Application of fire Suppression Optimisation in Allocating Resources (SOAR)

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Outline

- Background
  - Aerial suppression
  - Decision support systems
- Suppression research flow
- Inputs
- Research activities
  - Operational data collection
  - Experimental data collection
  - Suppression analysis tools
- Outputs
- Outcomes
Aerial Suppression
more effectively and efficiently

• Bushfires
  – New paradigm carries increased responsibilities and heightened expectations. It almost certainly will increase public expectations of aerial fire fighting (*fire authorities*) performance and accountability.
  – Increasing cost of suppressing fires is a pressing concern, requiring careful selection of suppression strategies and efficient application of tactics.
  – Bushfire agencies operate in an environment characterised by great variation in fire activity and its consequences.
  – We need to develop a performance-base system tailored to a local, state and national aerial fire fighting program

Aerial Suppression
more effectively and efficiently

– **Effectiveness**- a physical measure of productivity for a desired outcome
– **Efficiency**- getting the most out a given budget
– We need to define target outcomes and worst case outcomes for each suppression strategy considered:
  • For each outcome we need to:
    – Estimate final fire size
    – Resource damages
    – Suppression costs
    – Probability of that outcome occurring

– **BUT**
  • Logically structured decision analysis protocols are only as good as their inputs and there are uncertainties
  • Expert judgment- subjective assessments on the probability of success
**Decision-support systems**
for evaluating alternative suppression strategies

- Analytical requirements
  - Identify criteria for evaluating suppression alternatives
  - Develop suppression alternatives
  - Analyze suppression alternatives by evaluating criteria and selecting the alternative that:
    1. Best provides for fire fighter and public safety
    2. Minimises the sum of suppression costs and resource damages
    3. Has an acceptable expected probability of success or failure.
Inputs

- Fire Environment
  - Weather
  - Fuel
  - Topography
- Management Environment
  - eg: land tenure; bush/urban interface; fuel management
- Suppression Resources
  - eg: aircraft; tankers; machinery; ground crews
- Resource Values
  - eg: conservation; primary production; community assets; cultural & heritage values
- Fire History
  - History of ignition and major fires
  - spatial and temporal

Research Activities

- Operational data:
  - Collected on fire ground
- Experimental data
  - Selected conditions, controlled parameters
- Simulation model
  - Structured assessment of the outcomes and costs associated with alternative budgets and suppression resource mixes.
Operational data collection

Collected by operational personnel

- Potentially collect a large amount of data
- Collect data from all states
- Qualitative data (limited application)
  - Limited fuels and fire behaviour information
- Observer bias Two survey forms distributed to fire agencies:
  - Air Attack Supervisor report
  - Suppression operation report
- Supported by supplementary information
  - Maps
  - Reports
  - Photos

Operational data collection

Collected by researchers

- Closely observe and monitor drop zones
  - During fire
    - On ground observations
    - Observations from aircraft
  - Post fire
- Logistical problems
  - Notification
  - Travel
  - Safe access
Operational data collection

Preliminary trends (2004/05 season data)

- First attack is likely to be successful if:
  - Few fuel layers involved in fire (e.g., fire in litter, not shrubs)
  - Quick response (first suppression underway <2.5 hours after detection)
  - Low flame height (≤1m)
  - Low - moderate wind speed (<25 km/h)

- More significant than FDI – due to some fires that burnt under high winds during low drought factors (high elevated fuels)

Data collection

Experimental data collection

- Target conditions
- Comprehensive site assessment
- Detailed & accurate data
- Small amount of high quality data
- Cost & time for preparation
- Dependant on weather and resource availability
- Limited sites & opportunities
Experimental data collection

2005 Stubble fire suppression experiment Tasmania

- **Aim:**
  - determine the effects of suppression drops on fire behaviour in stubble fuels
  - develop a field method for further experiments
- **Site:** Uni of Tasmania farm
  - barley stubble (3 ½ t/ha)
- **Medium helicopter (Bell 212):**
  - bellytank & bucket
- **Components:**
  - Drop pattern tests
    - Determine suppressant ground distribution
  - Fire suppression experiments
    - Single drop
    - Multiple drop

Experimental data collection

Tasmanian experiment 2005

- Helicopter tested works well in moderate conditions, light fuels (3 ½ t/ha), with no canopy
  - Water just as effective as foam in these conditions
  - Unlikely to deploy helicopter in these conditions
- Streamlined experimental methodology
  - Evaluation in heavier fuels and elevated fire danger
**Experimental data collection**

**Future experiments**

- **Possible future experimental work**
  - Sydney Bioregion
    - In conjunction with other fire experiments (fire behaviour, ecology, smoke, remote sensing)
    - 2006/07 season
    - Type 1 & 2 helicopters
    - Different fuels
  - South Western Australia
    - Single engine air tankers
    - Different suppressant types

**Suppression analysis tools**

**Simulation models**

- **SOAR** - Suppression Optimisation in Allocating Resources
- Structured assessment of resourcing alternatives - resource mixes/locations
  - Effectiveness - productivity
  - Efficiency - cost effectiveness
- Test optimal resources for changed fire patterns
- Computer based decision support systems to evaluate suppression strategies under different scenarios
Fire suppression scenarios

• **Fire behaviour**
  - Location
  - Fuel type
  - Current and future fire behaviour/ fire weather
  - Fire load (number of fires)
  - Size
  - Fire growth, perimeter

• **Suppression resources**
  - Dispatch rule
  - Type- tankers, crew, aircraft, dozers, etc
  - Availability
  - Constraints
  - Travel time
  - Suppressant type
  - Production rates
  - Cost- standby / operating

Suppression effectiveness

*Illustration of suppression effectiveness*

- Need to predict fire behaviour in complex environment,
- Ability to model productivity and effectiveness of suppression resources,
- Provide assessments of the probability of fire containment for varied fire size, fire danger ratings, fire intensity.
**Outputs**

- Resource Use Guidelines
  - Define suitability and limits of effectiveness of resource types under different conditions
- Cost effectiveness
  - Optimise base locations and resource mixes, cost effectiveness analysis of different resourcing strategies

**Outcomes**

- Optimal resource selection, placement and deployment
- Maximise fire fighter and public safety
- Minimise the sum of suppression costs and fire damage
- Acceptable probabilities of success and failure
Project A3. Suppression Research Flow

**Inputs**
- Fire Environment
  - Weather
  - Fuel
  - Topography
- Management Environment
  - Land Tenure
  - Bush/Urban Interface
  - Fuel Management
- Suppression Resources
  - Aircraft
  - Tankers
  - Machines
  - Ground crews
  - Volunteers
- Resource Values
  - Conservation
  - Primary production
  - Community assets
  - Cultural & Heritage
  - Fire History

**Research Activities**
- Operational data
  - Resource effectiveness
  - Line building capacity
  - Response times & types
  - Expert judgment
- Simulation model
  - Structured assessment of the outcomes and costs associated with alternative budgets and suppression resource mixes.
- Experimental data
  - Drop coverage levels
  - Holding times
  - Suppressant evaluation
  - Fire behaviour

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