Use of InSAR to monitor peatland condition, carbon accounting and basin hydrology

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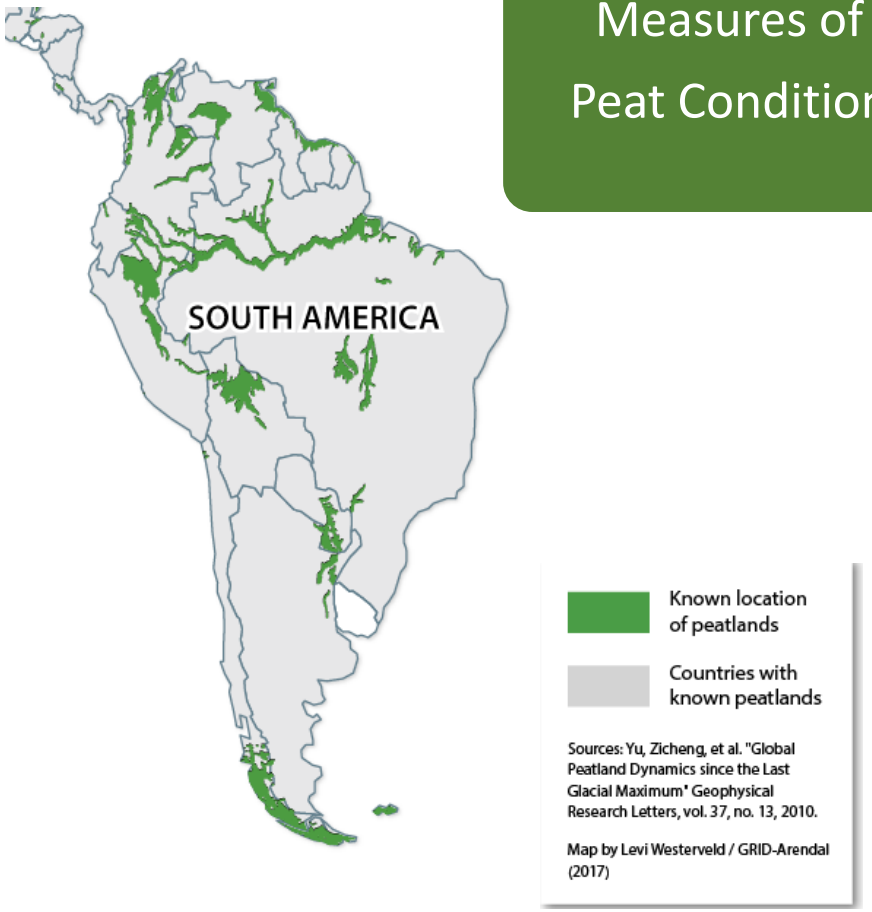
Managing our Peatland Carbon Assets

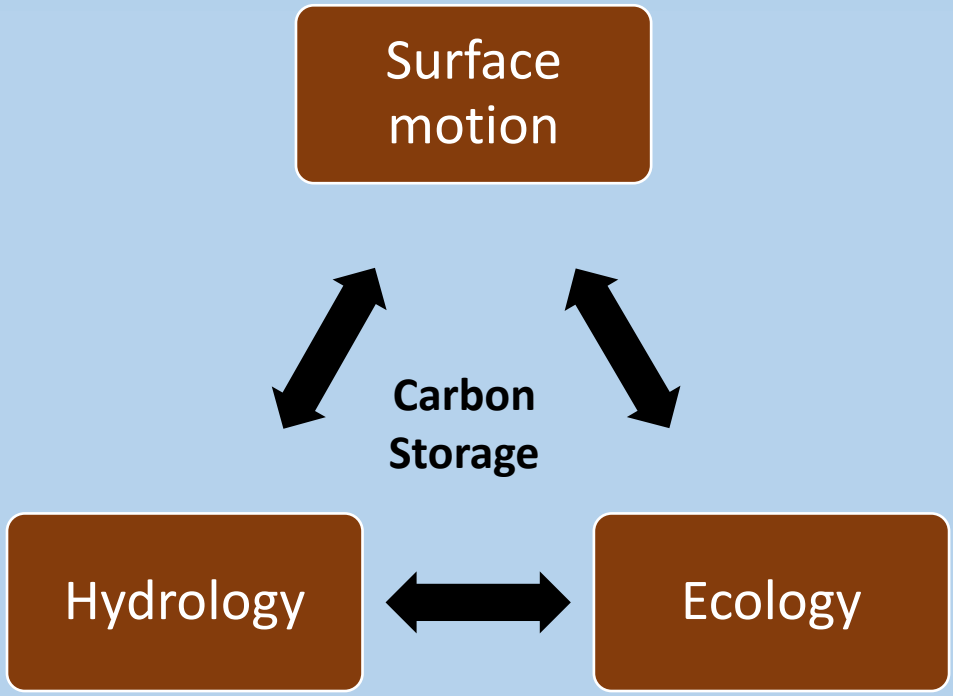


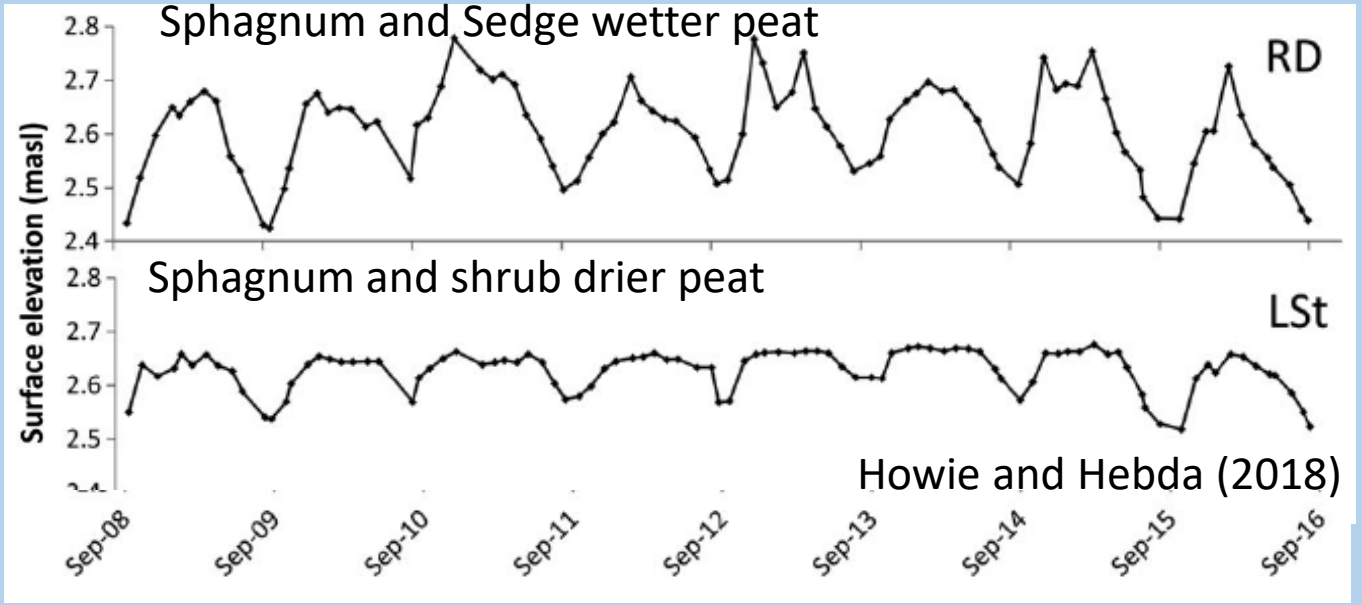
Measures of Peat Condition

- Carbon accounting
  - Condition mapping vs emission data
- Strategic Management
  - Restoration Progress
  - Local to national scale baseline conditions
- Loss Prevention
  - Restoration failure
  - Risk assessment (bog burst, infrastructure damage, fire)

Underlying Science

How peat swells and shrinks in response to changes in water content is a measure of condition.



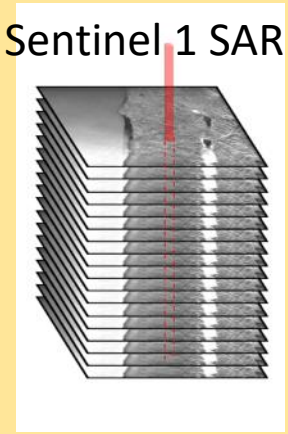


Peatland surface motion can be measured using Interferometric Synthetic Aperture Radar (InSAR)

The Process

Copernicus Data

ESA Sentinel 1 SAR Data

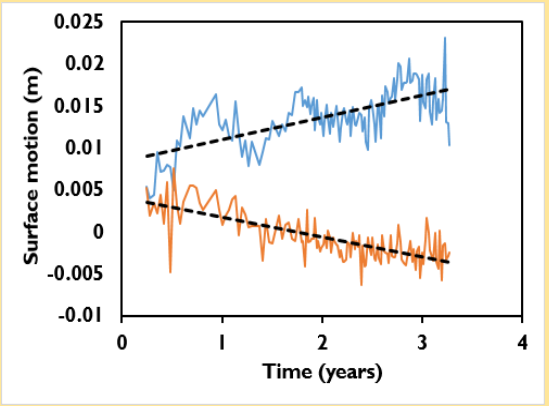


Every 6-12 days

APSIS
InSAR Processing
Technique

Terra Motion

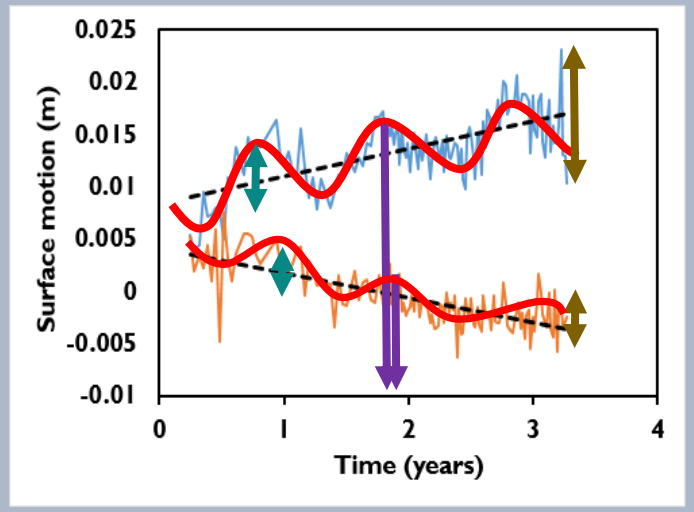
Time series/long term velocity



Per 20m or 90m pixel

Time series analysis

Extract and classify surface motion metrics



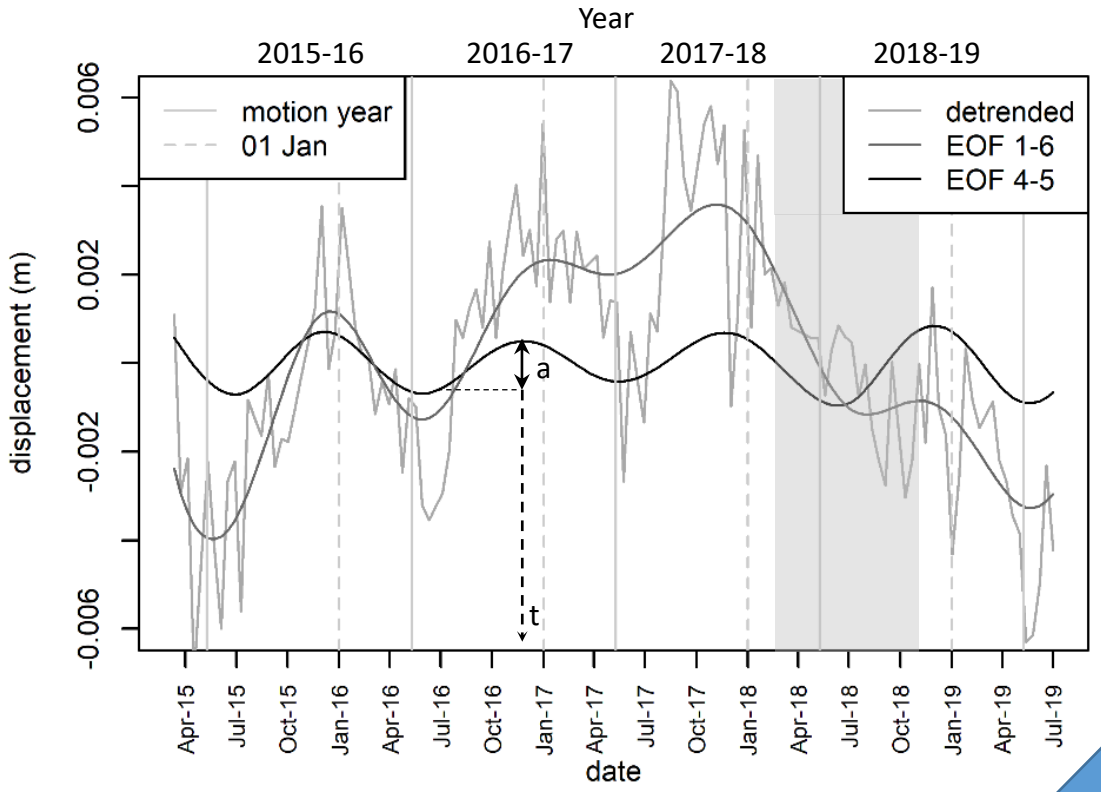
- Trend
- Seasonal Oscillations
  1. Amplitude
  2. Timing
  3. Regularity
  4. Shape
- Variance

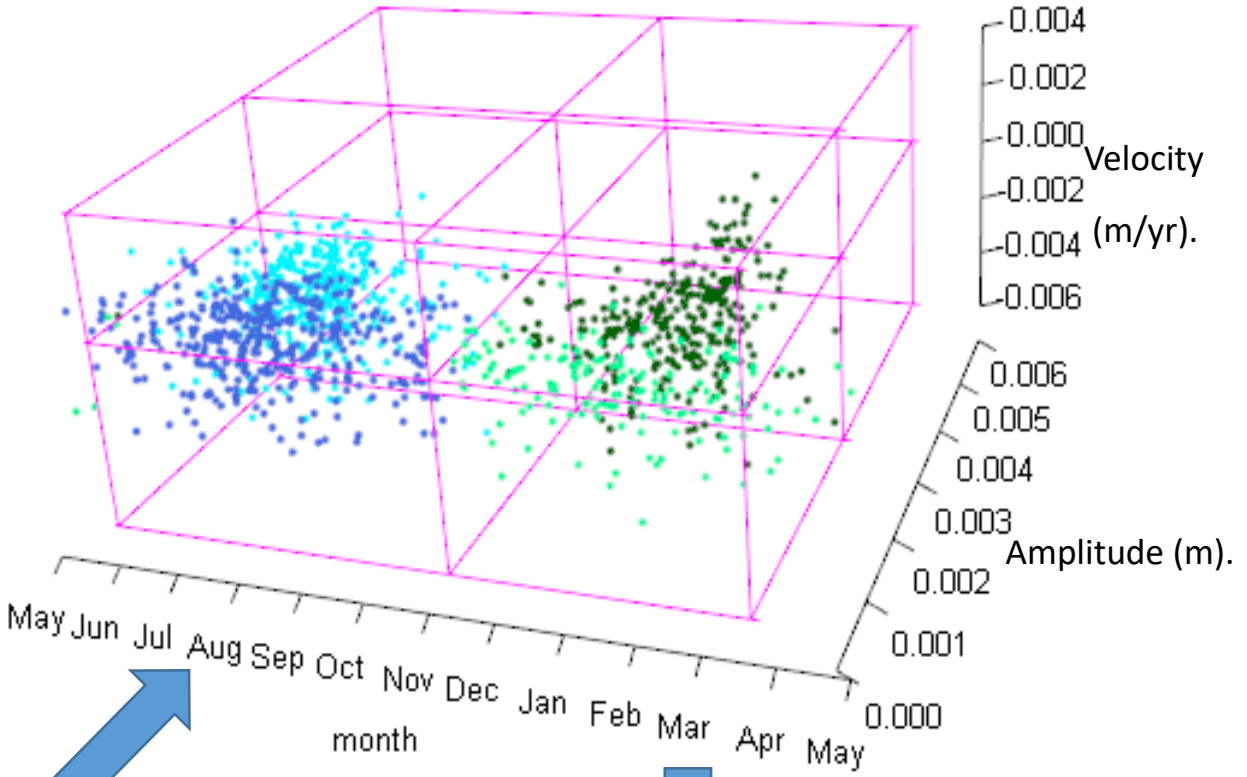
Validation

Spatial distribution of metrics
vs
Field Observations (Ecology, Hydrology, Levelling)

Application

Time series characteristics and peat condition



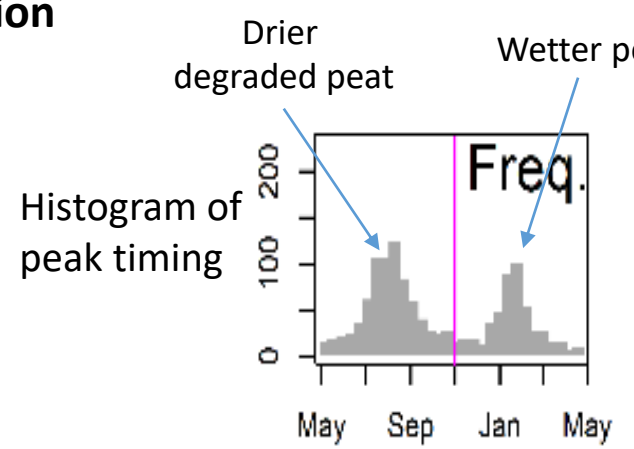


Timing of seasonal peak

Key variables

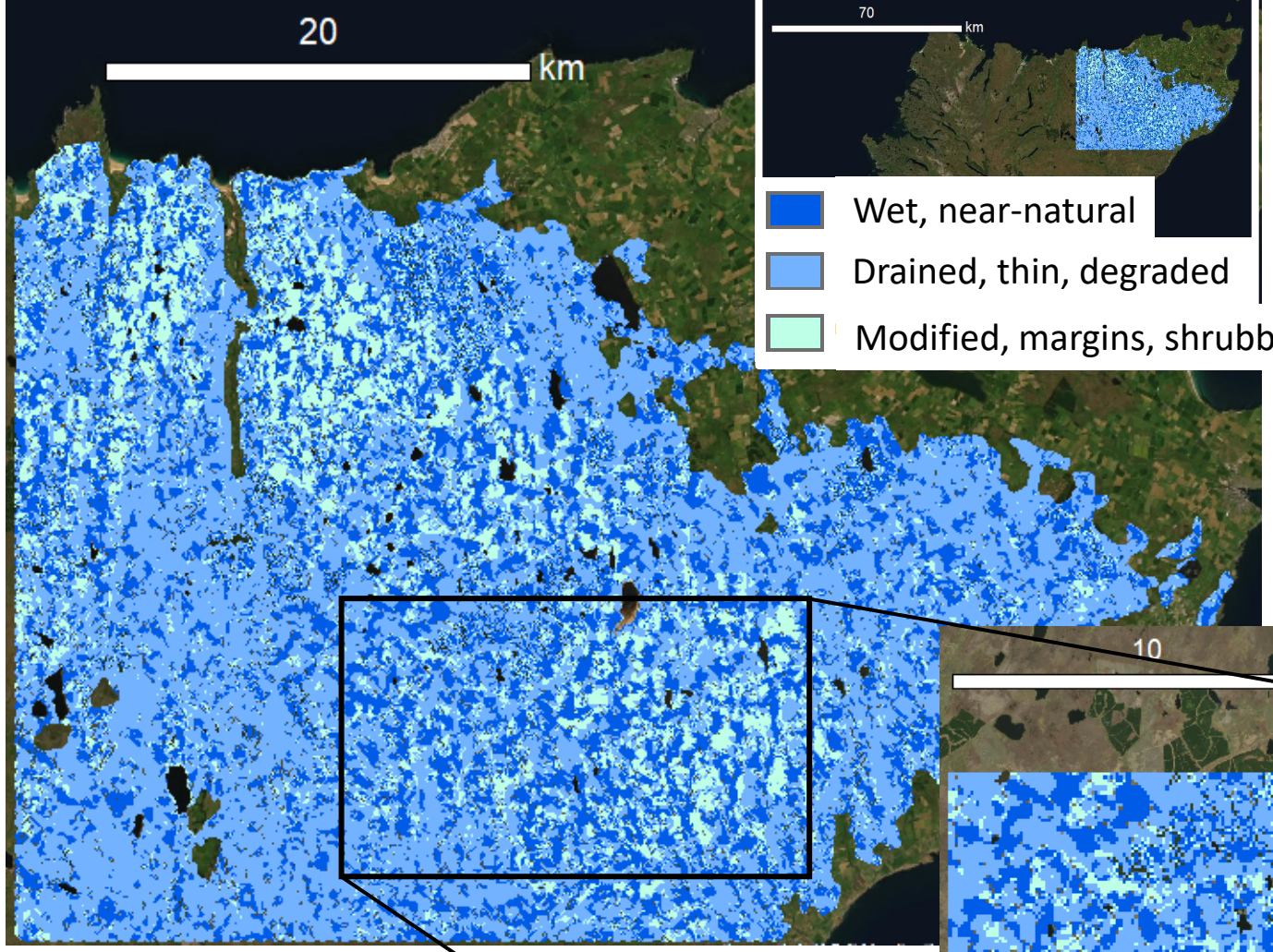
1) Multiannual surface velocity
2) Amplitude of the seasonal peak (a)
3) Timing of the seasonal peak (t)

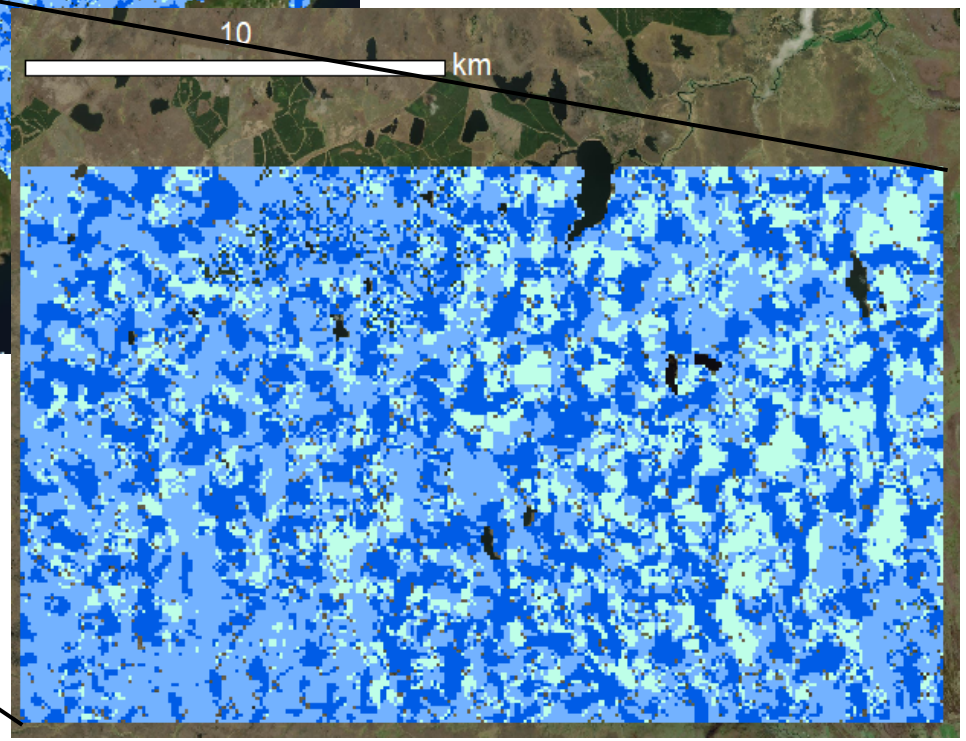
Field validation



Landscape scale
Baseline Condition Mapping and Carbon Accounting

- Condition classes correlated to carbon emission factors of Evans et al 2017





Whole area 1400 km²
57% Degraded – mainly eroded/drained
Mean Carbon emissions 6.7 – 3.0 tCO_2e/ha/yr

Sub-area 280 km²
46% Degraded
Mean carbon emissions
5.9 – 2.6 tCO_2e/ha/yr

Monitoring Restoration Progress

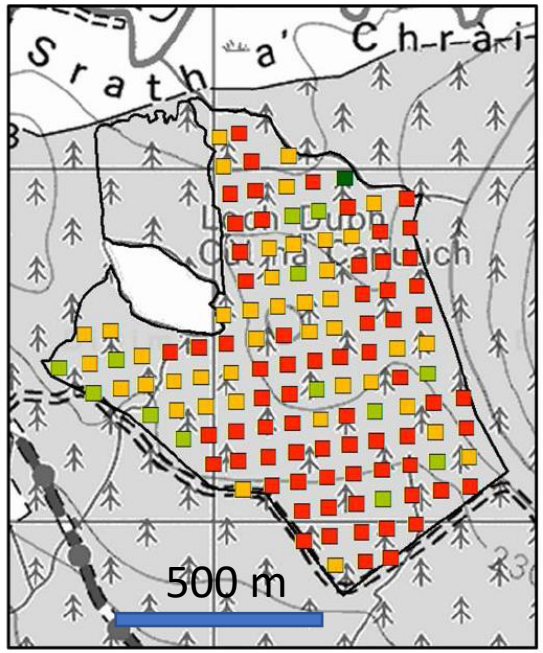
Progress towards sphagnum (class 4a) end member 2016 to 2019

Class 1 No progress

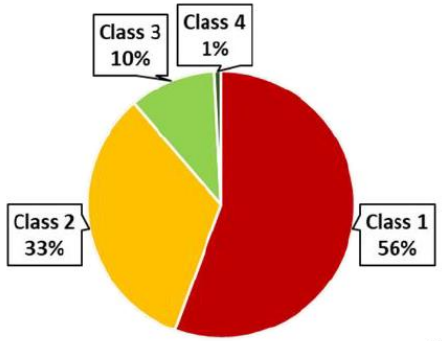
Class 2 Evidence of positive change

Class 3 Significant positive change

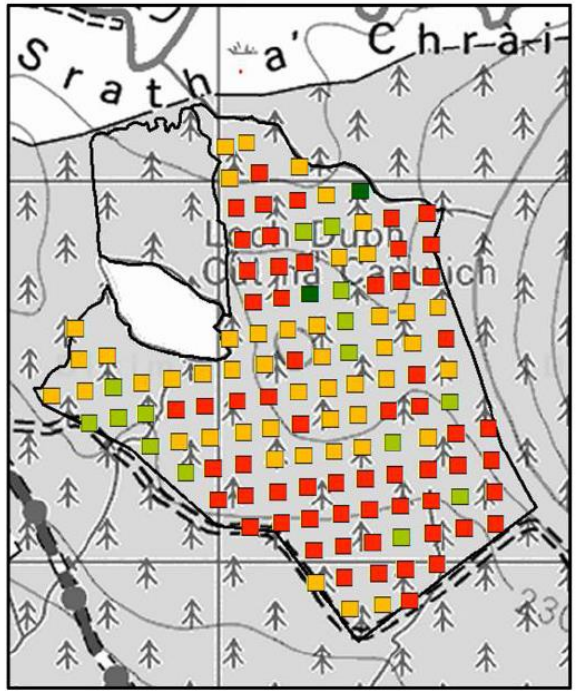
Class 4a Near natural characteristics

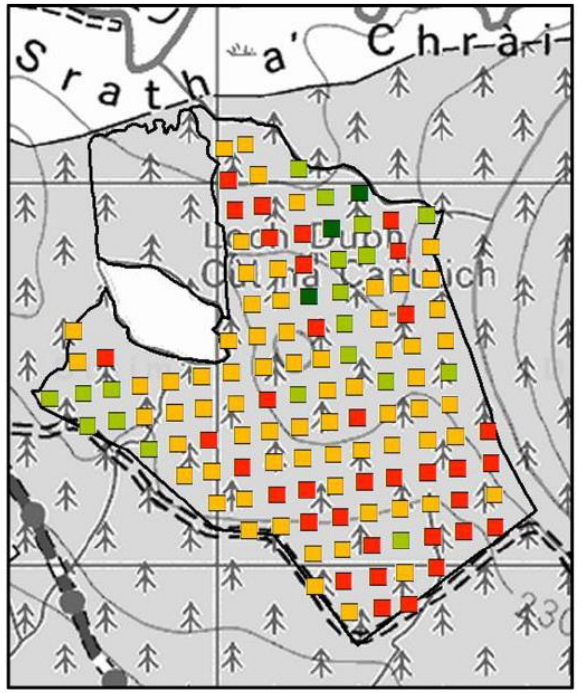


2016/17

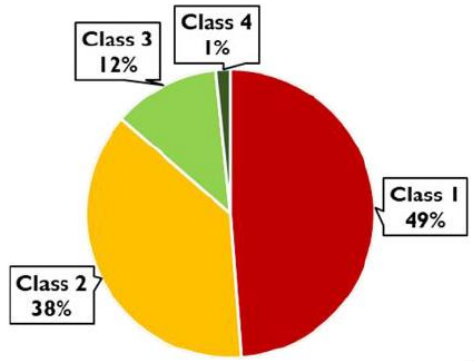


7.5 - 4.1 $tCO_2e/ha/yr$



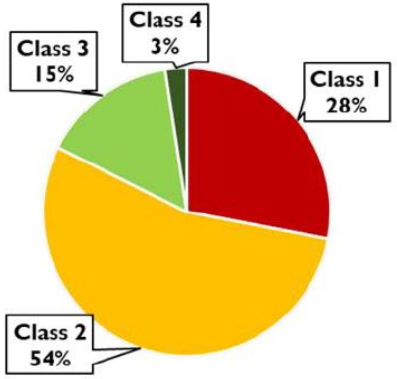


2017/18



7.1 - 4.0 $tCO_2e/ha/yr$

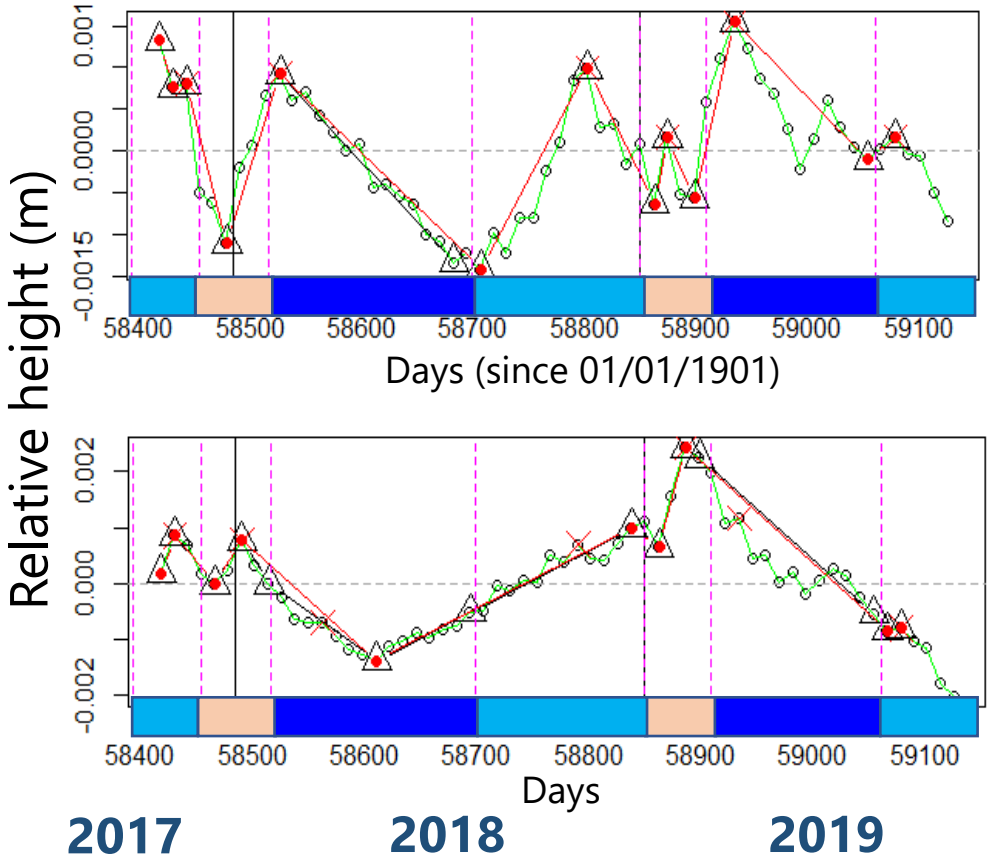
2018/19



6.0 - 3.6 $tCO_2e/ha/yr$

Monitoring the hydrology of the Paramo (Guantiva-La Rusia) Colombia

PARAGUAS
paraguas.ceh.ac.uk



Direct response to wet/dry seasons

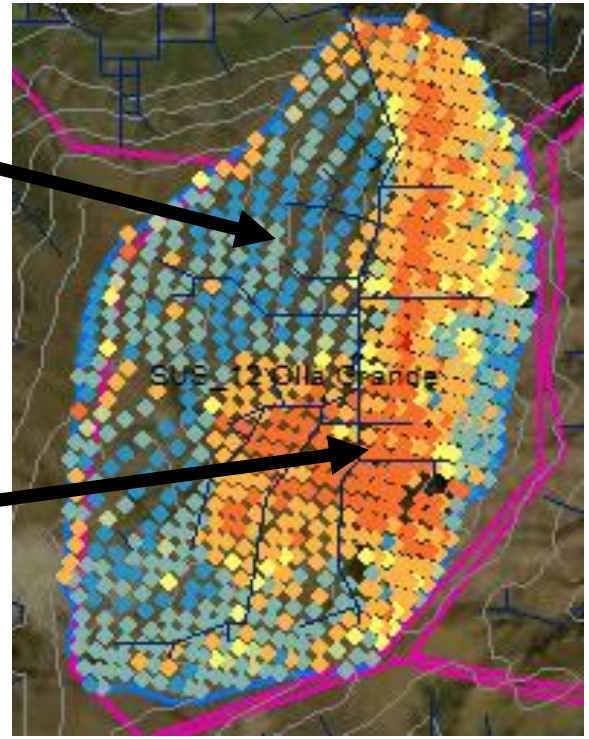
Recharge

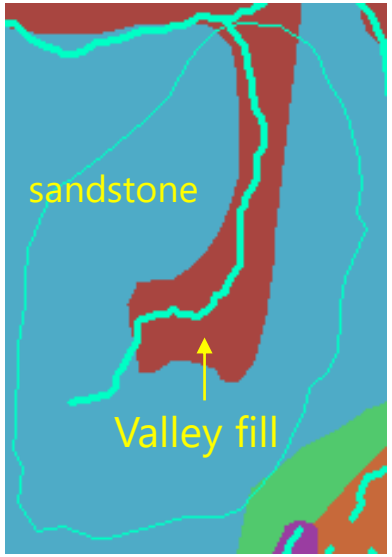
Peak at end of wet seasons/dry season

Storage in valley fill

Amplitude

Wet Season 1





~2.5 x 4 km

Key to the seasons

Recent Publications

Detailed validation of surface motion signal vs peatland condition

https://esurf.copernicus.org/preprints/esurf-2021-58/

Evaluation of InSAR method over multiple peatland sites in Scotland.

https://www.nature.scot/doc/naturescot-research-report-1269-using-peatland-surface-motion-bog-breathing-monitor-peatland-action

Fully coupled mechanical-ecological-hydrological model of peatland illustrating the importance of surface motion

https://doi.org/10.1002/eco.2361