MODIS-detected fire regime in Great Britain: Potential and challenges of validating against national fire incident data

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Significance of Wildfires in GB

- Wildfire included in National Risk Register after fires occurred across the UK in the dry Spring of 2011.
- Identified as a key risk in the UK Climate Change Risk Assessment 2012 (KfWf 2013).
- Over 118,000 'grassland' fires of all sizes attended by Fire and Rescue Services (FRS) in Great Britain in financial years 2010/11 & 2011/12 (DCLG 2012)
- Rarely cause loss of human life but significant economic and environmental problem.
- Fire-fighting costly and dangerous; suppression costs estimated at £55 million yr^{-1} (Moffat and Pearce, 2013).
- Damage to peatland ecosystem services *e.g.* loss of soil carbon store, wildlife, rural livelihoods (Fig 1).

Figure 1: Wainstalls smouldering peat fire, Ovenden Moor, near Halifax, northwest England, 30 April and 2 May to 8 May, 2011. Not detected as a MODIS hotspot ' due to thick smoke and short duration of flaming combustion stage.

Study context and aims

- Knowledge exchange project with the England and Wales Wildfire Forum and Chief Fire Officers' Association Wildfire Group.
- Government wanted a national picture of wildfire activity after the Spring 2011 fires. Not available from national fire statistics – the Incident Recording System (IRS).
- What could readily accessible, satellite-derived active fire databases tell fire managers about GB's wildfire regime?

Objectives

(i) To analyse spatial and temporal characteristics of GB's fire regime from MODIS active fire database
(ii) To compare performance of MODIS active fire and European Forest Fire Information System's (EFFIS) Rapid damage Assessment (RDA) data for Spring 2011 against IRS and other ground data
(iii) To identify the limitations of both datasets for studying GB fire regime.

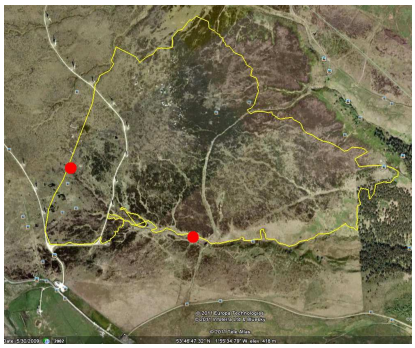

Figure 2: Wainstalls peat fire on Google Earth image. Two call-outs so two *IRS fire point locations shown as red dots. IRS estimate of burn scar, 4 km², but* 0.82 km² from *GPS mapping 55 days later (yellow polygon).*

Data

MODIS Rapid Response active fires

- Hotspot data for GB, November 2006 - May 2011, from DLR Fire Service Statistics and Fire Information for Resource Managers (NASA FIRMS, 2012).
- Screen out false positives; only use those on CORINE Land Cover Classification (CLC) vegetated classes; 66% 660 'vegetation fires' for the 4 years, 2007-2010

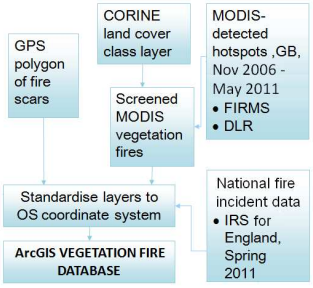

Figure 3: Integrating satellite-detected fires with IRS national incident fire data

Incident Recording System (IRS)

- Regionally fragmented; collected by >50 regional Fire and Rescue Services (FRS); delay of 6-12 months for national collating and quality checking by DCLG.
- Potential for spatial analysis (McMorrow & Cavan 2011), but published as spatially aggregated, tables.
- Single geo-referenced point per attended fire; can be estimated of point of ignition, vehicle rendezvous, or call-out point. On moorlands, may be up to 3km from centre of fire ground (McMorrow 2011).
- FRS do not operationally record fire perimeter. Visual estimate of area burned results in errors (Fig 2)
- Therefore challenging to relate IRS fire point to MODIS-detected hotspots at fire front.

Method and Results

Seasonal distribution (Fig 4)

- MODIS data shows marked spring fire season; 80% occur in March-April for the 4 calendar years (2007-2010 inclusive).
- Combined effect of: low fuel moisture content after winter-drying and before green-up (Almoustafa et al. 2012); more sources of ignition; fire weather favouring ignition and build up to large fires; but also relatively cloud-free skies for detection.
- Strong year-on-year variability; very weak fire season in 2008.
- Apparent shift in spatial distribution with seasons, mainly on moorland in Spring (Fig 5). Related to cloudiness or timing and location of causes such as land management burns?

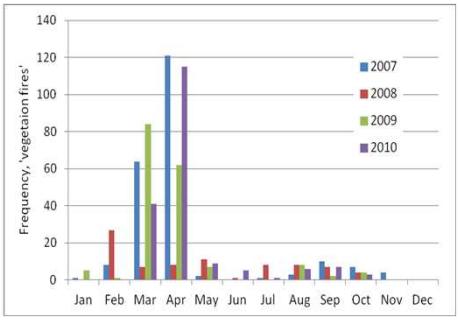

Figure 4: Seasonal distribution of MODIS-detected vegetation hotpots screened by CORINE land cover, Jan 2007 – Dec 2010, showing spring fire season, but very weak in 2008.

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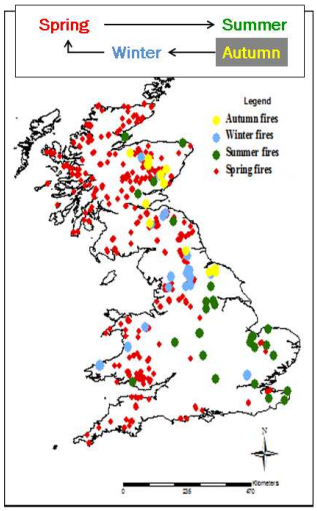

Figure 5: Seasonal distribution of MODIS-detected vegetation hotpots (screened by CORINE land cover classification), Jan 2007 – 31 May 2011

Spring 2011 fires: MODIS - IRS comparison

- MODIS Rapid Response detected 155 active fires in GB in 19 days (18 April-6 May). Of these, 21 were in England, representing 14 fire incidents due to multiple detections at long or long-lived fire fronts.
- Missed the remaining 92% of 250 'significant' IRS vegetation fires, due to a combination of cloud, smoke, small fire size and short duration (Fig 1) (Ogbechie & McMorrow 2011).
- EFFIS RDA detected only 12% of the fires, well below the 75% average for Europe. Most are too small, or cloud cover too frequent to obtain optical images. Radar is being explored as an alternative (Millin-Chalabai et al. (in press).

Conclusion and recommendations

- Cloud cover, small and short-lived fires limit the usefulness of fire databases for GB fires.
- Despite this, MODIS provides a near-real time, national picture of the largest fires, which is not currently available from IRS.
- FRS require faster, spatially-specific delivery of IRS data on wildfire, and agreed criteria to define 'wildfires'/'significant' vegetation fires in IRS.
- IRS is limited as a validation source for remote sensing; hard to relate MODIS fire front points to single, inconsistent point in IRS with only estimated burned area (no fire perimeter).
- Standardising IRS geo-referenced location to the estimated point of ignition, and/or recording fire perimeter, would assist validation of remote sensing fire products and spatial analysis of GB fire regime.

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Improving management of UK wildfire through knowledge exchange