INTEGRATED OPTIMISATION MODEL FOR FUEL MANAGEMENT AND SUPPRESSION PREPAREDNESS PLANNING

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Introduction

Wildfire management involves a complex mix of interrelated elements including fuel management, fire prevention, fire detection and the deployment and dispatch of suppression resources. A range of models have been developed that consider these elements in isolation from one another, including:

- models for the spatial allocation of fuel treatment across a landscape (Hof and Omi 2003),(Wei, Rideout, Kirsch 2008); and
- models for home-basing and deployment of suppression resources (Dimopoulou and Giannikos 2001), (Kirsch and Rideout 2005), (Haight and Fried 2007).

We have extended this work to consider fuel management and suppression preparedness planning within a single integrated model. We have adopted an optimisation modelling approach. Optimisation models feature a defined 'objective function' that is maximised or minimised subject to a series of constraints such as costs and resource availability. Our model's objective is to maximise the area covered by suppression resources, with prioritisation based on protection of "value-at-risk" such as population centres.

Objective Function
Maximise coverage by suppression resources with localities prioritised based on "value-at-risk".

$$\text{MAX} \quad \sum_{i=1}^{I}\sum_{j=1}^{J} COVER_{ij} * \sum_{hk\in THREATij} VALUES_{hk}$$

subject to

Budget Constraints
There is a budget for both fuel treatment and suppression preparedness spending. There is also a discretionary budget that can be spent on either .

$$\sum_{i=1}^{I}\sum_{j=1}^{J} TREAT_{ij} * TCOST_{ij} \leq TOTBUDGET - DBUDGET$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J} DEPLOY_{ij} * DCOST_{ij} \leq TOTBUDGET - TBUDGET$$

Fuel Treatment Constraints
Decisions are made on the spatial allocation of fuel treatment with only one treatment type permitted per locality.

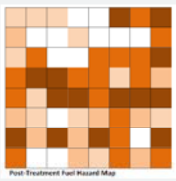
$$\forall i \in I \quad \forall j \in J \quad TREAT_{ijx} = (0,1)$$

$$\forall i \in I \quad \forall j \in J \quad \sum_{x\in X_{ij}} TREAT_{ijx} = 1$$

Deployment Constraints
Decisions are made on the deployment of suppression resources subject to locality specific restrictions.

$$\forall i \in I \quad \forall j \in J \quad DEPLOY_{ij} = Z_{+}$$

$$\forall i \in I \quad \forall j \in J \quad DEPLOY_{ij} \leq MAXDEPLOY_{ij}$$



Coverage Constraints
A locality is either "covered" or "not covered", this depends upon the fuel hazard, fuel treatment applied and suppression resources deployed in the proximity.

$$COVER_{ij} = f(FUELHAZ_{ij}, TREAT_{ijx}, TEFFECT_{ijx}, \sum_{gl\in PROX_{IJ}} DEPLOY_{gl})$$

$$\forall i \in I \quad \forall j \in J \quad COVER_{ij} = (0,1)$$

Integrated Model Benefits

- Provides an integrated spatially-explicit risk-based framework for fuel management and suppression preparedness planning
- Can incorporate inputs from a range of sources including geospatial databases and fire behaviour and climatology models
- Models the productivity interrelation between fuel management and suppression
  ➔ application of fuel treatment ➔ lower fire intensity & rate of spread ➔ reduction in required suppression effort & required proximity of suppression resources
- Outperforms models that treat fuel management and suppression preparedness planning separately
- Supports transparent defensible decision making
- Allows for analysis of total budget level and funding allocation to fuel management and fire suppression programs

References

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