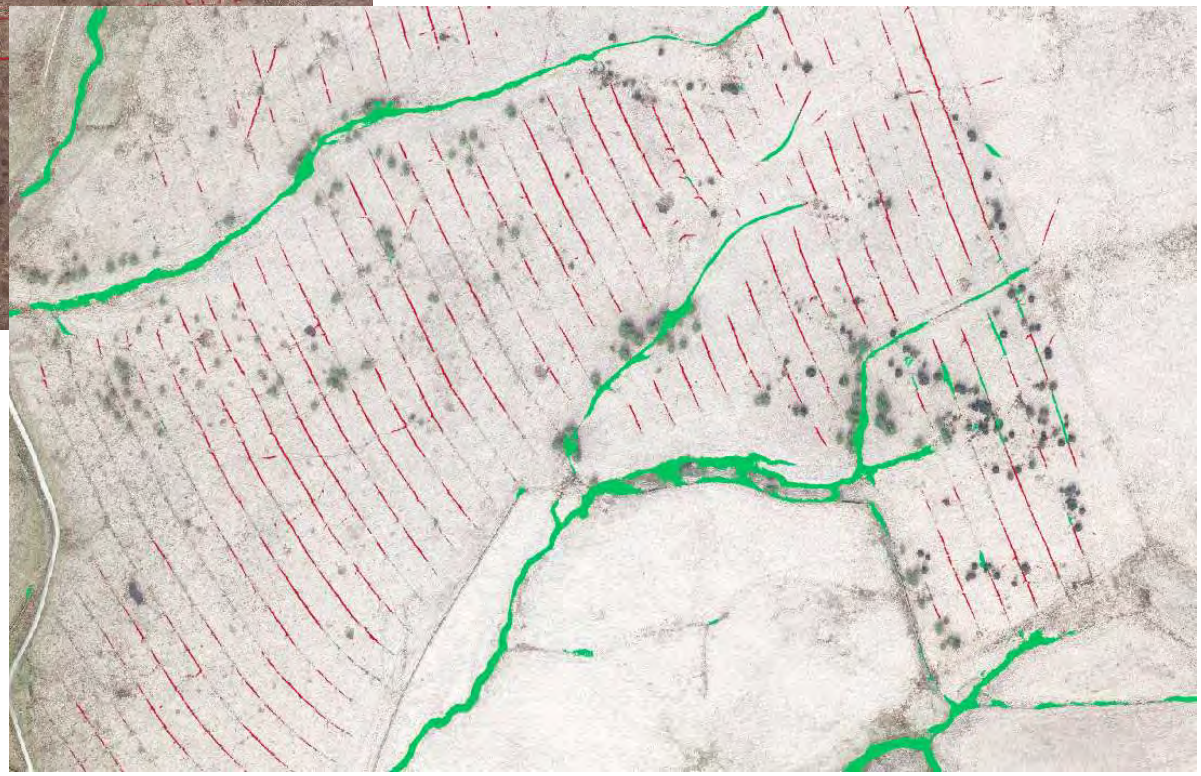






Grips and Gullies





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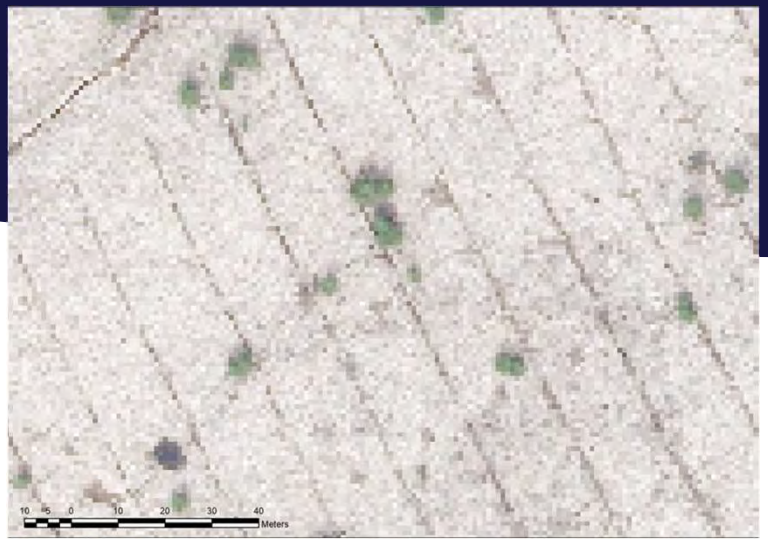
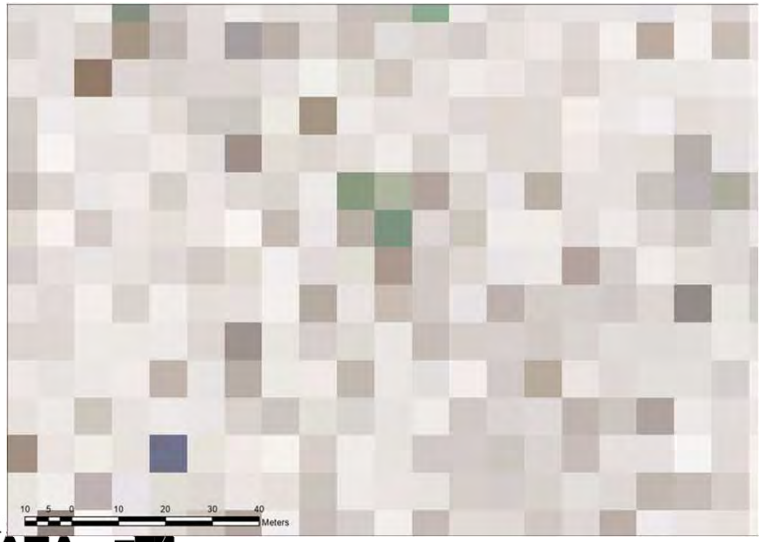
Earth Observation
Aerial Photography or Satellite Imagery ?

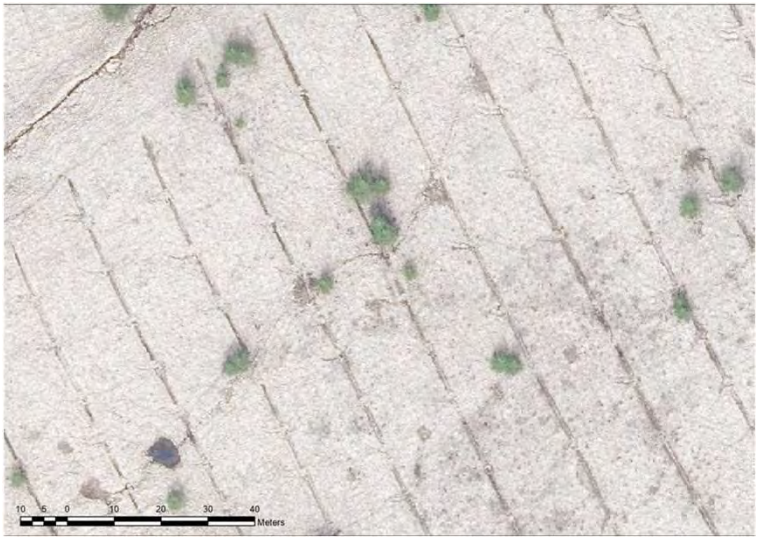
Source data

- Access to high resolution 12.5cm Aerial Photography for Great Britain – APGB via the Public Sector Geospatial Mapping Agreement
- Satellite Imagery – There are free sources e.g. NASA Landsat (30m) and ESA Copernicus Sentinel missions (10m)
- However - it's a judgement call between the spatial and temporal resolution
- We are exploring access to high resolution Commercial Satellite providers e.g. 30cm

CIVIL SERVICE DATA CHALLENGE







Satellite resolutions

32m (rough equivalent to Landsat)

8m (rough equivalent to Sentinel)

Aerial Photo resolutions

1m

12.5cm (APGB)

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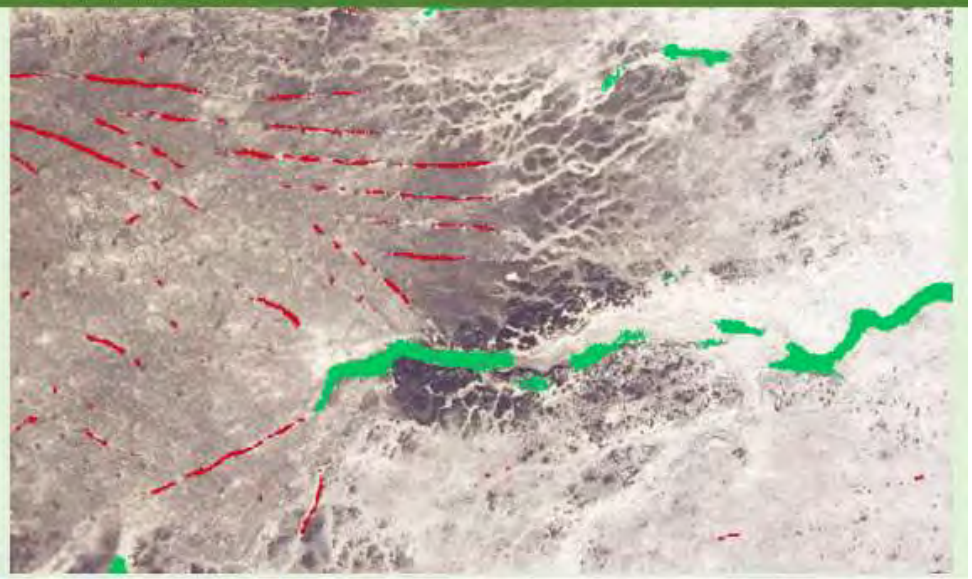
Ground Truth

12.5cm model

25cm model

50cm model



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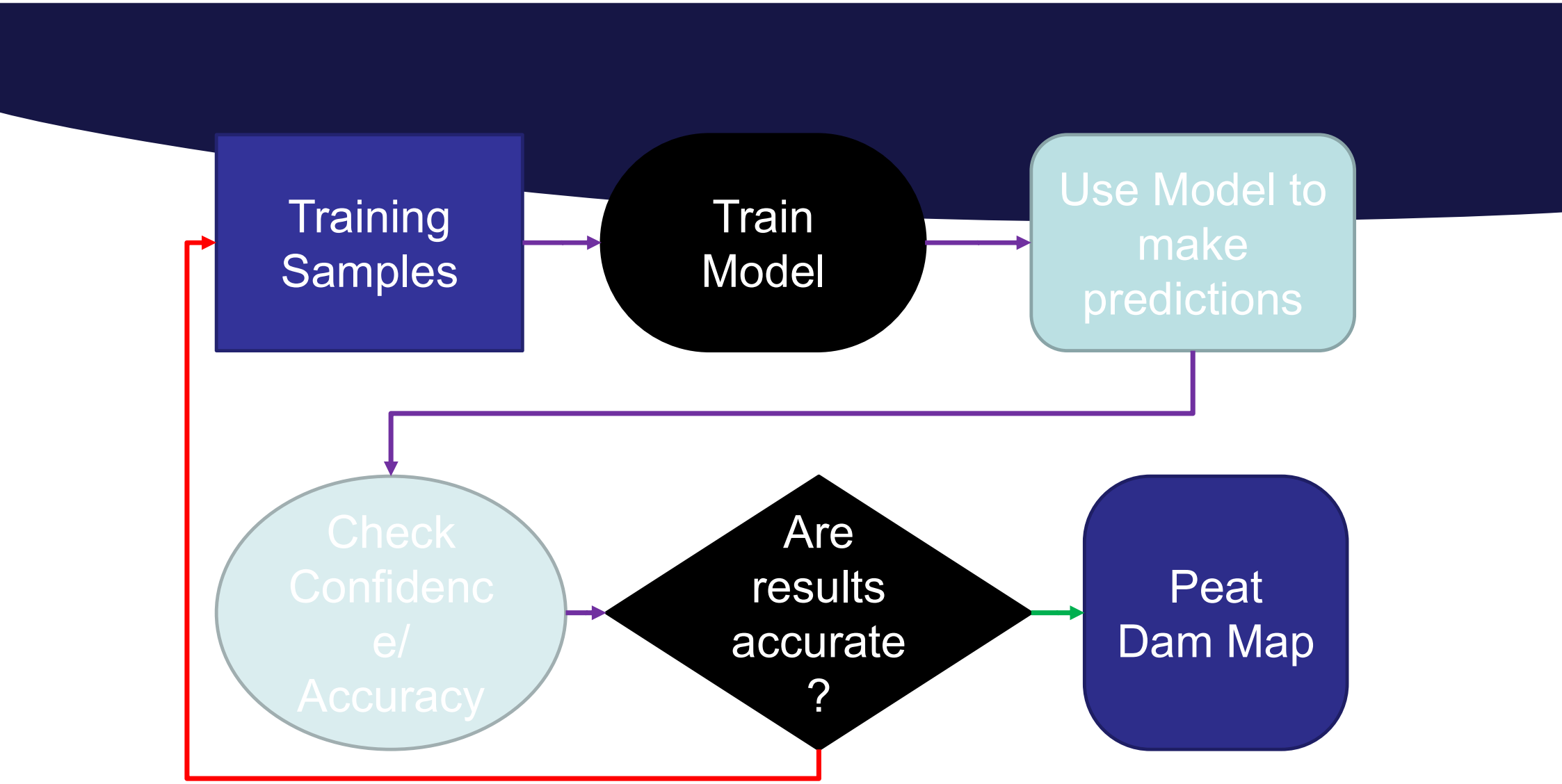
"You Only Look Once"
Dog
Cat
Become a YOLO Peat Dam Detector

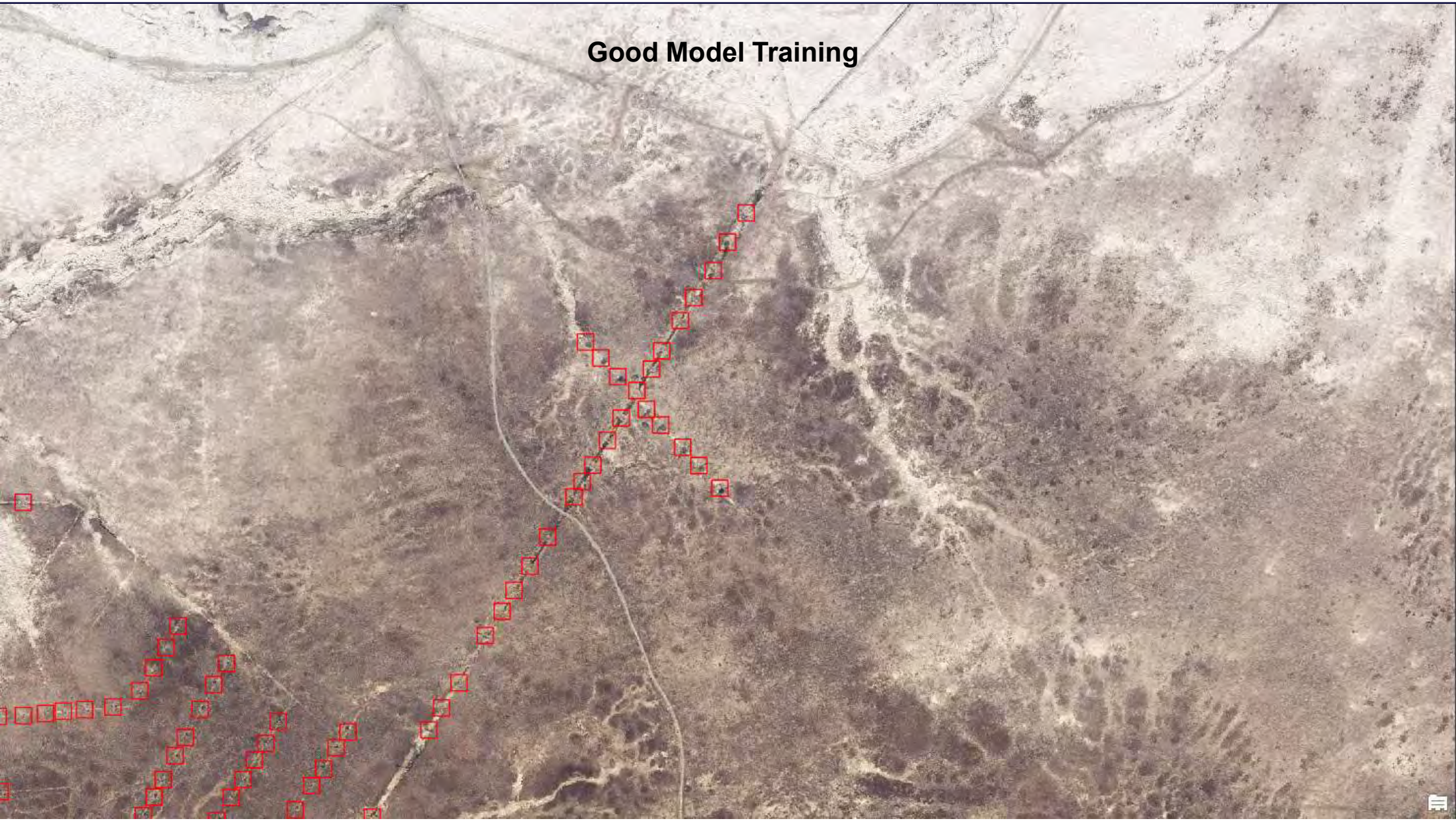


CIVIL SERVICE DATA CHALLENGE

AI4Peat

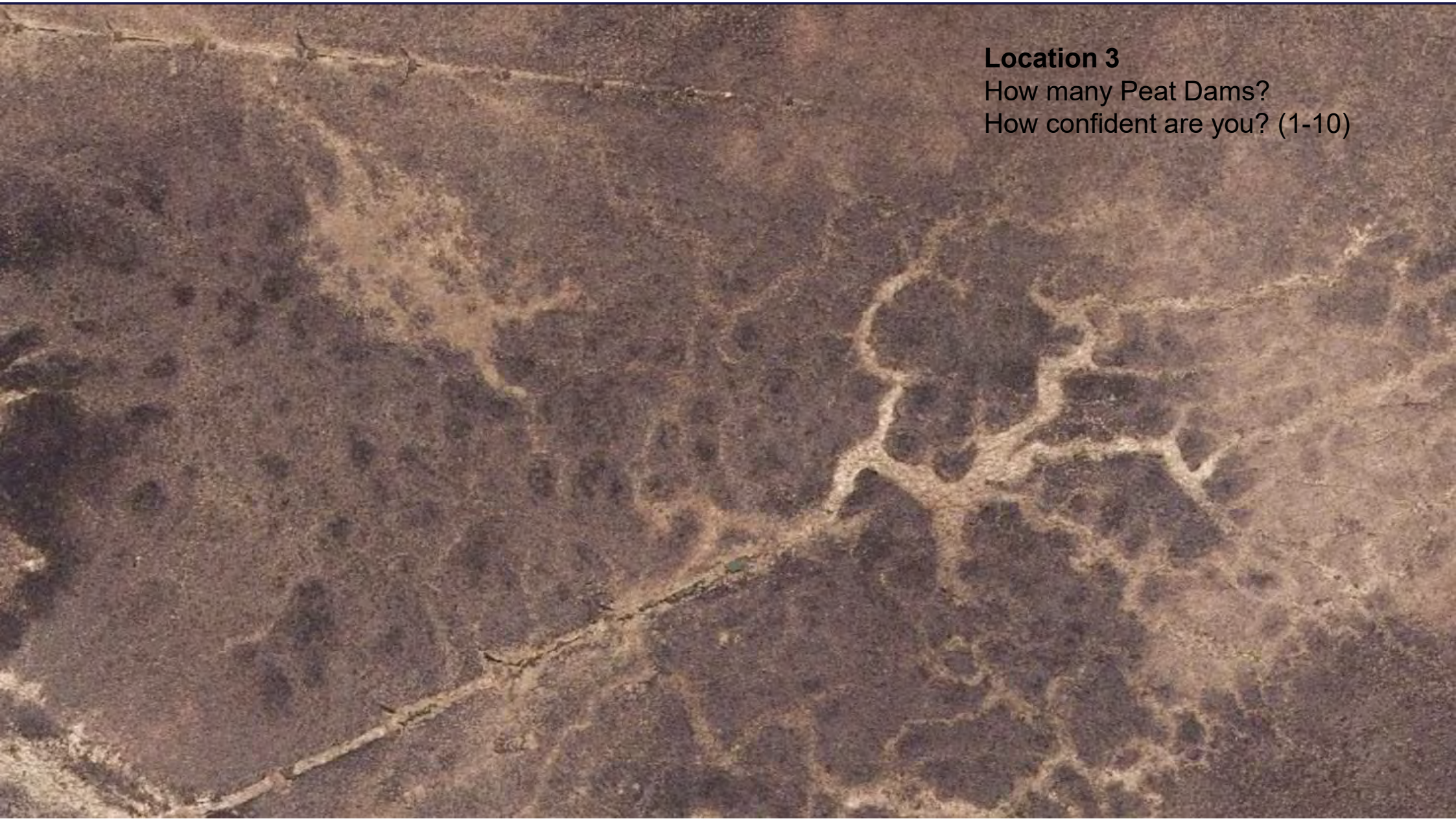

Model Training

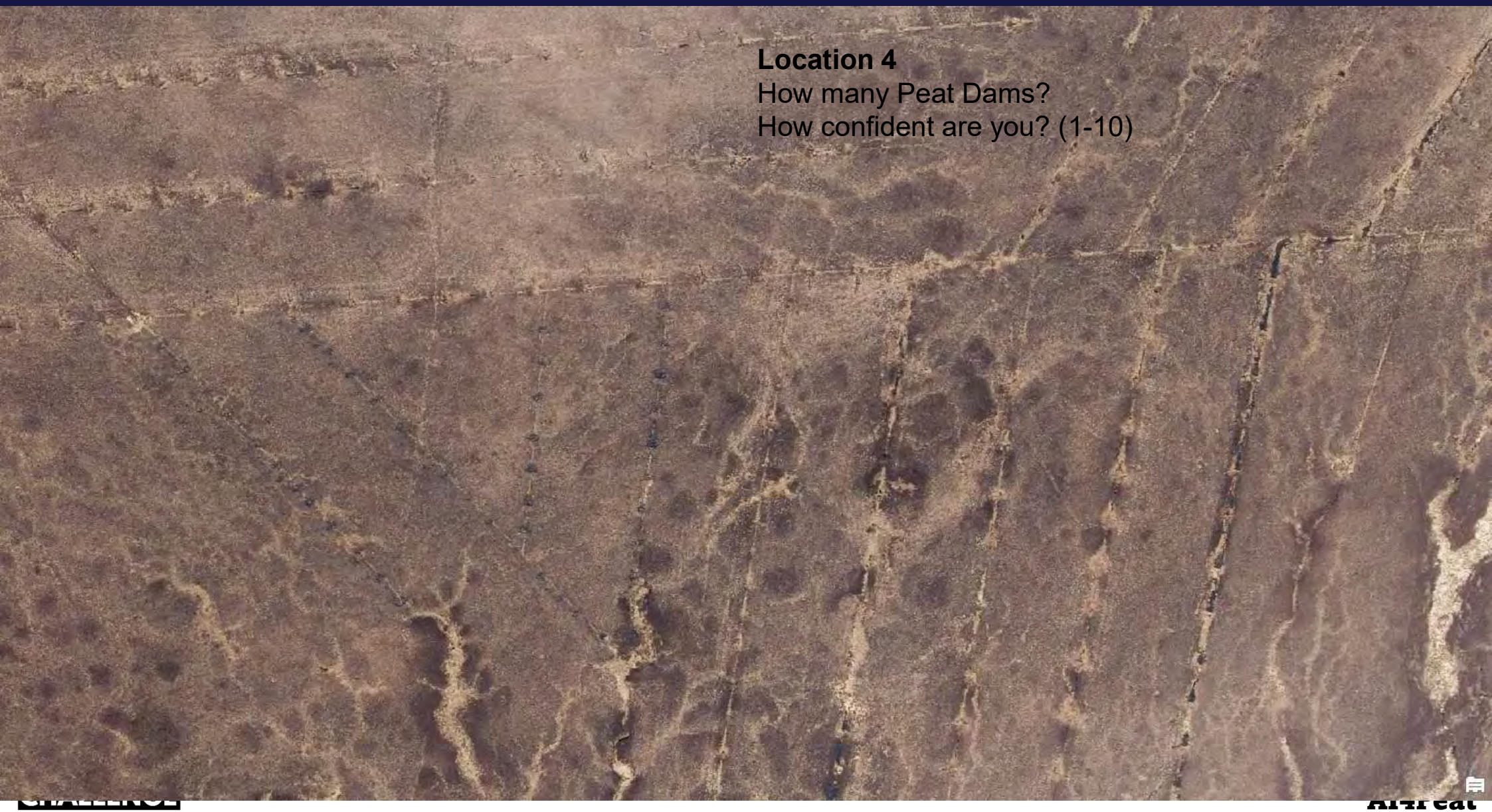

Location 1
How many Peat Dams?
How confident are you? (1-10)


Good Model Training


Good Model Training

Location 2
How many Peat Dams?
How confident are you? (1-10)

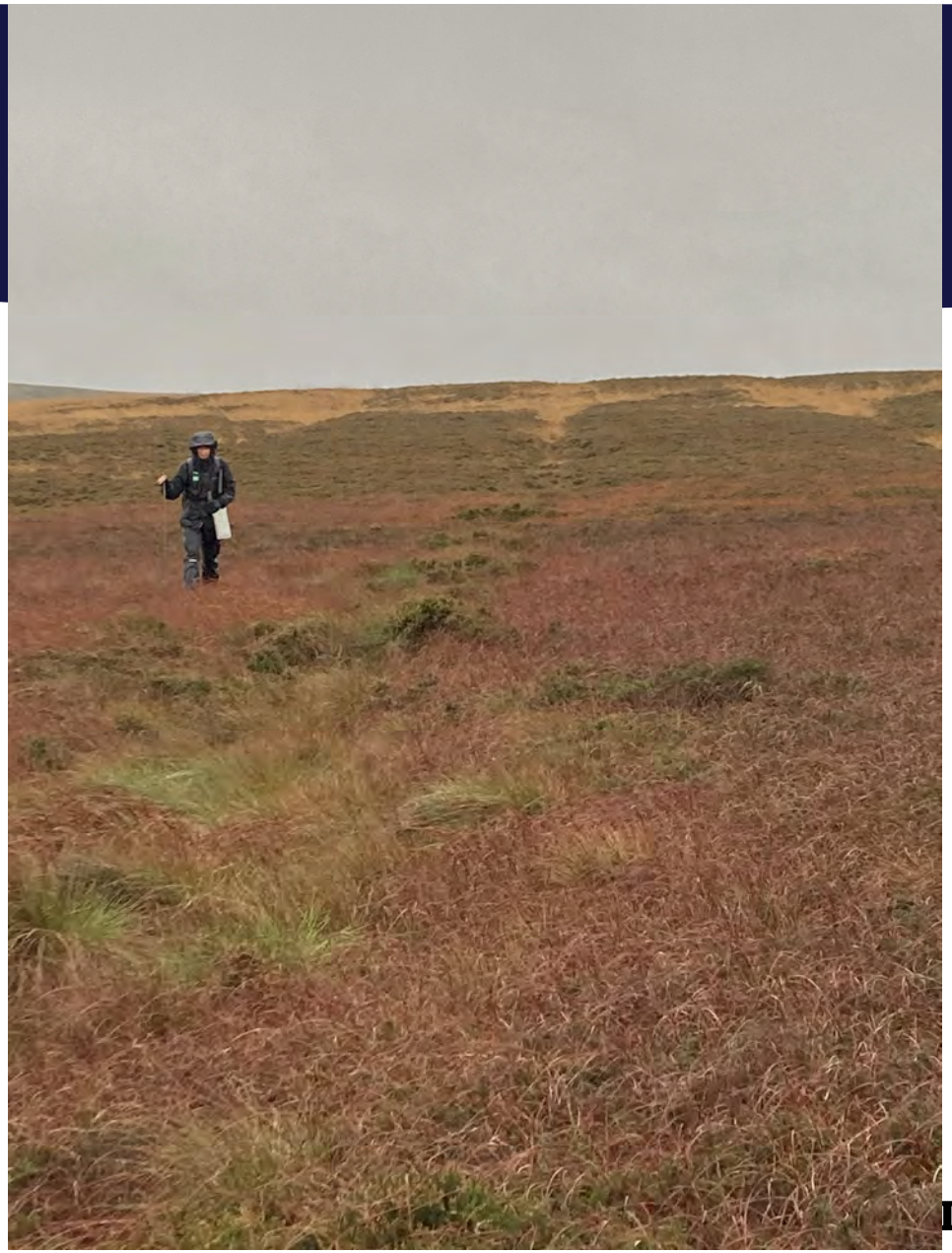

Location 3
How many Peat Dams?
How confident are you? (1-10)


Location 4
How many Peat Dams?
How confident are you? (1-10)

Some real peat dams

CIVIL SERVICE DATA CHALLENGE

AI4Peat



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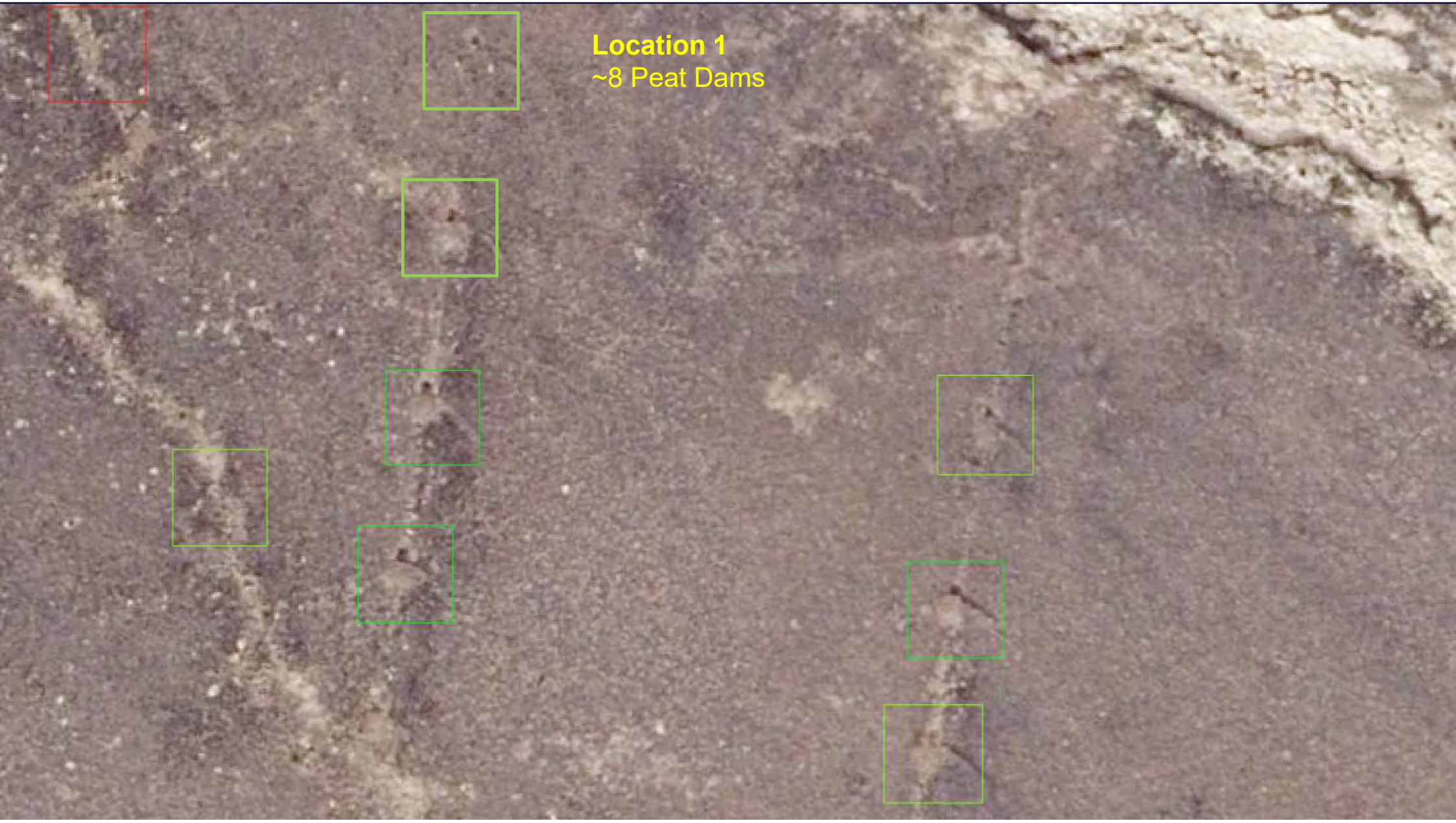
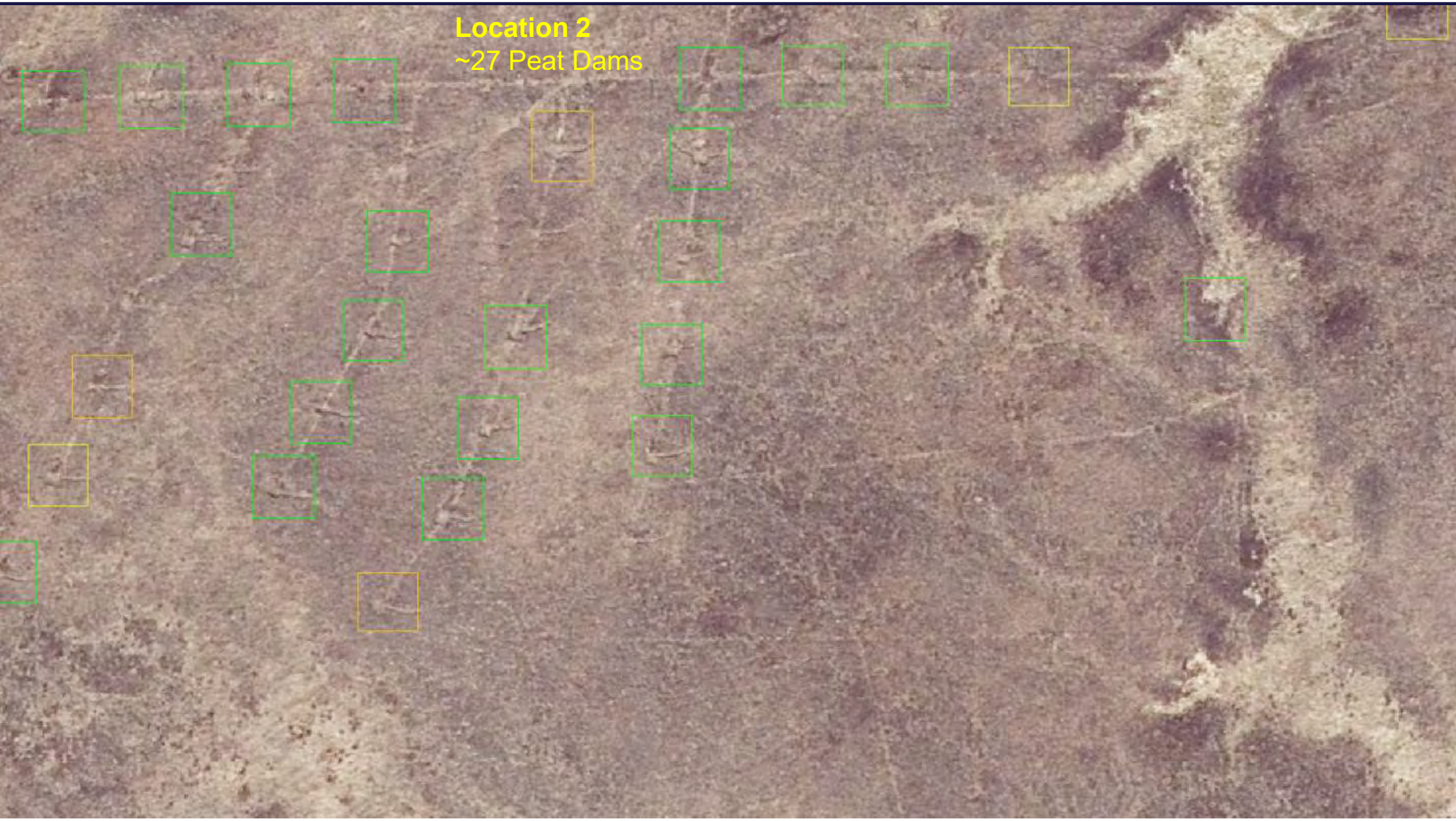
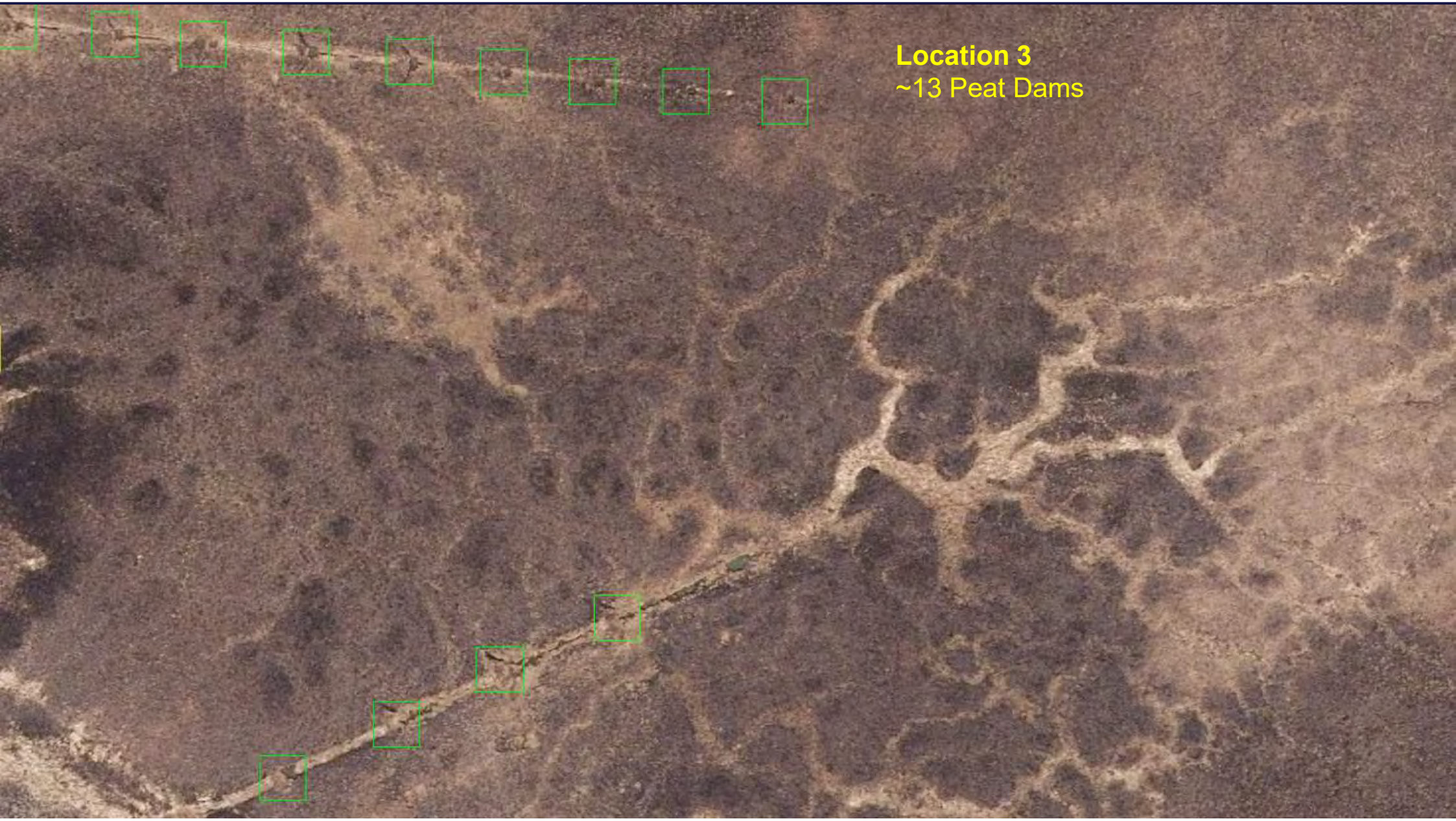
Badly eroded gully

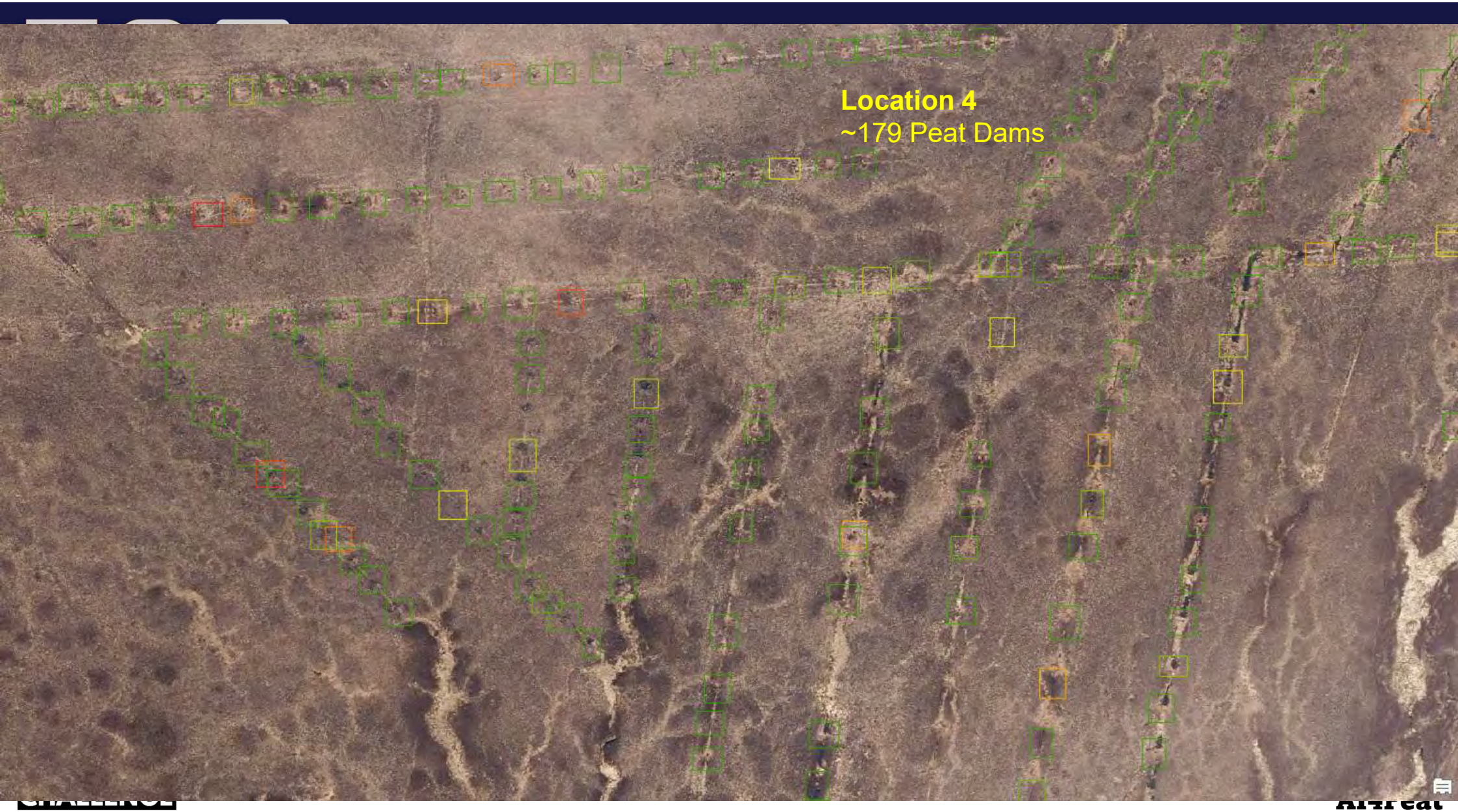
CIVIL SERVICE DATA CHALLENGE

AI4Peat

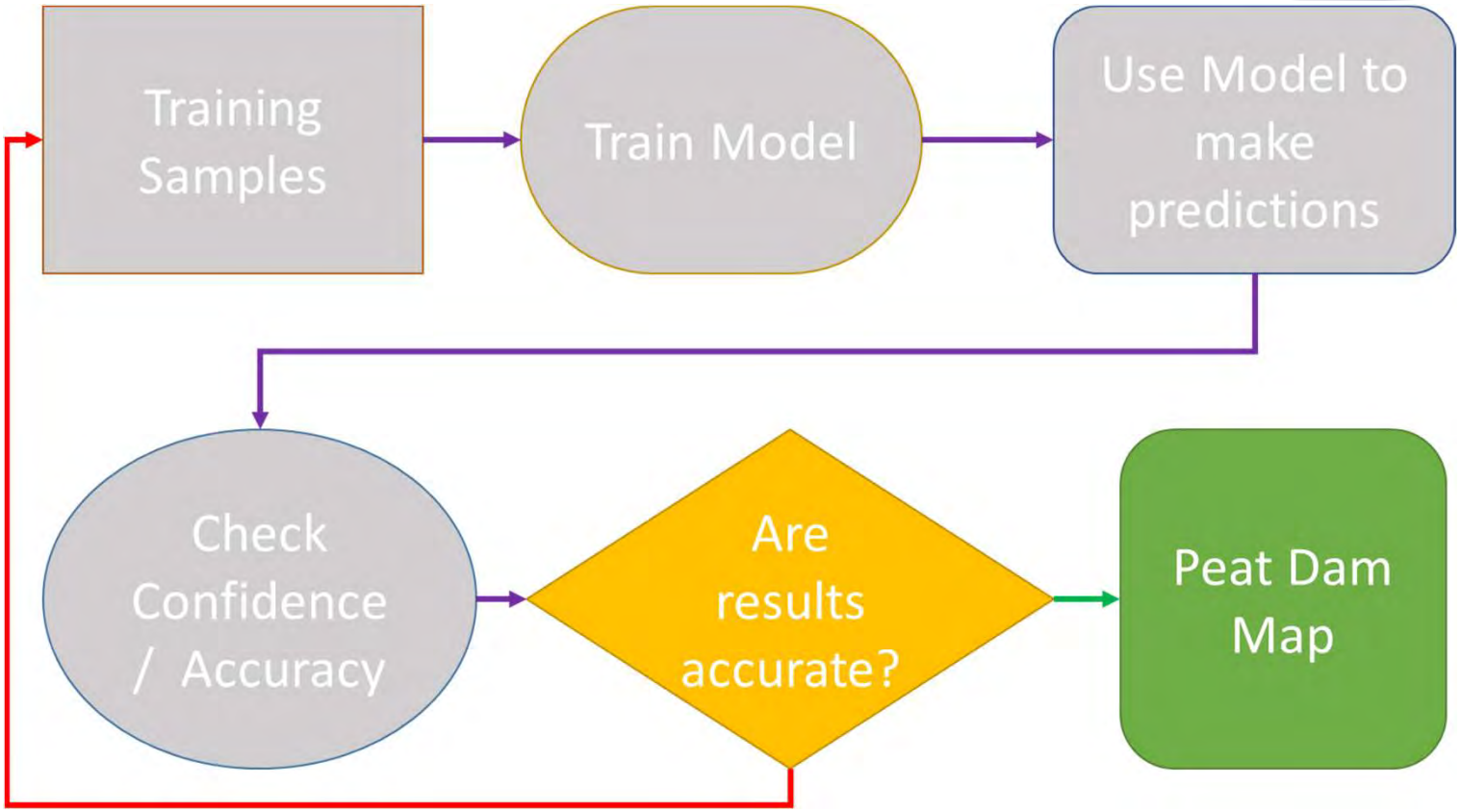

Location 1
~8 Peat Dams


Location 2
~27 Peat Dams


Location 3
~13 Peat Dams

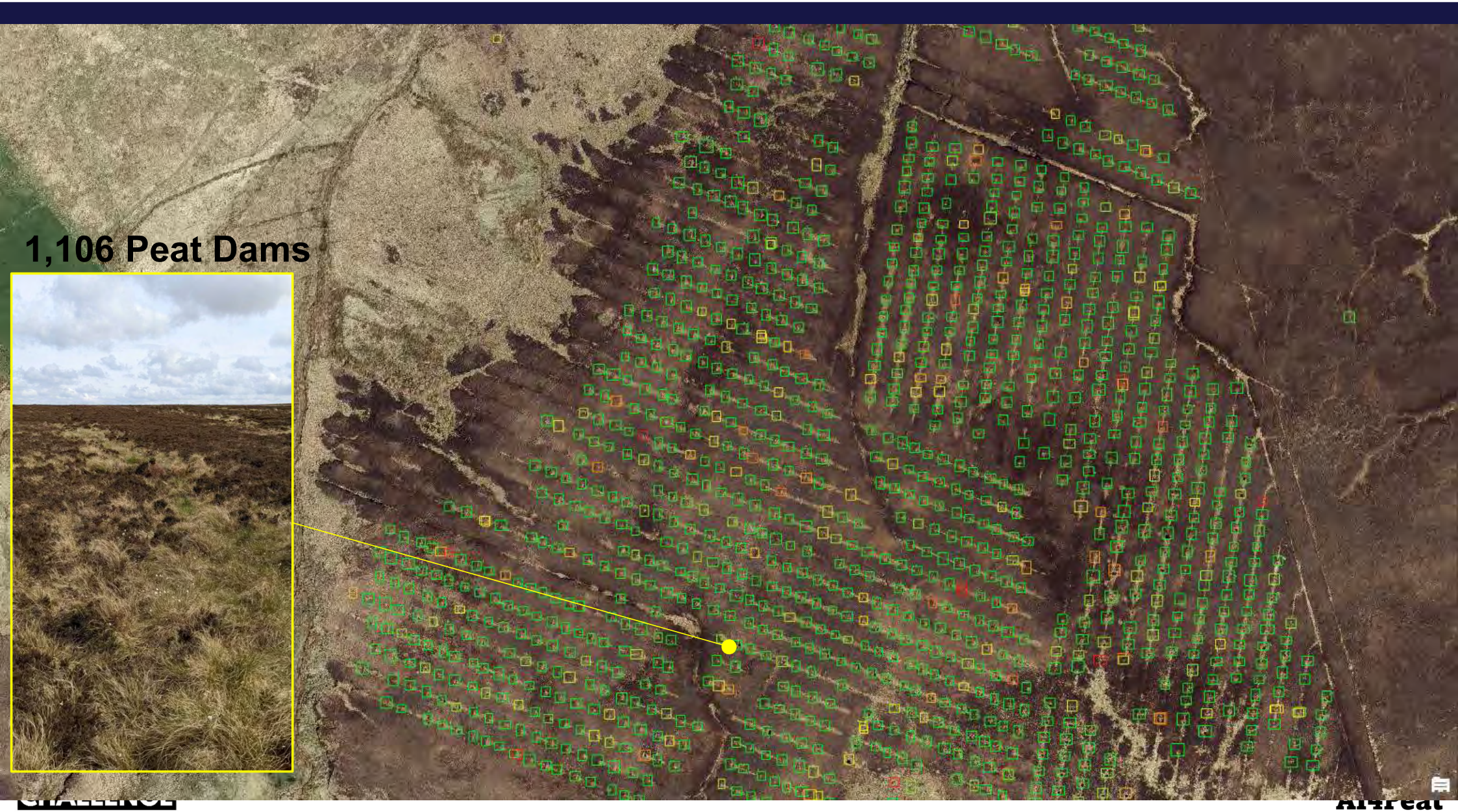

Location 4
~179 Peat Dams

Ready to map some dams!



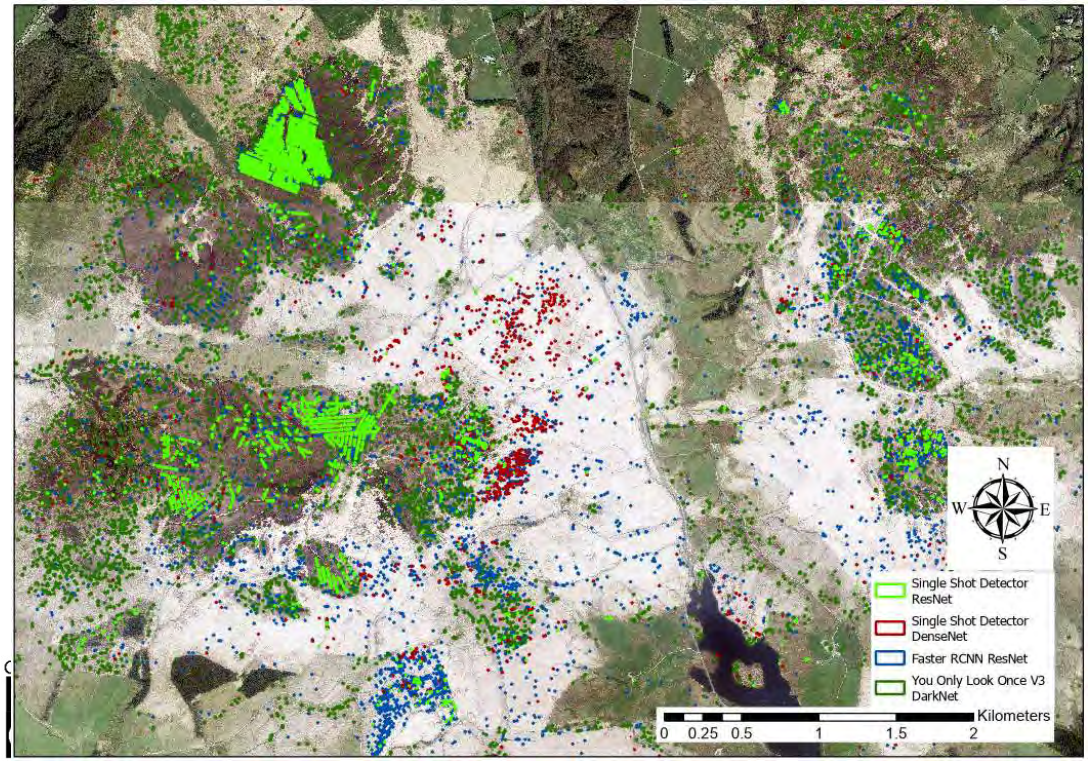
CIVIL SERVICE DATA CHALLENGE

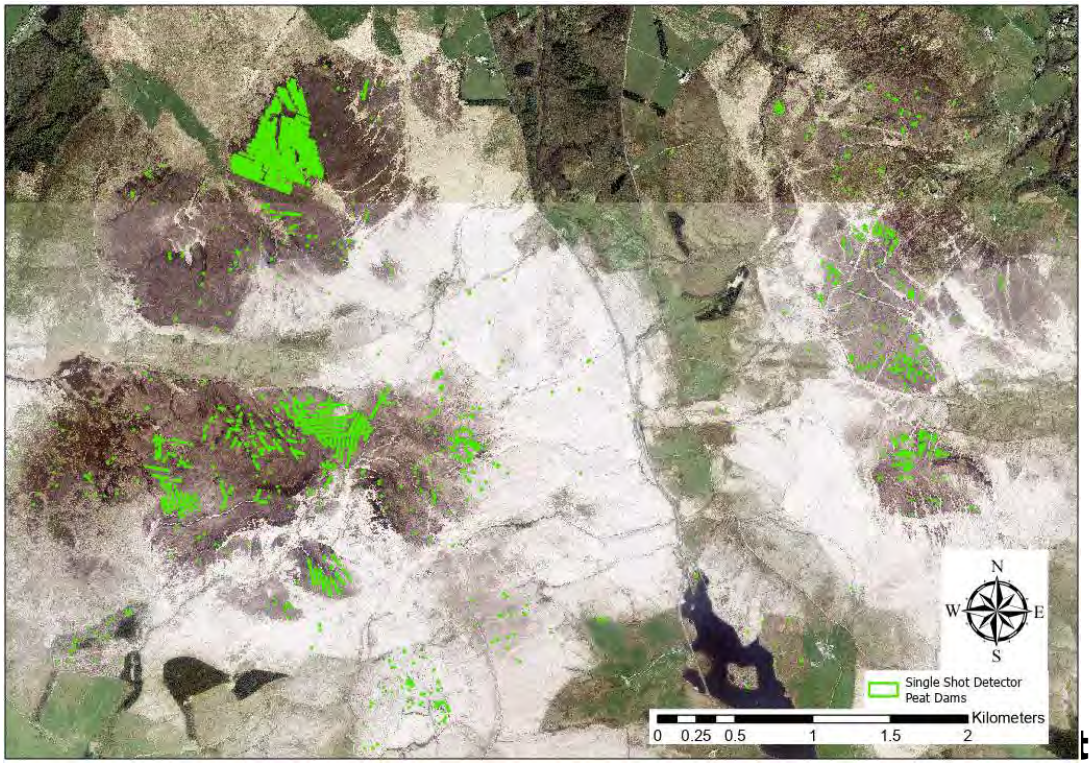
AI4Peat

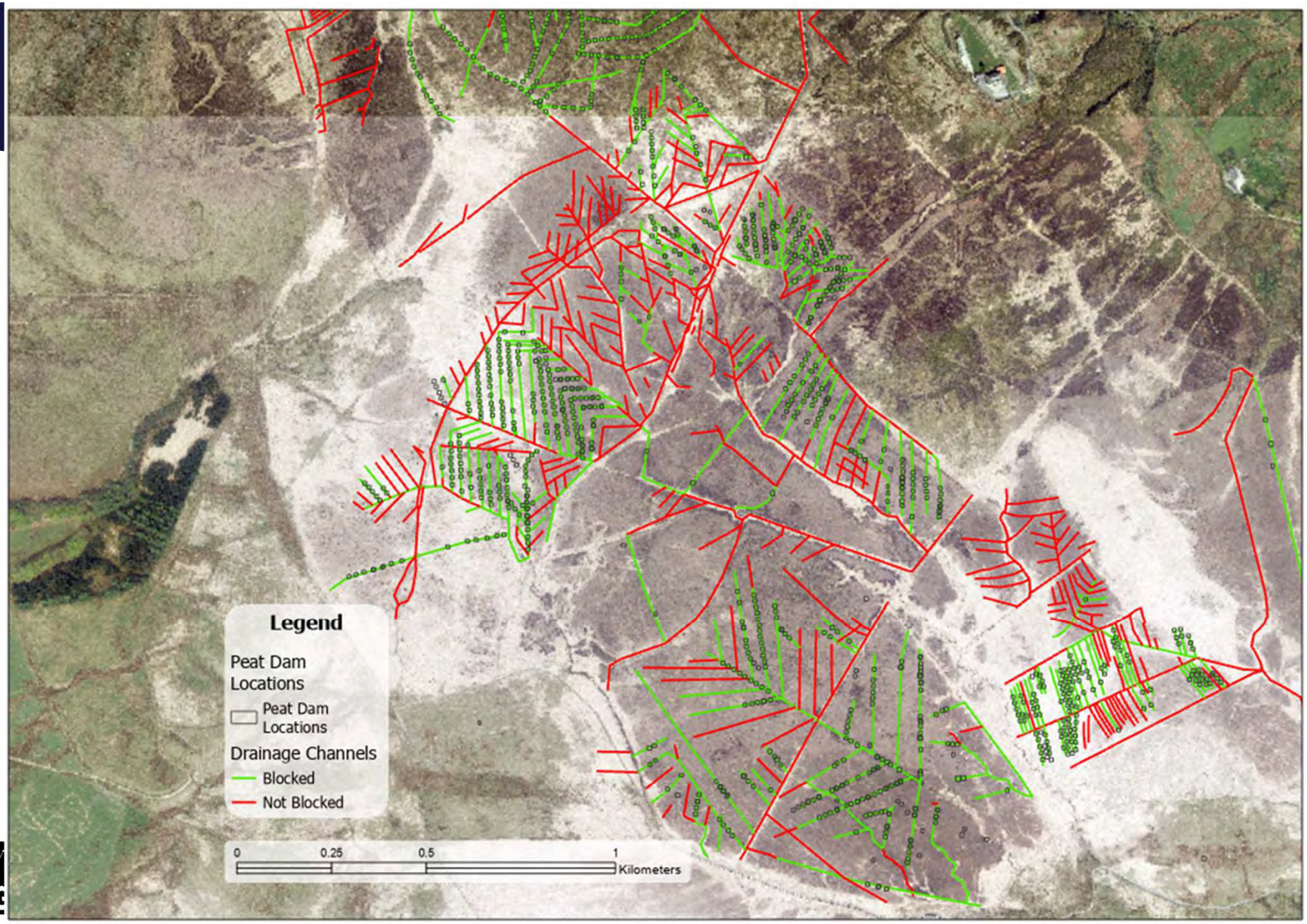

1,106 Peat Dams

Peat Dam Detection

- Initial results look promising
- 6 Model architectures trialled
- 4 showed promising results
- >3,000 Peat dams mapped
- More diverse examples of peat dams are required to train a better model



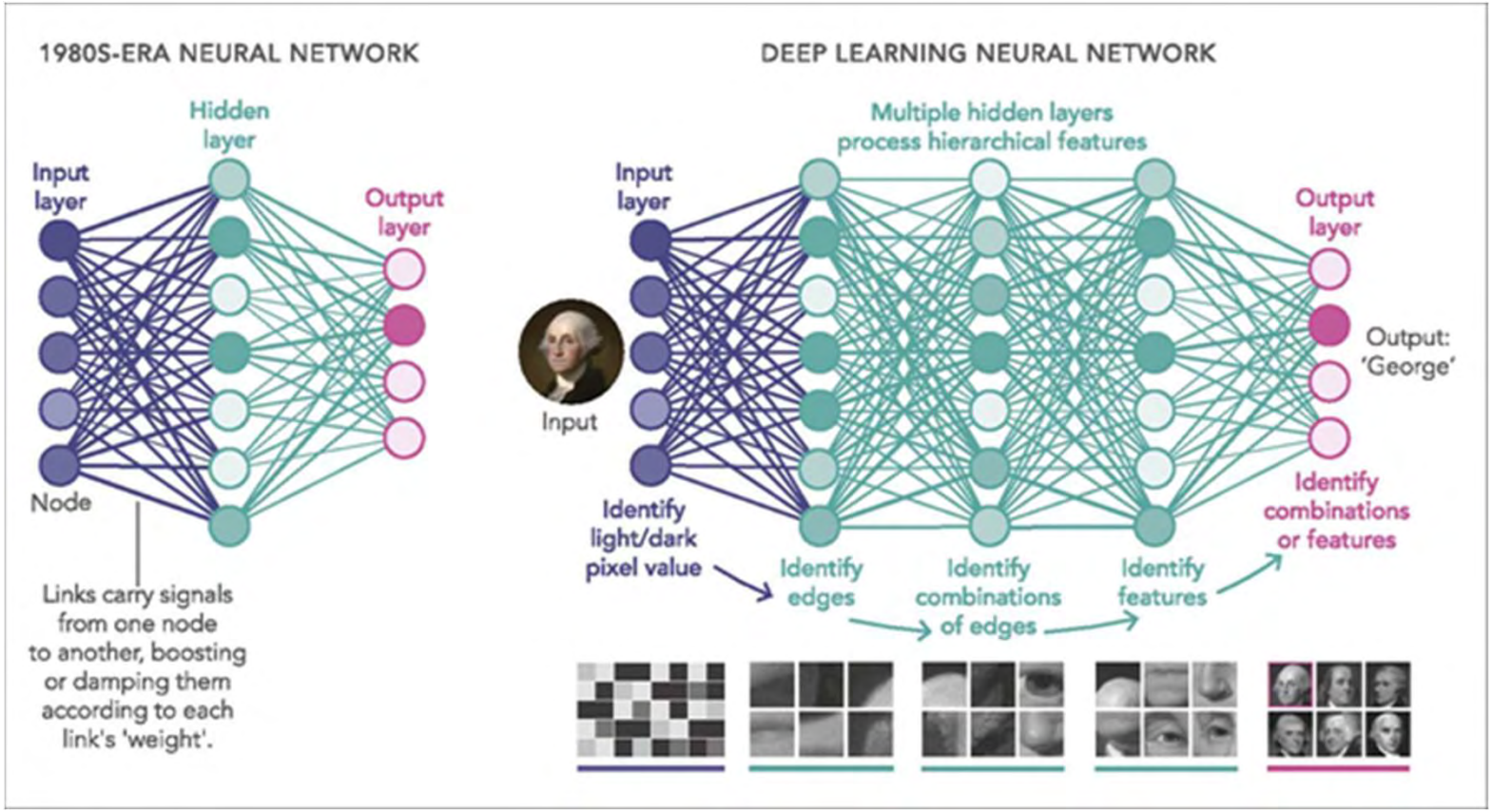




CIVIL SERVICE DATA CHALLENG

AI4Peat

What is Deep Learning



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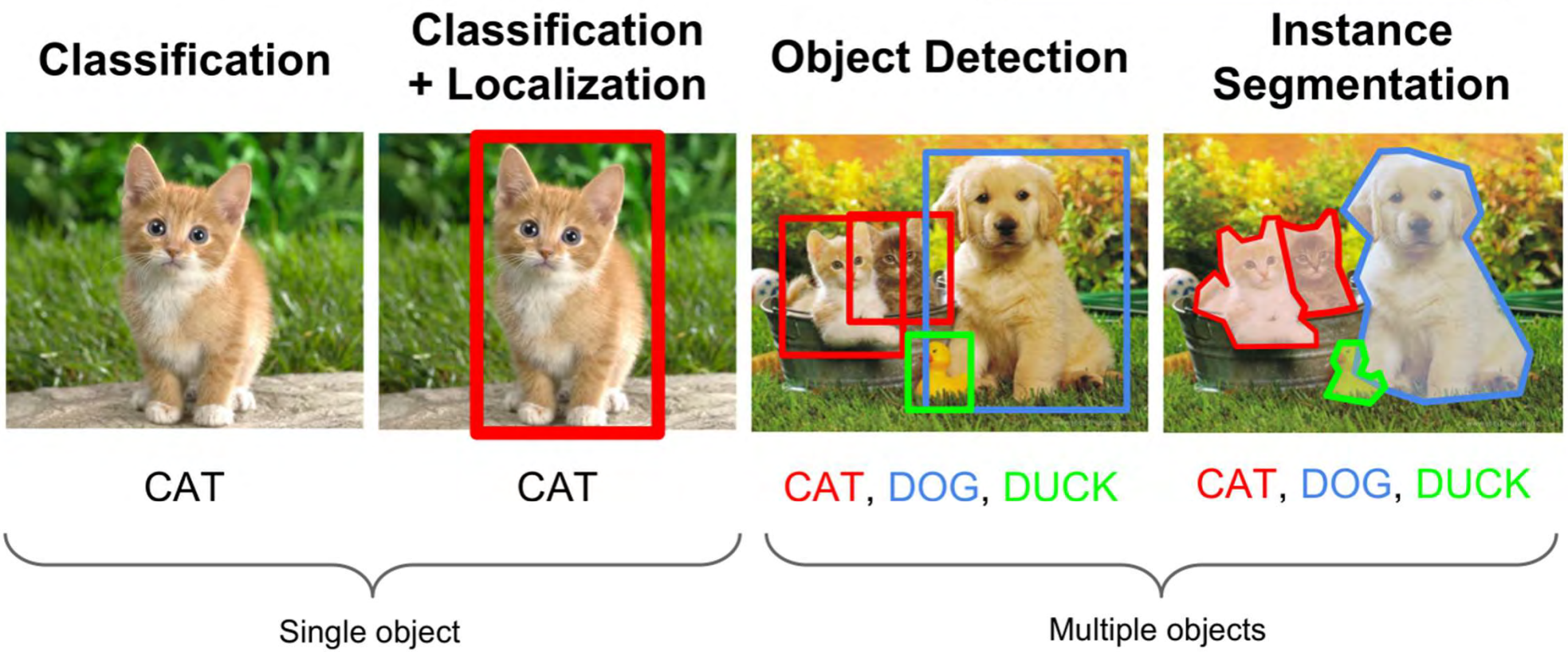

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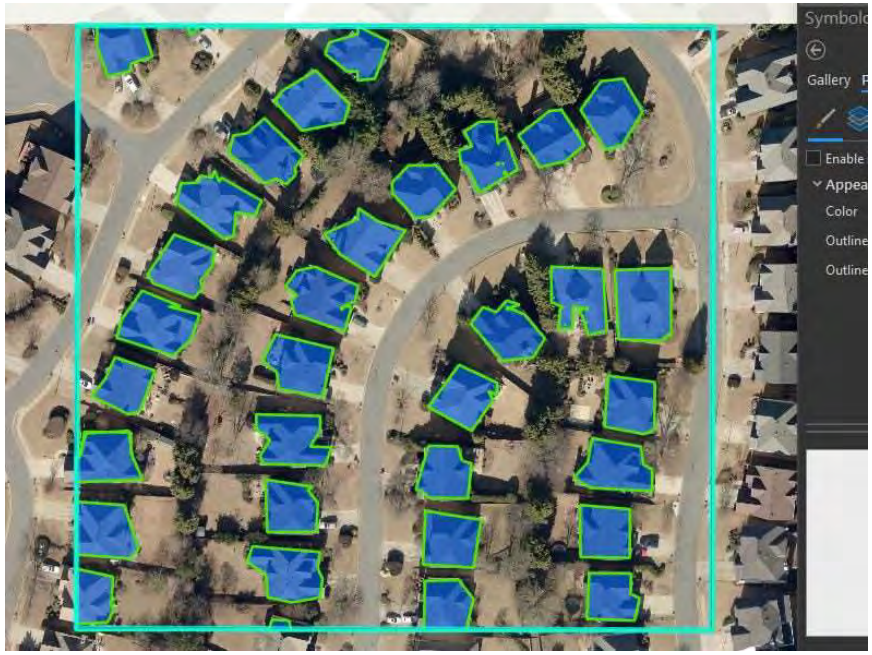
Examples

- Palm Trees

- Houses



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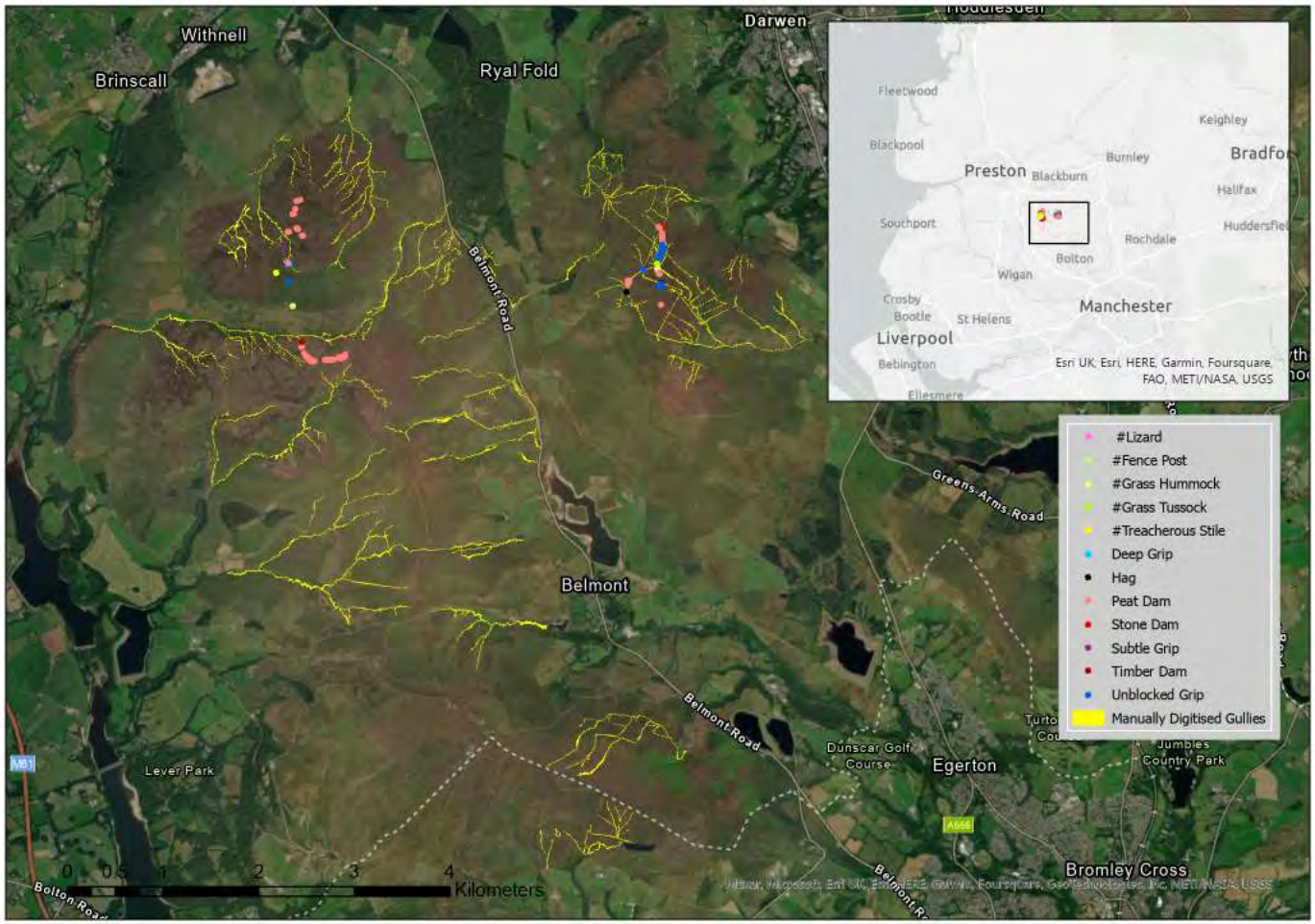
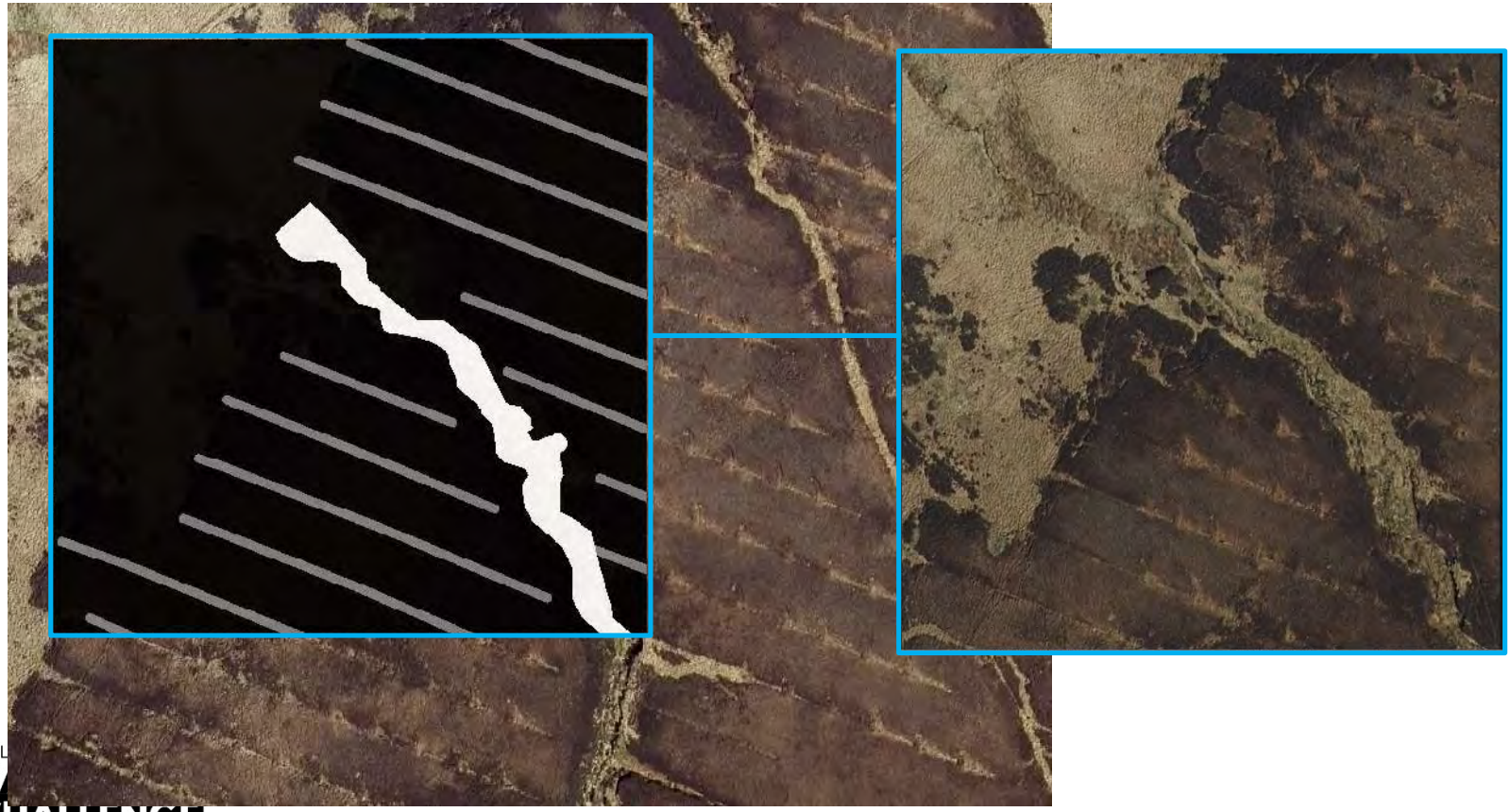
Manual Mapping

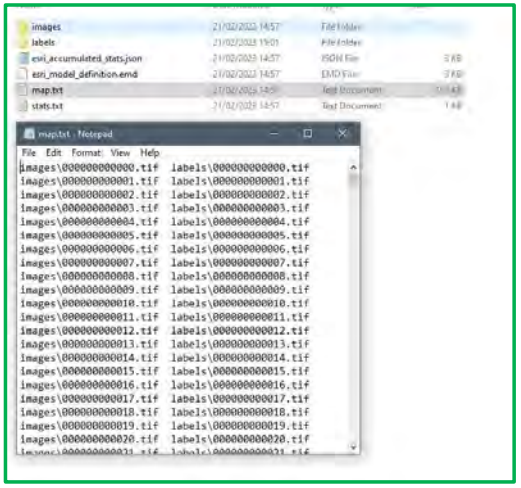
- 2 days GPS surveying
- 4 days manual digitising



CIVIL SERVICE DATA CHALLENGE

Training data – showing the model what to look for





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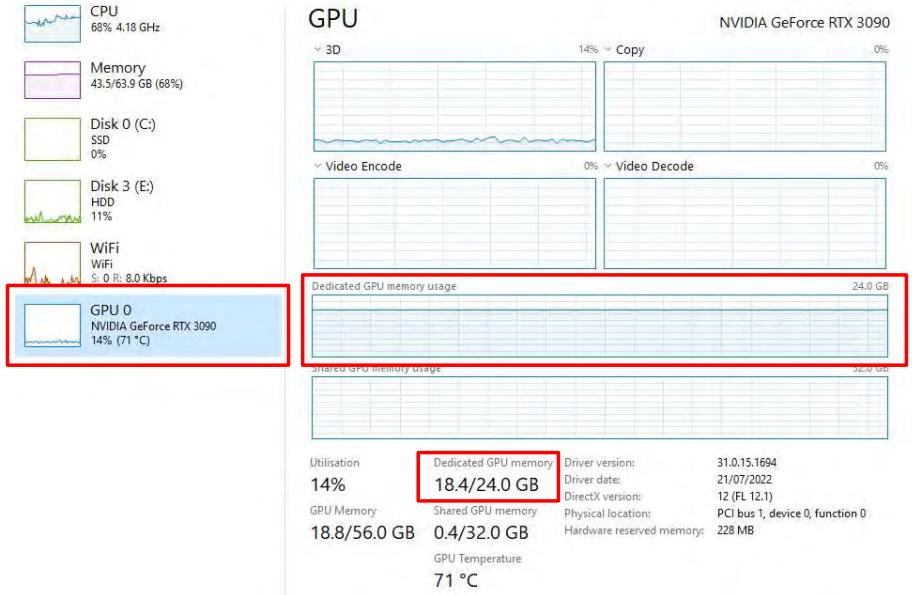
Compute Power



System resources

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Cloud Computing

databricks

1-10 Workers	64-640 GB Memory 8-80 Cores
1 Driver	14 GB Memory, 4 Cores
Runtime	12.2.x-scala2.12

Microsoft

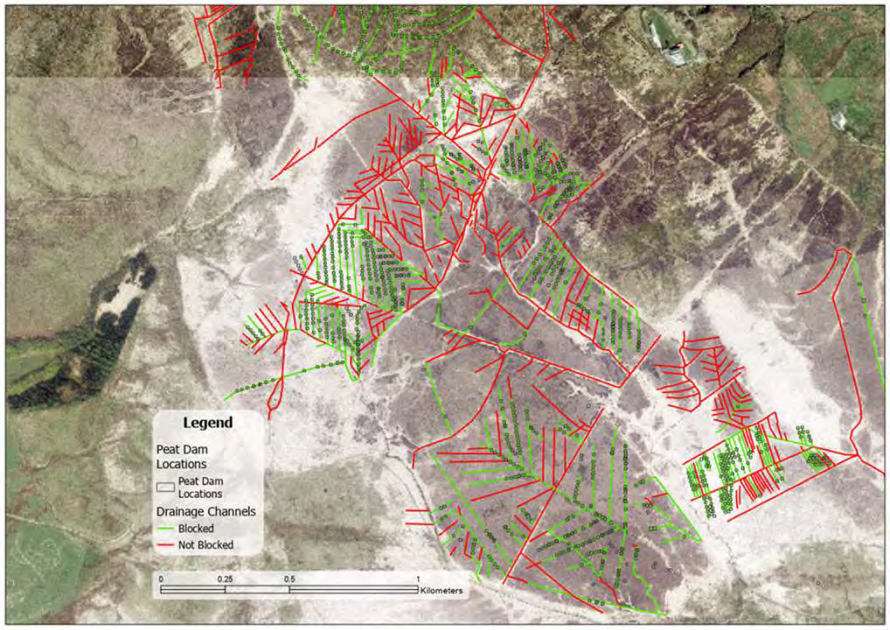
Department
for Environment
Food & Rural Affairs

- Near limitless access to compute power and storage
- Expert collaborators

CIVIL SERVICE DATA CHALLENGE

Results so far and Next Steps

- Scaling up to England
- Deliver national map for England Peat Map (EPM) for Mar 2024
- Aspirations to scale to UK …and beyond?!
- Carbon capture potential
- Make results accessible via a dashboard
- DEFRA's restoration register
- Building partnerships with NTT, Microsoft and Databricks



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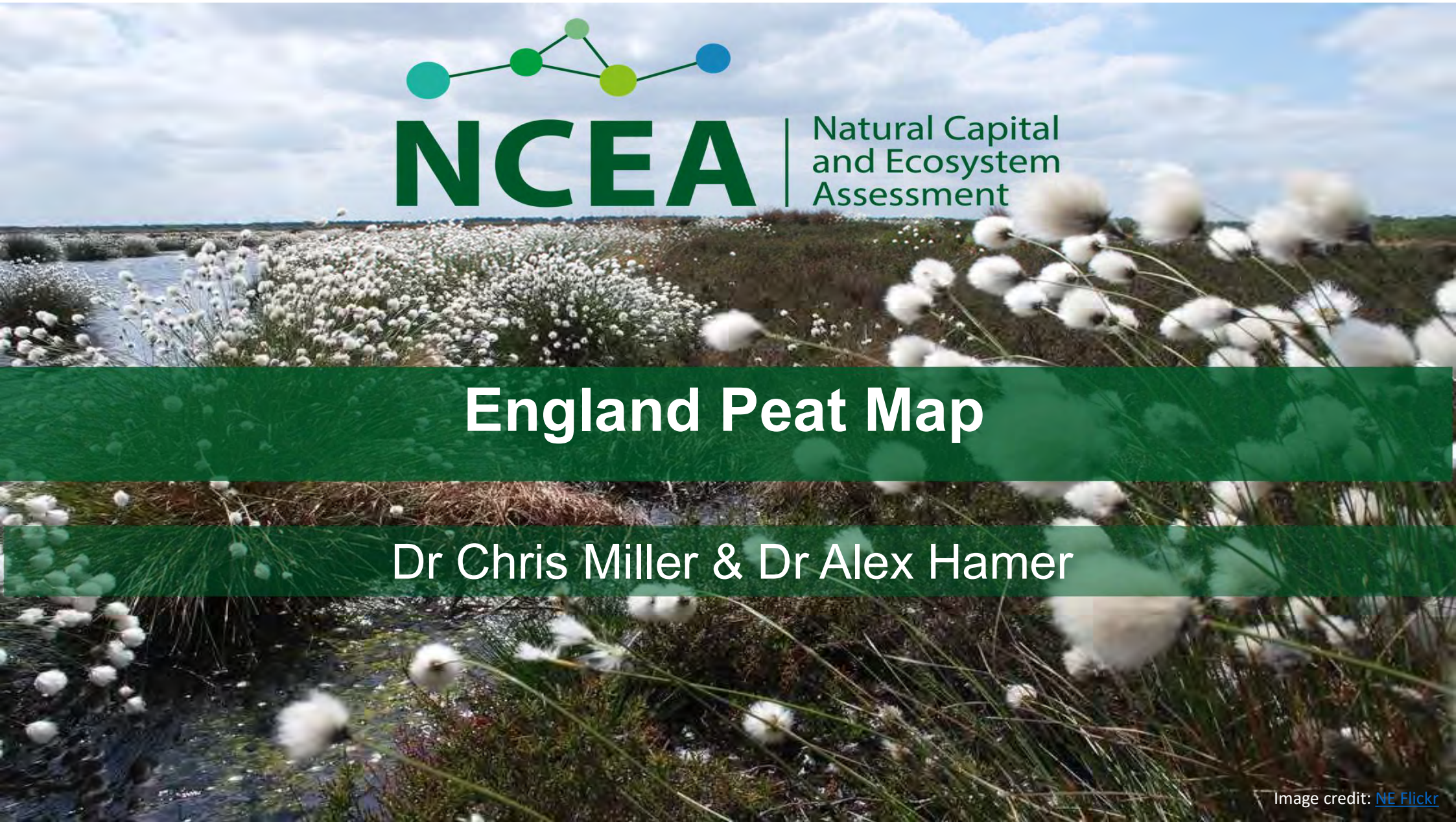

England Peat Map

Dr Chris Miller & Dr Alex Hamer

Image credit: NE Flickr

England Peat Map

Andy Webb
Principal Adviser

Chris Miller
Senior Adviser - Field survey coordinator

Tom Hunt
Senior Adviser - Data Engagement

Sam Dixon
Senior Adviser - Surface Features

Christoph Kratz
Senior Adviser - Extent & Depth

Jessica Steward
Lead Adviser - Field survey coordinator

Craig Dornan
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Alex Hamer
Senior Adviser - Vegetation

Mark McDougall
Team Leader

Mike Prince
Senior Adviser - Data Licensing

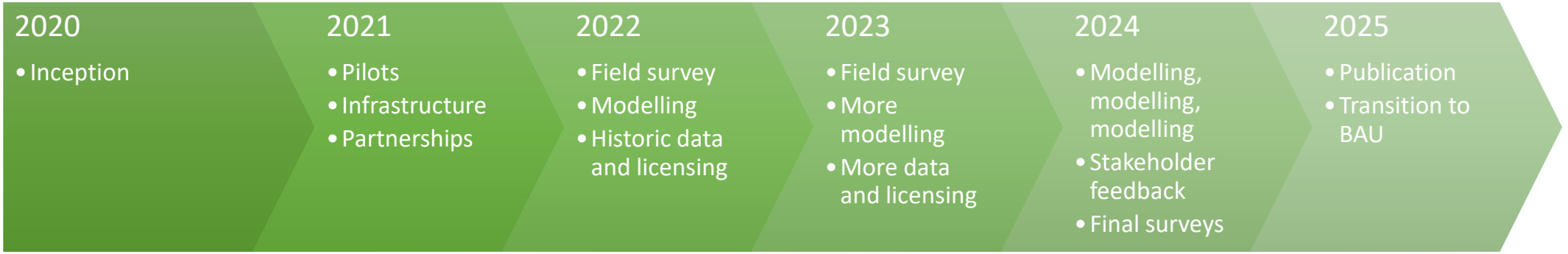
Cressida Godding
Project Manager

Sarah Lamb
Lead Adviser - Field Surveyor

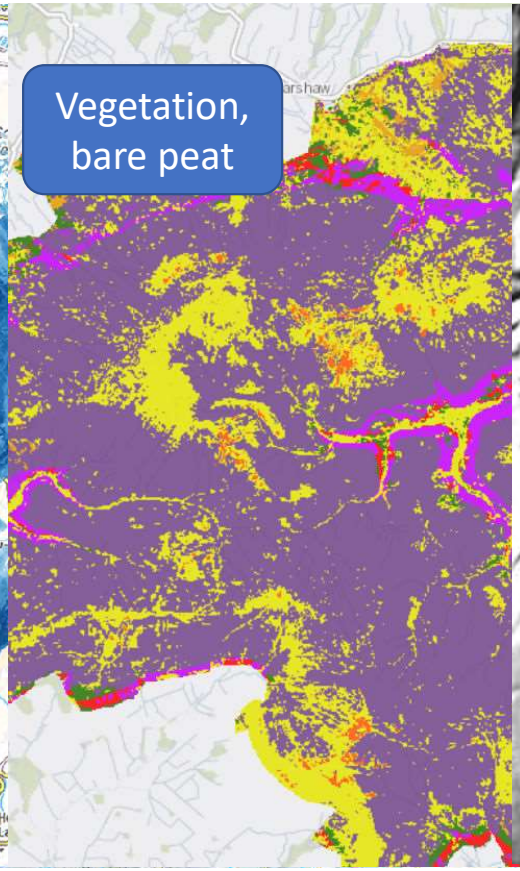
Jacob Podesta
Lead Adviser - Field Surveyor

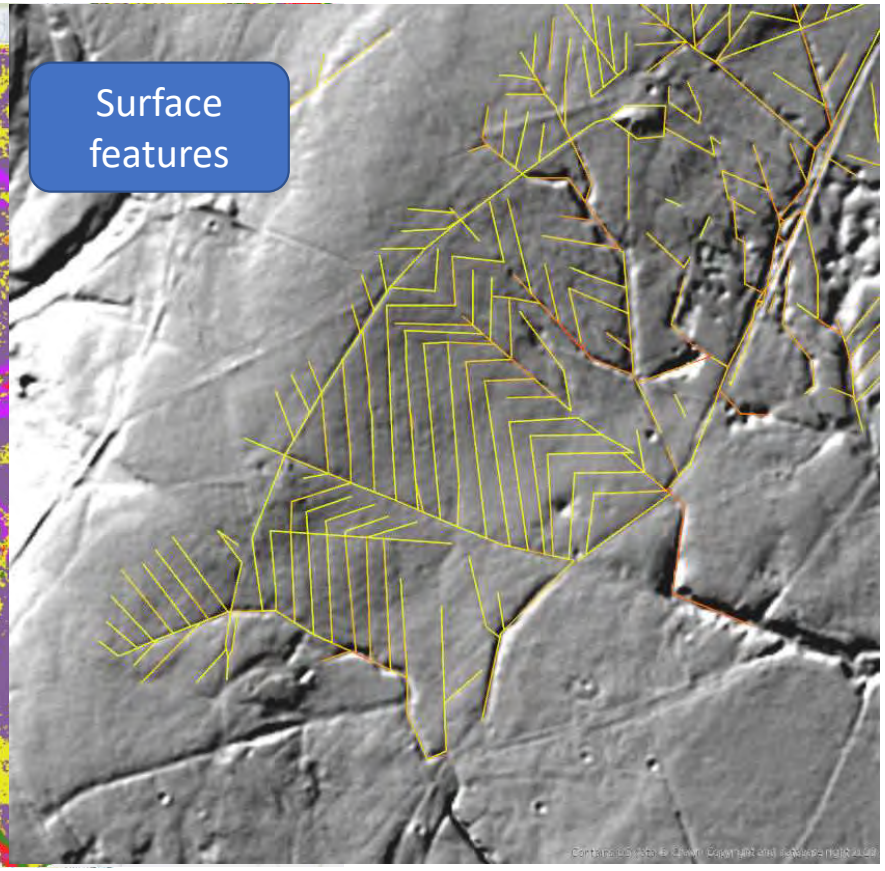
England Peat Map

- A set of open maps describing *extent, depth and condition* of peat
- New national baseline evidence to support:
  - Improved GHG emissions reporting
  - Peat restoration targeting
  - Natural capital asset recording
  - Nature Recovery



Expected Outputs





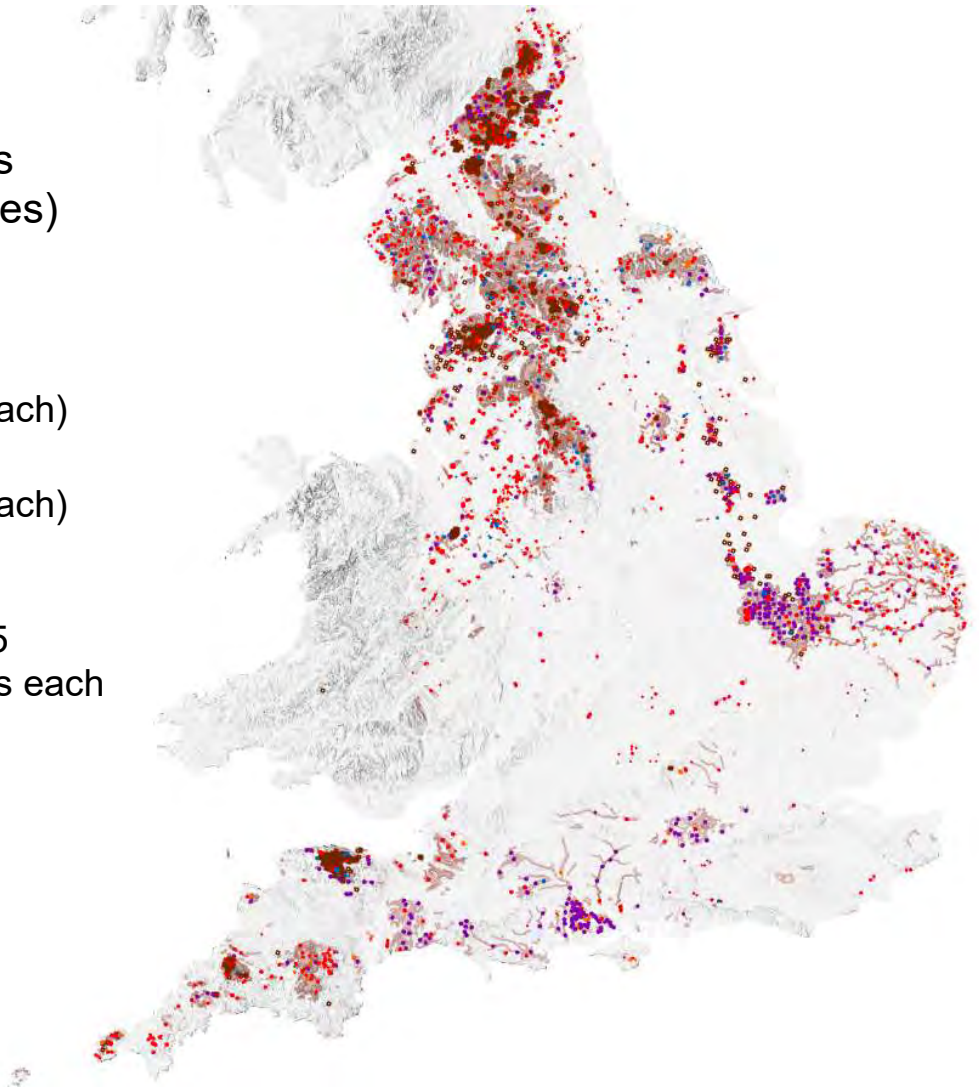
What's the training data?

- Historical / External
  >>3,500 observations
  (various methodologies)

  EPM Field Survey
- Sample
  (754 areas, ~8 quads each)
- Additional sample
  (181 areas, ~8 quads each)

  approx:
  - 7480 quadrats with 5 depth measurements each
  - 6,516 depth-only measurements

  Absences
  - BGS Borehole data
  - ALC



Sampling priorities for survey:
- BGZ
- Under-surveyed areas / strata

Stratification
- Shallow peaty soils
- Small peatlands
- Lowland peatlands
- Transition areas

- Wooded peaty soils
- Southern valley mires

Back in the real world…
- access permission,
- surveyor availability,
- time and money

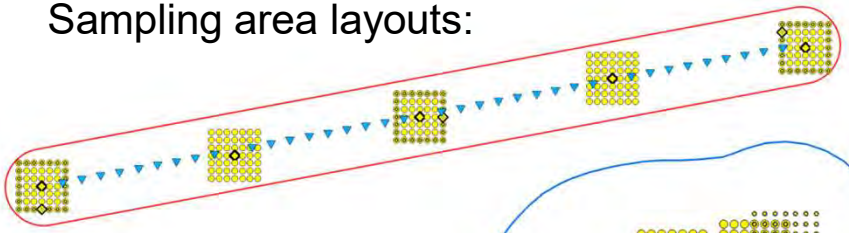
… will determine the final sample.

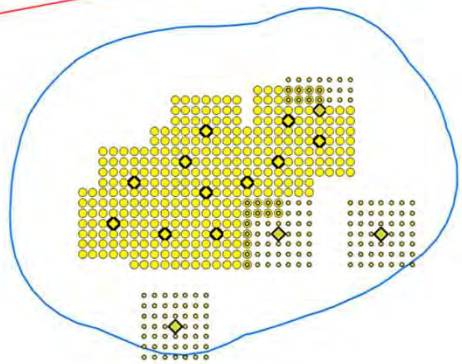
Data Partnership

NCEA

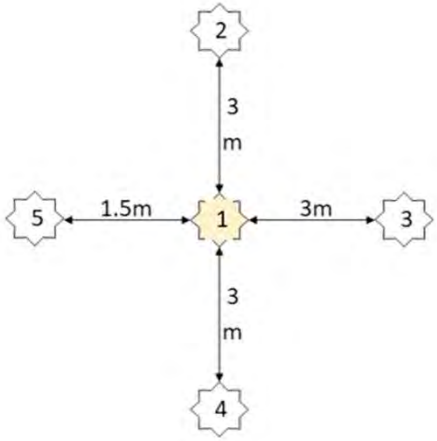
Soil Survey

Sampling area layouts:



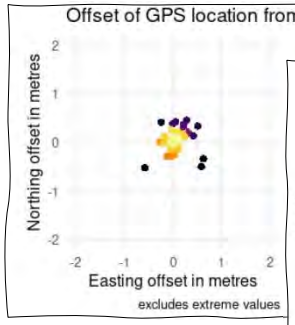


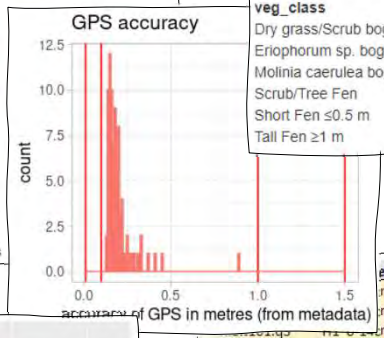
Quadrat layout:



- Peat depth
- Soil ‘textures’ in top 40cm (or 100cm)
- Samples for lab
- drainage

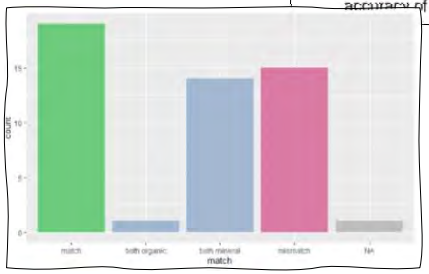
QA – desk and field:





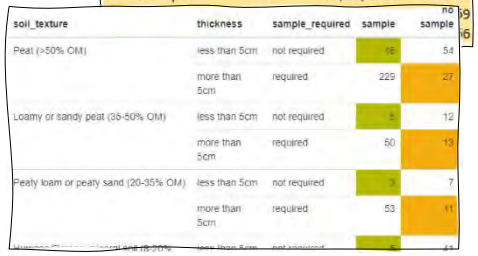
Overall classification agreement

veg_class	correct	misclassified	no test
Dry grass/Scrub bog	16	NA	NA
Eriophorum sp. bog	10	NA	NA
Molinia caerulea bog	4	2	NA
Scrub/Tree Fen	4	NA	NA
Short Fen ≤0.5 m	NA	NA	26
Tall Fen ≥1 m	NA	NA	23

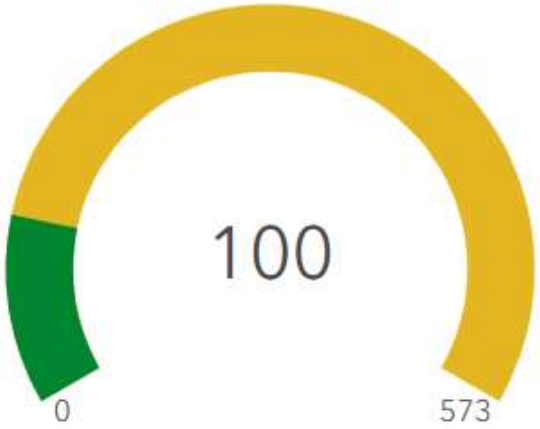


epth	Date	LOI (375 º
m	17+18/05/23	44.50
m	17+18/05/23	63.64
m	17+18/05/23	63.36
EPM.3.t101.q4 H1 Point 1	17+18/05/23	20.84
EPM.3.t101.q5 Core 0-11cm	17+18/05/23	33.00
EPM.3.t101.q6 H1 0-15cm	17+18/05/23	82.90
EPM.3.t101.q7 H1 0-22cm	17+18/05/23	76.54
EPM.7.c73.q7 H1	18/05/2023	19.23
EPM.7.c73.q11 H1	18/05/2023	15.90
EPM.7.c73.q2 H1	18/05/2023	35.71
EPM.7.c73.q3 H1	18/05/2023	20.32
EPM.7.c73.q14 H1	18/05/2023	10.95
EPM.7.c73.q1 H1	18/05/2023	16.41
EPM.5.c7.q11 H1	17/05/2023	76.79
EPM.5.c7.q12 H1	17/05/2023	46.99
EPM.5.c7.q12 H2	17/05/2023	82.89
EPM.5.c7.q10 H1	17/05/2023	40.78

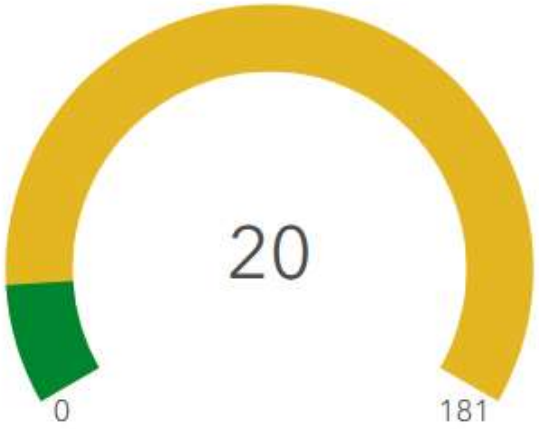
	Survey		QA			
quadrat	texture	depth	texture	depth	match	difference
EPM.13.t17.q1	Mineral soil	2	Peat (>50% OM)	7	mismatch	4
EPM.13.t17.q2	Mineral soil	8	Peat (>50% OM)	13	mismatch	4
EPM.13.t17.q3	Mineral soil	6	Peat (>50% OM)	9	mismatch	4
EPM.13.t17.q4	Mineral soil	8	Peat (>50% OM)	10	mismatch	4
EPM.13.t17.q5	Humose/Organo-mineral soil (8-20% OM)	4	Mineral soil	6	both mineral	1
EPM.13.t17.q6	Mineral soil	6	Peat (>50% OM)	8	mismatch	4



Soil Cluster Complete

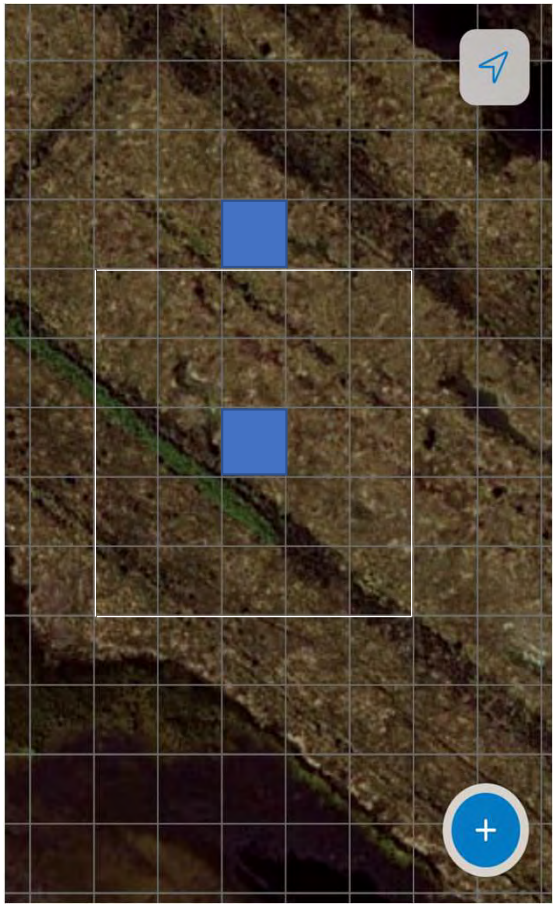


Soil Transect Complete



Vegetation Survey

- 2,600 quadrats (325 of each class)
- Minimum of 20 metres between each quadrat
- Quadrats need to be a minimum of 20 metres in from the edge of the peaty soils layer
- Ideally more than 3 quadrats of a particular vegetation class need to be collected from a single site. However, certain vegetation classes/sites this may not be possible.



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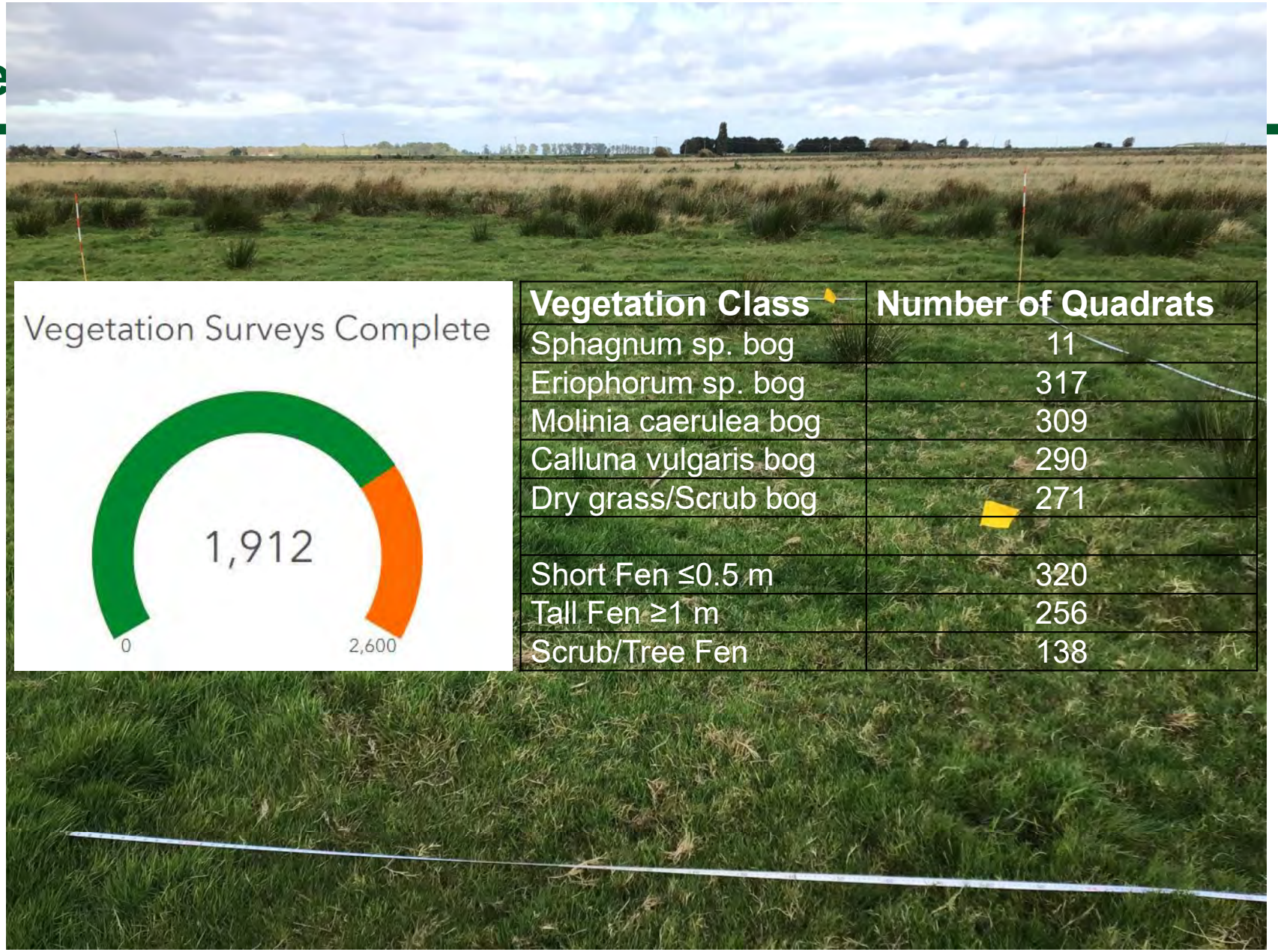
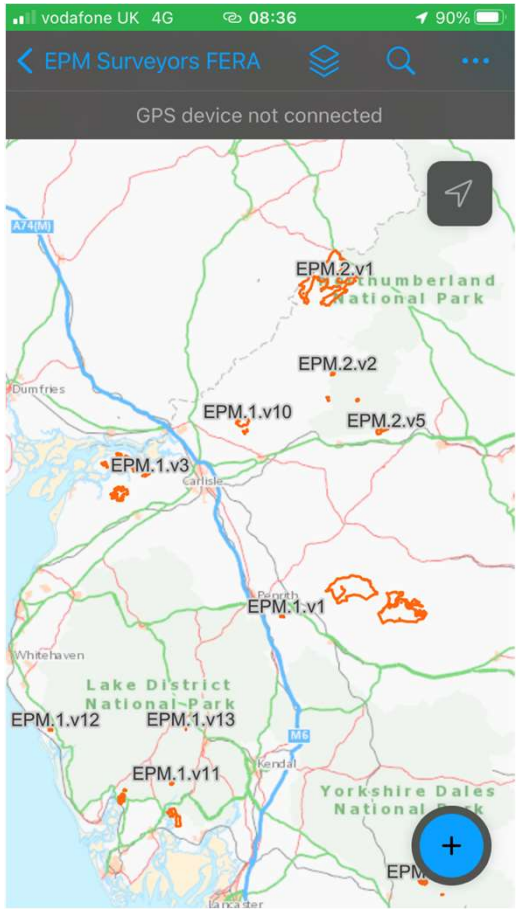
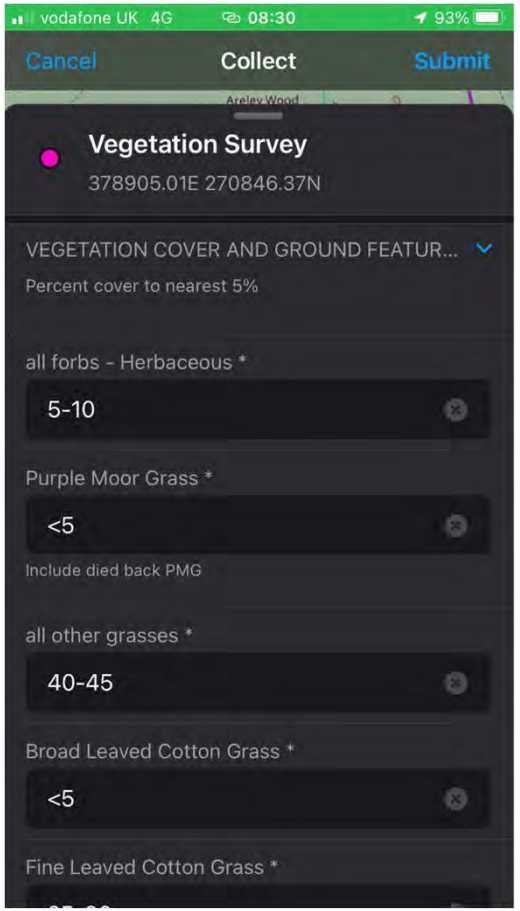


Vegetation Class	Number of Quadrats
Sphagnum sp. bog	11
Eriophorum sp. bog	317
Molinia caerulea bog	309
Calluna vulgaris bog	290
Dry grass/Scrub bog	271
Short Fen ≤0.5 m	320
Tall Fen ≥1 m	256
Scrub/Tree Fen	138

Data collection app

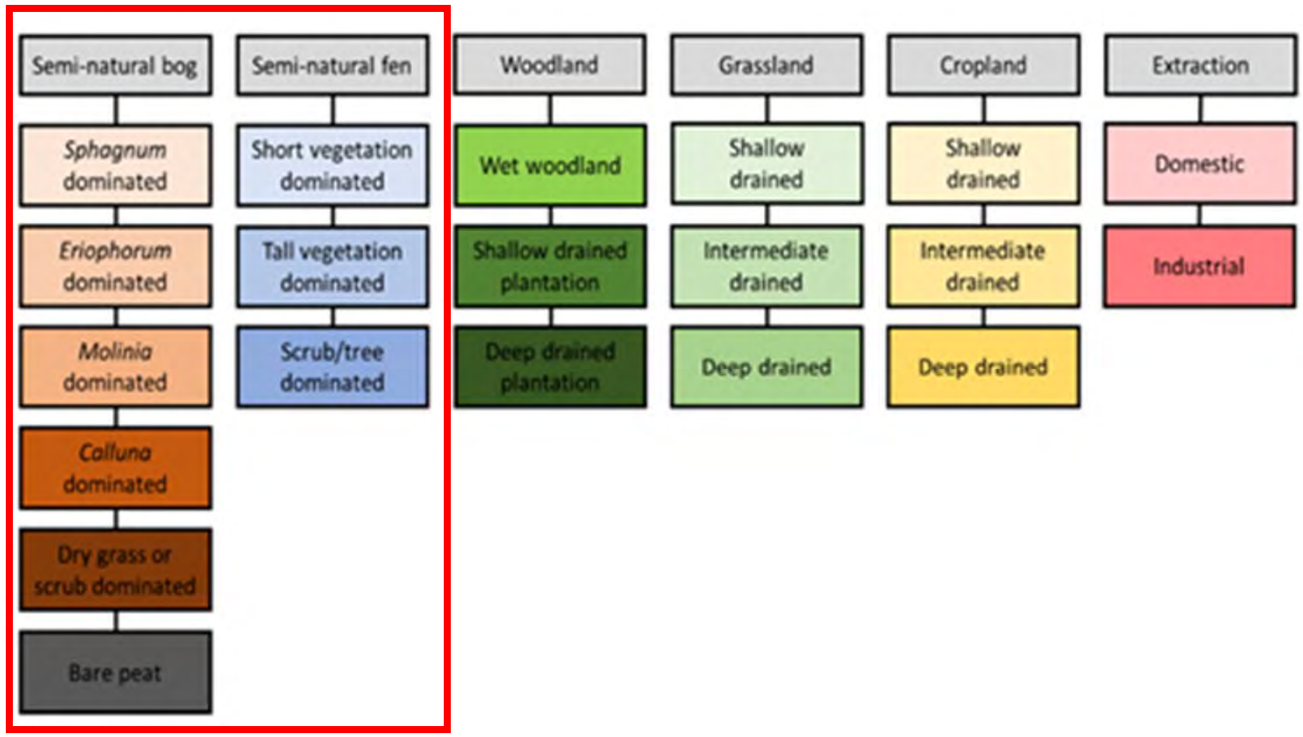
- Pictures taken from four sides of the quadrat
- Peat presence (for extent use)
- Dominant vegetation class
- Percentage cover of all vegetation
- Five peat depth measurements (for depth use)





Vegetation condition categories

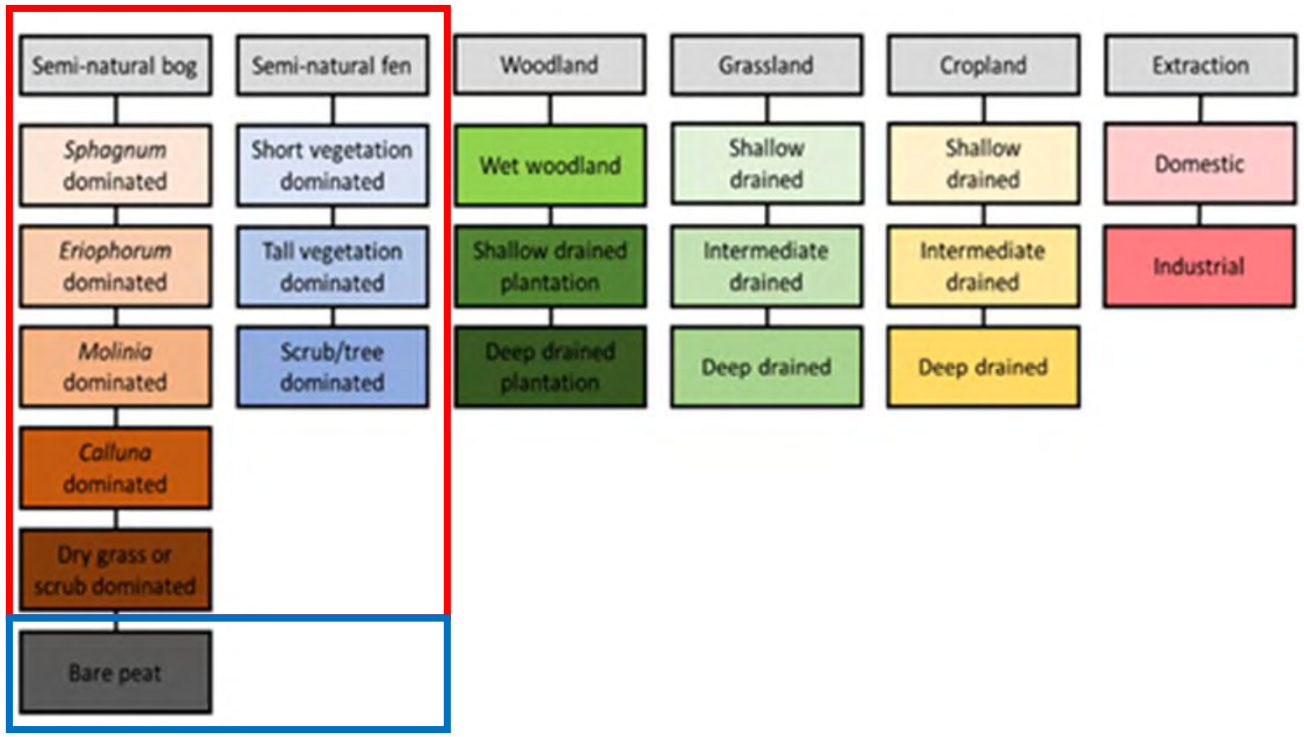
- Assessing condition through vegetation presence
- Focusing on the evidence gap within GHG emission categories



Suggested condition categories for the emission inventory for UK Peatlands (Chris Evans, UKCEH).

Modelling approach

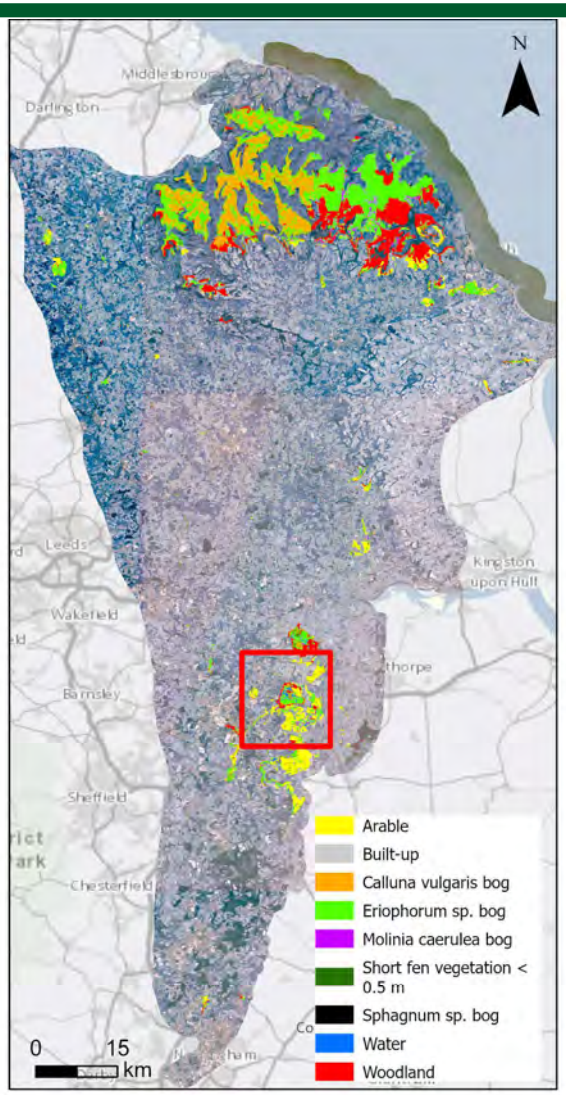
- Machine and deep learning models: vegetation (10 m resolution) & bare peat (25 cm resolution – uplands only)
- Sentinel 1 (radar) & Sentinel 2 (optical) satellite imagery and aerial photography
- EA LiDAR elevation data
- Labelled data:
  - Existing datasets (internal and external)
  - EPM field survey



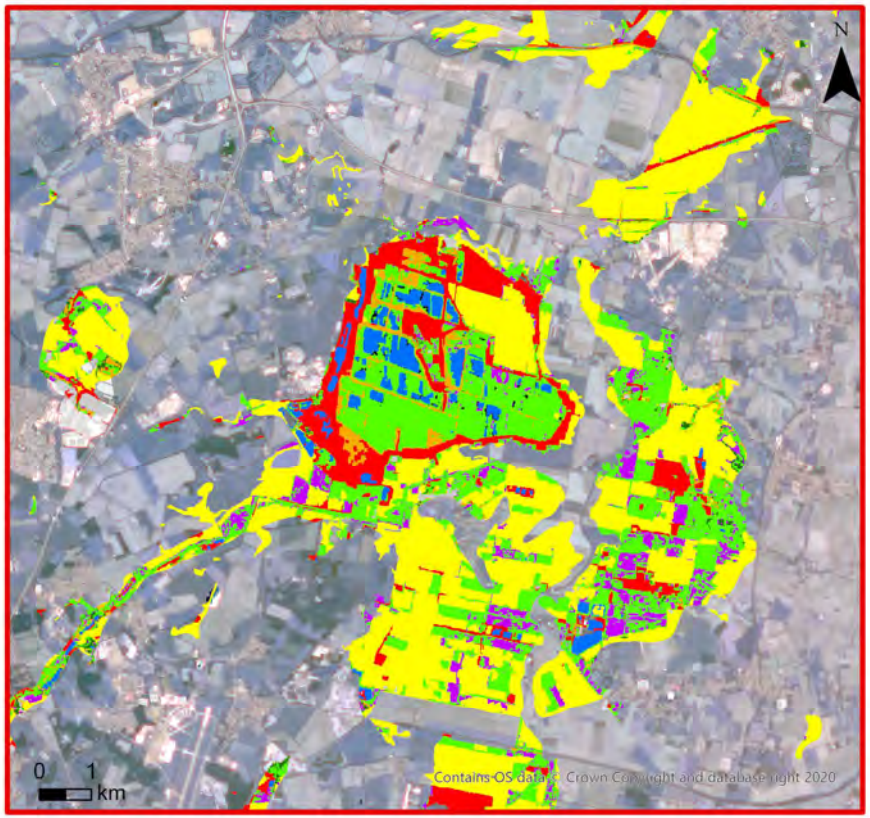
Suggested condition categories for the emission inventory for UK Peatlands (Chris Evans, UKCEH).

Vegetation output: alpha product

Arable
Built-up
Calluna vulgaris bog
Eriophorum sp. bog
Molinia caerulea bog
Short fen vegetation < 0.5 m
Sphagnum sp. bog
Water
Woodland

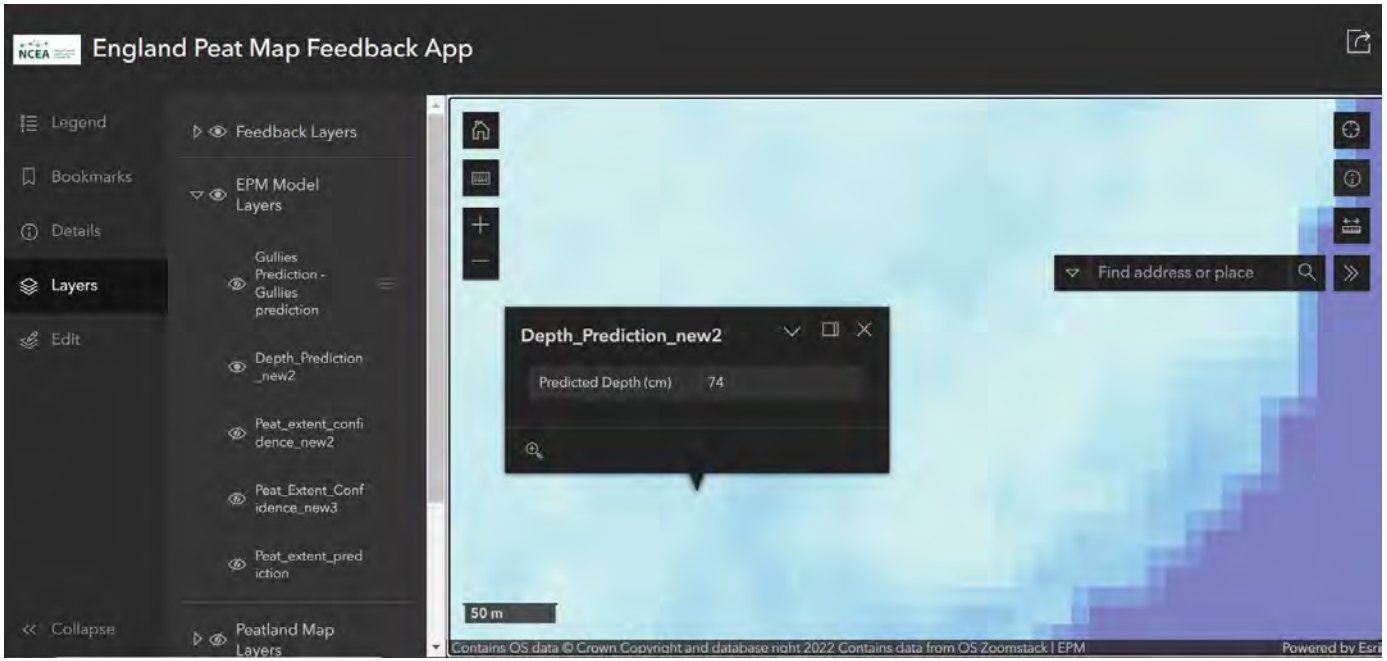


Alpha product: 89% accuracy across Yorkshire and 82% for the national product



Data feedback portal and data sharing

- Online platform to provide feedback on our maps to improve them in your local patch
- Aim: Engage with the community to improve our maps (extent, depth, vegetation presence and surface features)
- **Do you have data we might be able to use?** Presence, depth, vegetation and surface features
- peatmap@nautralengland.org.uk



Demonstration

Data standards

- Consistency across data collection
- Peat depth survey data standard developed by NE and hosted by IUCN
- Further standards needed e.g. vegetation and surface features

Activity:

Have you seen our standard?

Have you used it?

What more do you think needs to be done for standards?

Discussion

- What is the future roadmap for data in the peatland community?
  - What data should we prioritise?
  - How do we maximise opportunities for data sharing and analysis?
  - What are the key barriers to sharing/using data and how do we overcome them?

- How can we effectively implement new technology for monitoring peatlands?

NCEA | Natural Capital and Ecosystem Assessment

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