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Using remote sensing to monitor peatland fire occurrence and recovery

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Introduction

Many peatlands in the UK are managed as grouse moors, using regular prescribed burns to encourage heather (*Calluna vulgaris*) growth. The remoteness and size of moorland areas can make fire occurrence difficult to monitor accurately, meaning that knowledge of burn frequency is limited.

Aerial photography has previously been used by Allen et al. (2016) and Yallop et al. (2006) to detect managed burns, but is limited to relatively small areas. Satellite imagery covers much larger areas, but the spatial resolution of earlier satellites was too coarse to accurately detect the small burns typical of peatland fire management. Newer satellite sensors such as Sentinel-2 have much finer scale resolution and the advantage over aerial imagery of a frequent return interval and large scale coverage.

This study also considers the timescales of burn recovery, and how recovery may be related to annual weather patterns.

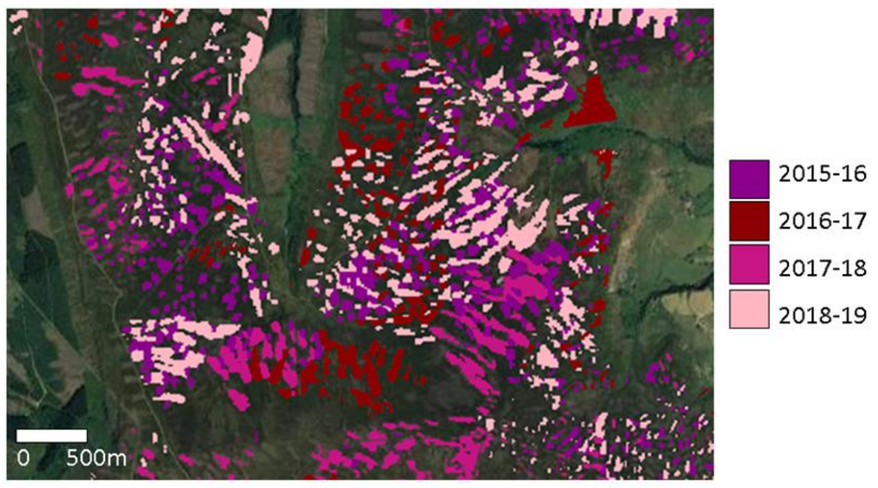
Methods

- **dNBR for fire detection**

The differenced Normalised Burn Ratio (dNBR) is often used to assess fire severity from remote sensing data. In this study we used the closest cloud-free Sentinel-2 images to the start (October) and end (April) of the burn season to calculate the dNBR, and a threshold of 0.4 to detect managed burns.

- **Burn density and frequency**

Burn coverage and frequency was calculated following Yallop et al. (2006) who estimated burn repeat intervals by calculating the percentage of fire-managed moorland area which was burnt each year. We created a grid of 500 m by 500 m squares within visually identified fire-managed moorland polygons, and used these grid squares to calculate burn density for each year, and therefore burn repeat intervals.



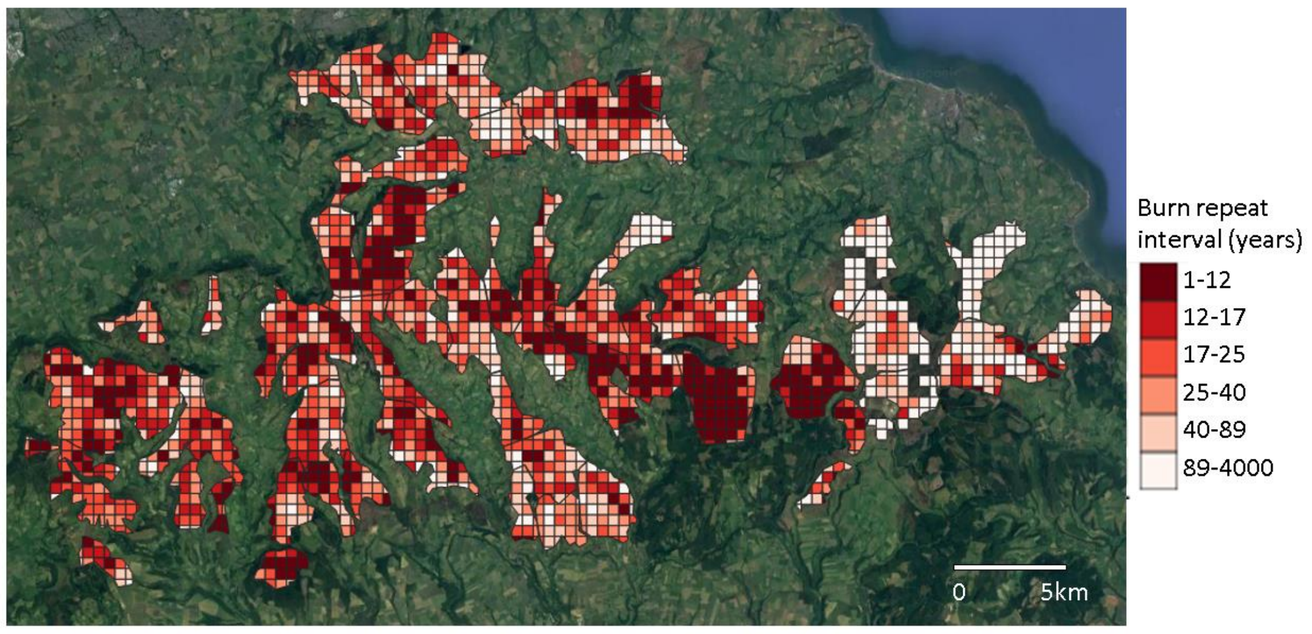
Detected burns in the burn seasons beginning 2015 to 2018, on an area of the North York Moors.

- **Burn recovery using the NDVI**

The average Normalised Difference Vegetation Index (NDVI) cycle for the whole of the North York Moors fire-managed area was calculated using Sentinel-2 data from 2015-2019. This average annual cycle was then subtracted from the NDVI values for each burnt pixel, from the start of May following the burn season to the end of the year. The residuals were smoothed using a 20-day moving average, and the time taken for these residuals to reach zero, ie. to recover to the average seasonal cycle, was then calculated. If the NDVI residuals had not reached the average seasonal cycle by the end of the year, ie. after 244 days, the recovery period was automatically set to 244 days.

Results

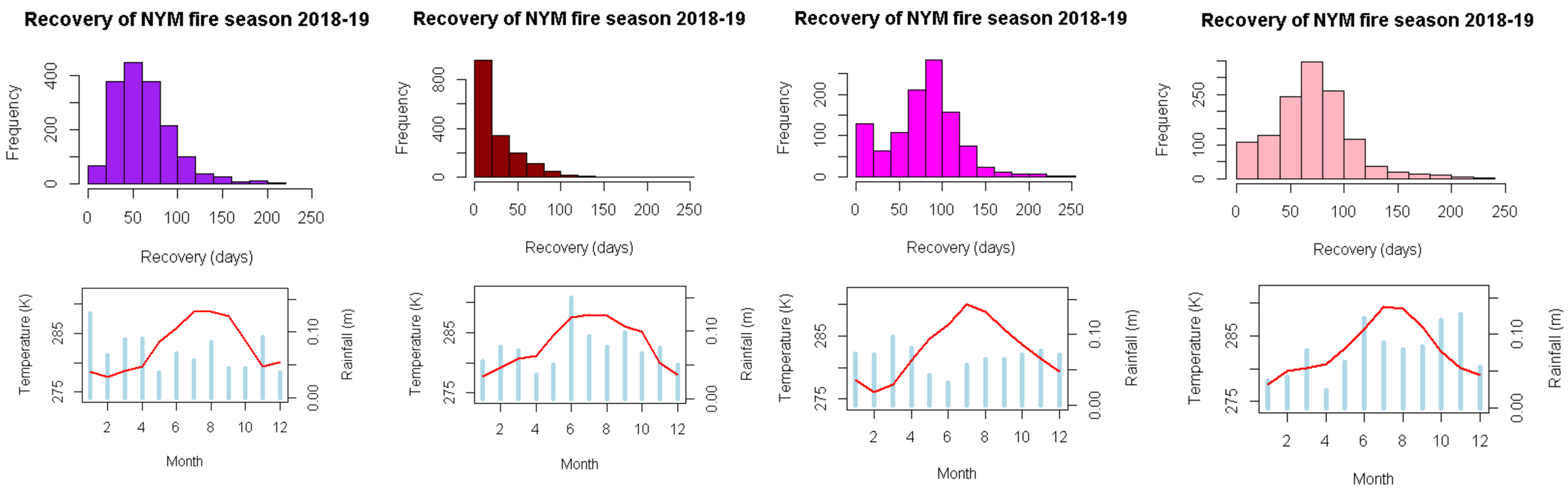
The burn repeat intervals vary across the North York Moors, with some grid squares being burnt at intervals of less than 12 years. The area of fire-managed moorland burnt each year ranged from 2.11% (return interval of 47 years) in 2017-18, to 6.67% (return interval of 15 years) in 2016-17.



Burn repeat interval over the North York Moors, estimated from four fire seasons.

There appears to be some correlation between longer recovery times and hotter, dryer summers (calculated from ERA5 averaged over moorland area).

Histograms showing the average recovery timescales for the grid squares used for calculating burn density and frequency, and weather graphs showing temperature and precipitation for each year.



Future directions

We aim to extend this method to three other fire-managed moorland areas in the UK: the Yorkshire Dales, North Pennines, and the Peak District. Comparing the burn density and frequency across each of these areas will provide important information for conservation practitioners and policy makers. These additional datasets will also enable us to statistically analyse the potential correlation between hotter, dryer summers and longer recovery times, which we anticipate will give insight into fire-managed moorland resilience in a changing climate.

References

1. Allen et al. (2016) *Ecological Indicators*. 62. Pp76-85
2. Yallop et al. (2006) *Journal of Applied Ecology*. 43:6. Pp1138-1148

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