Natural Hazards Research Australia

What makes a good fire simulator?

Embracing complexity and uncertainty

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I recognise that we are meeting today on the traditional country of the Kaurna people and I pay my respect to their elders past and present as well as to First Nations people here today.
Sovereignty was never ceded.

What makes a good fire simulator?

Embracing complexity and uncertainty in situational awareness

What makes a good fire simulator?

Research team:

Primary Investigator - Hamish Clarke[1],

Co-investigators: Caitlin Symon[1], Timothy Neale [2], Gabrielle Miller [2], Alex Filkov[1], Kate Parkins[1], Erica Marshall[1], Trent Penman[1]

University of Melbourne[1], Deakin University[2]

End users: Thomas Duff (CFA), Simon Heemstra (RFS), David Field (RFS), John Bally (AFAC)

NHRA Project Manager: George Goddard

Acknowledging there are things we **do not know**
is just as important as piecing together
everything we **do know**

Overview of today's talk

1. What is a fire simulator and how are we using them?
2. Why it is important to think about what makes a **good** fire simulator
3. How our research is helping to inform this challenge
4. Outcomes of our research
5. Implications of our findings for the development of fire simulators

What is a fire simulator and how are we using them?

What is a fire simulator and how are we using them?

- Imitations of real-world processes or systems
- Combines data and models to develop spatially and temporally explicit depictions of how fire behaves
- Helps build our knowledge of fire and to support-decision-making

Why it is important to think about what makes a **good** fire simulator

Why it is important to think about what makes a good fire simulator

- There are no agreed standards that simulators must meet to be 'fit for purpose’.
- We must question what it would look like for simulators to be functioning well and adding value to our work.

How our research is helping to inform this challenge

Key objectives

- **What it means to be ‘fit-for-purpose’?**
- To build a picture of simulator users.
- Ask whether we can develop a clear set of standards to be used by simulator developers.
- Consider the issues, gaps and priorities around the next generation of fire simulators.

Methods

- → Literature review
- → Semi-structured interviews
- → Workshops
- → Questionnaire

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Methods

- Literature review - peer reviewed and grey literature evidence on, strengths, weaknesses and development priorities,drivers and effects of simulator use

- Semi-structured interviews – expert elicitation on current use; priorities; needs and gaps; additional contacts and literature

- Workshops –expert elicitation, key criteria,

Literature review – use groups

Tactical	Strategic	Research	Other
Tactical prediction (real-time)	Landscape risk assessment incl fuel mgmt & scenario analysis, readiness at various timescales	Research into tactical use cases	Community engagement
Tactical suppression	New estate siting and layout incl new settlements	Research into strategic use cases	Staff engagement
Back burning planning	Prescribed burning planning	Simulator evaluation	Scenario training
Public warnings	Scenario training	Understanding processes, Module development	

Smoke assessment
// Evaluation of effectiveness of interventions
//Readiness
		Fire spread reconstruction
		& evaluation of effectiveness of intervention, effort	

Literature review – Key criteria

Desirable criteria	Comments
Easy to use	Includes graphical user interface
Fast	Includes speed of specific processes (e.g. fire spread simulation) as well as end to end speed i.e. from data input to usable output
Configurable	Users can tweak / tune / tailor parameters; Caters to users with different skill levels
Validated	Includes performance for specific processes (e.g. spotting) or conditions (e.g. vegetation types, extreme weather) as well as overall performance; Refers also to nature of validation (e.g. identity and number of test fires)
Good modelling framework	Able to run ensembles, explicitly consider uncertainty; Transparency (e.g. a preference for deterministic approaches over 'black boxes' and machine learning); Functional software platform; Open source software
Good input process	Ease of preparation of inputs; Sensitivity to inputs
Good outputs	A range of detailed spatial outputs; Outputs are easy to store and curate; Outputs can be audited
Right scale	Fine spatial resolution; Large spatial coverage; Fine temporal extent; Long temporal coverage (e.g. multi-day fires, fire regime)
Well supported	Access to training, education, technical support
Good reputation	Awareness, familiarity; Respected by peers; Endorsed by agency; Trust in developers; Trust in underlying research
Compatible	Compatible with agency systems; Compatible with agency programs and policy (e.g. risk horizons, baselines); Compatible with other models (e.g. loss and impact models, weather forecasts)
Good price	Upfront and ongoing costs including computational resources

Methods

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Interviews and workshops – key findings

→ People wanted standards but struggled to provide clear numbers.

→ Importance of broader simulator ecosystem.

→ It’s complicated.

Next steps

→ Literature review

→ Semi-structured interviews

→ Workshops

→ Questionnaire

What makes a good fire simulator?

Caitlin Symon[1], A/Prof Timothy Neale[2], Gabrielle Miller[2], Dr Alex Filkov[1], Dr Kate Parkins[1], Dr Erica Marshall[1], Prof Trent Penman[1], Dr Hamish Clarke[1]

[1]University of Melbourne, [2]Deakin University

NHRA Project manager - George Goddard End Users - Dr Thomas Duff (CFA), Dr Simon Heemstra (RFS)

INTRODUCTION

- Fire modelling and simulators have become central to how we understand, predict, and communicate fire behaviour and risk.
- But what makes a simulator fit-for-purpose? How do the criteria for 'good' vary between user groups?
- The 'What Makes a Good Fire Simulator?' project, funded by NHRA, aims to support the future development and use of simulators in Australia.
- We are engaging with users to understand simulator use, the decisions they support, as well as their strengths, weaknesses, opportunities and challenges.

METHODS

Phase 1: Consultation with AFAC working groups to refine project scope and engagement process, interviews with key stakeholders and literature review including relevant international and interdisciplinary research.
Phase 2: Two online workshops with key stakeholders and a questionnaire.
Project end: August 2024.

LET'S MAP IT OUT

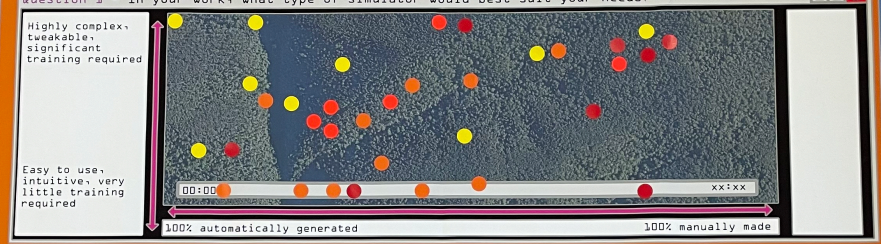
>TELL US WHAT YOU THINK MAKES A GOOD FIRE SIMULATOR?

> 1. Choose the colour sticker that most accurately corresponds to how you use fire simulators:

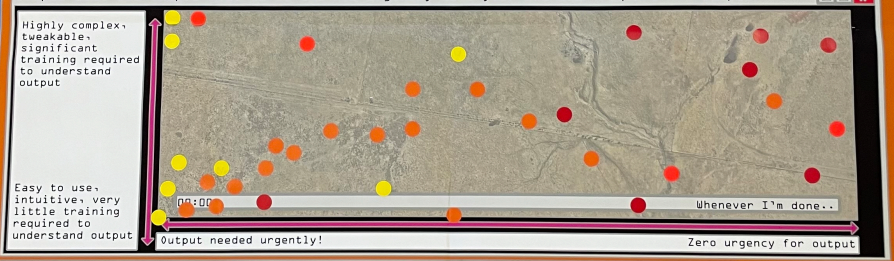
Tactical (ie. Emergency response), Strategic (ie.planning), Research, Other.

> 2. Read each question and look at the scales on the vertical and horizontal axis of the aerial map below it. Place 1 sticker on the map corresponding with where you sit for both scales* *Don't stress too much over the perfect spot- This is just for fun...

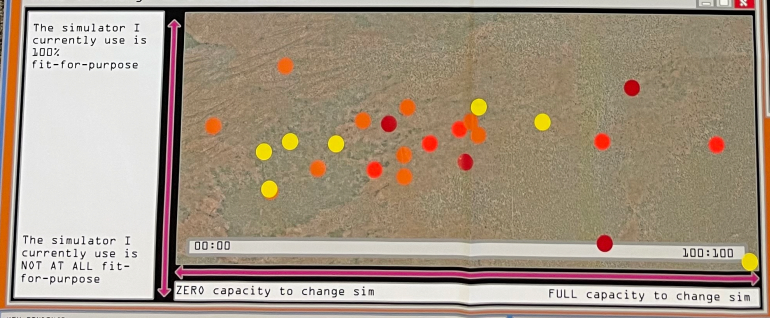
Question 1 - In your work, what type of simulator would best suit your needs?



Question 2 - Think of the type of simulator outputs that you typically produce or use. How complex or simple does the output need to be and how urgently does your end-user require the output?



Question 3 - Think about the simulator that you use most often. Is it fit-for-purpose and what capacity (time, money, resources, support)do you have to change to a new simulator?



HAVE YOUR SAY IN AN OFFICIAL WAY!

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KEY FINDINGS

- Users want clear and measurable standards for simulators, but definitions of 'acceptable' and 'fit-for-purpose' depend on context.
- Ultimately, what makes a simulator 'good' is about far more than just the simulator itself.
- Futher discussions about simulator development must consider the governance, culture, and reputation of simulators; the validation and use of data and inputs; and the training and support systems available to simulation creators and end-users.

EMERGING QUESTIONS

- How should we focus future investment to meet the diverse needs of users and jurisdictions.
- How can we build uncertainty and nuance into simulations whilst maintaining trust in outputs among end-users?
- Should we have one simulator for everything, or multiple simulators for different goals and skill levels?
- Who should get to decide how fire simulators are developed and used in the future, and who's needs matter most?

It’s complicated

Implications of our findings for the development of fire simulators

- Standards and benchmarks will be valuable.
- We must engage with and account for the complexity inherent in fire simulators.
- Can we develop a framework for engaging with this nuance?

Summary

- Fire simulators support knowledge building and decision-making
- They are complex and imperfect tools
- Our research is helping to create standards for future simulator development
- We must also begin to think of ways of engaging with their complexity and imperfection

Given that a good fire simulator is still never going to work 100% as we hope it would, how should this influence how we design and use them?

What does embracing complexity and uncertainty mean for how we relate to and manage fire?

Thank you!

”One of the greatest mistakes made by human beings is to want certainties when trying to understand something. The search for knowledge is not nourished by certainty: it is nourished by a radical absence of certainty. Thanks to the acute awareness of our ignorance, we are open to doubt and can continue to learn and to learn better."

Carlo Rovelli