Fire behaviour simulation: a gamification approach supporting complex system learning, fire management planning and community engagement.

Rohan Fisher
Savanna landscapes are the most fire-prone on earth and their management has significant impacts on:

• biodiversity,
• GHG
• Economy and regional employment

North Aust: 23%
Southern Aust: 6%
• NAFI is a key source of data informing mitigation burn strategies

• Year since last burnt data is used to assess current fuel loads.

• These data are then combined with local landscape knowledge to design burning strategies.

• Prescribed burns reduce fuel with ‘cool’ fires.
Cool burn.
- Green House gas
- Biodiversity
<table>
<thead>
<tr>
<th></th>
<th>Southern Australia</th>
<th>North Australian Savannas</th>
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<tbody>
<tr>
<td>Fire management focus</td>
<td>Emergency response. Mitigation to save life and property.</td>
<td>Environmental, cultural and livelihoods</td>
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<tr>
<td>Resources</td>
<td>Highly resourced for wildfire fighting with a high degree of access infrastructure.</td>
<td>Few resources, vast landscapes with few people, roads or intervention resources.</td>
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<tr>
<td>Spatial Scale</td>
<td>Regional, generally &lt;1,000km²</td>
<td>Landscape scale, often &gt; 10,000km²</td>
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<td>Temporal Scale</td>
<td>Fires burn over a few days, with prediction focused on a few hours.</td>
<td>Fires can burn for many weeks.</td>
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<tr>
<td>Fuel type and fire intensity</td>
<td>Very high-intensity forest fires are common.</td>
<td>Relatively low-intensity grass fuel fires.</td>
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<tr>
<td>Fire extinguishment</td>
<td>Most fire actively controlled and extinguished</td>
<td>Most fires self-extinguish</td>
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<tr>
<td>Cultural background of fire managers.</td>
<td>Predominantly state government led</td>
<td>Diverse cultural context with many Indigenous led land management.</td>
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Current fire behaviour models. Fit for the Savanna Landscapes?

- Derived from empirical rate of spread algorithms.
- Focused on relatively small spatial temporal scales
- Application by centralised management with trained users
- Emergency response focused.
Fire behaviour models for the Savanna Landscapes.

- Facilitate the broader use of available fire-related data sets for understanding fire and ecosystems dynamics.
- Support the communication of fire management objectives to a culturally diverse range of land managers.
- Allow the visualisation of fire behaviour at a landscape scale to support strategic fuel reduction burning.
Fire behavior is complicated
Fire spread is complex and fire management is difficult.
Fire as a complex system.

Fire spread is a complex process operating over multiple temporal and spatial scales as do the characteristics of variables effecting fire behaviour.
Fire simulation as a tool for north Australia

• Visualise complex large-scale fire behaviour
• Understand key driving spatial and temporal forces and their interaction.

**Temporal**
- Previous fire histories (years)
- Time of year
- Diurnal cycle

**Spatial**
- Fuel type
- Slope
- Natural and anthropocentric breaks
• NetLogo is a multi-agent programmable modeling environment.

• FOSS - most widely used ABM students, teachers and researchers worldwide.

• Explore complex systems and emergent properties
Simulation method

• Stochastic cellular automata

• Geosimulation
Simulation for understanding complex systems

- Actions can be repeated under the same or different conditions.
- Processes can be stopped to reflect on outcomes.
- Decisions that are dangerous, infeasible or unethical in the real system can be taken in the virtual world.
- Not predictive but explanatory
Fire simulation as a ‘serious game’.

• Supporting discussion and exchange of local knowledge

• Multi-modal learning
  • Physical 3D models

• Supports Learning by doing. ‘Heuristic’
• Bottom up planning

• Local + Traditional Ecological Knowledge

• Intergenerational knowledge exchange

• Evidence based planning