



Up in smoke

Exploring the data behind UK wildfires

Who we are

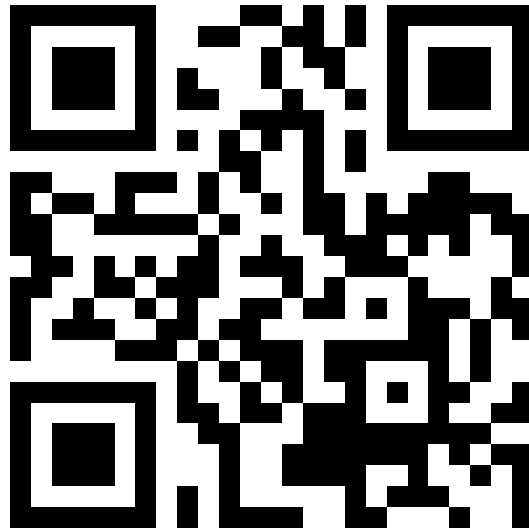


Our mission is to promote responsible data practices that focus on the needs of all and ensure that data is used in ways that help people, our planet and prosperity.



Sign up to our newsletter

<https://bit.ly/ODM-NES>



hello@opendatamanchester.org.uk

www.opendatamanchester.org.uk

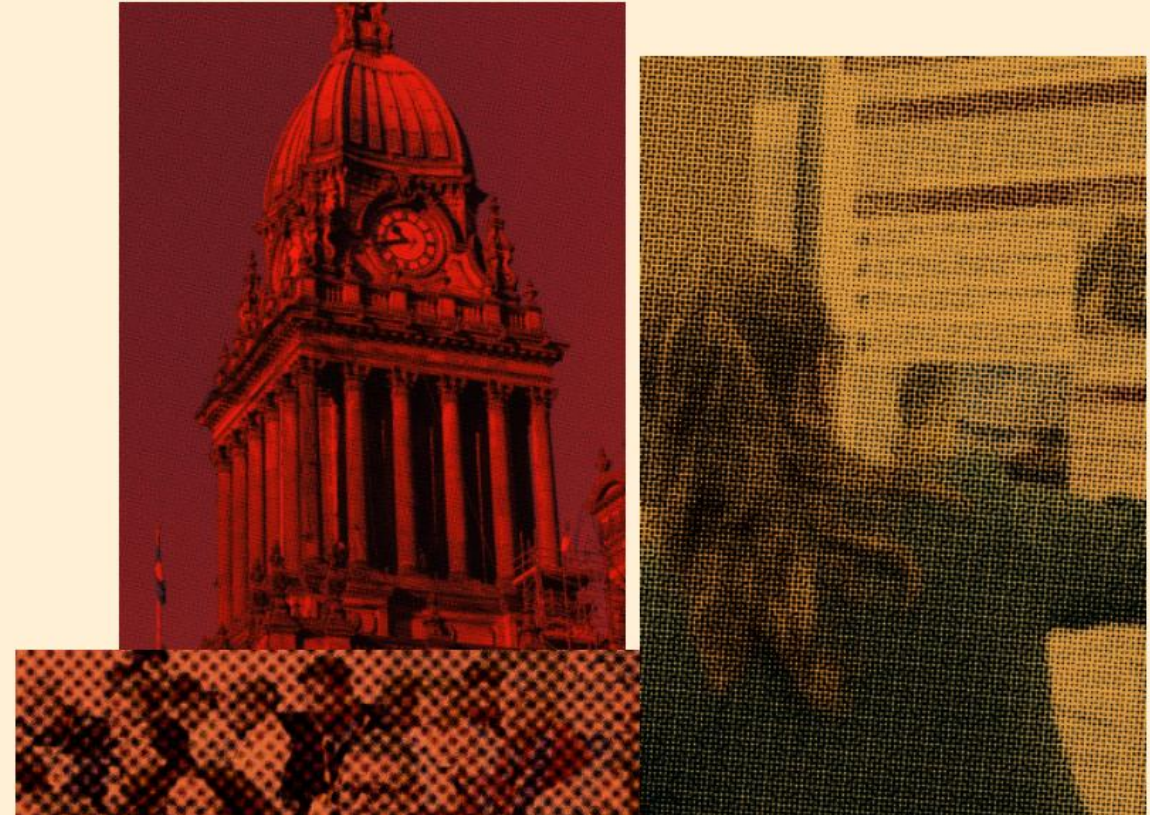


New Perspectives. Shared Solutions.

10th - 11th November 2026 • Headingley Stadium, Leeds

The UK Wildfire Conference returns as a key biennial event for wildfire professionals. Wildfire2026's theme, "New Perspectives — Shared Solutions," highlights collaboration and innovation in wildfire management. Attendees will gain insights from expert-led keynote sessions promoting shared learning.

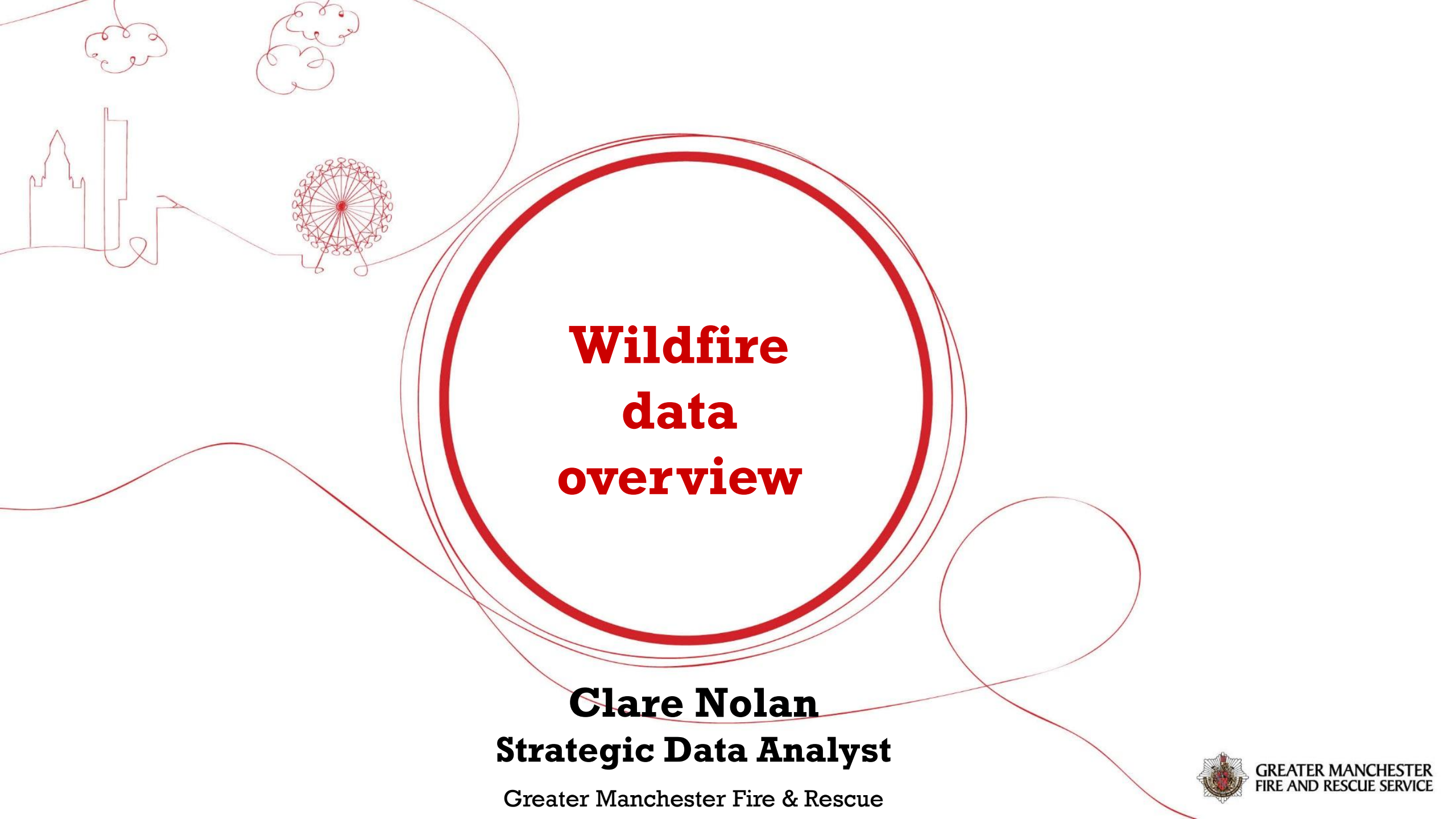
Receive exclusive updates on event announcements by joining the [Wildfire2026 newsletter](#).



- Call for speakers and poster now open
- Early-bird tickets on sale now

www.ukwildfireconference.co.uk





Wildfire data overview

Clare Nolan
Strategic Data Analyst
Greater Manchester Fire & Rescue



GREATER MANCHESTER
FIRE AND RESCUE SERVICE

What is a wildfire?

Not all outdoor fires are wildfires.

Currently, there is no single definition of what constitutes a wildfire and categorisation varies across different agencies.

NFCC's Operational Guidance definition of a wildfire meets one or more of the following:

- Involves a geographical area of at least one hectare (10,000 square metres)
- Has a sustained flame length of more than 1.5 metres
- Requires a committed resource of at least four fire and rescue service appliances/resources
- Requires resources to be committed for at least six hours
- Presents a serious threat to life, environment, property, and infrastructure.

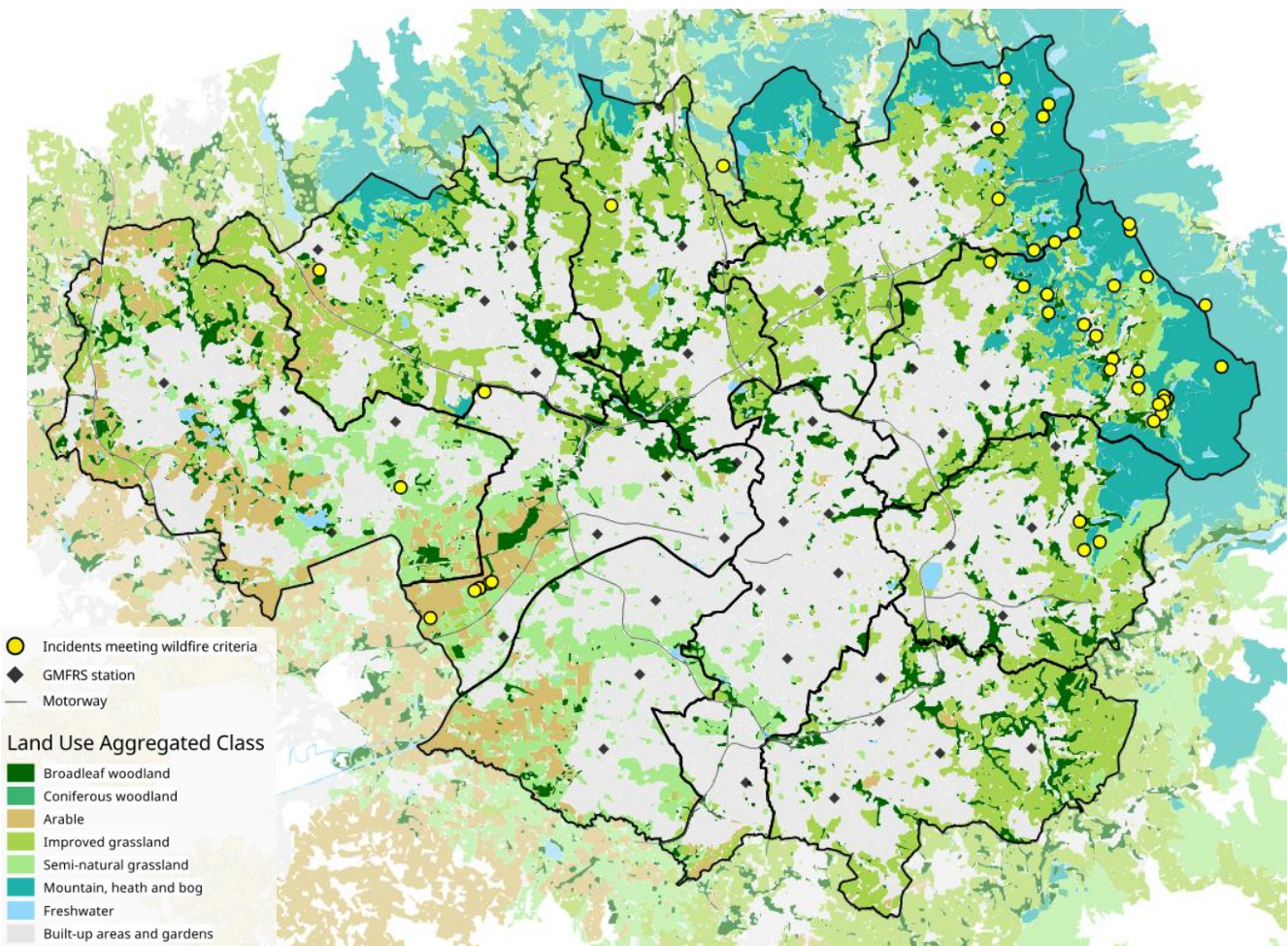


What is a wildfire?

This table shows a breakdown of all outdoor fires and how many of them are classified as a wildfire by the NOG definition.

Low in number but can be high impact in terms of resources

Year	All outdoor fires	Wildfires
2021/22	631	5
2022/23	601	6
2023/24	360	1
2024/25	391	6
2025/26	674	7
2026/27	447	9
Total	3104	34



map of land use in Greater Manchester denoting areas of moorland and displaying historical wildfire incidents (Morton, R. D.; Marston, C. G.; O’Neil, A. W.; Rowland, C. S. (2020). Land Cover Map 2019 (20m classified pixels, GB). NERC Environmental Information Data Centre)

Data during the incident

The data for all incidents remains at NWFC whilst they are ongoing. The read only version is in the form of a log file such as the example below.

Behind the scenes this is also going into a database. When the incident closes there is an automatic data transfer into GMFRS's incident recording system (IRS). Here the Officer in Charge fills in incident details and the record is sent to DHCLG/Home Office. All the data is then available to analyse internally.

Informative messages – the OIC is relaying pertinent information

Assistance messages – the OIC requires something

Resource is being allocated and mobilised

Resource has set off to incident

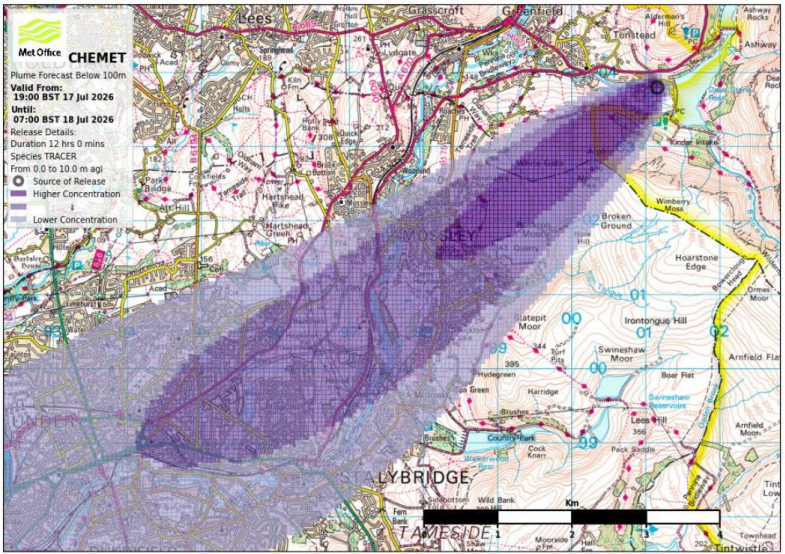
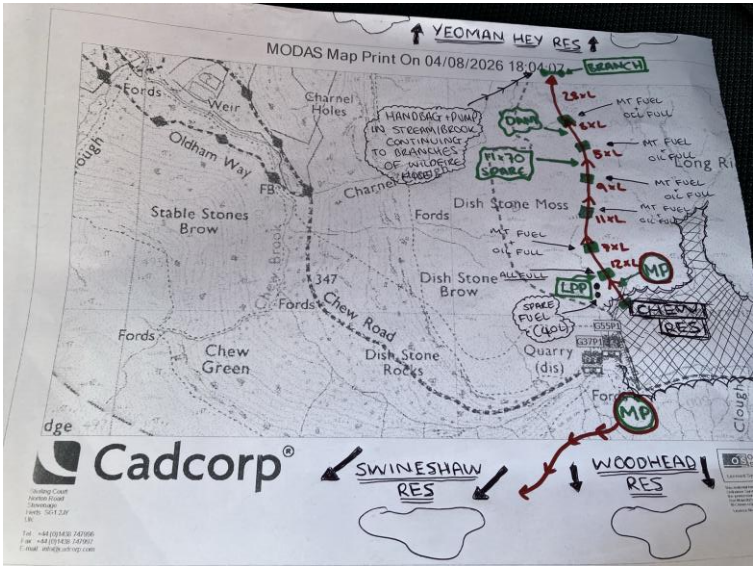
Incident:2607014909 cancelled. Duplicated to 2607014793 from Nearby Incidents.			
End of Duplicate Incident data			
10:51:30	25/07/2026	caddispmw08	404
COMMENT=[G30C1] [INFORMATIVE] BY RADIO FROM GM BURDSALL - FOLLOWING REPORTS FRs HAVE STARTED EXTENDED OUR CHEW RESERVOIR LINE FURTHER THAN AGREED. THE ORIGINAL CUT TERMINATES AT LADDOW MOSS. WE AGREED TO EXTEND THE HOSE THAT WILL BE RUN OUT BY THE PENNINE WAY TO CUT OFF THE VULNERABLE POINT IN DERBYSHIRE FRs LINE THAT WOULD AFFECT GMFRS LINE. THIS WAS AGREED BY GM LACEY AT DERBYSHIRE FRs. THE REPORTS THIS MORNING ARE THAT DERBYSHIRE FRs ARE EXTENDING THIS FURTHER DOWN THE PENNINE WAY. FOLLOWING A CONVERSATION WITH AM GILLET SHE INFORMED ME THIS WAS AGREED AND UU CONFIRMED THEY WOULD TAKE WATER FROM CHEW RESERVOIR. I HAVE SPOKEN TO GM LACEY WHO HAS RECONFIGURED DERBYSHIRE FRs WHO ARE EXTENDING 4 LENGTHS OF HOSE FROM THE END OF GMFRS DUG LINE AT LADDOW MOSS TO THE PENNINE WAY. CONFIRMED THAT I WILL NOT SUPPORT EXTENSION TO THIS WET PROTECTION LINE. I HAVE OFFERED TO SUPPORT TO DERBYSHIRE FRs WITH THIS WATER SUPPLY ON THEIR RIGHT FLANK ON LADDOW MOSS IF WE ARE ABLE TO SUPPORT THEM.			
10:54:02	25/07/2026	cadintnw02	
10:54:02	25/07/2026	cadintnw02	
10:54:02	25/07/2026	cadintnw02	
10:57:40	25/07/2026	caddispmw05	50195
10:57:57	25/07/2026	caddispmw05	50195
10:58:00	25/07/2026	caddispmw05	50195
11:12:47	25/07/2026	caddispmw05	50195
11:13:59	25/07/2026	caddispmw08	404
11:16:33	25/07/2026	caddispmw05	50195
11:16:34	25/07/2026	CADINTNW02	
11:16:34	25/07/2026	caddispmw05	50195
11:17:21	25/07/2026	G54P1	30495
11:17:23	25/07/2026	G54P1	30495
11:17:35	25/07/2026	caddispmw05	50195
11:17:36	25/07/2026	CADINTNW02	
11:17:36	25/07/2026	caddispmw05	50195



Data during the incident

Data during the incident is captured in several places:

- Incident log at NWFC
- Decision log used within Incident Command
- Resilience Direct
- Chemet
- Ordnance Survey mapping (internal)

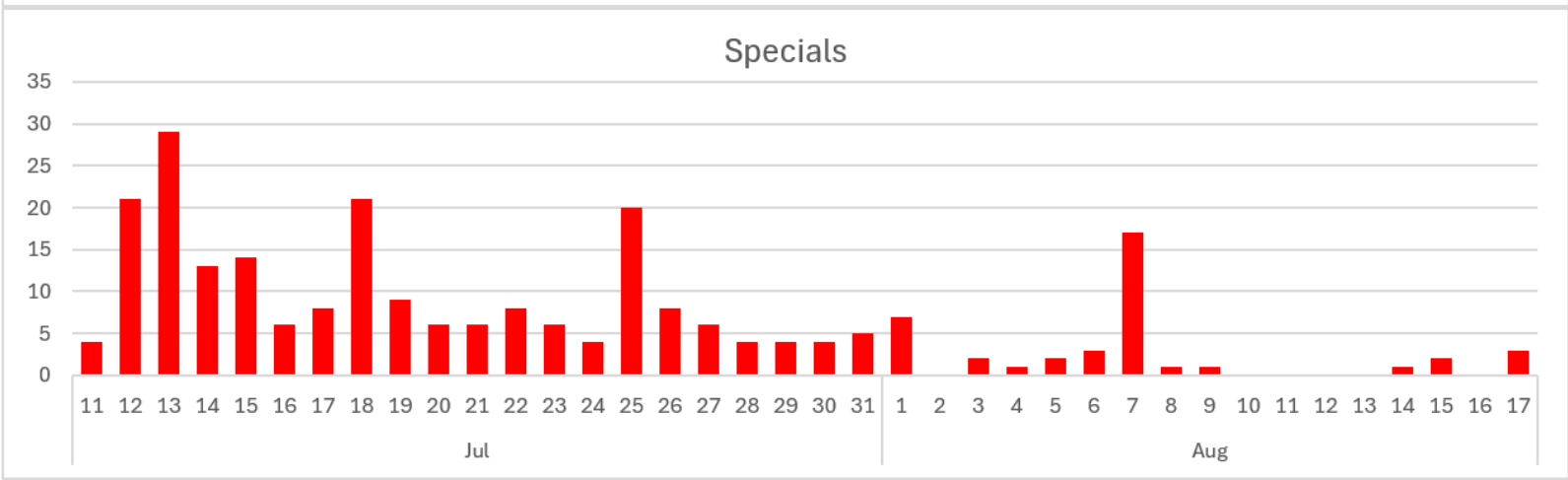
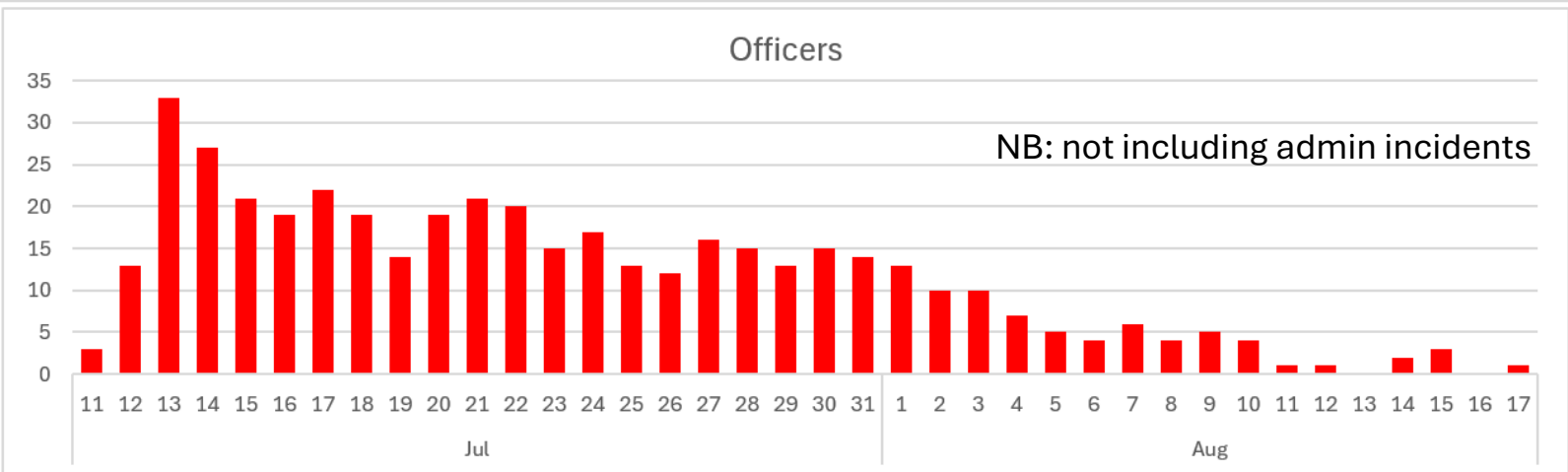
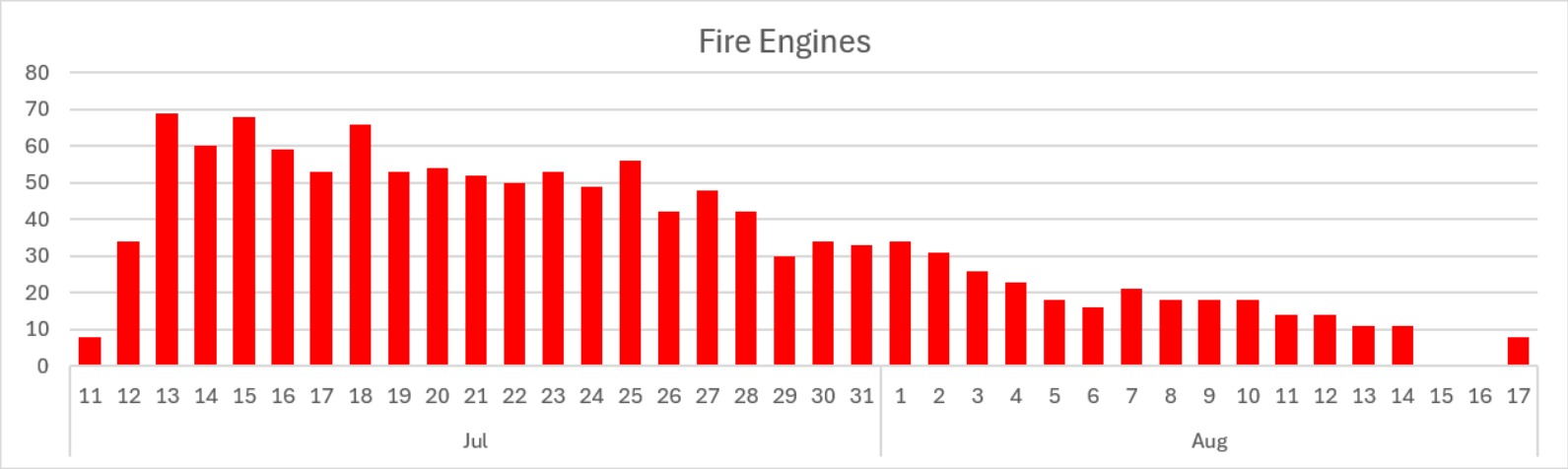


Number of mobilisations

One of the main things we look at is number of mobilisations to the incident

The Dove Stone fire is the 3rd most resourced incident we've had. The other two were also wildfires in 2018 (Saddleworth and Winter Hill).

The max number of fire engines sent to the incident in one day was 69 and the max number of officers was 33.



Counting mobilisations and time

Will also look at further breaking down mobilisations by number and time (hours) by call sign

In general the closer fire engines will be mobilised the most, although rotated for reliefs. However, fire engines with wildfire special vehicles in their station will also be mobilised many times.

Fire engines

Call Sign	No of Mobs	Time
G10P1	11	540
G40P1	28	466
G30P1	58	234
G51P1	43	215
G30P2	41	206
G15P1	23	178
G37P1	42	165
G21P1	38	147
G24P1	18	147
G58P1	18	141

Officers

Call Sign	No of Mob	Time
GS055	16	306
GG022	13	139
GG020	14	137
GS084	14	133
GS058	18	130
GS089	13	112
GS102	5	109
GS072	12	98
GS074	5	94
GS099	9	93

Can think about time in aggregated way.

This table is the total amount of hours all resources were in attendance for the first two weeks of the incident

Date	Pump	Officer	Special	Total
11-Jul	17	9	11	37
12-Jul	142	89	137	368
13-Jul	285	187	645	1117
14-Jul	292	198	377	867
15-Jul	377	238	431	1046
16-Jul	307	218	60	586
17-Jul	281	151	37	468
18-Jul	559	339	2347	3245
19-Jul	299	102	423	824
20-Jul	339	128	10	478
21-Jul	236	207	75	518
22-Jul	120	206	67	393
23-Jul	68	106		174
24-Jul	70	101	11	182
	3392	2279	4630	10301

Can use this information to calculate costs if required

AVL data – a key source of information

Our fire engines and officers (via radio) are tracked so NWFC know their current location/status at any given time and they record location information every 10-1800 seconds depending on status



Data recorded

- Callsign
- Easting/northing
- Status
- Timestamp
- *(incident number)*
- Speed
- Heading

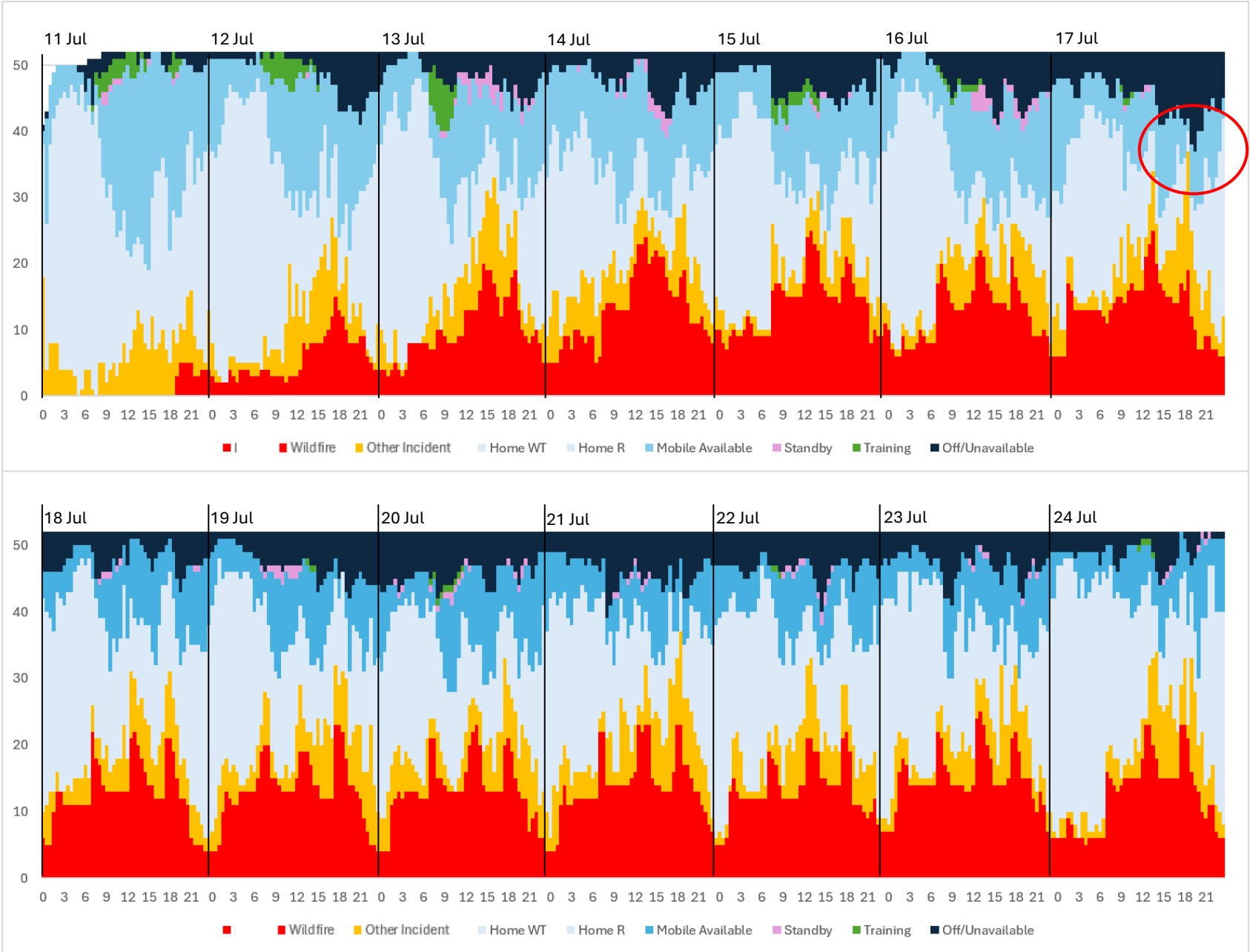
146,503,966 total data points!!!



AVL data to assess availability

Can also use the status and timestamps from the AVL data to look at fire engine availability

Presented in graph format can see on a hourly basis how many fire engines were where and in what status.

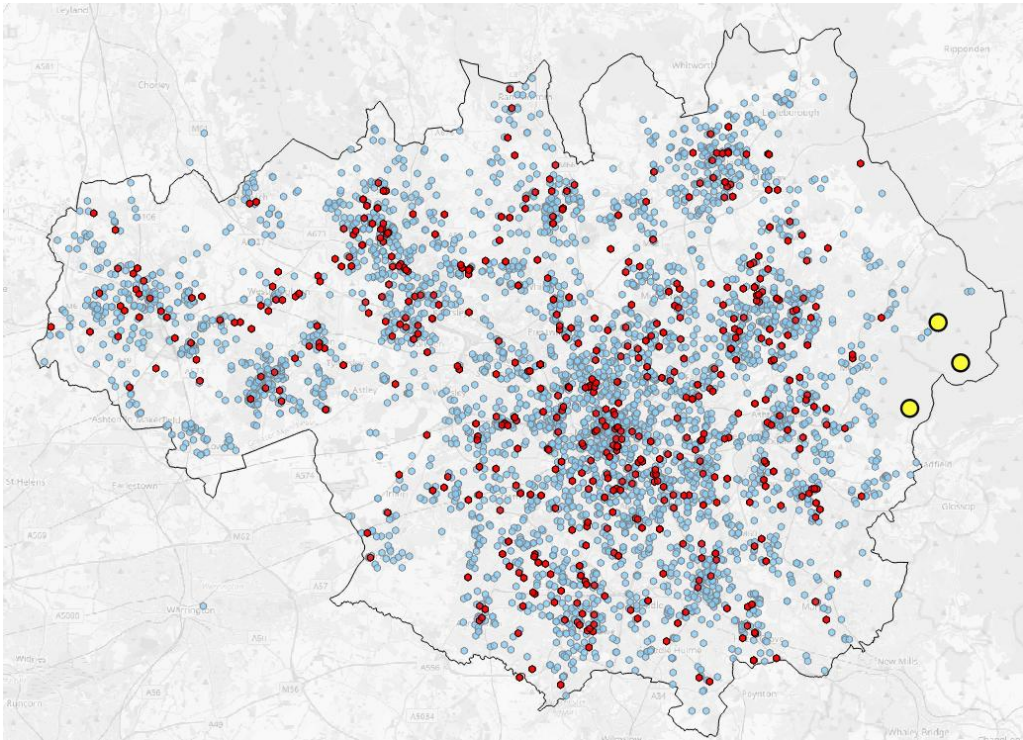


Non-wildfire life still goes on!

Whilst the wildfires are ongoing, still need to retain as much availability for business as usual. We can do this by:

- Pre-planning which pumps are sent as reliefs
- Using standby zones to ensure even spread of coverage
- Spate conditions (reducing attendance at incident and stopping non-essential activity)
- Requesting over the border resources

The map and table show the incidents we attended from 11th July to 18th August during the wildfire period



Incident Theme	Incidents	Fatal	Injured	Rescued	Mobilisations
Accidental Primary Fire	265	0	29	8	644
Deliberate Primary Fire	119	0	4	1	765
Unknown Primary Fire	59	0	2	0	356
Accidental Secondary Fire	551	0	0	0	641
Deliberate Secondary Fire	865	0	0	0	954
Special Service	965	20	193	229	1346
False Alarm - Apparatus	1177	0	0	0	1879
False Alarm - Good Intent	659	0	0	0	938
False Alarm - Malicious	65	0	0	0	98
False Alarm - Misc	14	0	0	0	26
Not Applicable	93	0	0	0	22
Total	4832	20	228	238	7669

Wildfires elsewhere

Large wildfires require the use of national resilience.

During Dovestones wildfire, over the border fire engines were not utilised, however specialised teams – burns teams and tac advisors came from other parts of the country as part of managing the incident.

This summer has been the biggest summer of wildfires across the country. GMFRS sent resources to Derbyshire, Wales and Hampshire (and maybe other places)

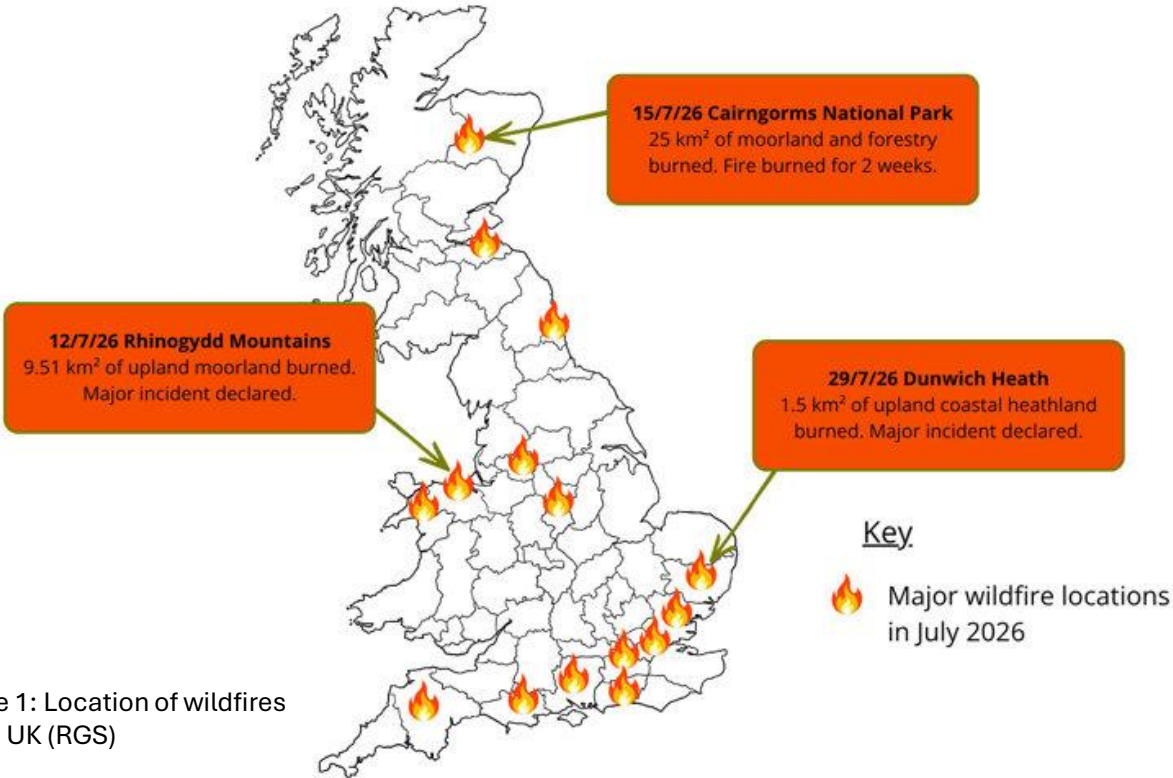


Figure 1: Location of wildfires in the UK (RGS)



Any Questions?

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**GREATER MANCHESTER
FIRE AND RESCUE SERVICE**

WILDFIRE, HEAT AND HOMES

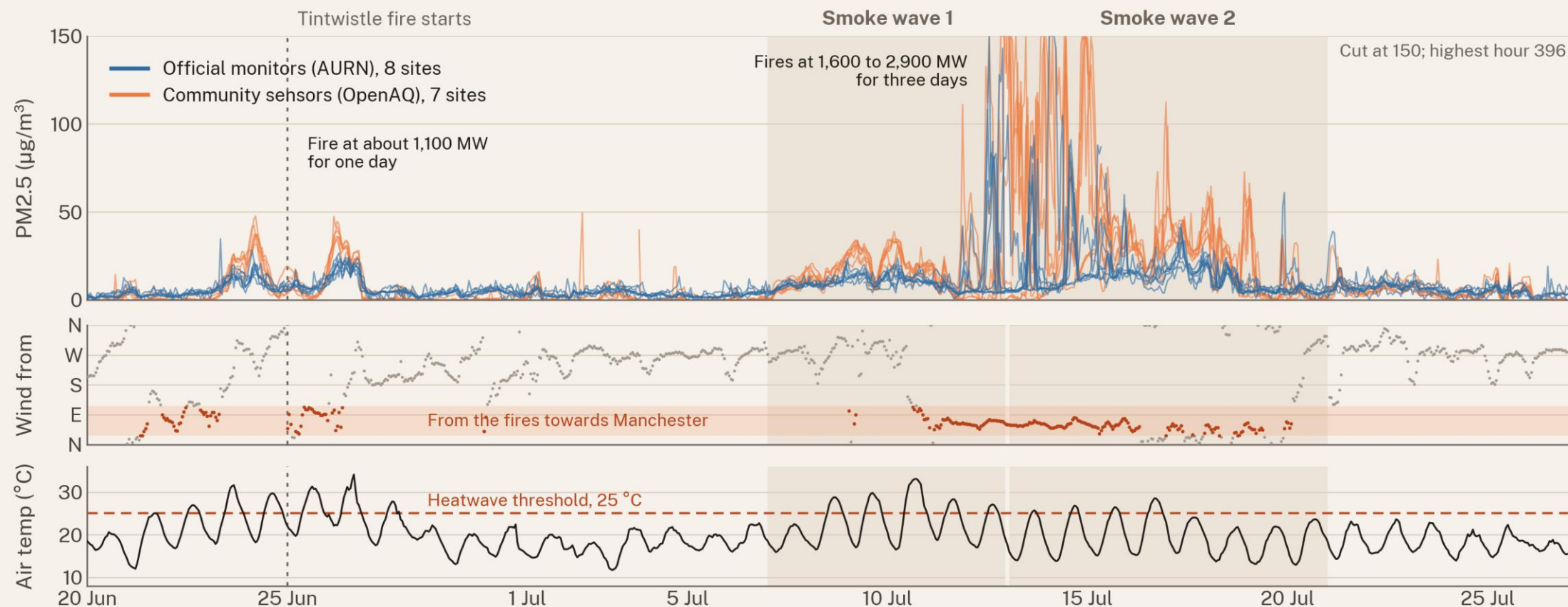
Smoke from fire to bedroom

How open data helps us understand wildfire smoke and indoor AQ

Congbo Song, Hao Zhang, Sharon Weinberg, Alexander Horsley and Thomas J. Bannan
National Centre for Atmospheric Science · University of Manchester

TINTWISTLE AND DOVESTONE MOORS · 1,500 HA BURNED

Two moorland fires, in the middle of a heatwave



OFFICIAL ADVICE, 14 JULY 2026

"Stay inside and keep windows and doors shut. If it becomes hot indoors, move to the coolest part of your home, particularly when sleeping."

UK Health Security Agency

Staying inside can mean sleeping in a hot, smoky bedroom

Most UK homes have no air conditioning. On a hot night, opening a window is often the only way to cool down.

FREE FOR ANYONE TO USE

Open data we used

Satellites that spot fires

NASA FIRMS · heat from active fires, seen from space several times a day

Air-quality monitors

DEFRA AURN network · hourly readings of fine smoke particles in UK towns

Weather records

Met Office · ERA5 · temperatures, heatwaves and wind direction

Smoke maps

Copernicus (EU) · computer maps of where smoke is drifting

Air-trajectory and dispersion

NOAA HYSPLIT · traces where air (and smoke) travels from the fire

Energy Performance certificates

EPC register · how millions of homes are built and ventilated

Population maps

EU Global Human Settlement · how many people live in each city

Outdoor air sensors

OpenAQ · readings from sensors people run at home

Air sensors in 22 homes

Our study · the one piece nobody else had: air inside bedrooms and kitchens

11 YEARS, 61 UK CITIES, 95,188 CITY-DAYS

13×

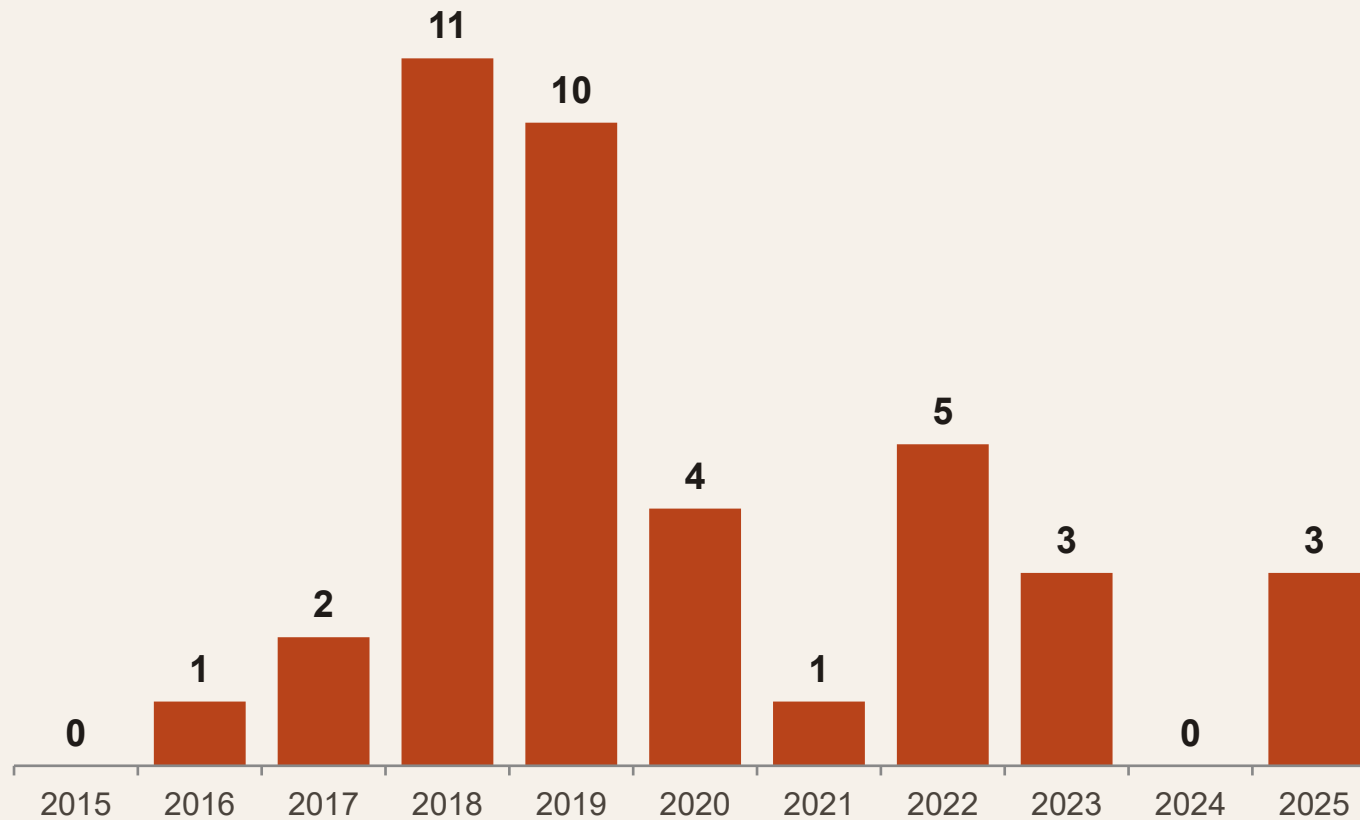
On heatwave days, wildfire smoke was about 13 times more likely



Smoke reached a city on 2.7% heatwave days, but on only 0.2% other days.

2015 TO 2025

40 heat-and-smoke episodes in 11 years



28

cities affected at least once

22.6 m

people live in those cities

8 in 10

homes there rely on natural ventilation

Heat-and-smoke episodes per year in UK cities. Sources: Met Office, DEFRA, NASA FIRMS, EPC register, EU population data

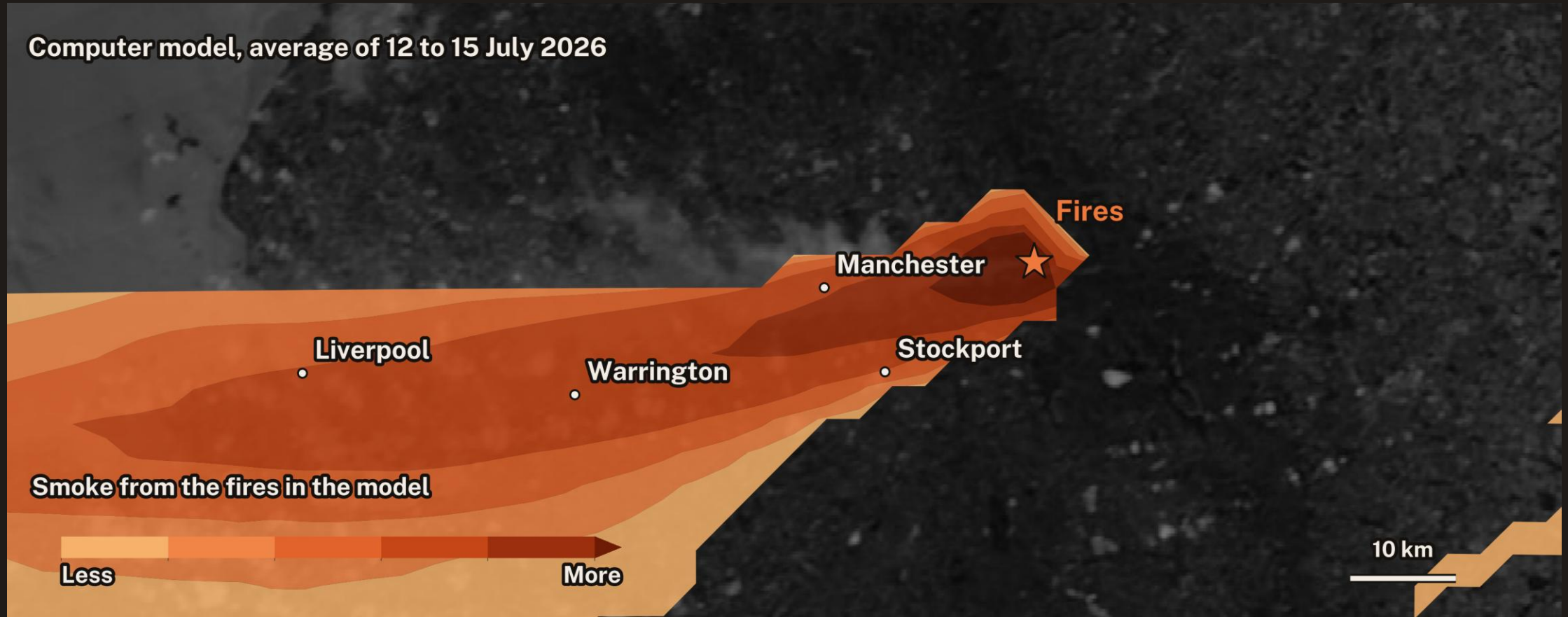
NASA SATELLITE IMAGE

Satellite photo of the smoke plume, 13 July



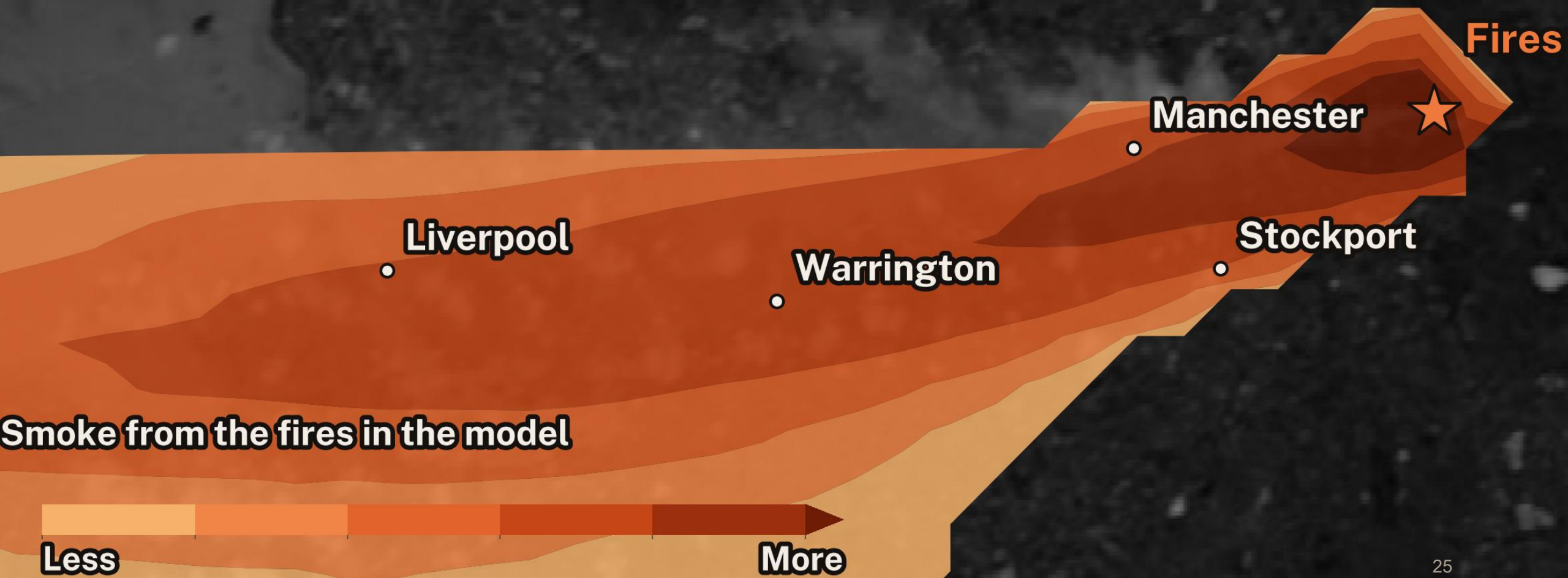
NASA Aqua satellite, true colour (NASA Worldview / GIBS). Orange dots: fire hot-spots from NASA FIRMS.

Modelled smoke dispersion from the fires



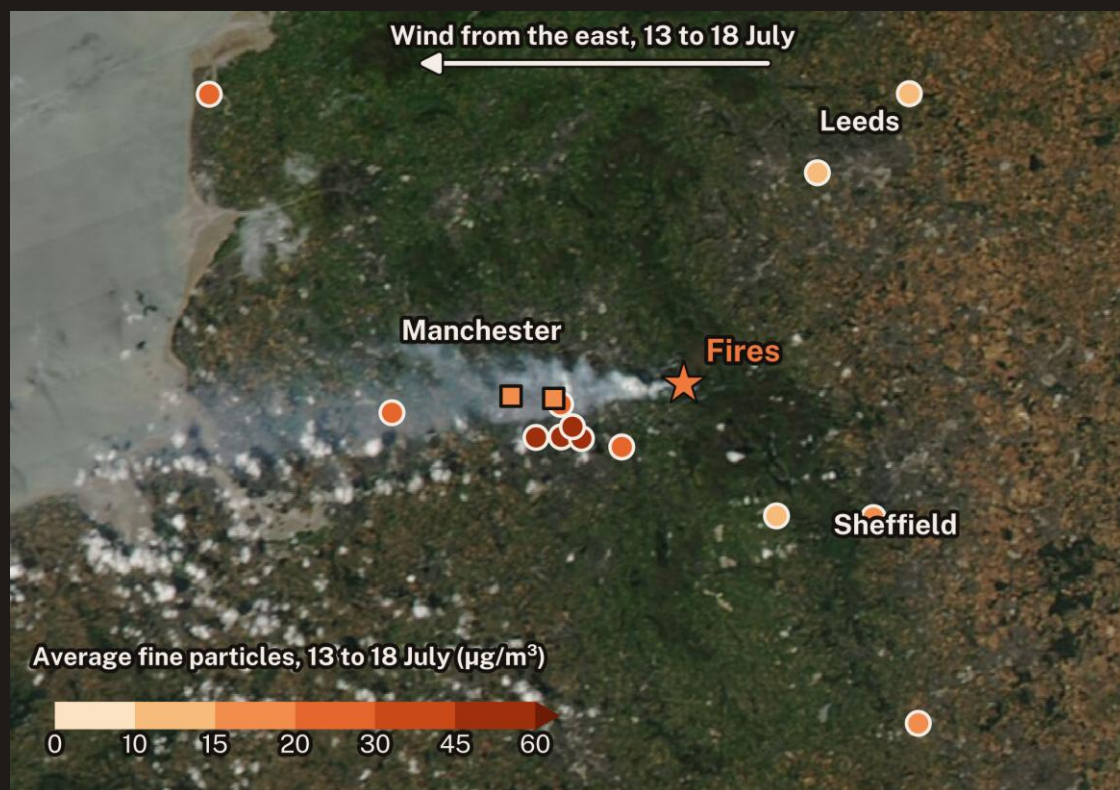
Chemical Transport Model (WRF-Chem) run twice, with and without the fires; the map shows the difference.

Computer model, average of 12 to 15 July 2026



COMMUNITY SENSORS

Air sensors run by the public, shared on OpenAQ



People run small air sensors at home and share the readings through OpenAQ. We used 13 of them.

In the second smoke wave the wind blew from the east. Sensors **downwind** of the fires read a middle value of about **37**; those **upwind** read about **15**.

On 12 and 13 July, when the fires were fiercest, sensors east of the fires read about 1 and sensors to the west read 30 to 47.

Squares are the official monitors. Home sensors show the ups and downs well, but their exact amounts are less reliable.

What happened inside people's homes?



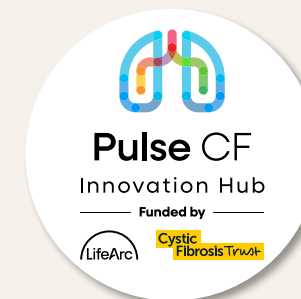
Each blue dot is a postcode district; "2" means two homes.

Monitoring with the Manchester Adult Cystic Fibrosis Centre

Low-cost sensors were already running in **22 homes** before the fires began.

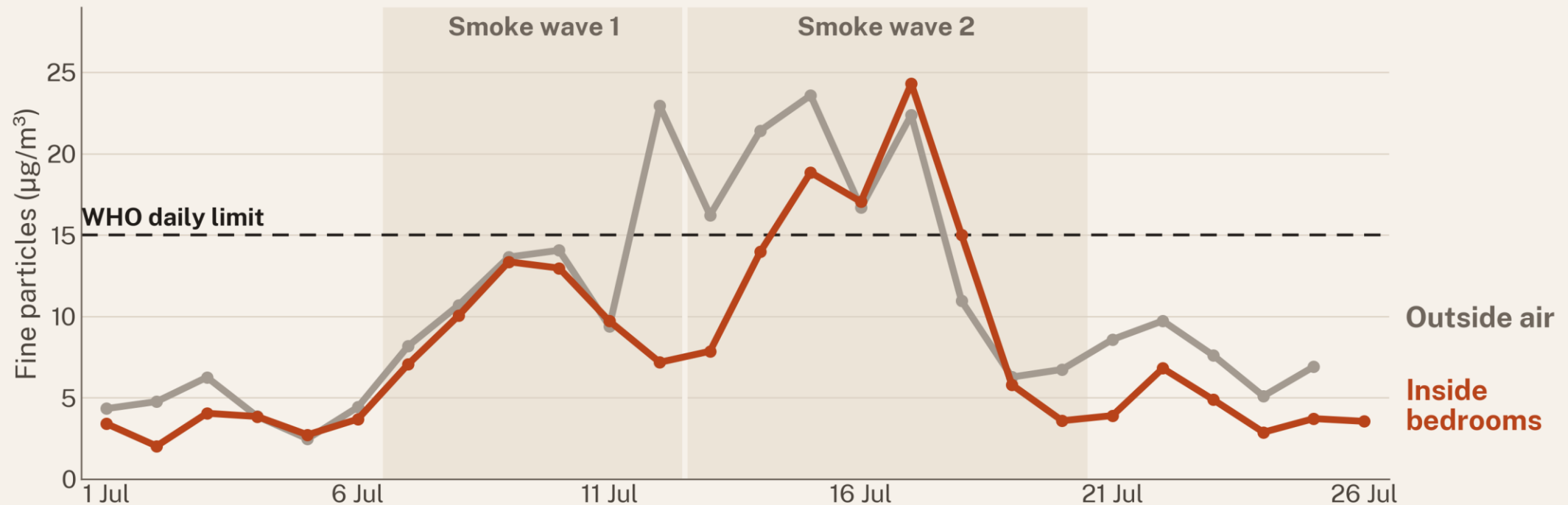
The people living there have **cystic fibrosis**, a lung condition that makes smoke especially risky. They are vulnerable population, exactly who the "stay indoors" advice is meant to protect.

Every 5 minutes the sensors recorded **smoke particles**, **carbon dioxide** (a sign of fresh air coming in), **volatile organic compounds** and **temperature**.



BEDROOMS AND OUTDOOR AIR

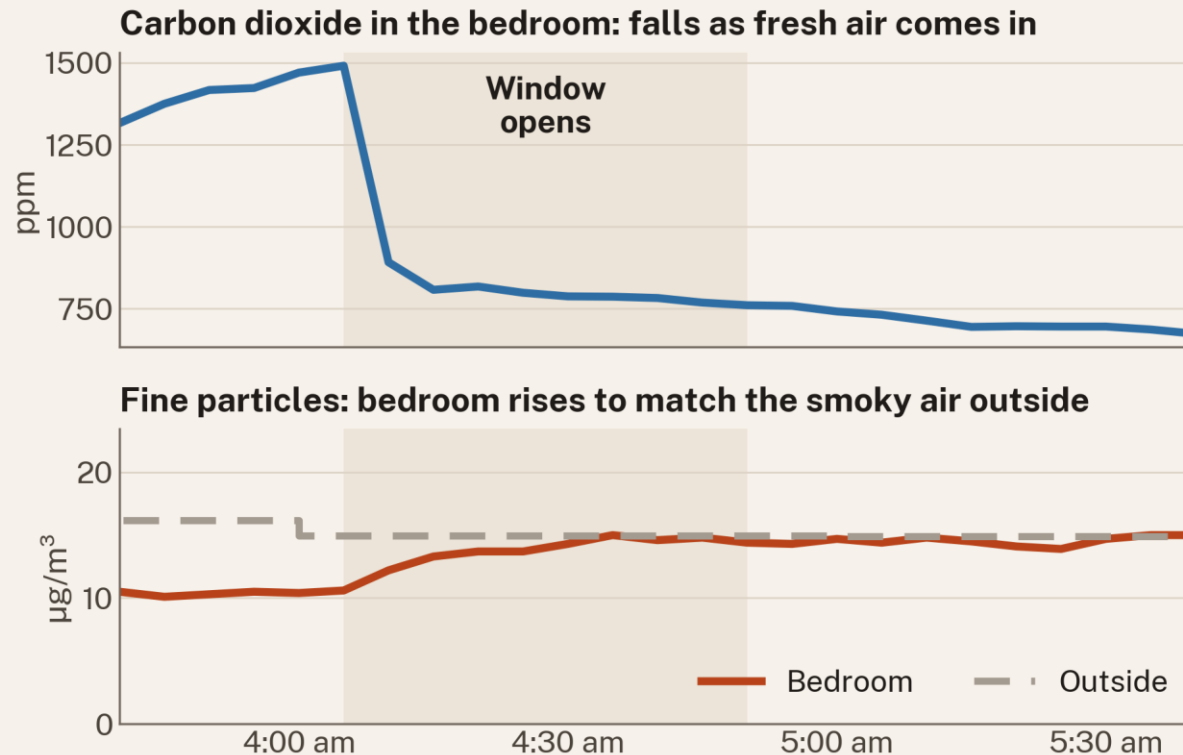
Bedroom PM2.5 rose and fell with the smoke outside



Daily averages. Red: 22 bedrooms. Grey: city air monitors at Salford Eccles and Manchester Piccadilly (DEFRA).

EXAMPLE FROM 16 JULY

Smoke came in when a window opened



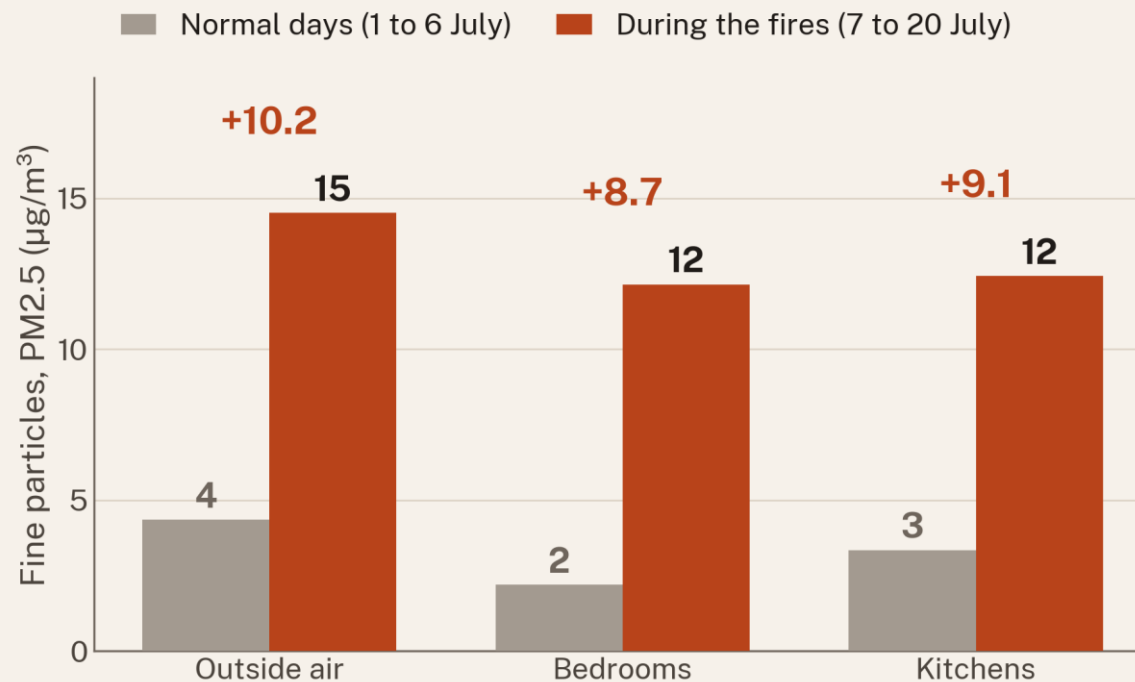
Just after 4 am on 16 July, carbon dioxide in one bedroom **suddenly dropped**: someone had opened a window for fresh air.

Within half an hour, smoke particles in the bedroom **rose to match the smoky air outside**.

We saw particles rise while carbon dioxide fell in 14 of the 22 homes.

THE INCREASE

The fires added about 9 $\mu\text{g}/\text{m}^3$ to indoor air



Extra during the fires	Bedrooms	Kitchens
Finest (PM1)	+4.1	+4.8
Fine (PM2.5)	+8.7	+9.1
Coarser (PM10)	+9.6	+10.5

Outside, fine particles went up by about 10. Indoors they went up by about 9, so most of the extra smoke outside made it inside.

All 22 bedrooms went over the WHO daily limit on at least one day (15 of 22 on the most cautious estimate).

VENTILATION

Heat kept windows open

20 of 22

homes let in more outside air than usual during the worst smoke.

Without air conditioning, **opening a window** is how most homes cool down on a hot night, and it let the smoke in.

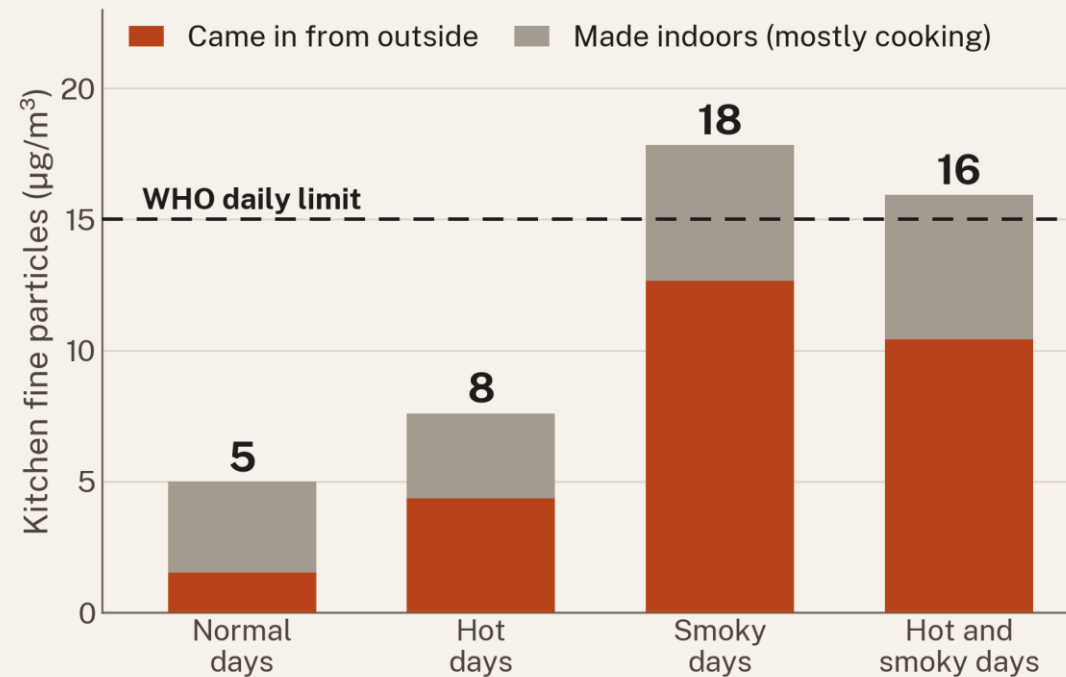
After the official warning, we saw **no drop in ventilation**.

On nights with less ventilation, bedrooms had **less smoke but were warmer**.

Fresh air coming in was measured from bedroom carbon dioxide

KITCHENS

Kitchen air on hot, smoky days



On hot, smoky days kitchen air had **three times** the fine particles of a normal day.

Almost all the extra **came in from outside**.

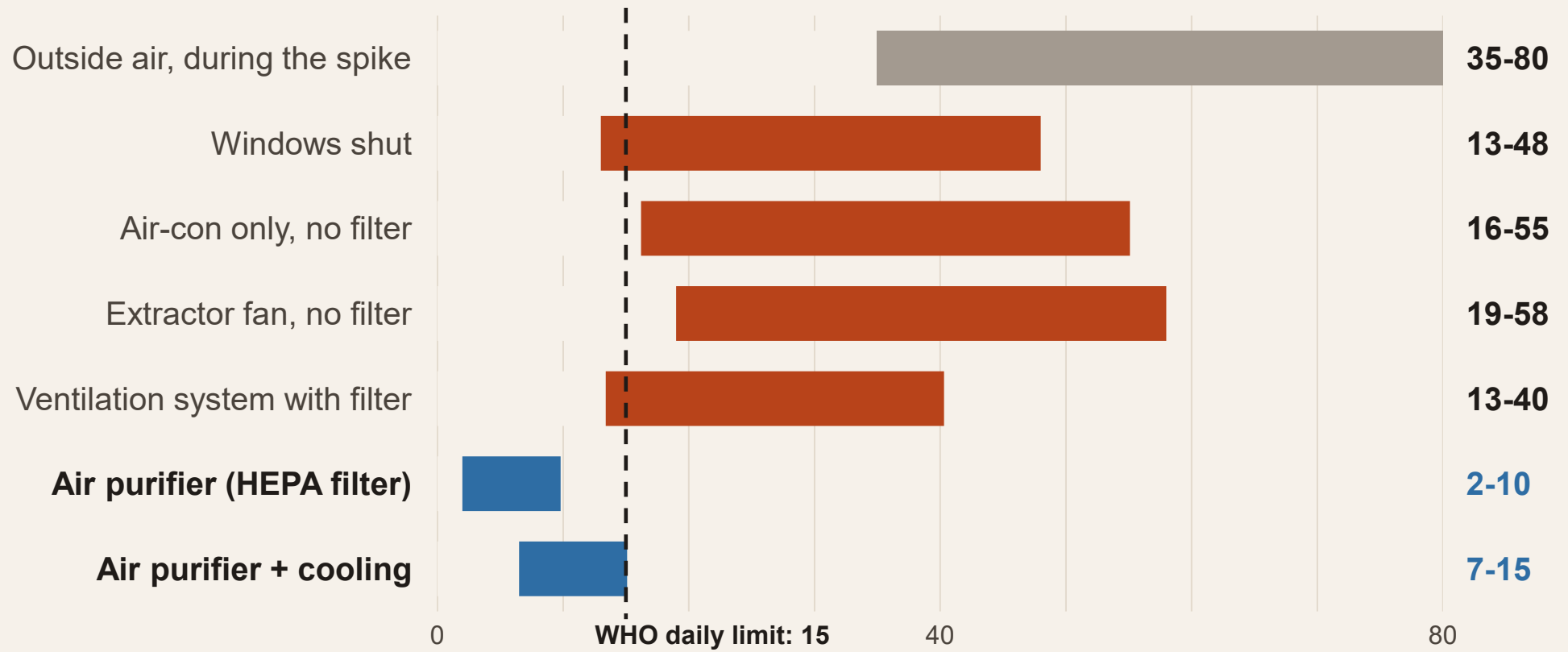
Windows shut with a **ducted cooker hood** copes with outdoor smoke up to about 40; windows open, only up to 17.

Gas and electric hobs have the same level of particles.

QUESTION 4

Which measures keep bedroom air clean?

Estimated bedroom smoke levels during a 3-hour smoke spike



Micrograms of fine particles per cubic metre. Model estimates based on air-flow measured in study homes; purifier figures are best-case.

Recommendations

Combine heat and smoke warnings

During the fires, heat alerts were at Amber while the air-quality index said "Low". A single heat-and-smoke warning would cost almost nothing.

Report sub-daily peaks

Daily averages hide short, intense smoke spikes at night, exactly when people sleep with windows open.

Purifiers and cooling for vulnerable people

89% of surveyed households owned no air purifier. For people with lung conditions, a purifier plus cooling could one day be offered through the NHS, after proper trials.

Building rules that cover heat and air quality

Building rules treat fresh air and overheating separately. New homes and retrofits should be designed for heat and smoke together.

PRACTICAL STEPS

What you can do on a hot, smoky night

- Look up local air quality and nearby fires before you open the windows.
- Run an air purifier with a HEPA filter in the bedroom, with the windows shut.
- Shade the windows during the day, and ventilate the house when the outdoor air is clean.
- Go easy on extractor fans while there is smoke about. They can pull smoky air in through gaps.
- If you have a lung condition, make a plan with your care team before summer.

EXPLORE THE DATA YOURSELF

Live fire map

firms.modaps.eosdis.nasa.gov/map

UK air quality, now and forecast

uk-air.defra.gov.uk

Smoke forecasts for Europe

atmosphere.copernicus.eu

Heat-health alerts

metoffice.gov.uk

Satellite photos, every day

worldview.earthdata.nasa.gov

Community air sensors

explore.openaq.org

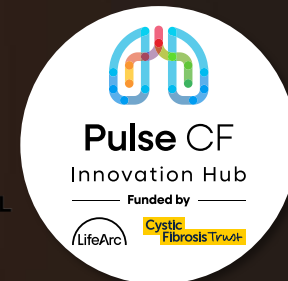
Open data + research data let us better understand the smoke from the fires **into people's bedrooms.**

Thank you. Questions?

National Centre for Atmospheric Science · University of Manchester · Manchester Adult Cystic Fibrosis Centre



**National Centre for
Atmospheric Science**
NATURAL ENVIRONMENT RESEARCH COUNCIL



Wildfire Intelligence: Using Earth Observation and GIS to Characterise Fire Activity in the UK

Gail Millin-Chalabi¹, Gareth Clay¹, Ana Maria Pacheco Pascagaza¹, James Morison², Thomas Smith³,
Sneha Mendiratta¹, Olivia Bickerstaff¹, Emma Coe¹

(1) University of Manchester (2) Forest Research (3) London School of Economics

Part of the 'Towards a UK Fire Danger Rating System' project

www.ukfdrs.com

Contact: Dr Gail Millin-Chalabi (Gail.Millin-Chalabi@manchester.ac.uk)



This project is funded by



Grant ref: NE/T003553/1



29th September 2026 - Up in smoke exploring the data behind UK wildfires, Open Data Manchester



2016



2002

2003

2005

2014

2016

2017 - 2023

2020 - 2025

2025 - 2026

B.Sc.

M.Sc.

GIS
Scientist

Co-I/
Geodata
Services



Ph.D./
Lecturer
Remote
Sensing/
EnviroSAR

Director
EnviroSAR
/ GIS & RS
Technical
Specialist

Co-I UKFDRS



2023 RLP Project
Manager/ GISMEO Lead

Head of Digital Reach/
GISMEO Lead

Multiverse
Apprenticeship - AI for
Business Value



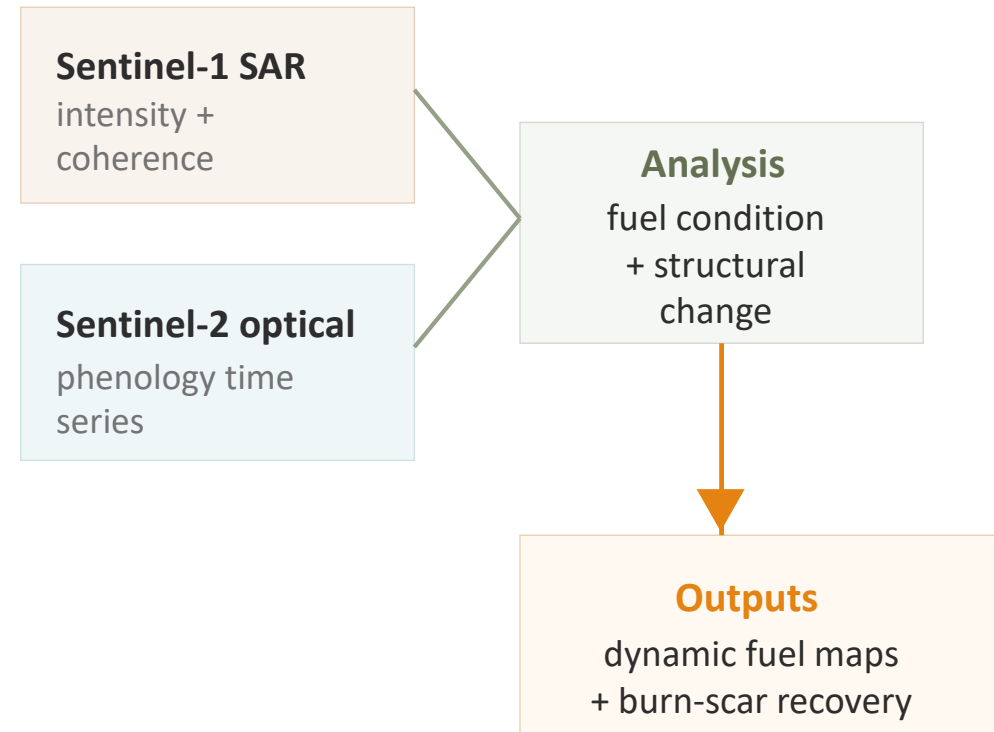
Research focus: mapping fuel, fire scars and recovery

Core research question

How can Earth Observation improve evidence for wildfire risk and landscape recovery in UK peatlands and heathlands?

My profile highlights the application of Synthetic Aperture Radar (SAR) to burn-scar detection, characterisation and recovery, with recent work on dynamic fuel mapping in the South Pennines.

NERC UK Fire Danger Rating System: Co-I researcher leading WP1 Fuel Mapping from landscape scale to local fuel structure.



Why it matters Better spatial evidence for fire danger, conservation response and post-fire vegetation recovery.

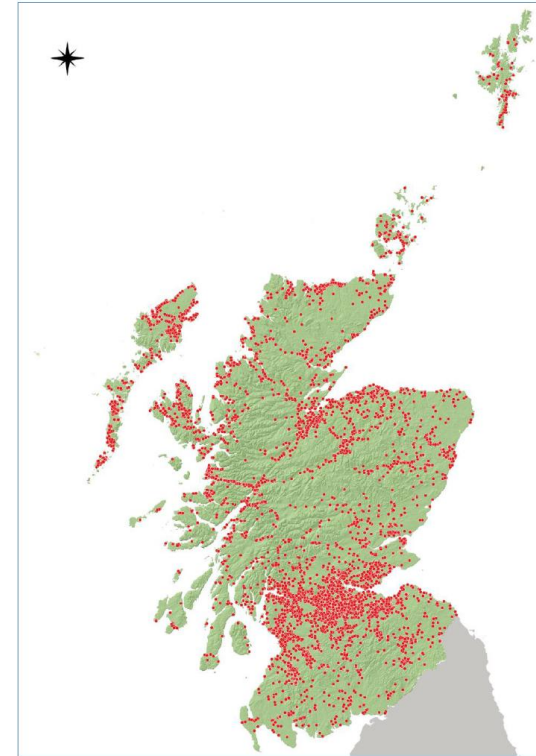
UK fire regime

- The UK has a complex fire regime, including managed burning and episodic wildfires.
- In addition, a mix of land cover types and a diverse rural-urban interface means there are distinct fire challenges:
 - human life and property
 - land assets and ecological disturbances.



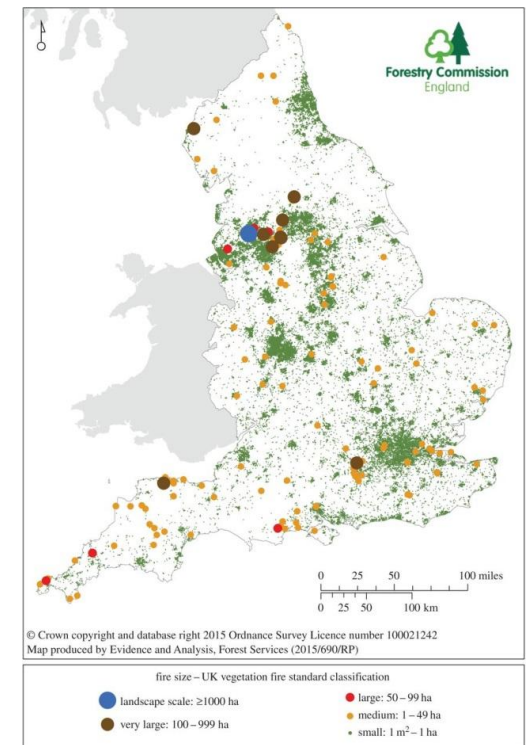
Why spatial data integration matters

- The UK combines managed burning with episodic wildfire across peatland, heathland, grassland, forest and the rural–urban interface.
- No single source is a complete fire record: incident logs locate response; satellites observe heat and surface change; GIS supplies environmental and exposure context.
- The operational task is to reconcile them at the right spatial and temporal scale.



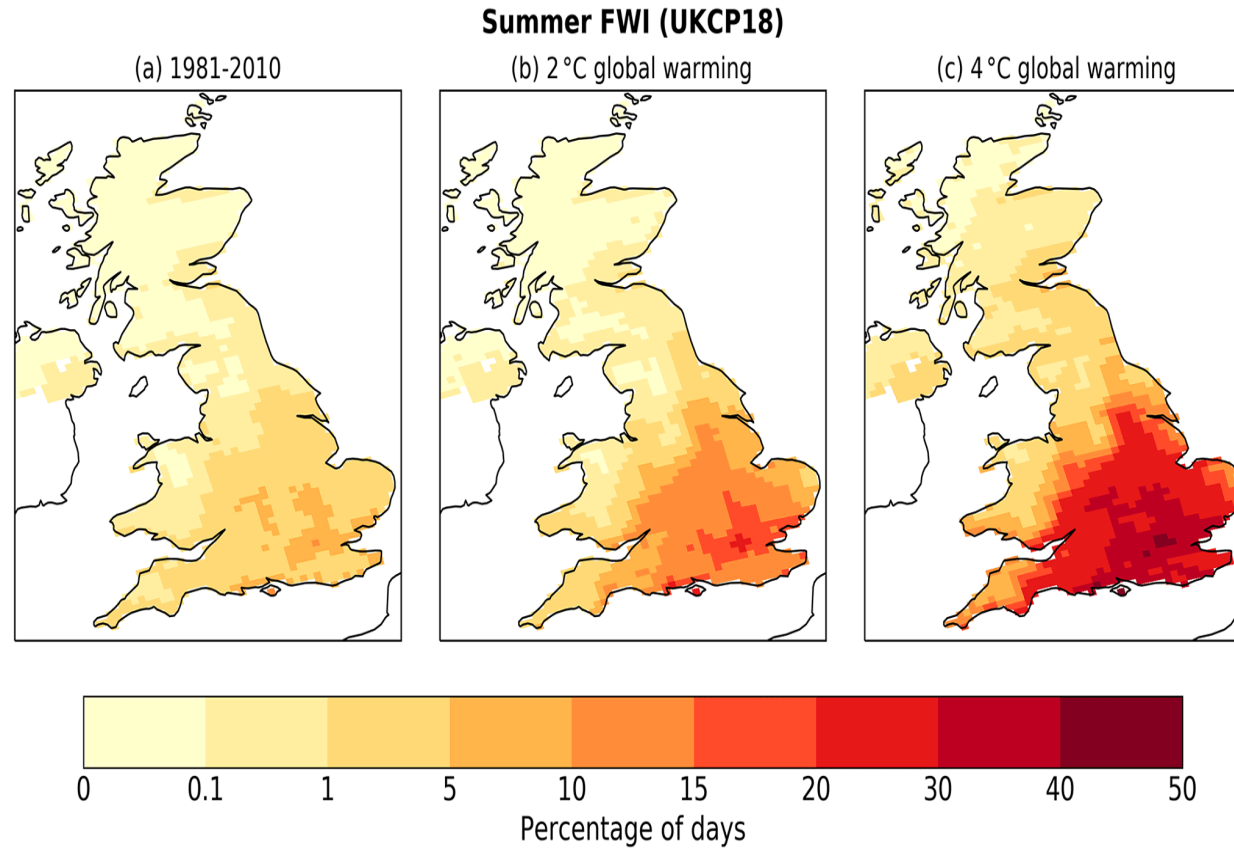
Wildfires on Incident Recording System (IRS)
1st Apr 2009 – 31st Dec 2020.

From [Gagas et al. \(2022\)](#)



Vegetation fires in England (1 Apr 2011 – 31 Mar 2012) from [Gazzard et al. \(2016\)](#)

More high-danger days increase the need for repeatable evidence



From Perry et al. (2022)

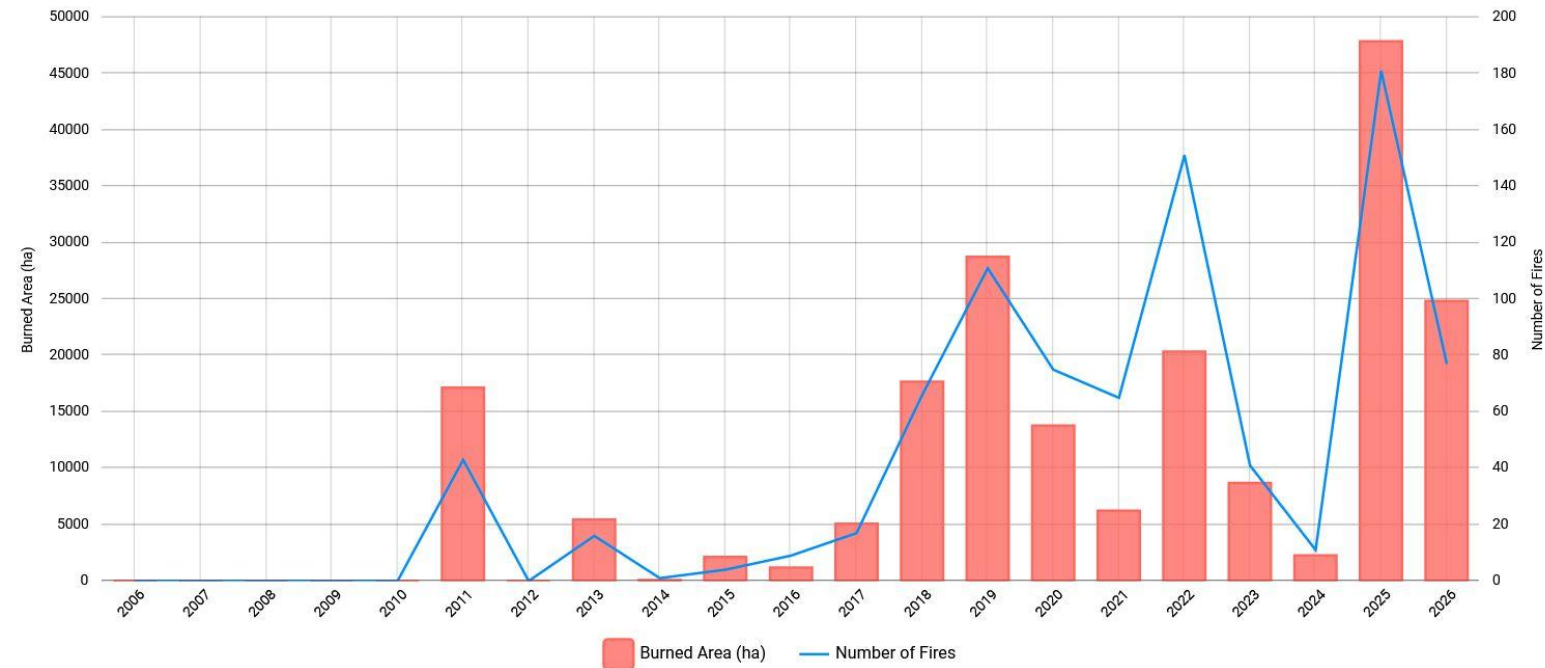
Percentage of summer days with very high fire danger (FWI > 17.35) over the UK, based on the UKCP18 12 km data averaged over the 12 ensemble members. **(a)** Historical period (1981–2010), **(b)** 2 °C global warming and **(c)** 4 °C global warming.

EFFIS annual context

Annual statistics shown to 2025;
2026 is current to 26 September.

EFFIS combines MODIS, VIIRS
and Sentinel-2 mapping. Since
2018, Sentinel-2 has improved
detection below the historic ~30
ha threshold.

Treat mapped totals as a
consistent operational view, not
every UK vegetation fire; managed
burns may be included.

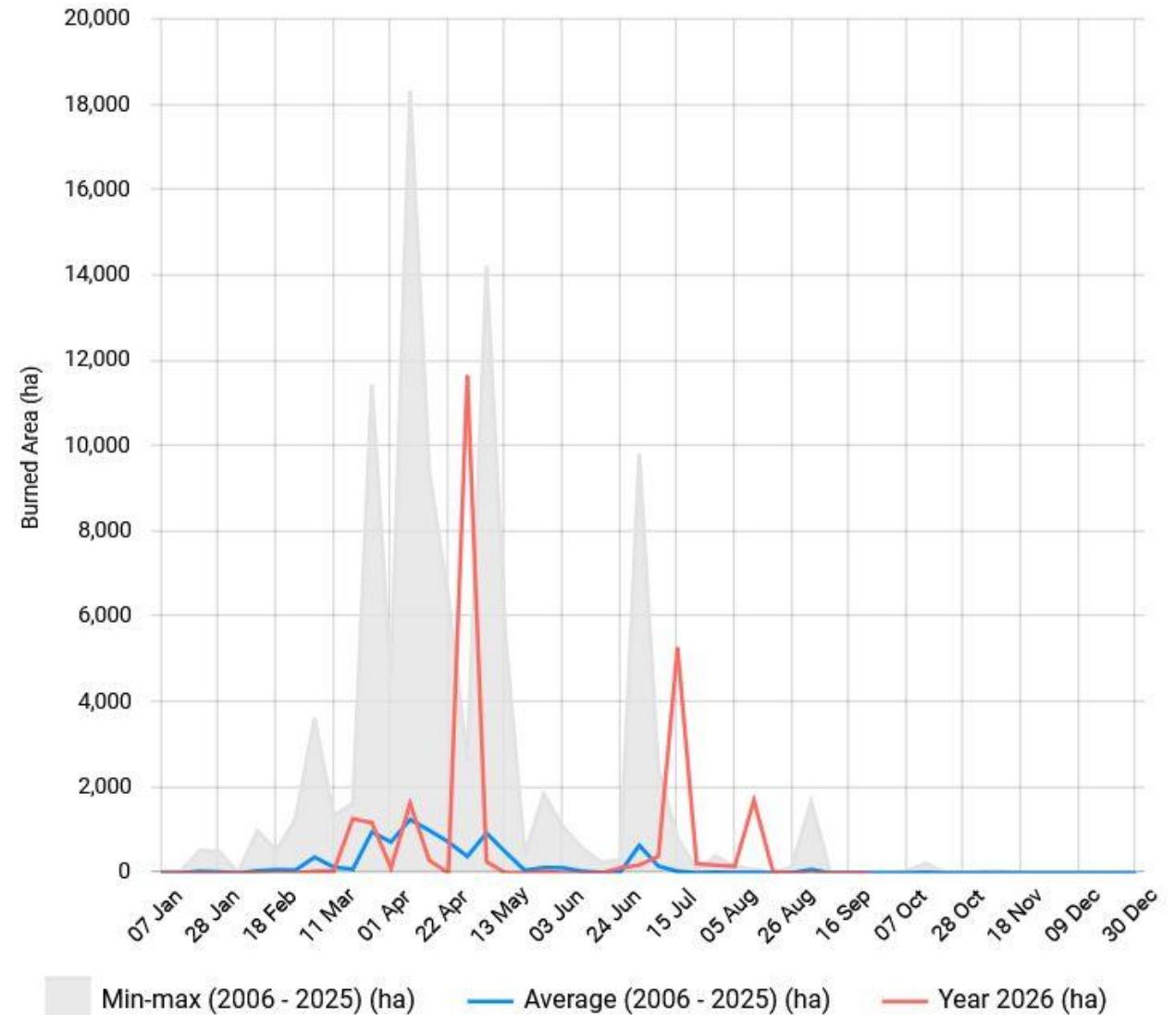


Seasonality

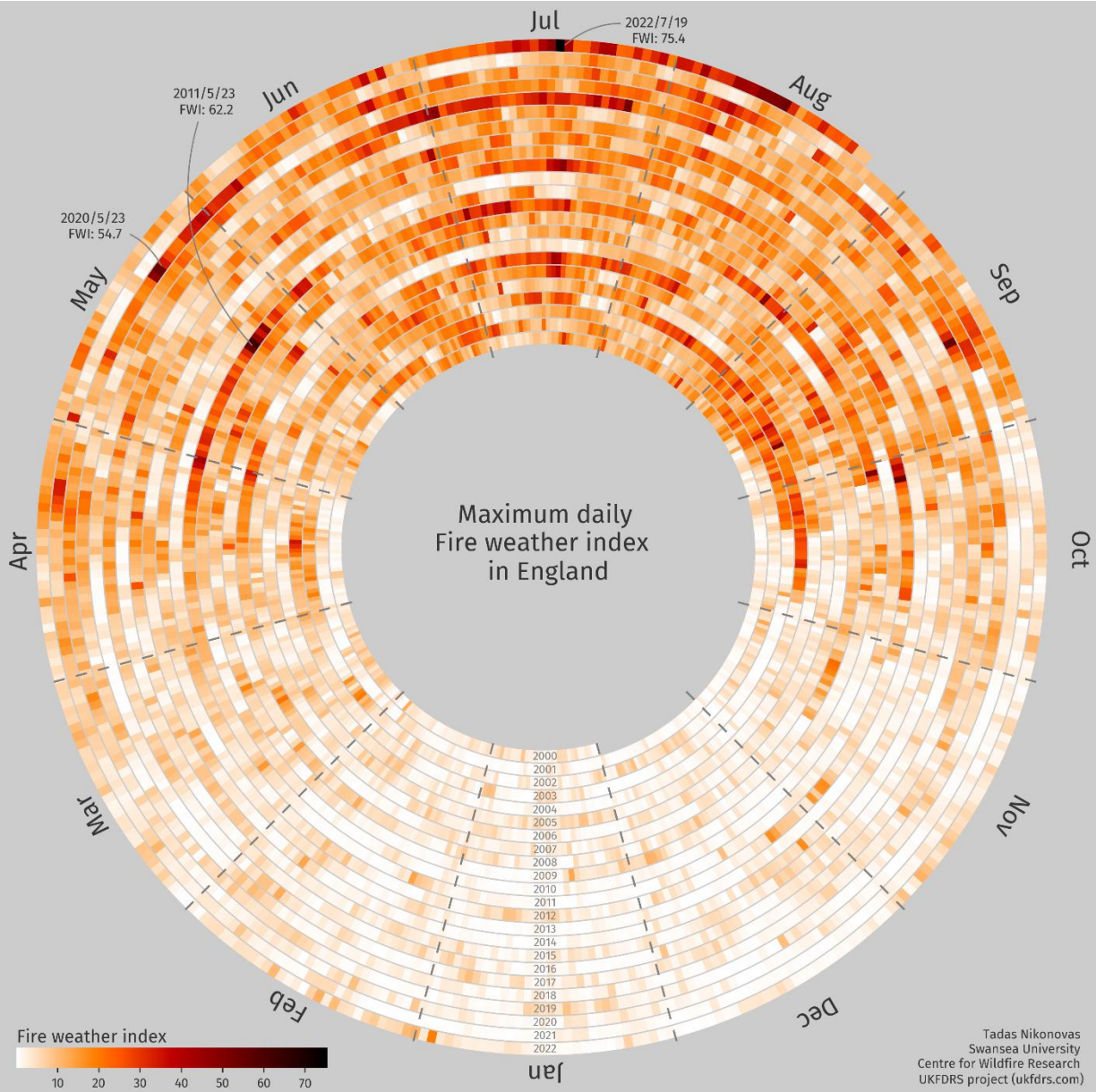
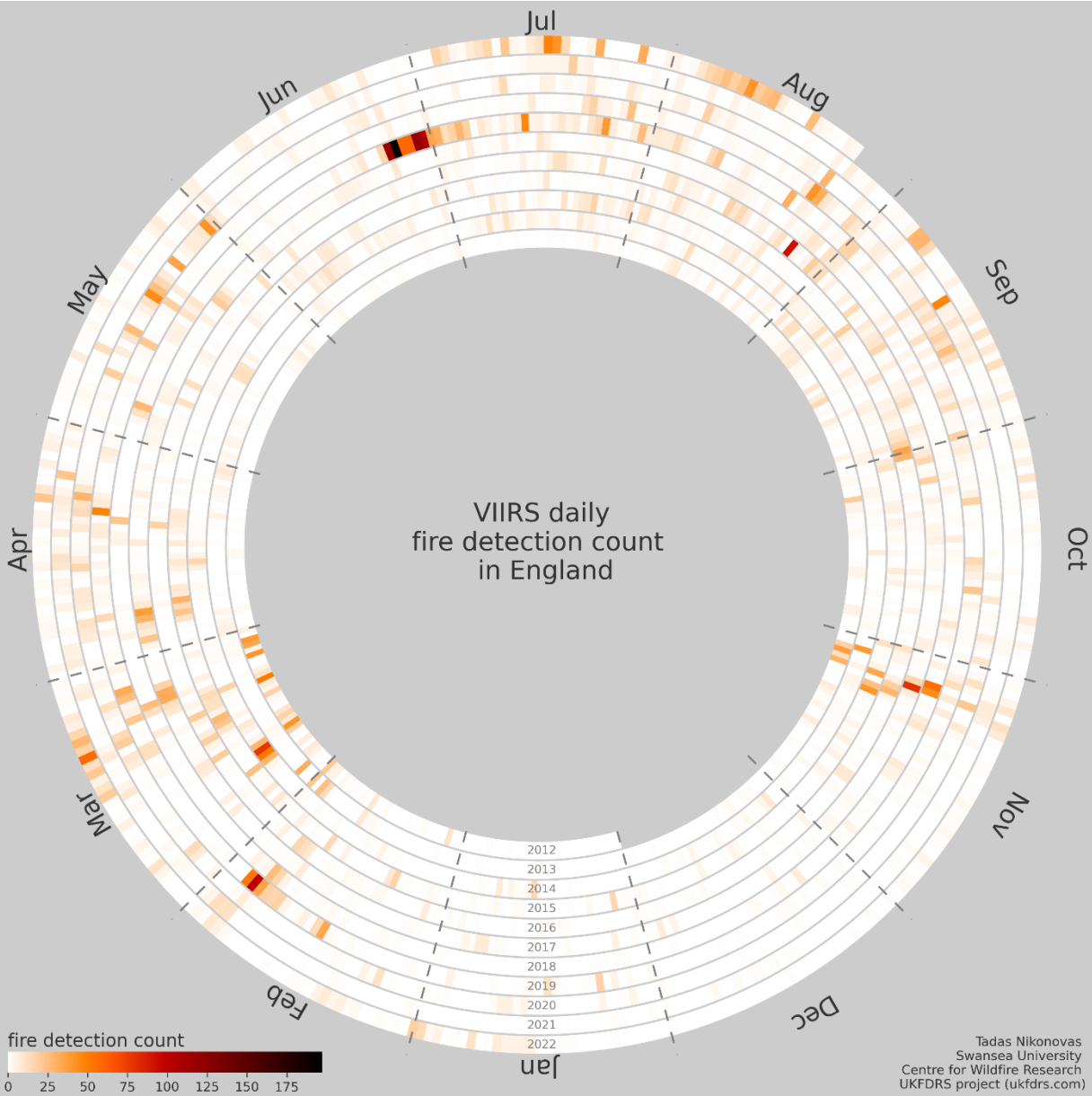
Weekly burned area shows when mapped fire activity concentrates.

Use the pattern with fire-weather indices, local burning seasons and incident records — not in isolation.

Cloud, smoke, revisit timing and deliberate vegetation management can suppress or complicate detections.

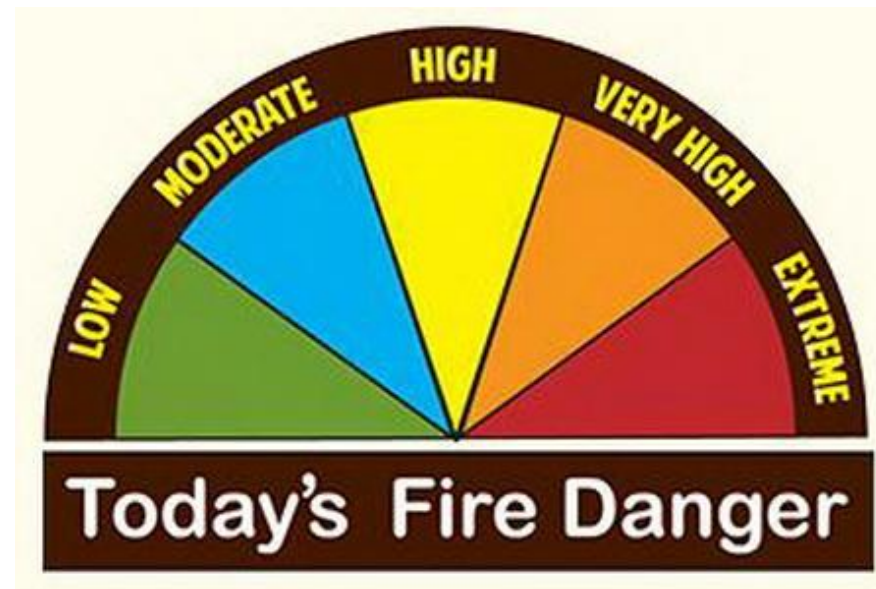


England FWI - Fire Seasonality

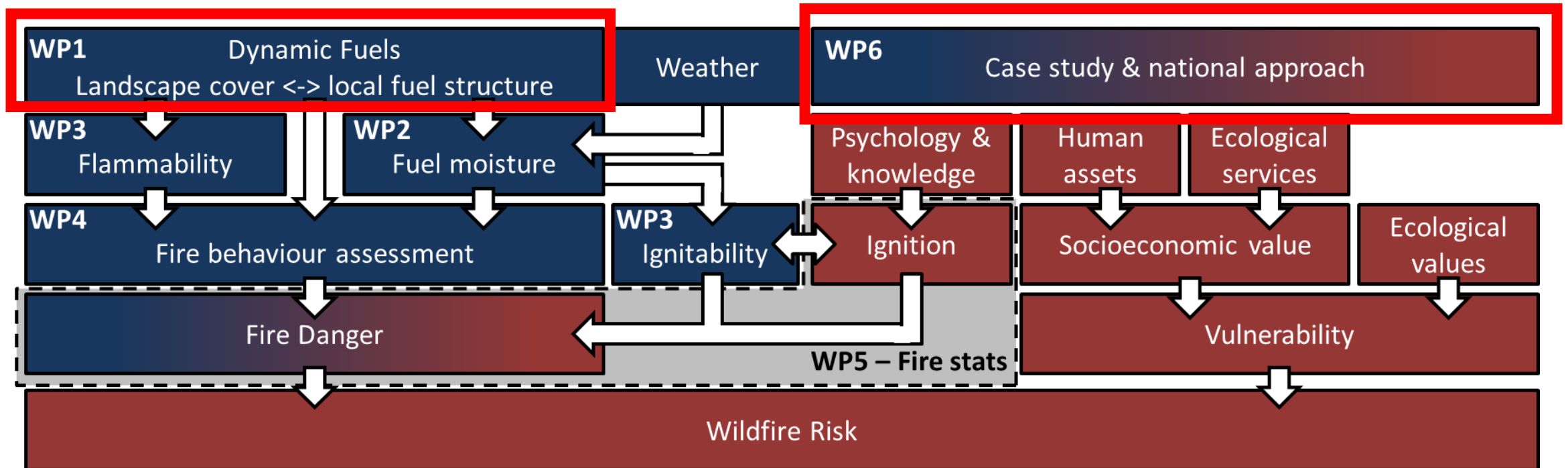


Fire danger rating systems

- Fire danger is the combination of both constant and variable factors that affect the initiation, spread, and ease of controlling a wildfire.
- **Fire Danger Rating Systems (FDRS)** have a primary objective of assessing fuel and weather conditions and provide broad estimates about fuel flammability and the potential fire behaviour under those conditions.



UKFDRS Project structure

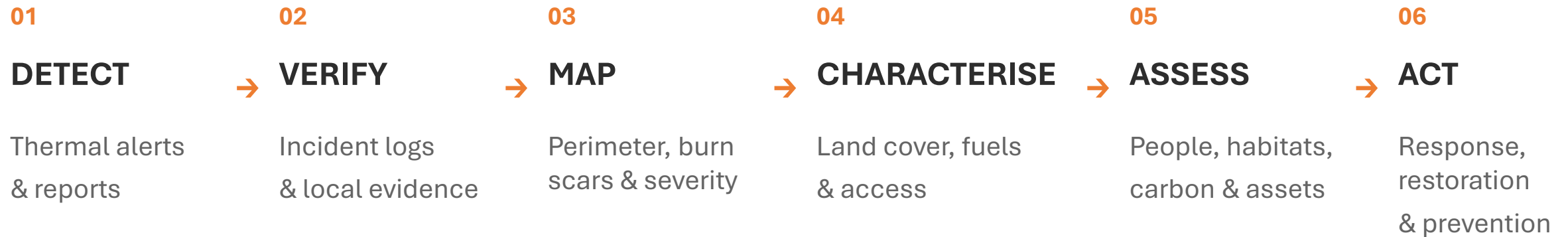


Sections in blue map onto WPs; some sections in red were explored through use of IRS data to explore ignition patterns (WP5) and a case study approach to wildfire threat analysis (WP6).

Further development of the red sections is needed at a national scale for a fully operational FDRS but were outside the scope of this project.



A single workflow links observation to management action



Fast evidence

FIRMS / EFFIS / control-room reports

Defensible evidence

Validated perimeters, time series and uncertainty

Actionable evidence

Priorities tied to a named decision and owner



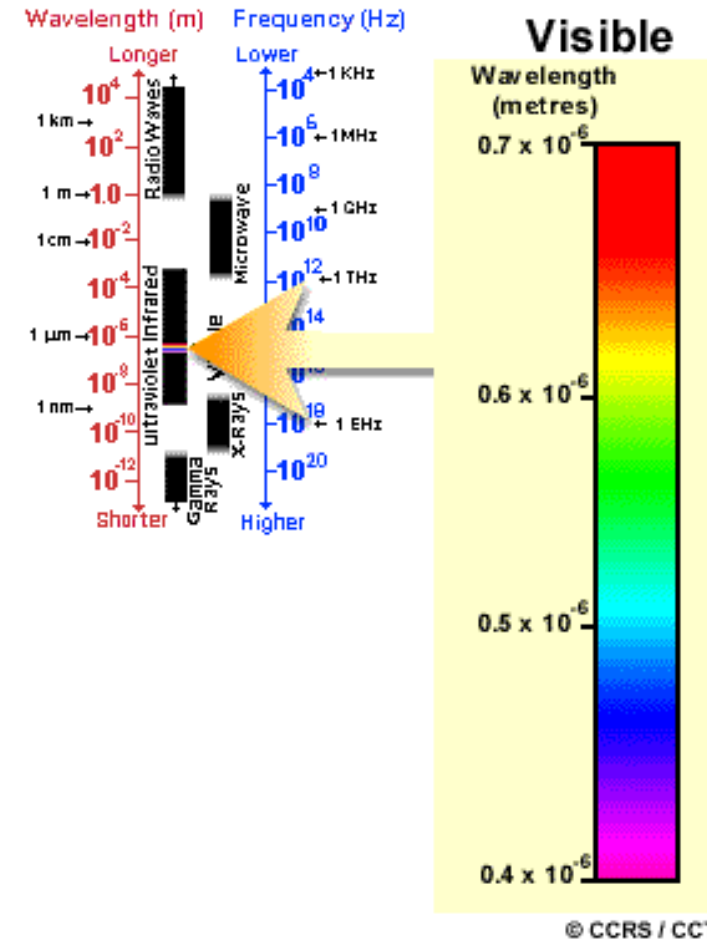
Optical remote sensing makes use of visible, near infrared and short-wave infrared sensors to form an image of the Earth's surface by detecting the solar radiation reflected from targets on the ground, they are therefore passive sensors.

Optical Sensors

Electromagnetic Spectrum - Optical

Violet: 0.4 - 0.446 μm
Blue: 0.446 - 0.500 μm
Green: 0.500 - 0.578 μm
Yellow: 0.578 - 0.592 μm
Orange: 0.592 - 0.620 μm
Red: 0.620 - 0.7 μm
Reflected Infrared: 0.7 μm – 3.0 μm

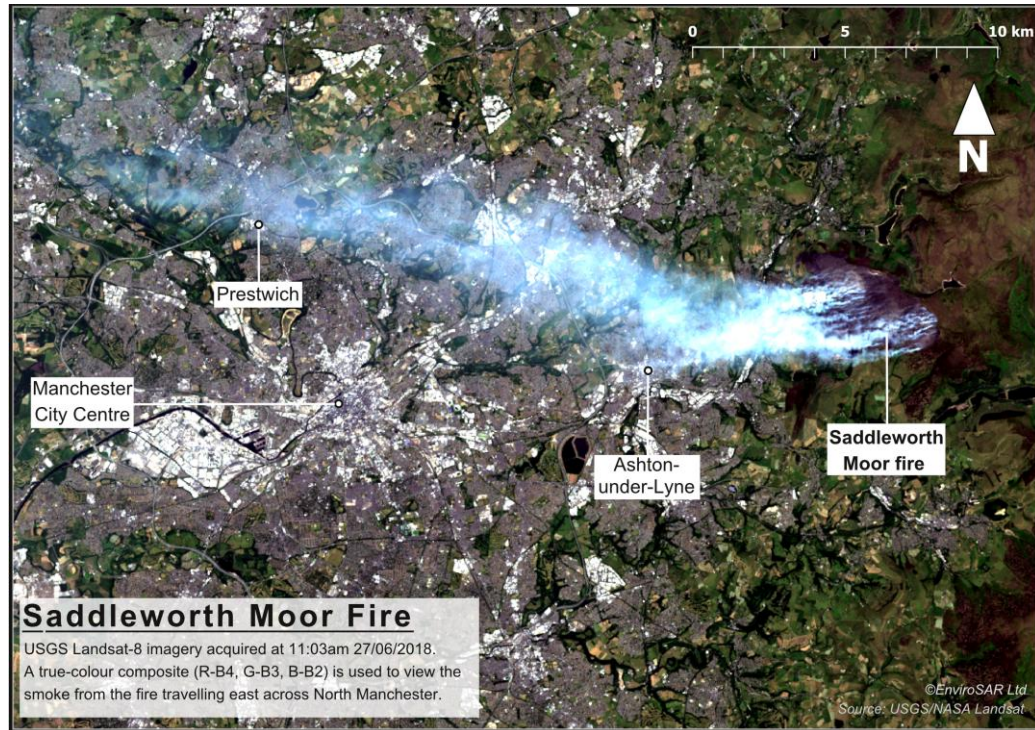
Canadian Centre for Remote Sensing (CCRS) accessed online
<https://www.nrcan.gc.ca/node/14623>



Managed burns – aerial photography

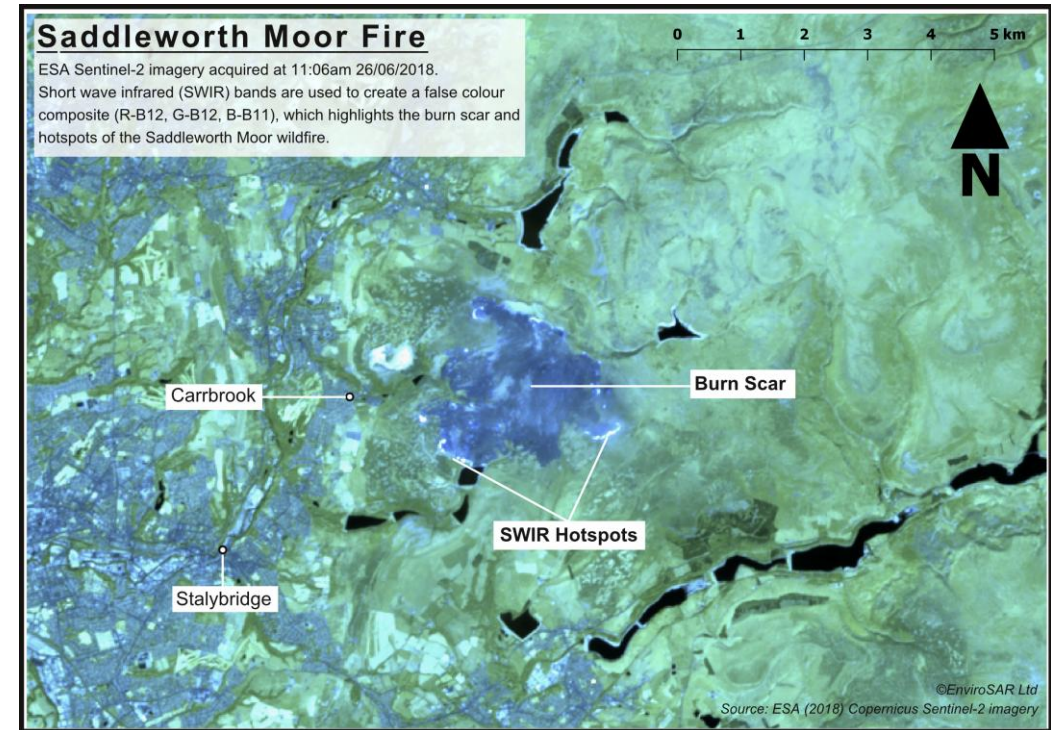


Optical and thermal sensors reveal different signals



LANDSAT 8 OLI

Smoke plume and landscape context; 30 m detail, constrained by cloud and overpass timing.



SENTINEL-2 SWIR

Burning edge, burn perimeter and change indices at 10–20 m; compare pre- and post-fire scenes.

Extract/digitise
the burn
perimeter



Marsden Moor



- The Marsden Moor Estate owned by the National Trust in West Yorkshire, is a Site of Special Scientific Interest (SSSI), a Special Area of Conservation (SAC) and Special Protection Area (JNCC, 2021).
- This blanket bog habitat is home to rare upland species such as the mountain hare and red listed Birds of Conservation Concern 4 (BoCC4) such as the lapwing, skylark and the curlew (British Trust for Ornithology, 2021).
- Since 2019, the National Trust reported a total of £700,000 worth of damage caused by wildfires on the Marsden Moor Estate with the largest wildfire damaging 705 hectares.

VEGETATION
LOSS



CO₂
RELEASE



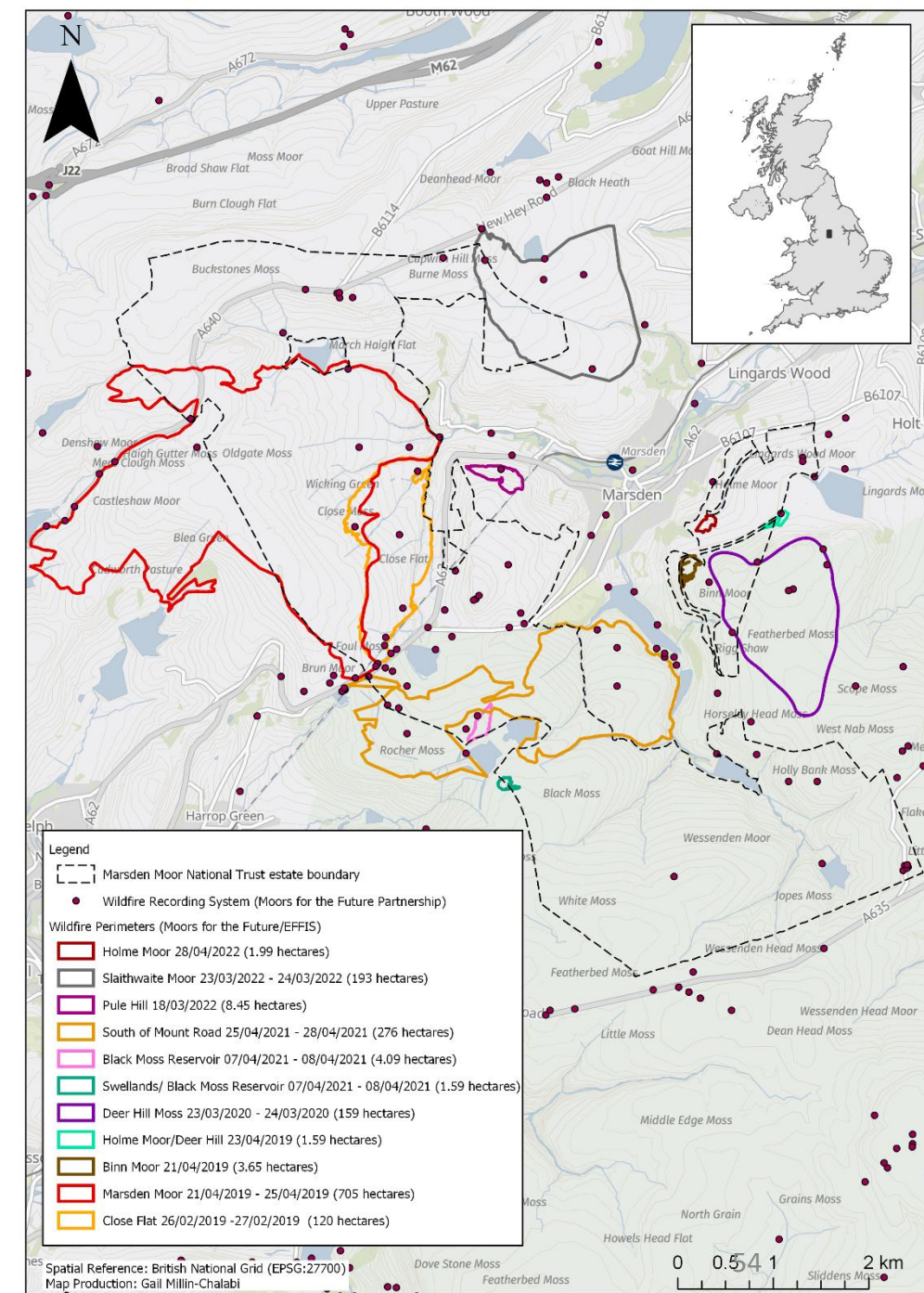
INCREASE IN
RUNOFF

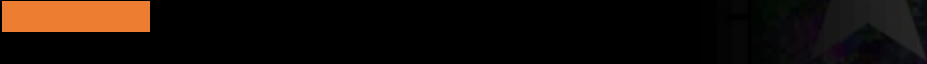


EROSION
(GULLIES)



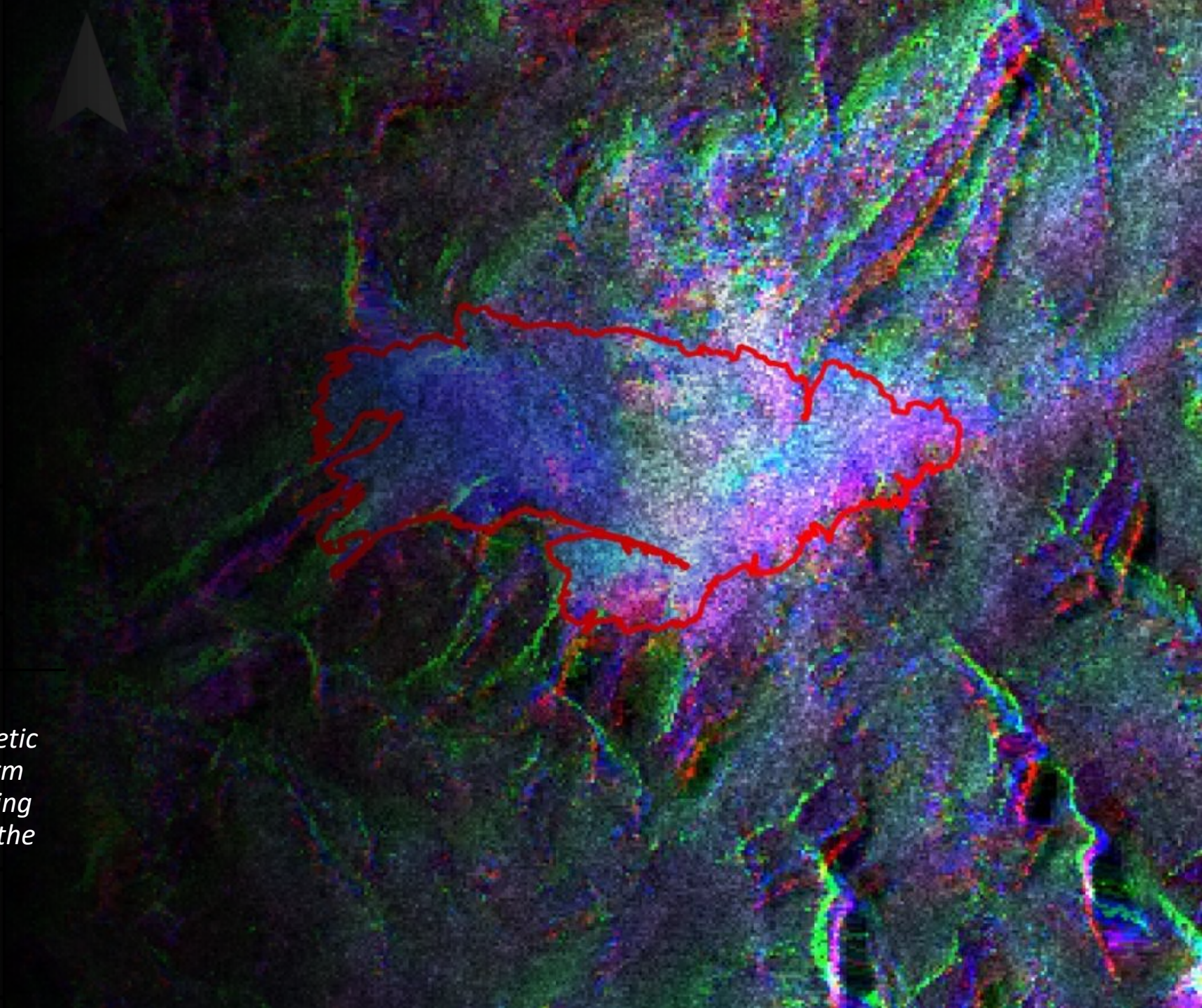
WATER
DISCOLORATION/
CONTAMINATION





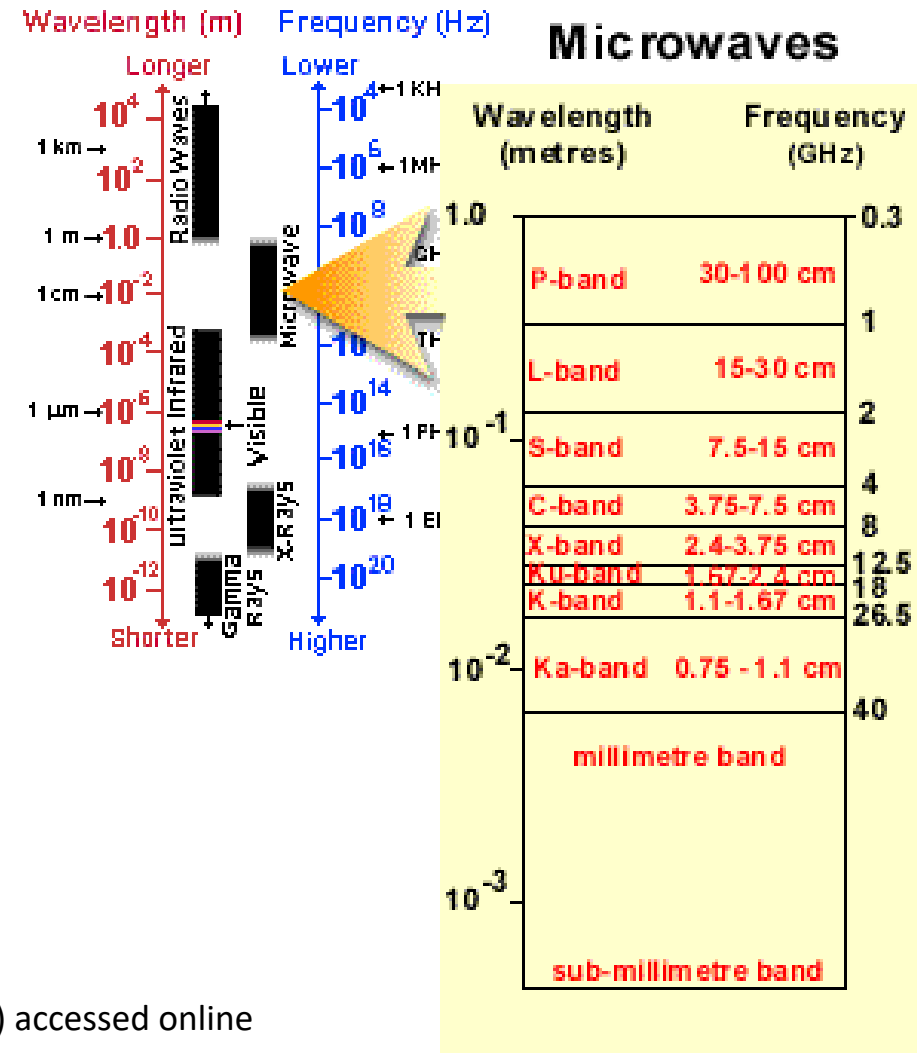
Radar Sensors

Radar remote sensing makes use of Synthetic Aperture Radar (SAR) active sensors to form an image of the Earth's surface by measuring the amount of backscatter returned from the Earth's surface.

A Synthetic Aperture Radar (SAR) image of a landscape, likely a forested area. The image is rendered in a false-color scheme where different backscatter values are represented by various colors. A prominent red line outlines a specific region of interest, possibly a field or a cleared area. The background is a complex pattern of green, blue, and purple, indicating varying levels of vegetation and surface roughness. The image has a grainy, high-contrast appearance typical of SAR data.

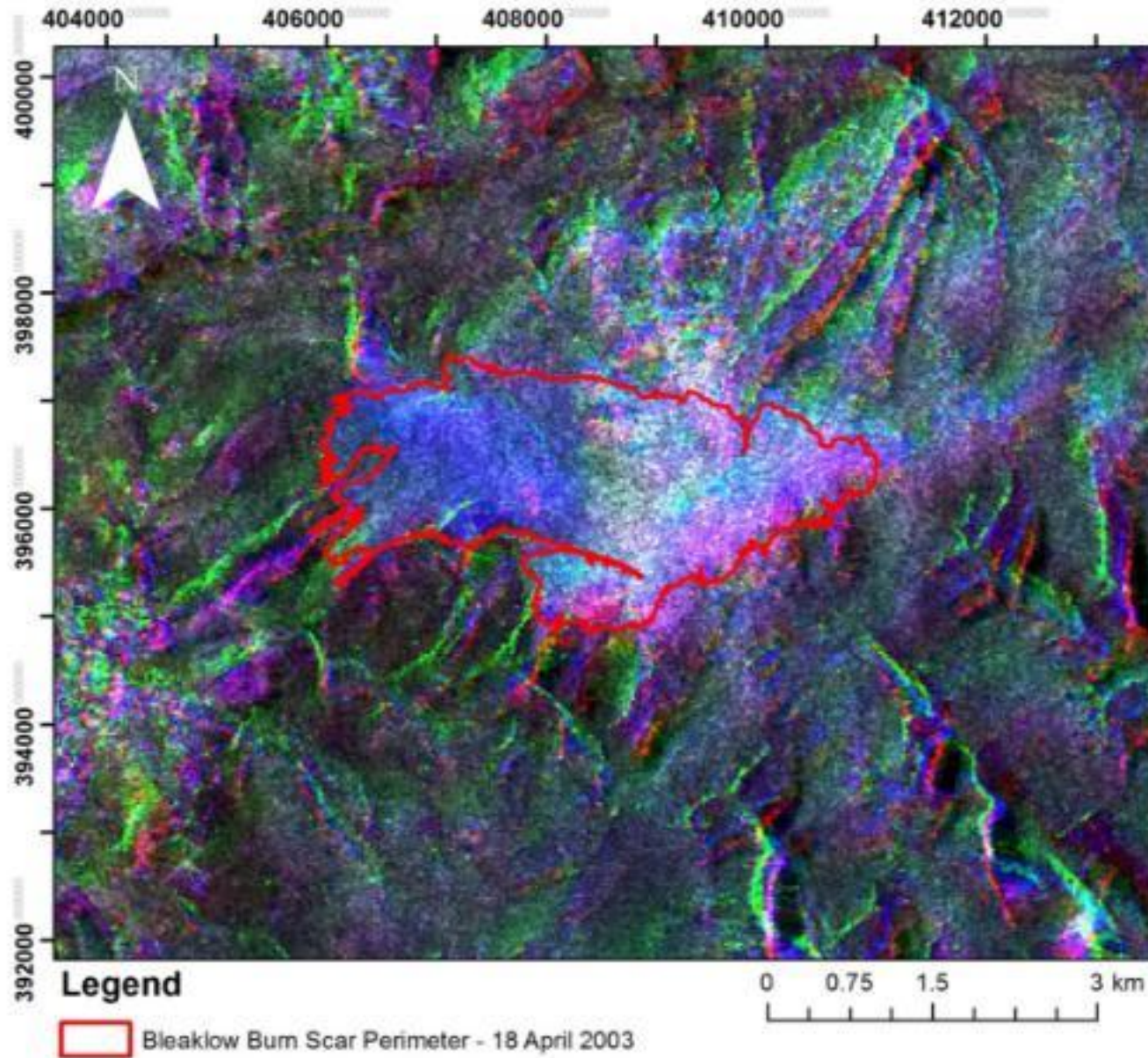
Electromagnetic Spectrum - Radar

The microwave region ranged from 1mm to 1m in wavelength.



Canadian Centre for Remote Sensing (CCRS) accessed online
<https://www.nrcan.gc.ca/node/14623>

Radar closes the cloud gap



SENTINEL-1 SAR

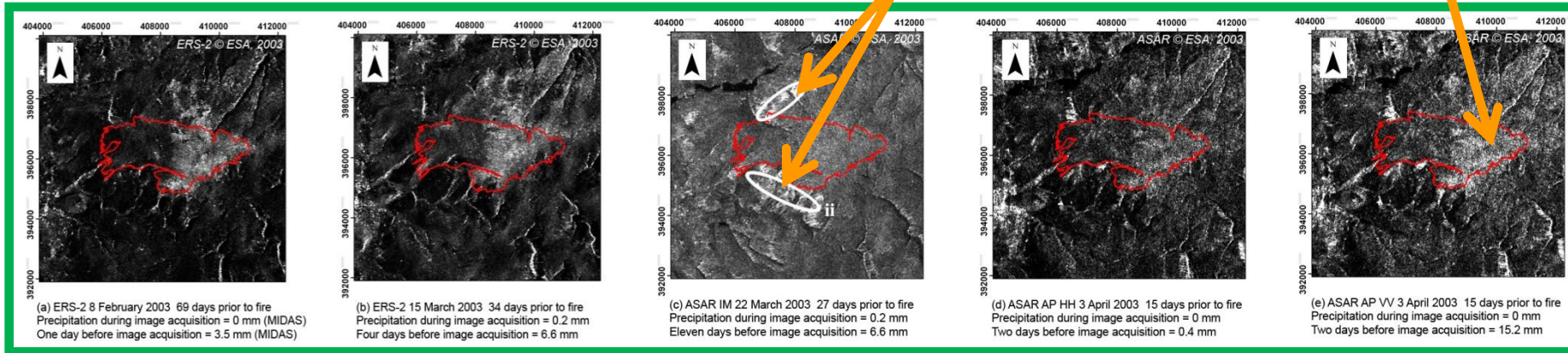
- Day/night acquisition and sensitivity to structural and moisture change
- Backscatter and coherence time series can reveal burn scars and recovery
- Useful when optical imagery is cloud-obscured

WATCH-OUTS

Rainfall, surface wetness, snow, topography can create similar signals. Validate against optical data and ground evidence.

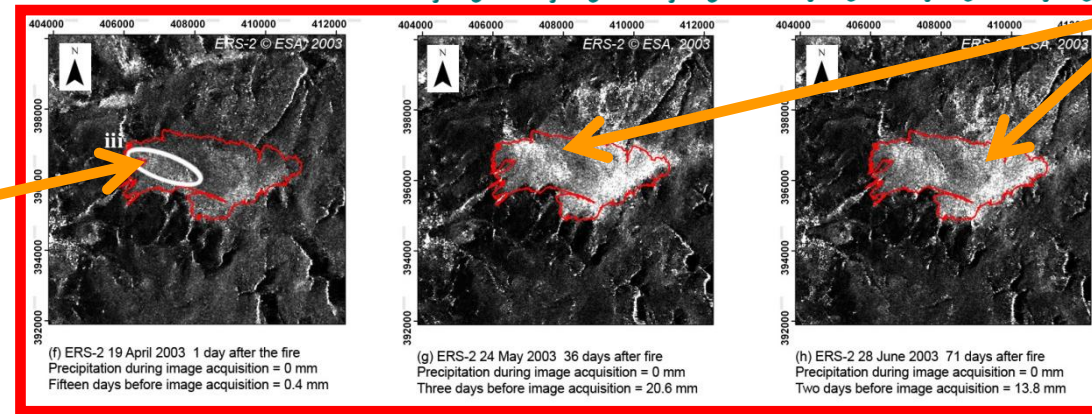
Bleaklow 2003 SAR Time Series

Pre-fire



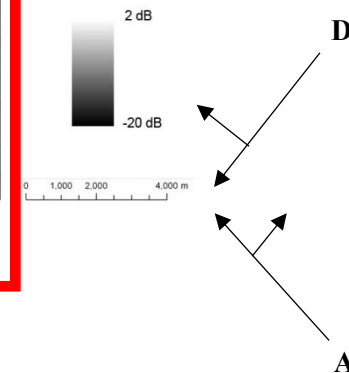
Post-fire

Vegetation removal :
increase
surface
roughness



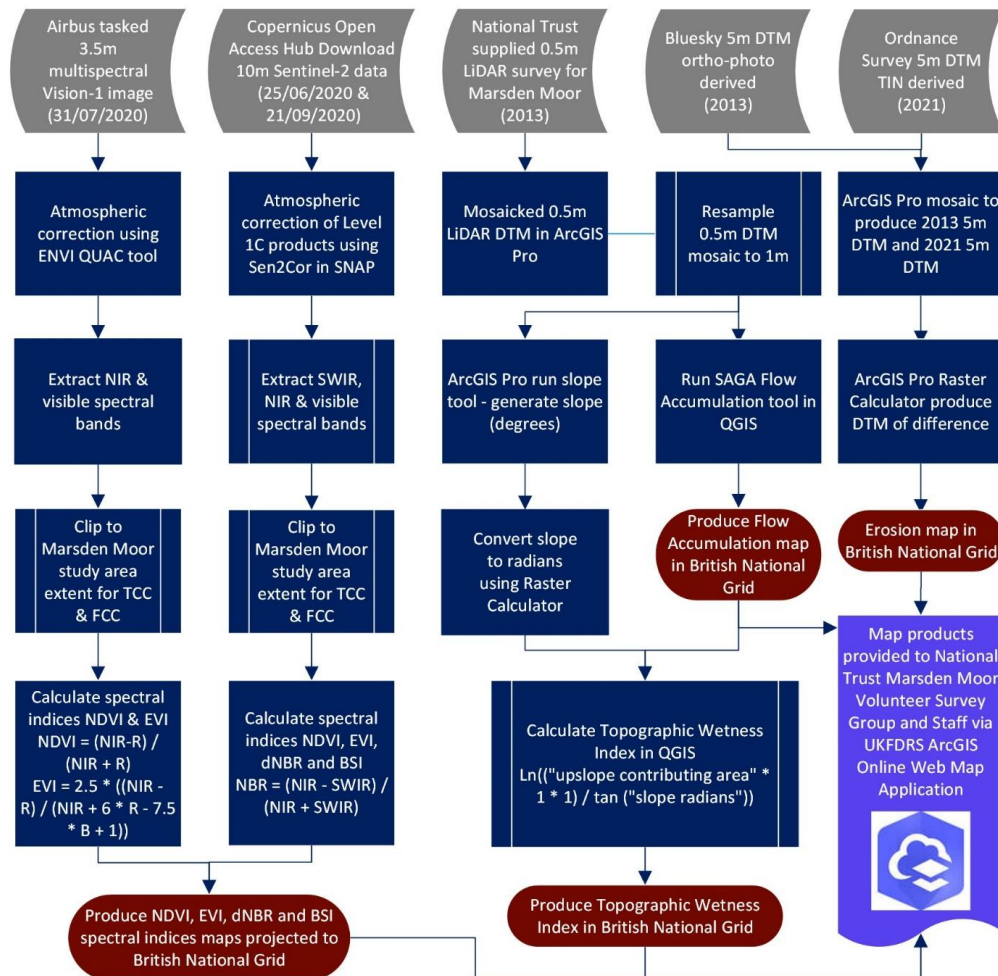
Rainfall:
increase soil
moisture

Clear burn scar signal due to exposed peat and rainfall





Landscape Ecology – Marsden Moor



Marsden Moor Land Cover Survey App

ArcGIS Survey123





International Journal of Remote Sensing, 2014
Vol. 35, No. 1, 54–69, <http://dx.doi.org/10.1080/01431161.2013.860658>



Detecting a moorland wildfire scar in the Peak District, UK, using synthetic aperture radar from ERS-2 and Envisat ASAR

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(Received 22 October 2012; accepted 16 September 2013)

Wildfires occur annually in UK moorland environments, especially in drought years. They can be severely damaging to the ecosystem when they burn deep into the peat, killing ground-nesting birds and releasing CO₂ into the atmosphere. Synthetic aperture radar (SAR) was evaluated for detecting the 18 April 2003 Bleaklow wildfire scar (7.4 km²). SAR's ability to penetrate cloud is advantageous in this inherently overcast area. SAR can provide fire scar boundary information which is otherwise labour intensive to collect in the field using a global positioning system (GPS). This article evaluates the potential of SAR intensity and InSAR coherence to detect a large peat moorland wildfire scar in the Peak District of northern England. A time-series of pre-fire and post-fire ERS-2 and advanced synthetic aperture radar (ASAR) Single Look Complex (SLC) data were pre-processed using SARscape 4.2 to produce georeferenced greyscale images. SAR intensity and InSAR coherence values were analysed against Coordinate Information on the Environment (CORINE) land-cover classes and precipitation data. SAR intensity detected burnt peat well after a precipitation event and for previous fire events within the CORINE peat bog class. For the 18 April 2003 fire event, intensity increased to 0.84 dB post-fire inside the fire scar for the peat bog class. InSAR



PHILOSOPHICAL TRANSACTIONS B

royalsocietypublishing.org/journal/rstb



Opinion piece

Cite this article: Little K *et al.* 2025 Priority research directions for wildfire science: views from a historically fire-prone and an emerging fire-prone country. *Phil. Trans. R. Soc. B* **380**: 20240001.

<https://doi.org/10.1098/rstb.2024.0001>

Received: 16 February 2024

Accepted: 27 August 2024

One contribution of 17 to a theme issue 'Novel fire regimes under climate changes and human influences: impacts, ecosystem responses and feedbacks'.

Subject Areas:
environmental science

Keywords:
wildfire, fire behaviour, research gaps, fire

Priority research directions for wildfire science: views from a historically fire-prone and an emerging fire-prone country

Kerryn Little¹, Rayanne Vitali^{2,3}, Claire M. Belcher², Nicholas Kettridge¹, Adam F.A. Pelligrini⁴, Adriana E.S. Ford⁵, Alistair M.S. Smith⁶, Andy Elliott⁴, Apostolos Voulgarakis^{5,7}, Cathelijne R. Stoop⁸, Crystal A. Kolden⁹, Dylan W. Schwilk¹⁰, Eric B. Kennedy¹¹, Fiona E. Newman Thacker¹², Gail R. Millin-Chalabi¹³, Gareth D. Clay¹³, James I. Morison¹⁴, Jessica L. McCarty¹⁵, Katy Ivison¹⁶, Kevin Tansey¹⁶, Kimberley J. Simpson^{17,18}, Matthew W. Jones¹⁹, Michelle C. Mack²⁰, Peter Z. Fülé²¹, Rob Gazzard^{22,23}, Sandy P. Harrison²⁴, Stacey New²⁵, Susan E. Page¹⁶, Tilly E. Hall²⁶, Tim Brown²⁷, W. Matt Jolly²⁸ and Stefan Doerr²⁹

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¹⁹School of Environmental Sciences, University of East Anglia, Norwich, UK

²⁰Center for Ecosystem Science and Society, Department of Biological Sciences, and ²¹School of Forestry, Northern Arizona University, Flagstaff, AZ, USA



Dynamic Fuels in the South Pennines Storymap



An optical satellite-based analysis of phenology and post-fire vegetation recovery in UK upland moorlands

Pia Labenski^{a,b,d,*}, Gail Millin-Chalabi^b, Ana María Pacheco-Pascagaza^{b,c}, Johannes Antenor Senn^a, Fabian Ewald Fassnacht^c, Gareth D. Clay^b

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^bDepartment of Geography, University of Manchester, Oxford Road, Manchester, M13 9PL, United Kingdom

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ARTICLE INFO

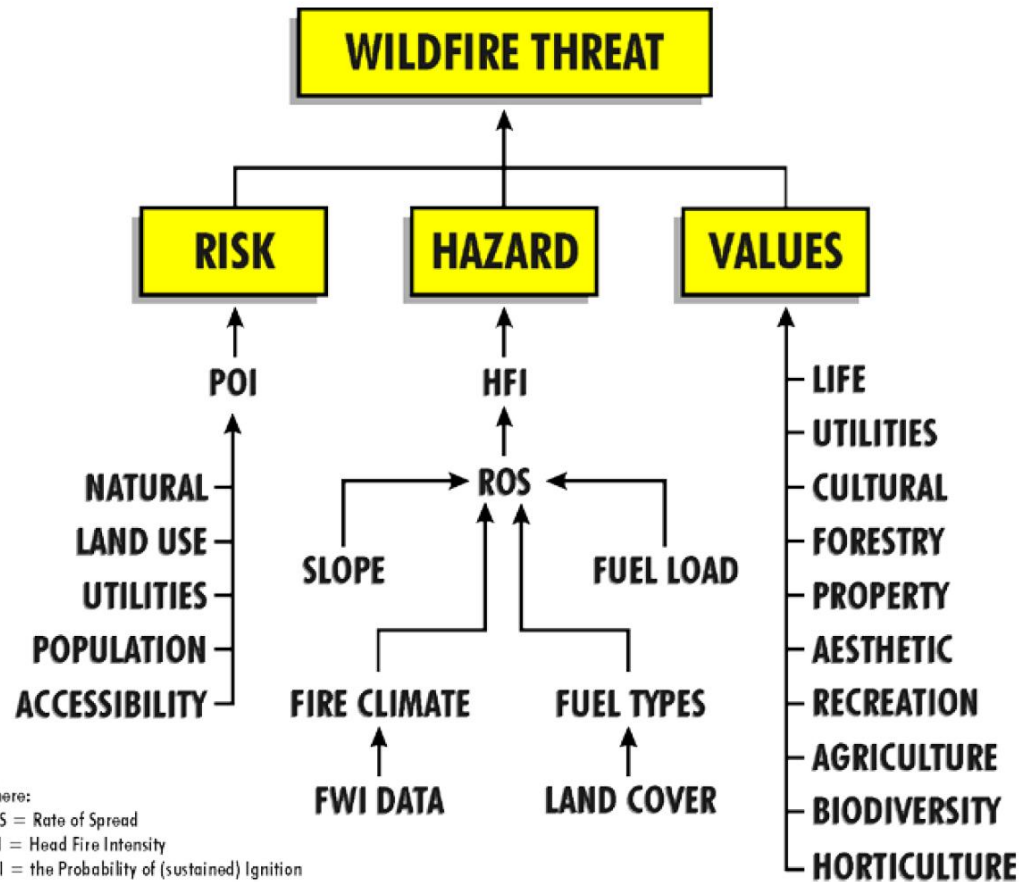
Keywords:
Fuel dynamics
Sentinel-2
Wildfires
Calluna vulgaris
Flammability
Harmonic modelling

ABSTRACT

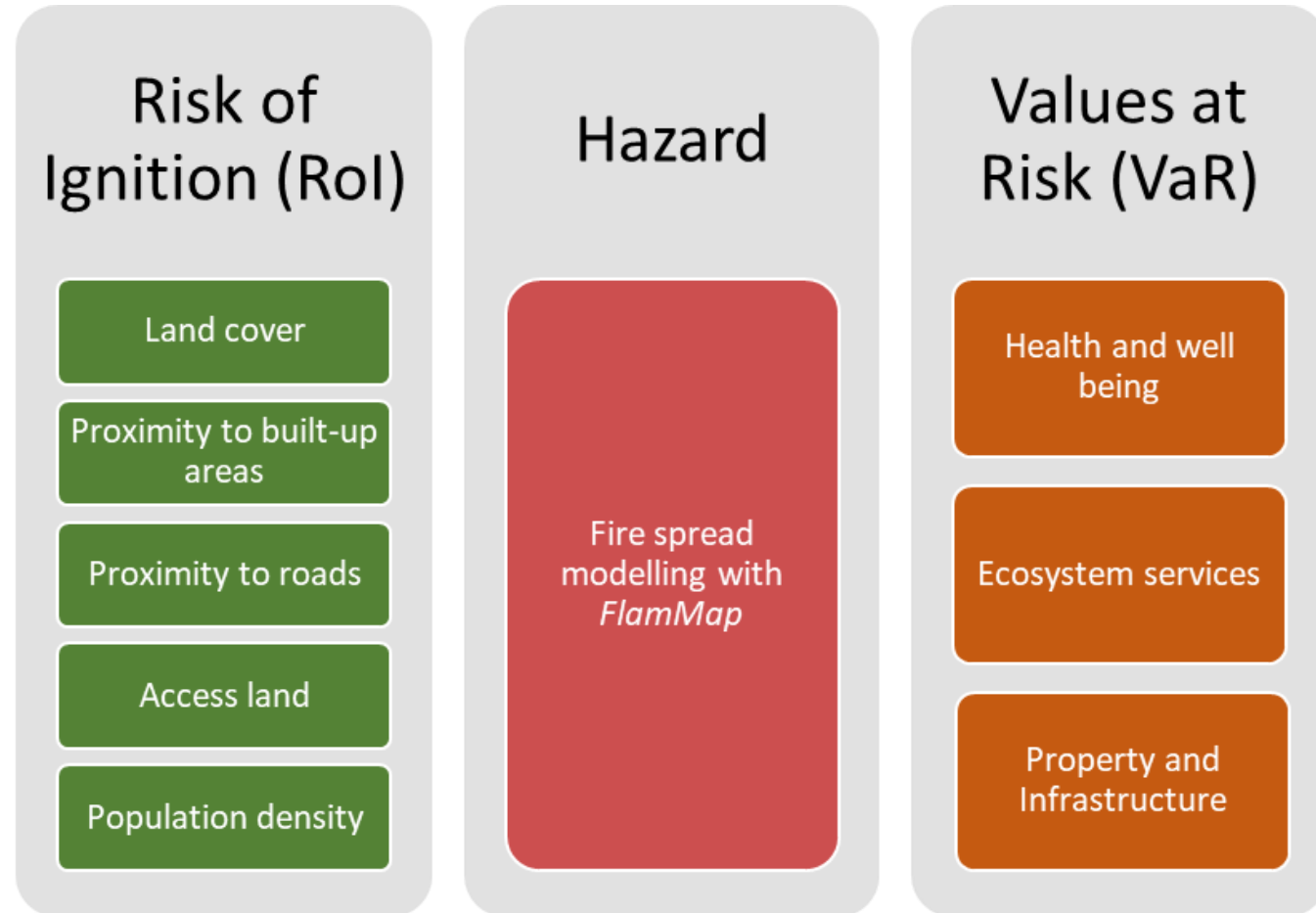
Vegetation fuel dynamics in the UK's upland moorlands are important in determining landscape susceptibility to wildfire. Changes in fuel availability are influenced by phenology, land management activities or disturbances such as wildfires. Monitoring such changes is therefore essential to assess wildfire risks and impacts. This study used vegetation indices (VIs) derived from Sentinel-2 time series (2017–2022) and harmonic modelling to capture the phenology of key fuel properties and monitor post-fire vegetation recovery in four upland land cover types (acid grassland, heather, heather grassland, bog). We identified periods of high flammability, assessed the impact of wildfires on the spectral signal, and determined the time for spectral recovery as well as potential drivers of recovery times. Results showed the period of highest flammability from mid-February to early May in acid grassland, extending to early June in heather and heather grassland, and late June in bog. Summer fires caused more pronounced changes in fuel properties than spring fires, particularly in moisture-related VIs. Graminoid-dominated areas recovered rapidly (under a year), matching field observations, while dwarf shrub-dominated areas required up to three years, consistent with measurements of vegetation cover on burned areas but not with height. Spectral recovery times were primarily explained by land cover class, burn severity, season, and winter snow cover (R² = 0.66). Field data highlighted pre-fire stand age's role in heather recovery and grasses' impact on spectral signals. This study improves understanding of fuel dynamics in upland moorlands through satellite monitoring, providing critical insights for more effective wildfire risk assessments and management strategies.



GIS: Wildfire Threat Analysis



NZ wildfire threat analysis framework
(Moffat and Pearce, 2013)

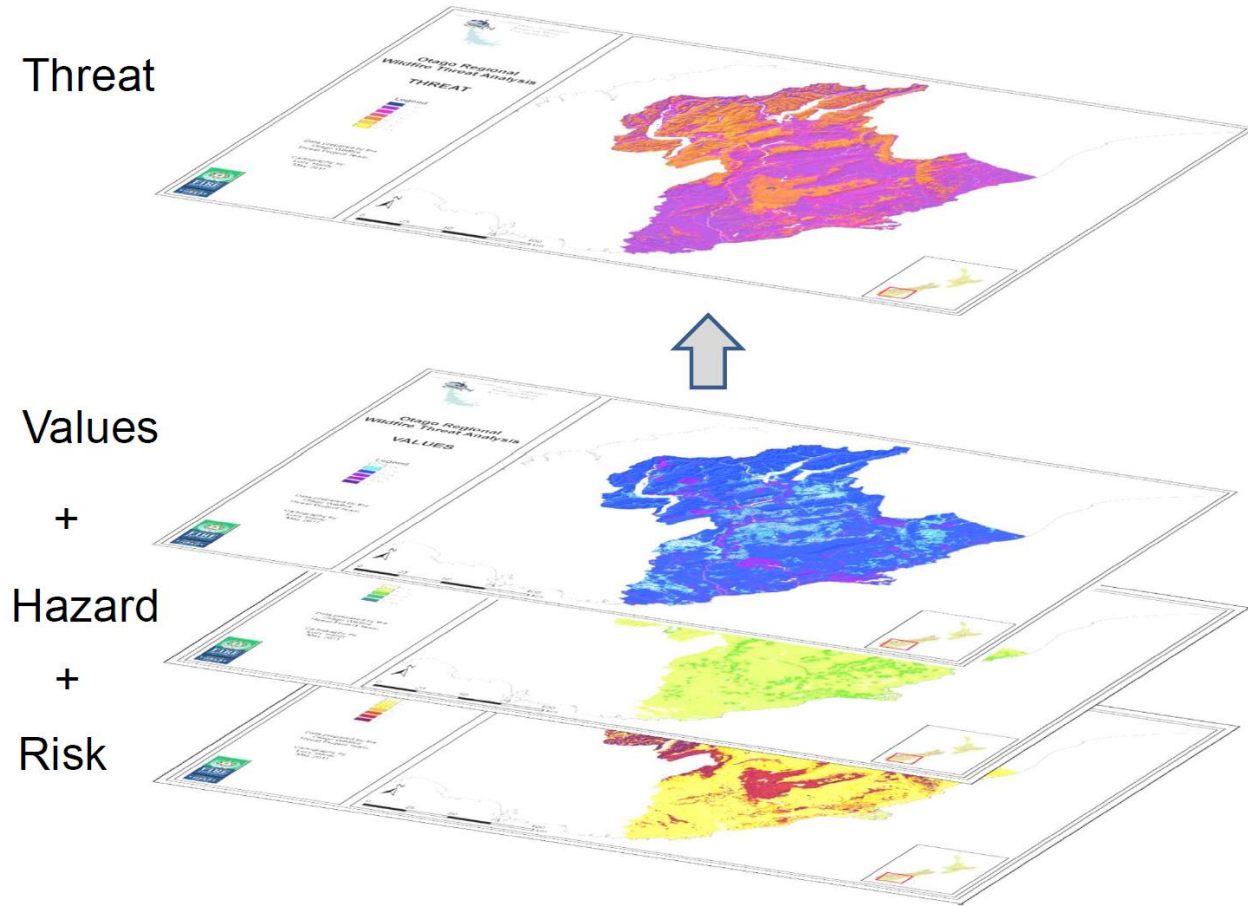


Modified structure for UKFDRS project

GIS analysis and integration

Multi-Criteria Evaluation (MCE) - combining GIS data layers, guided by expert knowledge and empirical data analysis

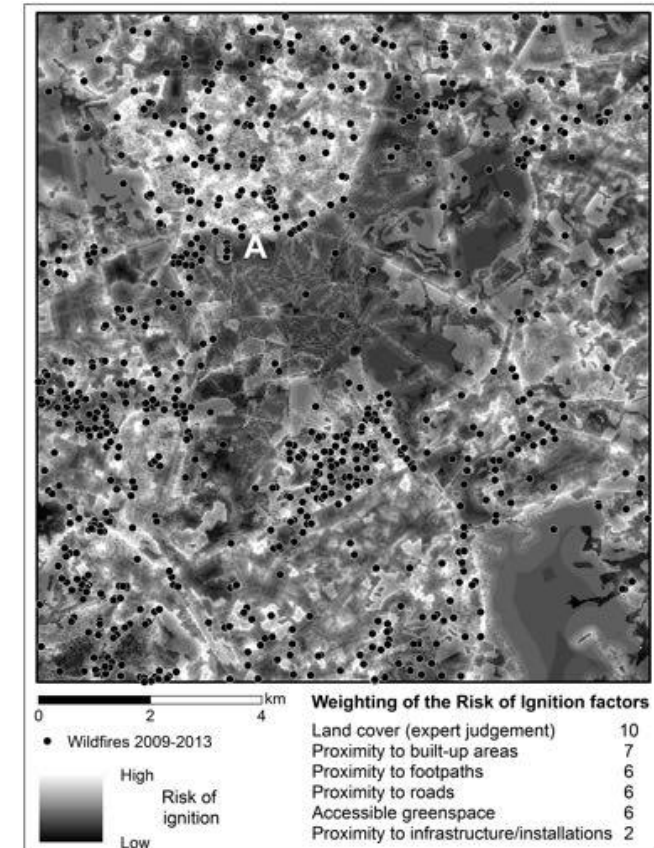
Expert judgement on scoring and weighting of layers within and between components and modules



Otago Regional Wildfire Threat Analysis

Previous WTA – Swinley Forest

- May 2011 major event
- McMorrow et al. (2021) took the WTA approach to explore the Risk of Ignition and Values at Risk components



New UKFDRS Case Studies

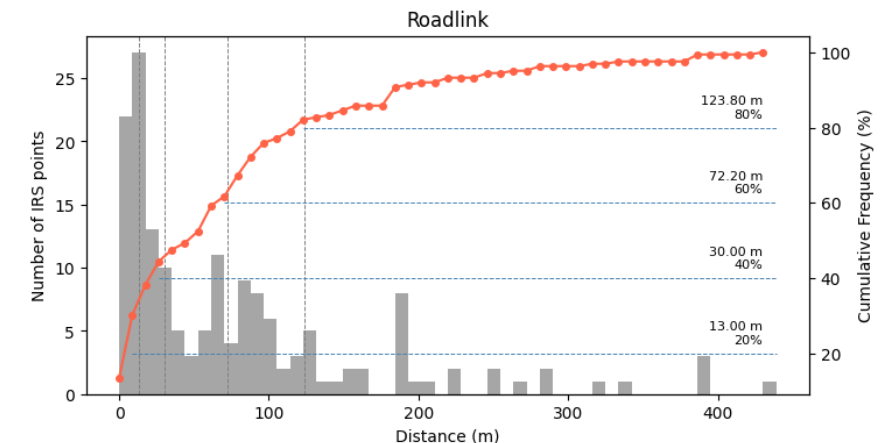
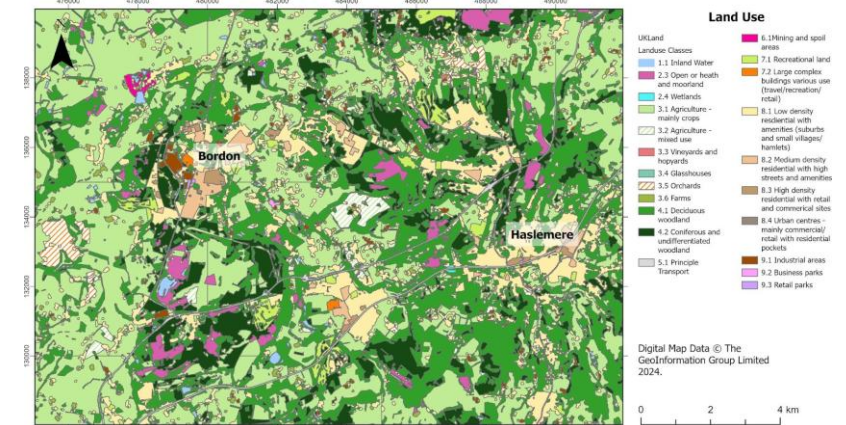
- **South Downs**

- Wealden Heath Special Protection Area, ~1900 ha of lowland heathland near urban areas with a history of wildfires

- **Mourne Mountains**

- Larger area covering most of the Mourne Mountains ASSI

Using existing land cover and infrastructure datasets, we can explore relationships between features and IRS data



Workshops

- Workshops in November 2023 (South Downs) and December 2024 (Mourne Mountains)
- Dozens of attendees from a range of organisations with wildfire interests (e.g., conservation groups, MoD, statutory agencies, local authority)
- Series of structured individual and group exercises to encourage discussion and consensus (where possible!) to get expert input into relative importance of a host of features for Risk of Ignition and Values at Risk
- Feeds into scoring and weighting of layers in GIS



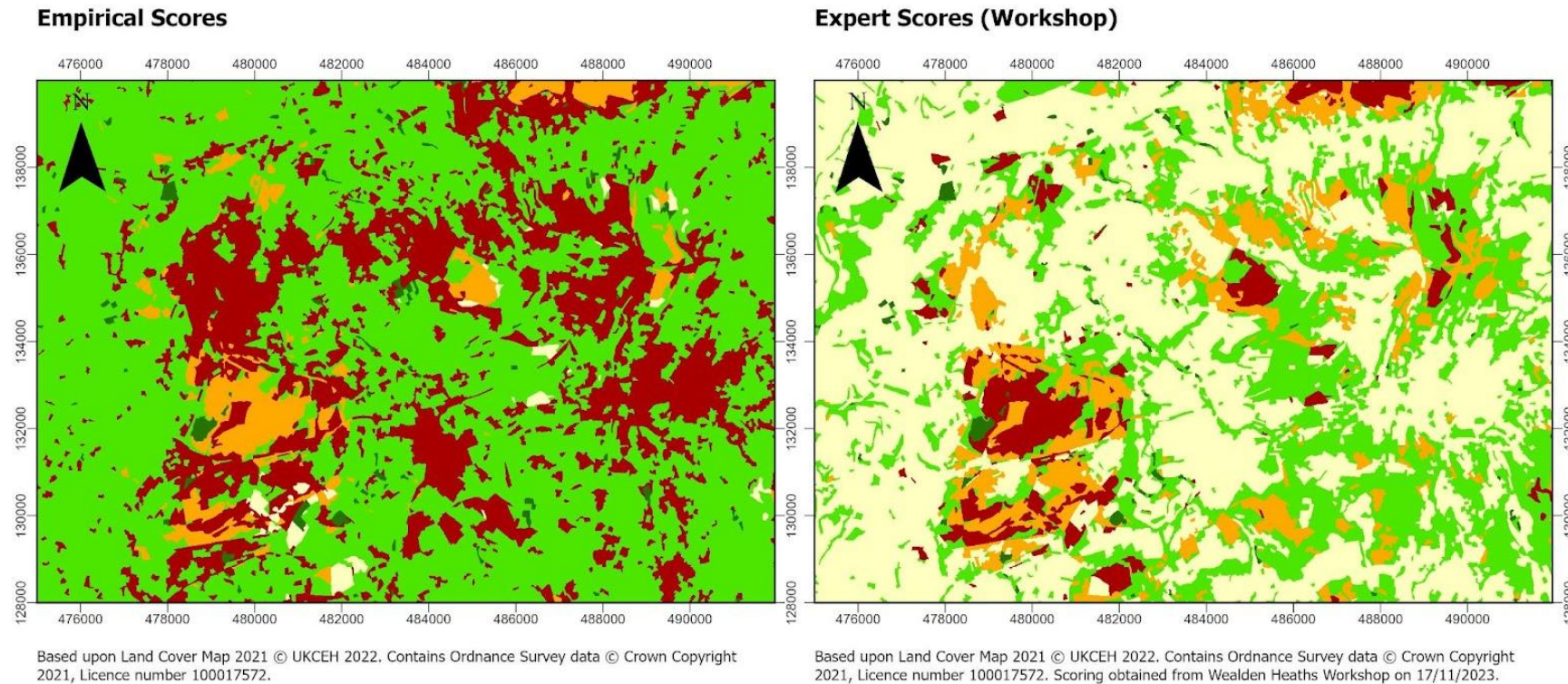
Risk of Ignition – assessment

Empirical: based on the distribution of IRS points among different land cover types – expected vs observed

- Expected number of fires: number of fires proportional to the land cover type's share in the case study area. e.g. If a land cover class occupies 10% of the study area, expect 10% of fires
- Observed number of fires: number of fires actually recorded on that land cover type
- Risk of ignition score = $(\text{observed} - \text{expected}) / \text{expected}$.

Expert judgement: based on the knowledge of the area and fire occurrence in different land cover types

Risk of ignition – empirical vs expert scoring



Risk of Ignition

Scores

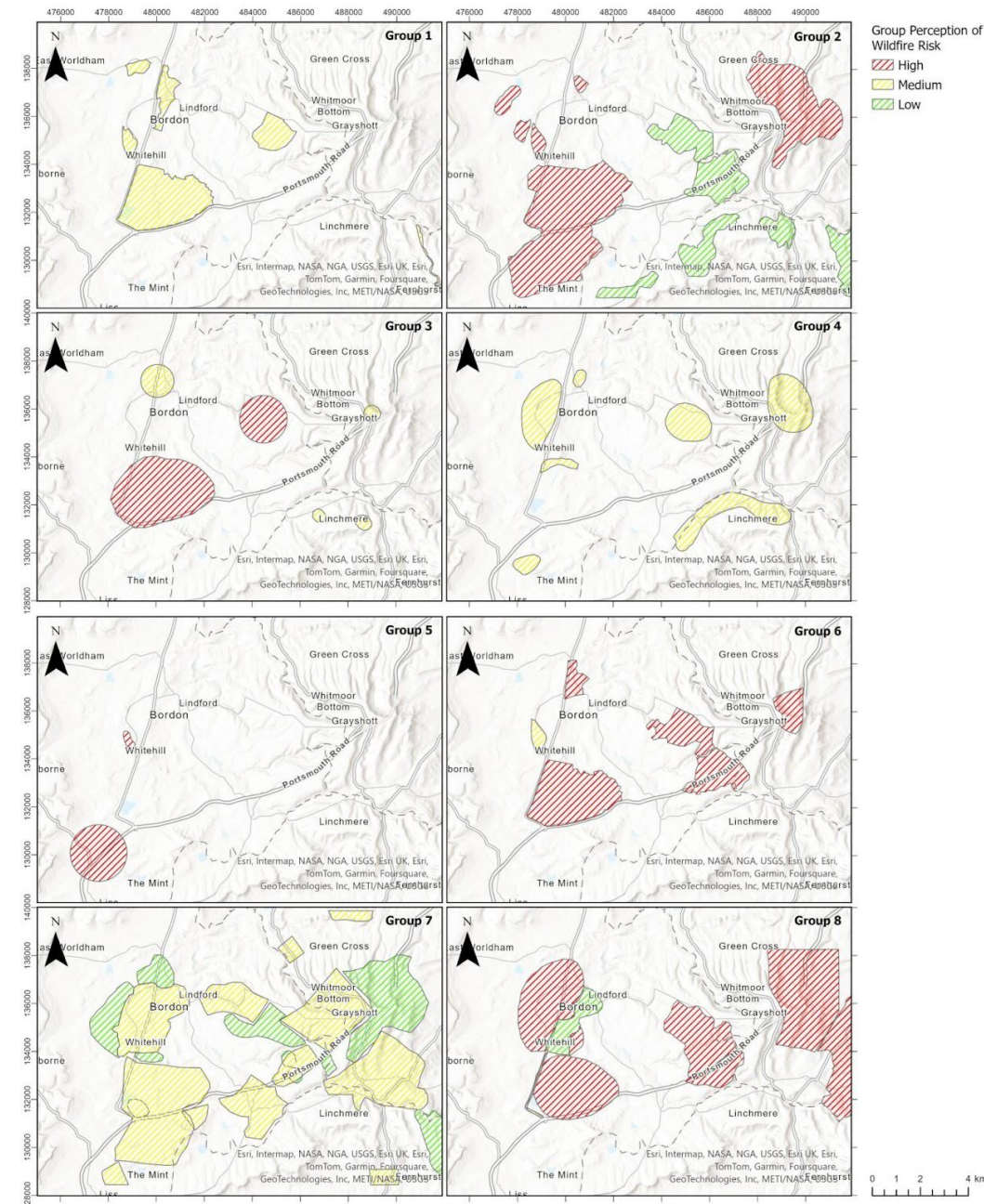
- 1 - Very Low
- 2 - Low
- 3 - Moderate
- 4 - High
- 5 - Very High



Population pressures

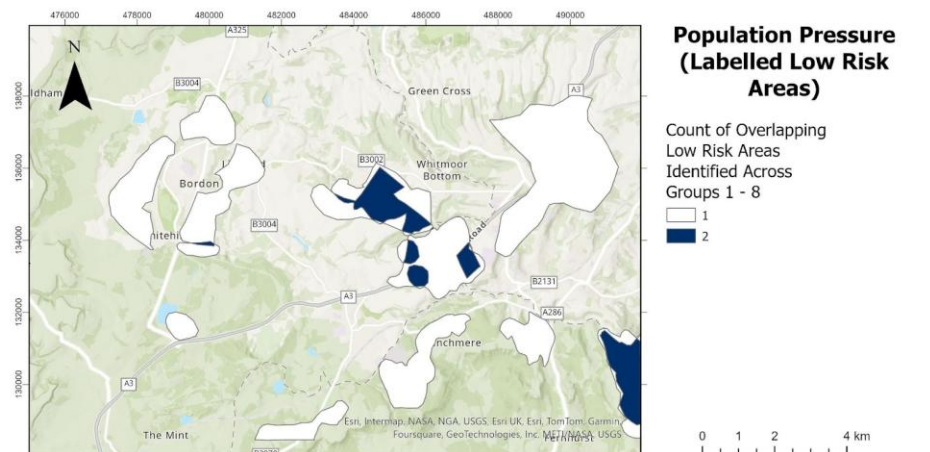
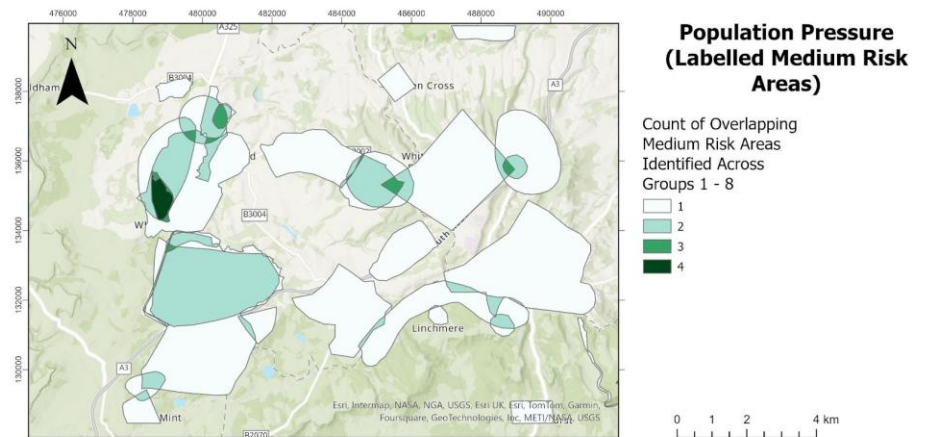
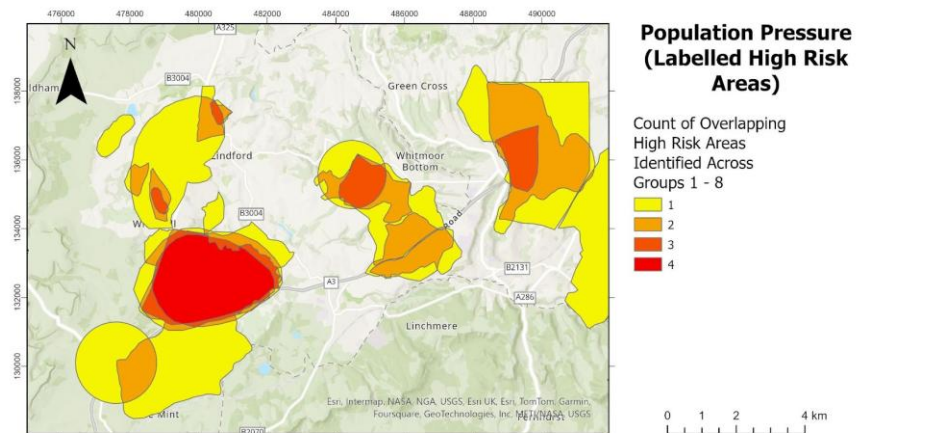
- Previous work has considered using population characteristics (e.g., measures of socio-economic deprivation, crime levels). However, this is problematic and fraught with assumptions.
- We used participatory mapping to identify areas of high and low concern when it comes to Risk of Ignition.
- Maps were georeferenced and digitised.
- Areas of high, medium and low concern were identified, and a combined strength of that concern could be noted (i.e., across multiple workshop groups).

Population Pressures: Highlighted Areas of the Wealden Heaths Where Groups Consider Wildfires to be a Problem



Population pressures

- This doesn't directly feed into the WTA approach but does provide local context for some of the stakeholder decision making elsewhere.
- Plans to roll this out for other areas and potentially use as a separate dataset and to highlight its role as a distinct methodology



WTA Compilation

- These case studies allow us to start comparing between cases to see if there are any common patterns or major differences
 - If consistent, potential to use scores/weights at larger scales

Risk of Ignition Component	Case study		
	Swinley (Kazmierczak et al. 2014)	South Downs	Mourne Mountains
Land cover	5	1	2
Proximity to built up areas	3.5	4	1
Proximity to foot access routes	3	3	3
Proximity to car access routes	3	3	4
Accesible land	3	3	2
Population density	3	5	1
Infrastructure and installations	1	1	1

Confirm occurrence by combining alerts, incidents and context

SATELLITE OBSERVATIONS

Hotspots, smoke, burn scars and change through time.

Strength: repeatable spatial coverage.

Limit: a detection pixel is not an exact ignition point or perimeter.

INCIDENT RECORDS

IRS and devolved fire-service data describe attendance, timing and event attributes.

Strength: operational confirmation.

Limit: locations and estimates can vary in quality.

GEOSPATIAL CONTEXT

Land cover, weather, terrain, access, protected sites, peat and infrastructure explain what burned and what may be affected.

Strength: decision relevance.

Limit: layers update at different rates and scales.

A practical UK operating model closes the evidence loop



01

BASELINE

Map fuels, land cover, peat, access and values at risk.
Establish versioned open-data layers.

02

→ WATCH

Monitor weather and fuel condition; track FIRMS/EFFIS alerts and local reports.

03

→ EVENT

Verify occurrence; capture provenance; map perimeter and exposure; communicate confidence.

04

→ RECOVERY

Assess severity, carbon/habitat effects and erosion; monitor recovery; feed lessons into prevention.

GOVERNANCE Named data owners • update cadence • reproducible processing • field validation • open outputs where licensing permits

Summary

- Scale at which this approach is useful needs to be considered
- Highlight the benefits from engaging with stakeholders as part of the process
- We still need to pull all the various components together for publication so keep an eye out over the coming year.
- Ongoing UKFDRS work and new work in Northern Ireland will move forwards the Hazard component of this work.

Any Questions?

One satellite is not a wildfire record. Fuse observations, incidents, context and local knowledge.

Explore: www.ukfdrs.com | www.fireinsite.org | EFFIS | NASA FIRMS

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