

Wildfire distribution in Scotland: a comparison of the Fire Service's Incident Recording System and MODIS-detected vegetation fires

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Aim

To compare the spatial and temporal distribution of MODIS-detected vegetation fires (screened by land cover type) against IRS 'wildfires' (using Scottish Government (2013) definition), and explain why they differ.

Main findings

- MODIS thermal remote sensing of wildfire has a good temporal match to Fire Service Incident Recording System (IRS) wildfires, using Scottish Government (2013) definition of wildfire (Figures 1 - 3)
- Poorer spatial match; only about 1 in 10 IRS wildfires match a MODIS hotspot (Figures 4 - 7)
- MODIS is poor at detecting IRS fires near coasts and in the most densely populated Glasgow-Edinburgh area (Figures 4 & 5).
- Large fires cause repeat MODIS detections as the fire front moves (Figure 8). Most hotspots in northwest and west Scotland (Figure 7) disappear when repeats are excluded (Figure 9a), suggesting that the northwest and west have the largest wildfires.
- Where there was an IRS-MODIS match, MODIS preceded Fire Service call-out time in about a third of cases. MODIS could therefore be a useful early warning.

Temporal comparisons

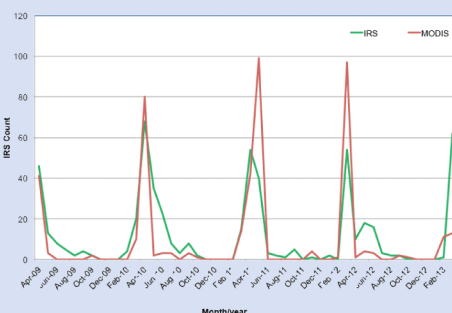


Figure 1: IRS and MODIS monthly counts for financial years (FY) 2009/10 - 2012/13

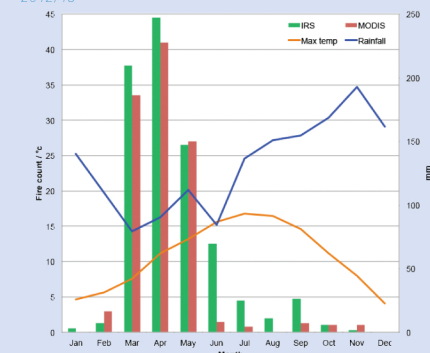


Figure 2: Average IRS and MODIS counts per month, FY 2009/10 - 2012/13. Average monthly maximum temperature and rainfall for Scotland, FY 2009/10 - 2012/13 (Met Office 2015)

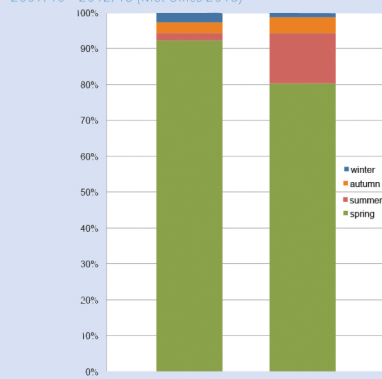


Figure 3: IRS and MODIS fires by season, FY 2009/10 - 2012/13

Spatial comparisons

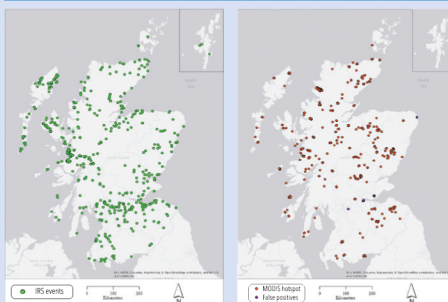


Figure 4: IRS wildfires, FY 2009/10 - 2012/13 (from SFRS)

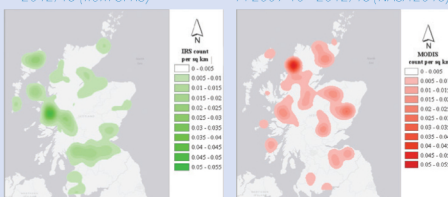


Figure 6: IRS kernel density (30 km search radius)

- IRS total, FY 2009/10 - 2012/13: 542 wildfires
- 11% (60) of these have a MODIS match

Figure 7: MODIS kernel density (30 km search radius)

- MODIS total: 440, excluding false detections e.g. gas flares at Grangemouth
- 47% (206) have an IRS match

Cause of differences 1: Repeat detections

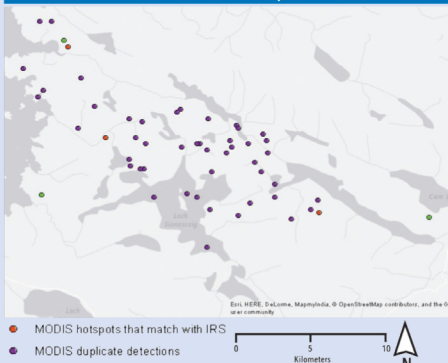


Figure 8: 1st-4th May 2011, Loch Sionascaig, Lairg; MODIS detected the same IRS fires multiple times

- MODIS detects the moving fire front. IRS records a single point (Figure 8)
- 294 MODIS fires when duplicate detections are removed, (Figure 9a).
- MODIS-IRS matches double to 1 in 5 (60/294)

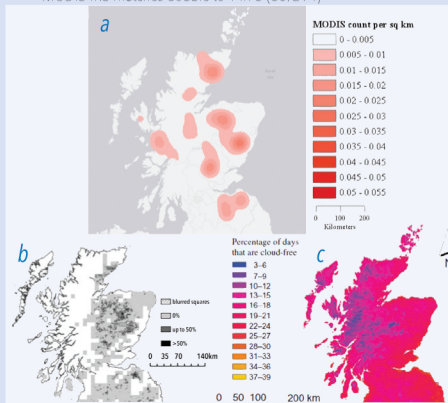


Figure 9: [a] MODIS kernel density, excluding repeat detections; [b] moorland burning (Douglas et al. 2015); [c] cloud likelihood (Armitage et al. 2013)

Cause 2: Confidence

	Confidence			Total
	Low	Nominal	High	
	0-29%	30-79%	80-100%	
IRS incident?	No	12	182	40
	Yes	17	119	70
Total	29	301	110	440

Table 1: How well MODIS hotspot confidence values (Giglio 2013) match an IRS wildfire

- 64% (70/110) of high-confidence MODIS hotspots matched an IRS wildfire, compared to ~40% nominal- (119/301) and low-confidence (17/29)
- Confidence therefore useful to screen near-real time MODIS alerts

Cause 3: Timing of overpass and cloud cover

- Timing: in Spring 2012, MODIS was overhead for 59% (48/82) of IRS wildfires

	Clear Sky?		Total
	No	Yes	
Detected by	No	22	15
MODIS?	Yes	0	11
Total	22	26	48

Table 2: Cross-tabulation of 48 Spring 2012 IRS wildfires and cloud cover

- 60% (22/37) of MODIS misses were when it was cloudy. All 11 MODIS detections were for clear skies
- 15 IRS fires still missed by MODIS, even for clear skies

Cause 4: Fire size

- Of the 15 MODIS misses for clear skies (Table 2), 69% were 'small' fires (<1 ha, 10,000 m²)
- Of the 11 MODIS detections (Table 2), 78% were 'large' fires (>1 ha)

References

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Acknowledgements

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Improving management of UK wildfire through knowledge exchange