Wildfire Threat Analysis (WTA)

Link to publication record in Manchester Research Explorer

Citation for published version (APA):

Citing this paper
Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights
Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy
If you believe that this document breaches copyright please refer to the University of Manchester’s Takedown Procedures [http://man.ac.uk/04Y6Bo] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.

Download date:16. Jul. 2019
Wildfire Threat Analysis (WTA)

Julia McMorrow, Jonathan Aylen,
University of Manchester
Aleksandra Kazmierczak
Cardiff University
Rob Gazzard,
Forestry Commission England
James Morison, Andy Moffat,
Forest Research

Wildfire research and its impact on policy, planning and operations;
the Swinley Forest fire. Greenwich, 10 Apr 2015
Vegetation fire in GB

- Fire Service Incident Recording System (IRS)
- 4 years for Scotland and Wales, FY 2009/10 – 2012/13
- Peri-urban

Acknowledgments:
- Data: Dept for Communities & Local Government, courtesy of Forestry Commission England
- Map: Sam Grundy, MGeog, University of Manchester.

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 20
Vegetation fires vs ‘wildfires’

- Shading shows all vegetation fires by Police Areas
- Symbols show large fires (‘category 4 & 5’); more rural
  - \( \geq 1 \text{ ha} \)
  - \( \geq 6 \text{ hours callout} \)
  - \( \geq 4 \text{ vehicles} \)

Acknowledgments:
- Data: Dept for Communities & Local Government, courtesy of Forestry Commission England
- Map: Sam Grundy, MGeog, University of Manchester. *Preliminary results: please do not reproduce without the author’s permission*
Moorland & Forest Fire in Community Risk Registers

Likelihood  
Impact  
Risk

Acknowledgments:
• Data: online Community Risk Registers
• Map: Yongjun Wang, MSc Geographical Information Science, University of Manchester. Preliminary results only; please do not reproduce without the author’s permission

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
WTA scoping study

Context: Forestry Commission England (FCE) need to manage wildfire threat to forest assets and to surrounding communities

Wildfire Threat Analysis (WTA) framework developed in Canada and applied successfully at national and regional scale in New Zealand

Aim: to evaluate WTA at local scale for a forest-urban interface in SE England

Questions
1. How well does WTA fit with existing UK risk assessment frameworks?
2. Can WTA can be translated into practice as a pilot GIS tool for FCE, considering data availability and sources of uncertainty?
In WTA, threat is a combination of 3 separate GIS modules

- Risk (probability) of a fire of a fire starting, regardless of size;
- Risk of ignition (RoI)
- Hazard of a fire spreading
- The assets which would be affected; Values at risk (VaR)

Case study area

964 attended fires in 4 yrs, 2009-2013; Fire Services’ Incident Recording System (IRS)

IRS data used to develop GIS layers

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Fire size: IRS damage area, 2009/10 - 2012/13

Small fires important for WTA Risk of Ignition

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
WTA Methods

For each module, Multi-Criteria Evaluation was used to combine GIS layers (criteria). Guided by expert knowledge from 2 workshops and meetings with individuals; Delphi approach

1. Select
   - Which GIS layers (criteria, factors) to include
   - Sourcing data (90+ layers); understanding data limitations.

2. Score
   - Capture how layers vary spatially
   - e.g. risk of ignition score of each land cover type; or with distance from urban areas, roads, paths

3. Weight
   - Relative importance of factors
   - Expert knowledge to weight layers before combining

4. Map
   - How to represent results
   - Number of classes, etc.

5. Evaluate
   - Accuracy of the results

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Each WTA GIS module is made up of map layers

IRS vegetation fires to score risk of ignition for all layers, except land cover

- Land cover map 2007 + National Forest Inventory (proxy for fuel and intensity of use)
- Distance to urban areas
- Distance to roads
- Distance to paths
- Access Land
- [Fine Fuel Moisture Code]

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Distance from urban boundary: 5 zones

Caveat: accuracy depends on accuracy of IRS point locations

Rural-urban interface (RUI)

80% of fires within 160m
60% of fires within 105m
40% of fires within 50m
20% of fires within 20m

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Map layer for distance from built-up areas

- Divide the map into zones at 25m, 39m, etc. from urban boundary
- Give higher score to zones closest to urban areas

- Can be sliced differently
- Same principle for distance to roads, paths, etc
Outputs: Risk of Ignition map to target prevention

Weighted combination of:

4  Land cover: expert judgement (IRS can be used)
3.5 Proximity to built-up areas
3  Proximity to foot access routes
4  Proximity to car access routes
3  Access Land

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Modified Wildfire Threat Framework

Wildfire threat

Risk of ignition

Hazard

Values at risk

VaR can be used by Emergency Planners for to other natural hazards

* Cabinet Office (2010) Improving Resilience of Critical National Infrastructure to disruption from natural hazards

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Example of Energy Values at Risk

Values at Risk

Property and Infrastructure: Utilities - Energy

- Electricity line (National Grid)
- Overhead powerline (Crowthorne)
- Underground powerline (Crowthorne)
- Gas Pipeline (Crowthorne)
  - Electricity towers
  - Electricity Sub-stations (Bracknell Forest)
  - Petrol Filling Stations (Bracknell Forest)

Participants asked to assign value scores to different energy utilities categories, and suggest the width of buffer preventing damage.
Values at Risk map to target forest management

Weighted combination of:
5 Health & well-being
3 Property & infrastructure
1 Ecosystems services

Overlay actual or simulated fire perimeter to quantify areas or number of values at risk..

McMorrow et al., Met Office Wildfire Workshop, Exeter, 3-4 Dec 2014
Modified Wildfire Threat Framework

Wildfire threat

Risk of ignition

Hazard

Values at risk

Head fire intensity

Rate of spread

Slope

Fuel load

Fire climate

Fire Weather Index data

Fuel types

Land Cover Map 2007 + National Forest Inventory

No fire climate data. Needs long-runs of high resolution fire weather indices

McMorrow et al., Met Office Wildfire Workshop, Exeter, 3-4 Dec 2014
HAZARD: modelled fire footprints

Prometheus fire spread modelling scenarios; wind 10 kph stronger (courtesy of Tom Smith, KCL)

- 86% larger fire footprint
- Mostly conifer & urban
- Smoke plume not modelled
Overlay on VaR: avoided impacts. ‘costs’

Within simulated fire footprint
• 13% greater area of timber (9 ha more)
• 6 x greater length of minor roads (5.5 km more)
• 33 ha urban; 791 properties, 1 listed building
Human vulnerability

- 43% larger area in high or very high human vulnerability class

McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015
Successes

- **Buy-in** from 11 organisations (22 person-days) including FCE, Natural England, MoD, Emergency Planners, FRS
- **Data catalogue** of >90 layers, mostly publicly available. Re-usable for other hazards
- **WTA adapted** for UK forest-urban interface: added *ecosystem services* and *social vulnerability* – NZ following suit
- **Identified RUI**, 80% fires within 160m
- Potential for ‘**What if’ scenarios:**
  - update to post-2011 fire – how was threat changed by fire itself?
  - management, new housing/footpath/Country Park, etc?
Issues and recommendations

• **Data collation effort** from multiple sources; mostly national datasets, but local data availability and quality varies. Update maps every 5 yrs. Re-use for/from other hazard assessments.

• **Add other ecosystem services** to VaR

• **Is IRS location accurate?** Need nationally-consistent, agreed point on fire ground, ideally estimated ignition point. Preferably fire perimeters

• **Test scalability & transferability** to landscape scale (25m $\rightarrow$ $\geq$100 m cells); to other types of RUI, especially moorland. **Most useful scale?**

• **Variable stakeholders’ views** on weighting factors. Trying a more objective method; logistic regression based on IRS with 1 ha cells

• **Importance of local stakeholder knowledge for VaR:** “The [VaR] maps are difficult to understand without having gone through the stages”  **Keep VaR locally defined?**

• **Develop landscape-scale Hazard module** using 2km Fire Weather Indices with fire ensemble spread modelling (KCL)
Nested WTA: national + landscape scales

Combine Manchester and KCL projects in a nested approach: national (2km) and landscape-scale (≥1ha):

1. **National RoI** module; IRS-based logistic regression
   - incorporating KCL/Met Office’s 2km probabilistic Fire Weather sub-indices, calibrated against Fuel Moisture Content → seasonal ‘ignitability’

2. **National ‘worst case’ wildfire hazard**, using KCL/Met Office Fire Weather sub-indices with slope, aspect, fuel/land cover

3. Combine national RoI with national Hazard → critical areas **for landscape scale WTA**, especially VaR

*McMorrow et al. Swinley Forest fire. Greenwich, 10 Apr 2015*
Further information

www.Kfwf.org.uk
Julia.mcmorrow@manchester.ac.uk

Thank you for listening