



# OPERATIONS RESEARCH (OR) TO SUPPORT BUSHFIRE MANAGEMENT

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“Operations Research (OR) is the use of analytical techniques such as mathematical modelling to analyse complex interactions between people, resources and the environment to aid decision-making and the design and operation of systems.”

(Altay and Green 2006)

OR methods successfully applied in a range of industries:

- Transportation
- Health Care
- Mining
- Finance
- Aviation
- Telecommunications

# RESEARCH QUESTIONS

- Defining challenges of bushfire management?
- Applicable OR methods?
- Current state of knowledge – OR use in wildfire management?

- Comprehensive review wildfire OR work 1961-81 (Martell 1982)
- Elements updated in 1998 (Martell et al. 1998)
- No detailed reviews of wildfire OR since 1998
- Our work addressing this significant gap

- Range of OR methods presented
- Ability to address – defining challenges of bushfire management:
  - complexity
  - multiple conflicting objectives
  - uncertainty
- Examples and case studies – wildfire/disaster OR literature

# COMPLEXITY

- Mathematical Programming (Optimisation)
- Problem Structuring Methods (Soft OR)
- System Dynamics
- Hyper-projects

# MULTIPLE CONFLICTING OBJECTIVES

- Multi-objective Optimisation
- Goal Programming



# UNCERTAINTY

- Simulation
- Stochastic Programming
- Robust Optimisation
- Fuzzy Models

Elements of this work presented at:

- Wildland Fire Canada Conference 2010
- Australia and New Zealand Industrial and Applied Mathematics Conference 2011

Paper based on this work accepted for publication:

- Minas JP, Hearne JW, Handmer JW **A review of operations research (OR) methods applicable to wildfire management.** *International Journal of Wildland Fire*, in press (WF10129).

# RESEARCH QUESTIONS

- Pressing problem faced by bushfire managers?
- Suitable OR methods to tackle this problem?
- Gaps in literature?

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Bushfire management - complex mix of interrelated components:

- fuel management
- fire prevention
- fire detection
- suppression preparedness

Previous OR models treat these in isolation from one another

# NEED FOR AN INTEGRATED APPROACH

Interrelation between fuel treatment and suppression programs



- Integrated optimisation model
- Scope developed in consultation with end user (DSE)
- Collaboration with Fire Management Systems Lab (U of T)
- First optimisation model to include both:
  - fuel management decisions
  - suppression preparedness decisions
- Model presented in a general form
- Tested on a series of hypothetical test landscapes

Elements of this work presented at:

- Australia and New Zealand Industrial and Applied Mathematics Conference 2011
- Conference for the International Federations of Operational Research Societies 2011
- Bushfire CRC and AFAC Annual Conference Science Day 2011

Paper based on this work to be submitted to Annals of Operations Research - special volume on OR in forestry

Minas JP, Hearne JW, Martell DL **An integrated optimisation model for fuel management and suppression preparedness planning**



Further model testing with real landscape data

Explore model extensions:

- multi-period (approximate dynamic programming)
- fire weather uncertainty (stochastic programming)
- multiple objectives (multi-objective optimisation)

Martell DL (1982) A review of operational research studies in forest fire management. *Canadian Journal of Forest Research* **12**(2), 119-140.

Martell DL, Gunn EA, Weintraub A (1998) Forest management challenges for operational researchers. *European Journal of Operational Research* **104**(1), 1-17.

Minas JP, Hearne JW, Handmer JW A review of operations research (OR) methods applicable to wildfire management. *International Journal of Wildland Fire*, **in press** (WF10129).

# QUESTIONS

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