Saddleworth Wildfire:

The impact of wildfire on contaminated moorland catchment water quality

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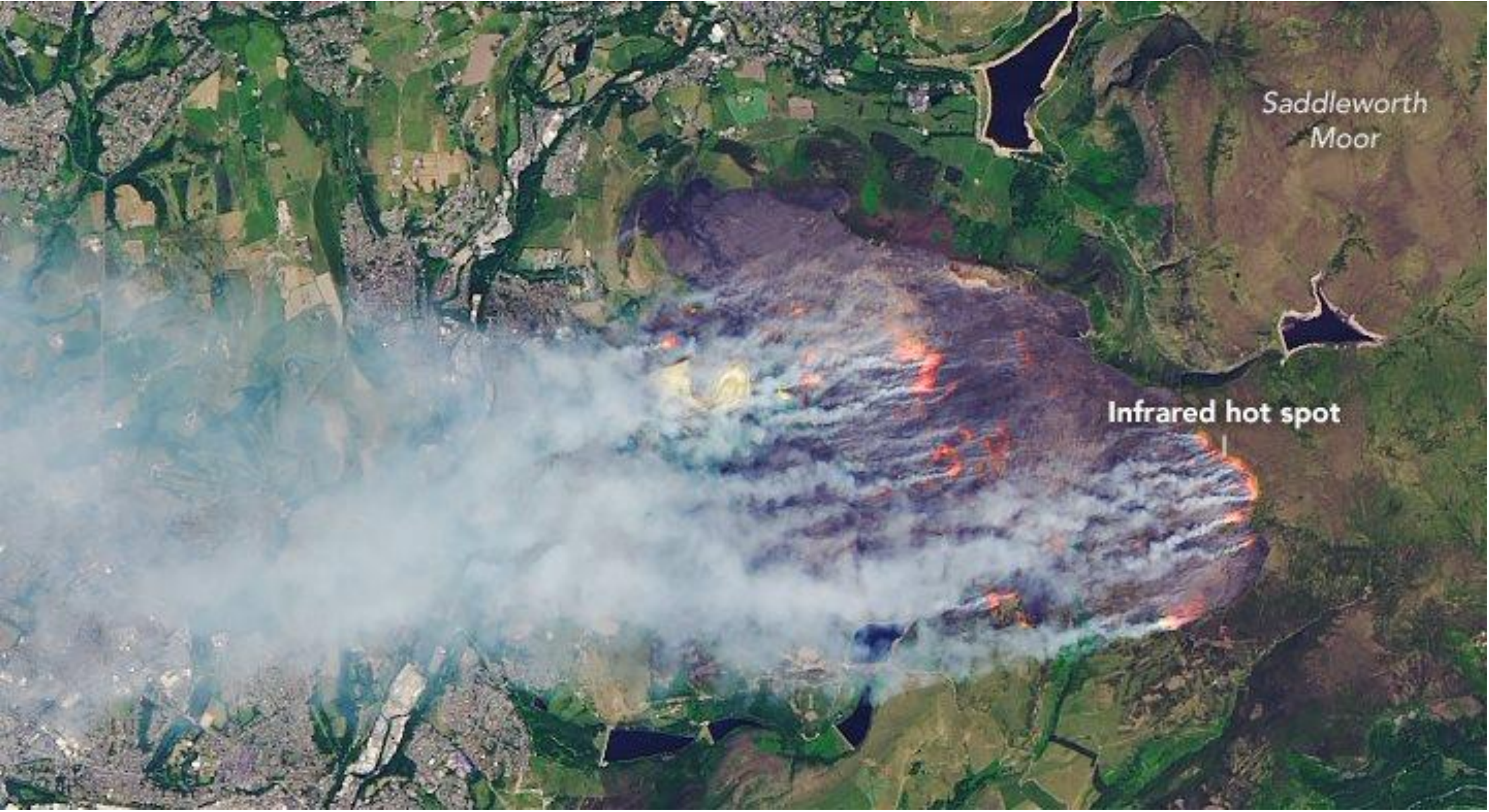

- Ignited June 2018, major national incident
- ~1000 hectares wildfire in rural urban interface
- Only 5 English wildfires of similar size since 2009 (Forestry Commission, 2019)
- Army activated to support fire suppression

A story of collaboration

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Thursday, June 28, 2018 75P
Come on England... but don't mention the VAR!
Harry & the lads are ready for Belgium... as Germany go out
TEAMWORK England squad at training and, above, shocked German fans
SEE PAGES 8&9 AND WORLD CUP PULLOUT
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VOUCHER: PAGE 22
MOOR BLAZE HELL
FIRE FIGHT
Army called in as crews struggle to halt inferno
DANGER The fire and, right, resident is given face mask
BY PAUL BYRNE
MORE than 100 firefighters have been battling to control blazes at Saddleworth Moor.
As the Army was called in to help tackle the wildfires, a local said: "It's like the apocalypse."
FULL STORY: PAGES 6&7
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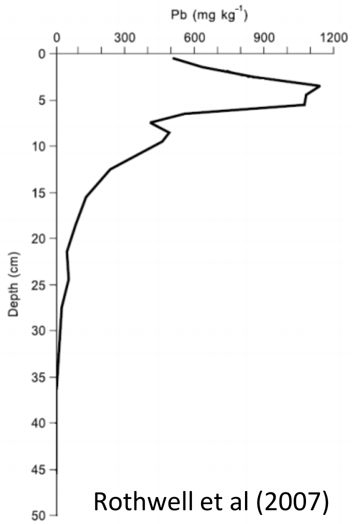
PADDYPOWER
ENOUGH OF THE NONSENSE
THE HAPPY NEWS

Media focus on many important impacts of the wildfire:

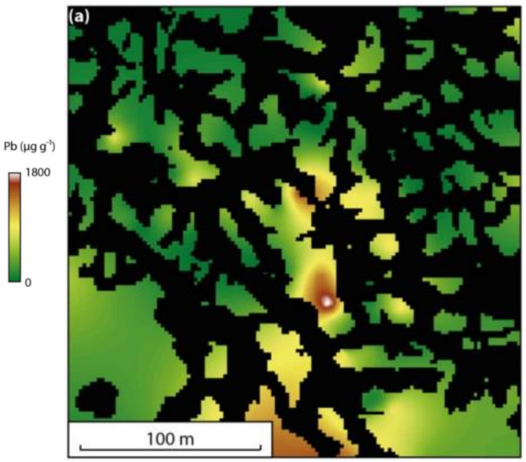
- Air quality
- Evacuations
- Threat to property
- Strain on emergency services
- Carbon emissions

Water Quality Impacts

- Water supply hotpots
  (Xu et al., 2018)
- Heartland of the British Industrial Revolution
- Atmospheric deposition of metals

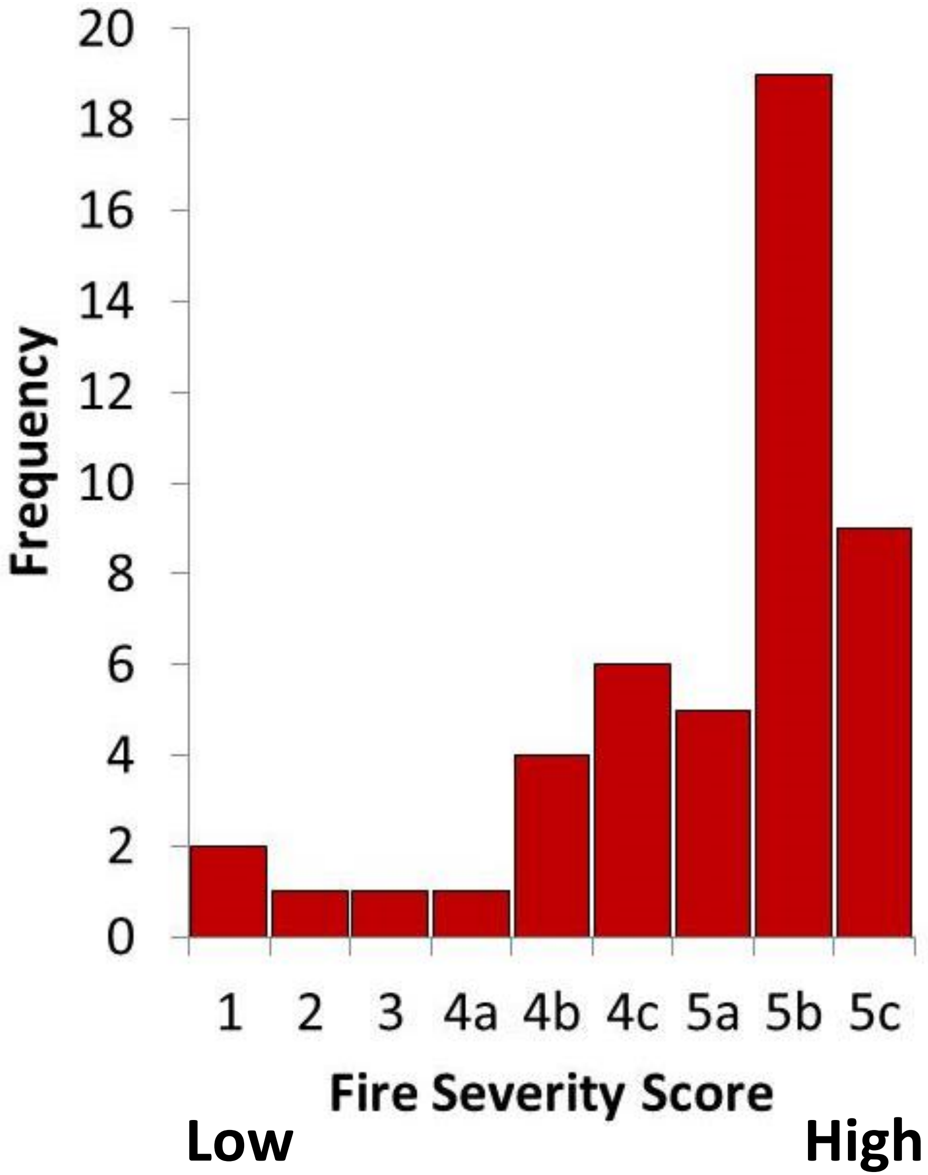


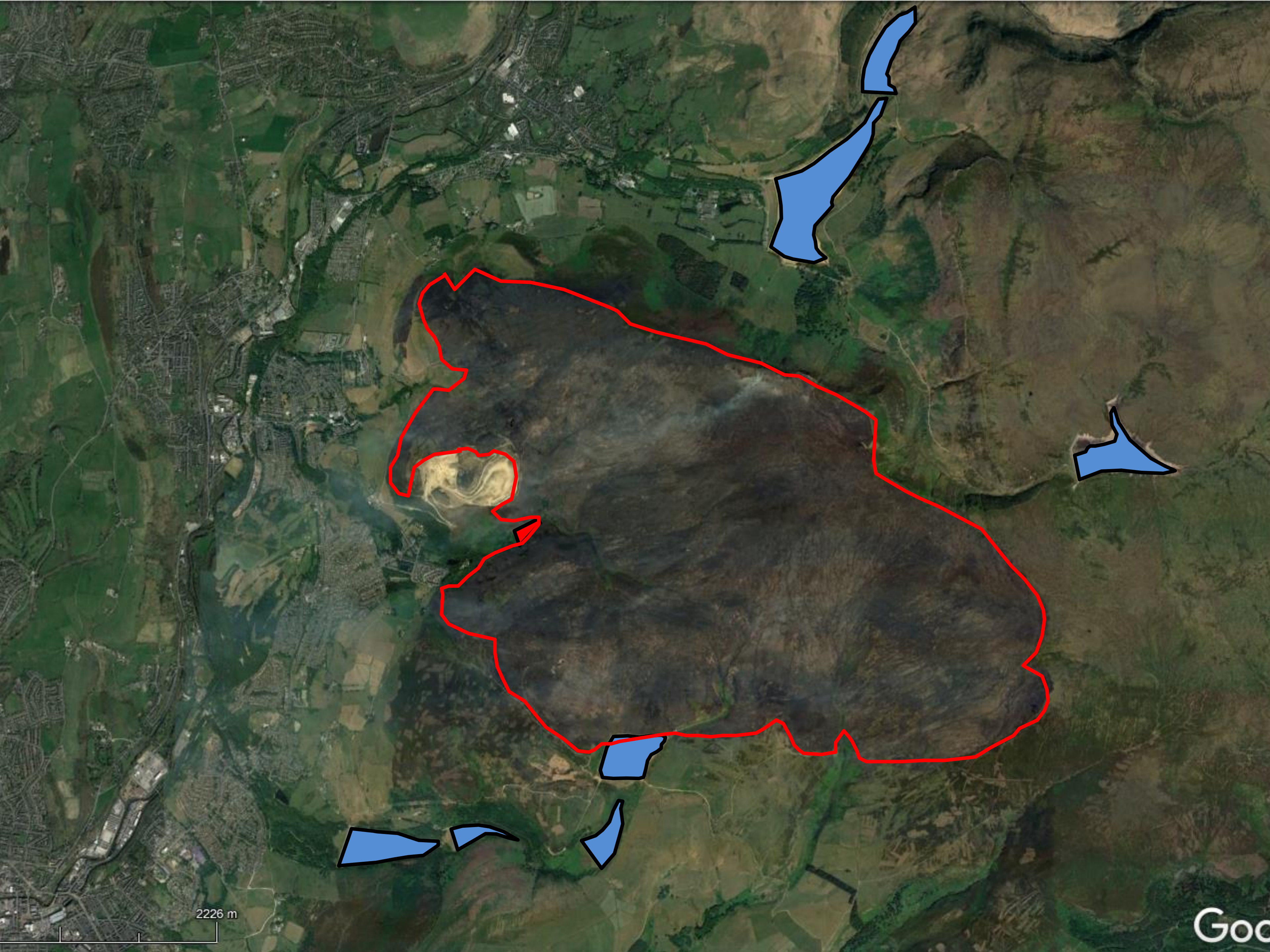
Rothwell et al (2007)



Shuttleworth (2014)

Fire Severity Scores

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Research Question

How do severe and spatially extensive wildfires within contaminated moorlands impact down-stream water quality through recurrent post-fire rainfall events?

Importance

- Predicted increase in summer wildfires (Albertson et al., 2010)
- No national capability to rapidly mitigate impacts of wildfire to the UK water resource network **at source**
- Highlight the magnitude of the threat and necessity of future mitigation strategies.

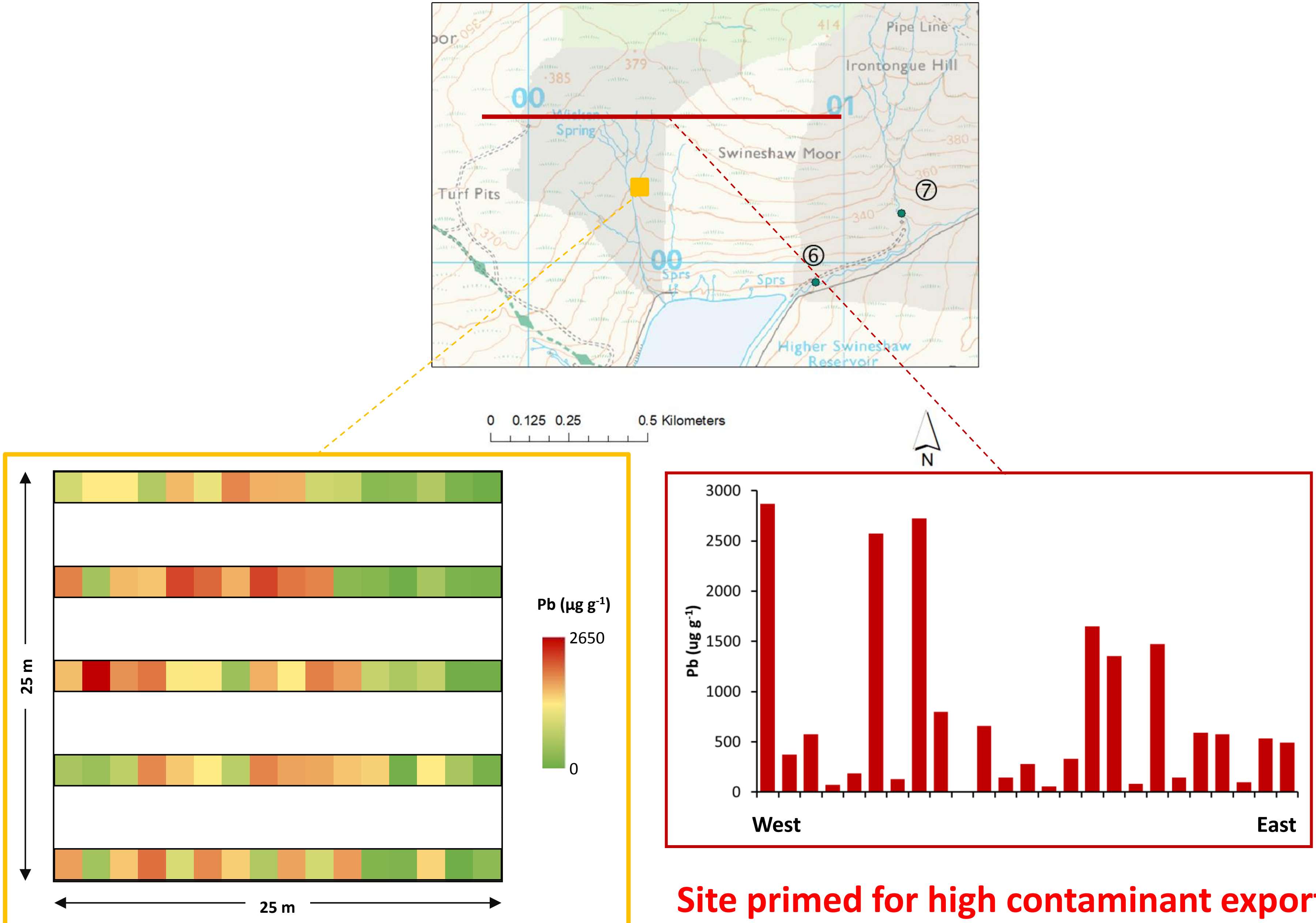


- Heavy metal concentration measured across burned peatland
- Removal of heavy metals from soil by water (ash leaching)
- Semi continuous measurement water quality.

Storm Sampling

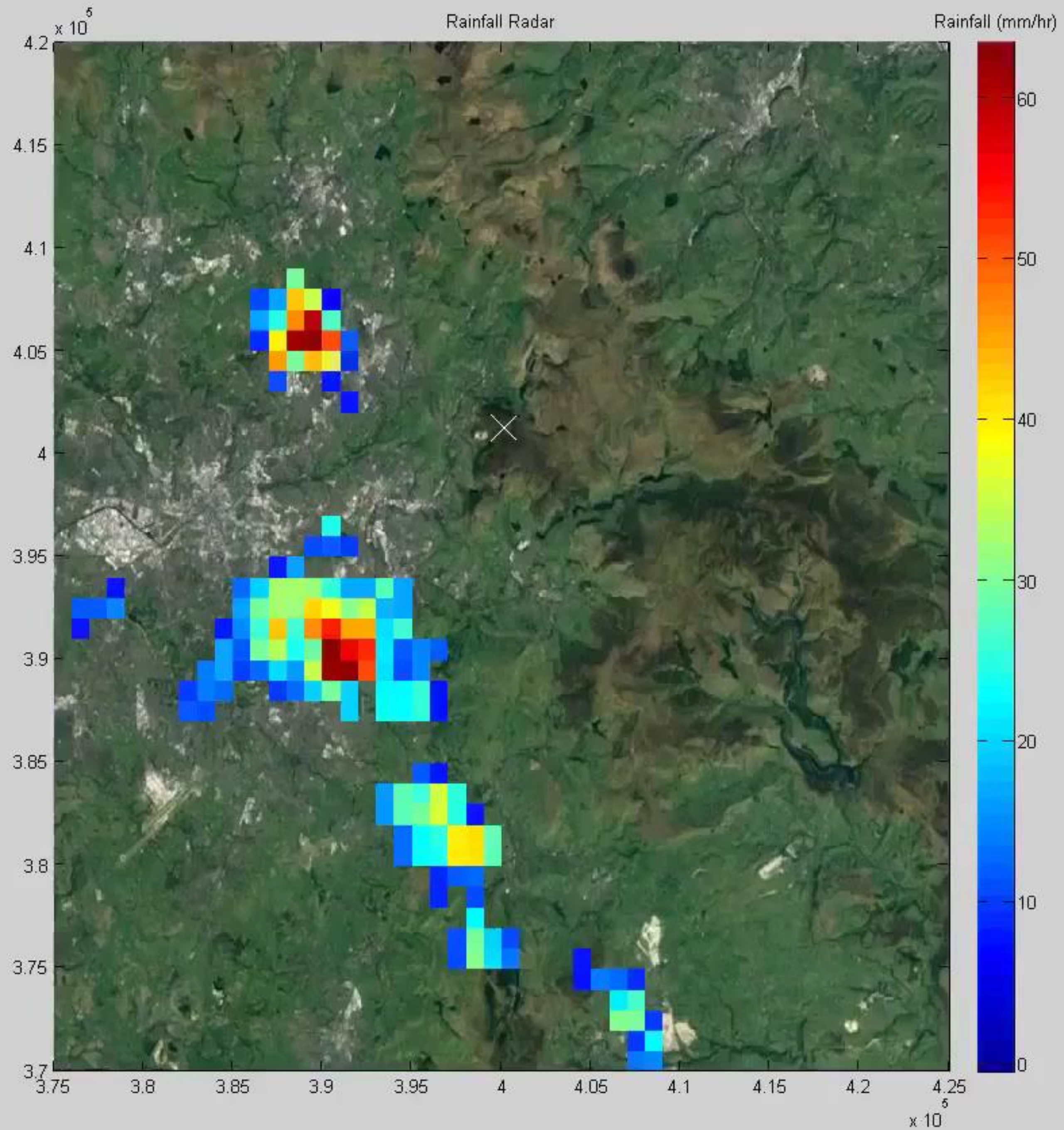
- The first and second post fire storm events
- First high turbidity autumn storm event
- First post winter dry period event
- Sequence of winter storm events
- Largest winter storm event (55mm)

Measurement of lead concentrations

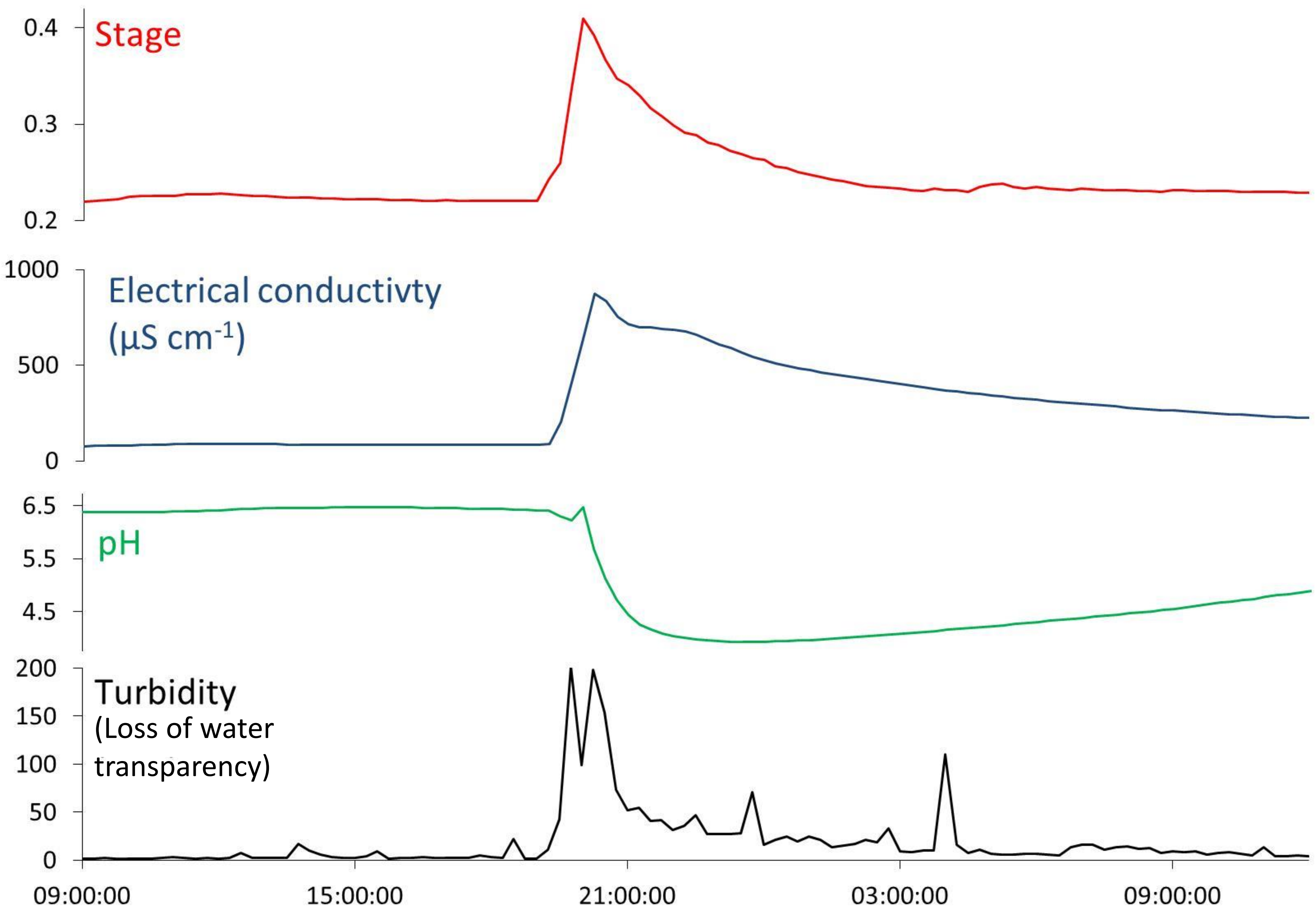


Site primed for high contaminant export

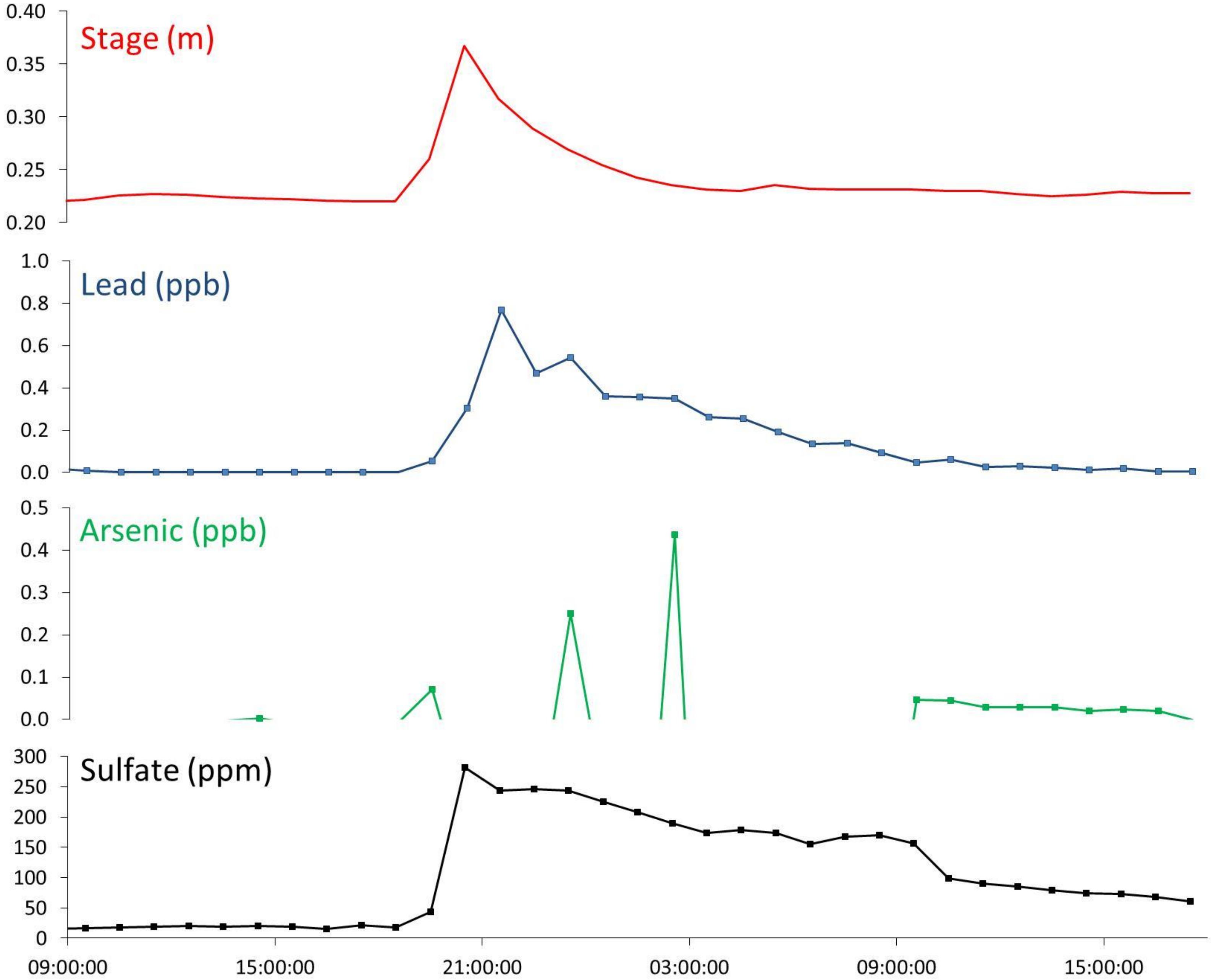
Intense summer storm



First post fire storm event



First post fire storm event



Comparison to wider peatland catchments

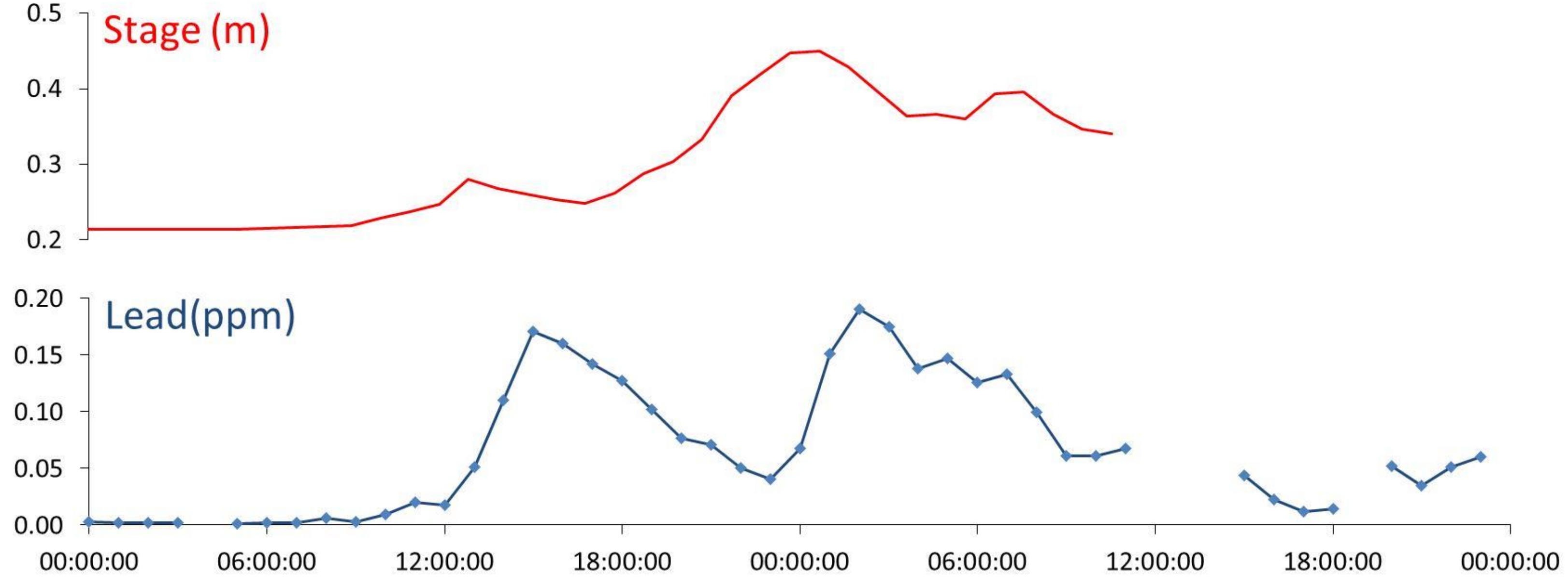
Table 1 Baseflow chemistry for headwater streams draining blanket peat catchments in the Peak District National Park

Catchment	n[a]	DOC[b]		pH		Cu[c]		Ni[c]	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Ashway Clough	3	8.07	0.06–22.7	6.19	5.87–6.73	4.27	0.83–6.17	1.98	1.70–2.20
Black Chew Grain	5	14.0	0.10–47.8	5.05	4.11–6.34	1.12	0.001–3.48	1.01	0.001–2.60
Hern Clough	5	8.37	1.30–24.6	4.97	4.16–6.57	1.08	0.002–3.54	1.68	1.14–2.02
Oyster Clough	2	12.3	8.46–16.1	5.36	4.79–5.92	1.78	0.01–3.56	n.d.	n.d.
Small Clough	2	22.0	0.03–44.0	4.59	3.99–5.19	n.d.	n.d.	0.20	0.16–0.24
Torside Clough	5	1.92	1.05–4.71	4.40	4.02–4.94	0.67	0.03–1.80	1.38	0.002–3.04
Upper North Grain	5	12.3	2.12–25.3	4.75	4.00–6.11	5.34	2.24–11.8	2.91	1.42–7.03
		Pb[c]		Ti[c]		V[c]		Zn[c]	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Ashway Clough	3	1.97	0.11–5.49	4.52	1.85–9.32	1.22	0.001–3.52	115	77.2–161
Black Chew Grain	5	2.76	0.15–9.94	2.46	1.39–5.29	0.10	0.001–0.52	61.3	40.7–87.6
Hern Clough	5	2.47	1.01–4.28	2.21	1.47–3.32	0.19	0.002–0.56	61.6	21.4–135
Oyster Clough	2	2.15	1.45–2.85	1.83	1.49–2.17	0.19	0.001–0.38	92.8	36.2–150
Small Clough	2	9.56	0.46–18.7	1.56	1.10–2.01	n.d.	n.d.	50.2	35.9–64.6
Torside Clough	5	1.76	0.65–3.74	1.72	0.94–2.23	0.02	0.01–0.11	50.2	26.9–79.1
Upper North Grain	5	3.94	1.20–8.78	3.10	1.56–5.37	0.99	0.001–2.93	69.6	53.2–82.6

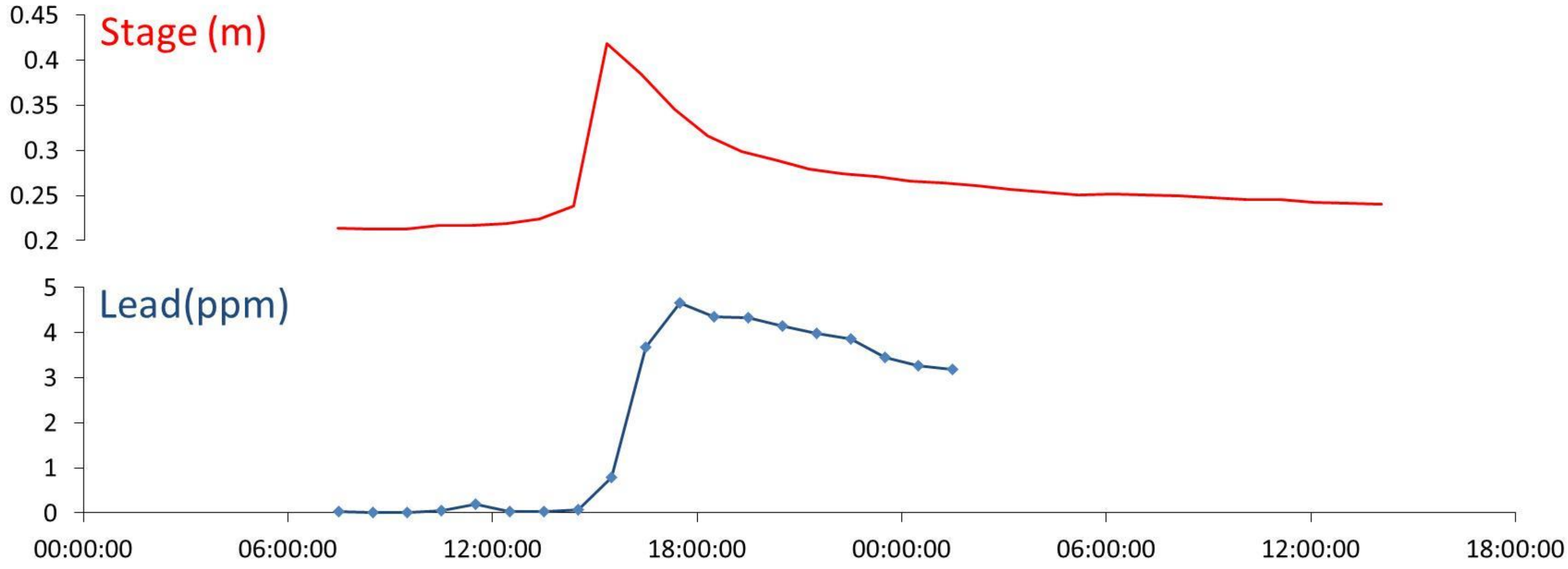
[a] Number of headwater streams sampled.
[b] $mg\ l^{-1}$.
[c] $\mu g\ l^{-1}$.

(Rothwell et al., 2007)

2^{nd} post fire event



First high turbidity event



Why is the impact limited?

1) Low solubility of elements

LOCATION	ECOSYSTEM	pH	C.E.	Al	Si	SO4=	Mn	Fe	Ni	Zn	Pb
			(µS·cm-1)		(mg·l-1)				(µg·l-1)		
Australia	Eucalypt forest	11.05	3880	0.00	2.3	203.3	<0,00	10.3	<0,00	<0,00	0.80
Canada	Boreal forest	10.3	2500	0.00	1.4	1614.4	3.40	27.6	<0,00	<0,00	0.14
Spain	Pine forest	9.13	233	0.00	1.3	168.5	6.82	20.3	<0,00	<0,00	0.33
USA	Chaparral	11.23	2570	0.18	9.1	509.0	<0,00	32.1	<0,00	<0,00	0.34
Spain	Heatland	10.28	1505	0.99	6.6	280.0	32.78	108.6	42.21	<0,00	0.24
Wales	Heatland	7.9	293	0.00	1.3	60.1	464.62	218.9	2.93	7.00	3.20
Saddleworth	**Extreme severity-Grey ash**	**9.54**	**1176**	**29.70**	**0.0**	**587.5**	**<0,00**	**12.4**	**1.39**	**<0,00**	**0.03**
Saddleworth	**Very high sev-Black ash**	**7.26**	**1232**	**0.00**	**6.7**	**440.6**	**1360.54**	**165.9**	**17.21**	**6.41**	**0.56**

Ash loads (t/ha)	Extreme severity-Grey ash	Very high sev-Black as
Min	1.7	0.4
Max	136.3	5.2
Average	**36.0**	**2.3**
Standard Dev	34.6	1.1

2) Potential high soption by char generated within the wildfire

Conclusions

1. Wildfire concentrates heavy metal within contaminated moorlands

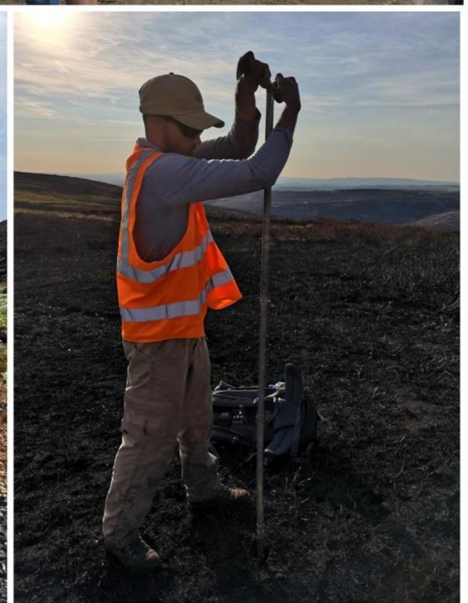
2. Solubility of heavy metals is low, limiting mobilisation during post fire rainfall events

3. The resultant post fire export of heavy metals in to water supply system is low

4. Consideration of the long term, chronic impact on water quality

PhD Opportunity

Enhancing peatland resilience to wildfire through ecological and hydrological reclamation; building the evidence base



NATURAL ENGLAND

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UKRI Natural Environment Research Council

15 PhD Opportunities

PyroLife is funded by the prestigious Marie-Curie Action within the European Horizon2020 programme

“ The EU-project PyroLife will train a new generation of experts in integral fire management ”

Dr. Cathelijne Stoof, PyroLife Coordinator

20+	20+	10+	15
EVENTS + TRAININGS	BENEFICIERIES + PARTNERS	SECONDMENTS	ESRs

https://pyrolife.lessonsonfire.eu/

Fire severity	Description	Burn severity score	Burn severity classification modifications for All Saints raised bog	Figure references
Unburned	Plant parts green and unaltered, no direct effect from heat	1	Plant parts green and unaltered, no direct effect from heat	Not illustrated
Scorched	Unburned but plants exhibit leaf loss from radiated heat	2	Vegetation on hummocks intact and grasses unaffected, but consumption of fine fuels in the shrub layer	Not illustrated
Light	Surface litter, mosses and herbs charred or consumed. Soil organic layer largely intact and charring limited to a few mm depth	3	Hummocks composed of sedge, *Sphagnum* and lichens killed by radiated heat, but uncharred. Fine fuel from shrub layer consumed (foliage and twigs) some larger stems scorched/partially charred.	Site 6. **Figure 2Bi**
Moderate or severe surface burn	All understory plants charred or consumed. Fine dead twigs on soil surface consumed. Pre-fire soil organic layer largely consumed	4	Understory shrubs (primarily *Calluna*) consumed. Charred bryophyte ground layer and surface peat	Site 10. **Figure 2Bii**
Deep burning or crown fire	Surface litter of all sizes and soil organic layer largely consumed. White ash deposition and charred organic matter to several cm depth	5	Exposed tree roots and charred peat surfaces. Charred and/or consumed shrub layer and bryophyte ground layer.	Site 11. **Figure 2Biii**